State of California
Department of Fish and Wildlife

Memorandum

Date: June 10, 2015

To: Sonke Mastrup
Executive Director
Fish and Game Commission

From: Charlton H. Bonham
Director

Subject: Status Review of Fisher

The Department of Fish and Wildlife (Department) has prepared the attached Status Review for the Fish and Game Commission (Commission) regarding the Center for Biological Diversity's Petition to list Fisher *(Pekania pennanti,* formerly *Martes pennanti*, former common name Pacific fisher*)* as threatened or endangered pursuant to the California Endangered Species Act (CESA, specifically Fish and Game Code section 2074.6). The Commission received the petition on January 23, 2008. The attached status review represents the Department's final written review of the status of fisher and is based upon the best scientific information available to the Department.

Because fishers occur in California in two geographically separate areas with demonstrated distinct genetic differentiation, the Department treated the two geographic areas as two separate Evolutionarily Significant Units (ESUs); the Northern California ESU and the Southern Sierra Nevada ESU. The status review contains the Department's recommendation that listing of the Northern California ESU is not warranted, but to list the Southern Sierra Nevada ESU as threatened.

Regarding the scientific determinations of the threats to the fisher, the Department finds that the continued existence of fisher in the Northern California ESU is not in serious danger or threatened by the following six listing factors individually or in combination:

1. Present or threatened modification or destruction of its habitat;
2. Overexploitation;
3. Predation;
4. Competition;
5. Disease; or
6. Other natural occurrences or human-related activities.

The Department however, finds that for the fisher in the Southern Sierra Nevada ESU, the threat to its habitat from wildfire, its small population size, and the future predicted trajectory of human-related climate change do present a serious danger and threat to their continued existence. In combination, these factors indicate to the Department that listing the Southern Sierra Nevada fisher ESU as threatened is warranted.

If you have any questions or need additional information, please contact Dan Yparraguirre, Deputy Director, Wildlife and Fisheries Division at 916-653-4673 or Eric Loft, Chief, Wildlife Branch at 916-445-3555.

Attachment

STATE OF CALIFORNIA

NATURAL RESOURCES AGENCY

DEPARTMENT OF FISH AND WILDLIFE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [formerly *Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

May 12, 2015

Table of Contents

List of Figures

List of Tables

List of Appendices

Acknowledgments

This report was prepared by: Richard Callas (co-lead), Dr. Deana Clifford, Pete Figura (co-lead), and Stella McMillin. Internal CDFW review was provided by Dan Applebee, Esther Burkett, Dr. Deana Clifford, Joe Croteau, and Stella McMillin. CDFW GIS analysis and mapping was provided by Kristi Cripe. Janelle L. Deshais and Linda Miller analyzed timber harvest rates within planning watersheds in northern California. Dan Applebee provided assistance with responding to comments from external peer reviewers. The Department would like to thank Dr. Lowell Diller, Dr. Mourad Gabriel, Mark Higley, Dr. Sean Matthews, Dr. Roger Powell, Dr. Wayne Spencer, Dr. Craig Thompson, Dr. Jody Tucker, and Dr. Bill Zielinski for donating their time to provide external peer review for this document.

Executive Summary

This document describes the current status of the fisher (*Pekania pennanti*) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act. On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of the fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Predator control and other poisoning efforts, including those for porcupines, may have also impacted fisher populations. In addition to trapping and predator control, the historical decline of fisher populations has also been attributed to forest management activities which may have rendered habitats unsuitable.

Early researchers believed that in the late 1800s the range of fishers in California extended from the Oregon border south to Marin County in the Coast Ranges, through the Klamath Mountains, and through the southern Cascades and the southern Sierra

Nevada. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to Euro-American settlement with little or no genetic exchange between them. Although the location and size of the gap (or gaps) separating these populations is unknown, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Currently, fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population) – and also in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN ESU) from fishers in northern California (NC ESU) and the degree of genetic differentiation between them. No comprehensive survey to estimate the size of the fisher population in California has been conducted. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals. Evidence available to the Department indicates that fishers are widely distributed and common in northern California. Research suggests the population in the southern Sierra Nevada is comparatively small (probably less than 350 individuals), but is stable or nearly stable.

Early work on fishers appeared to indicate that fishers required particular forest types in the western US (e.g., old-growth conifers) for survival. However, studies over the past two decades have demonstrated that fishers do not depend on old-growth forests per se, nor are they associated with any particular forest type. Fishers are most typically found at low- to mid-elevations within areas characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests. At finer spatial scales, fishers are associated with structurally complex forests containing large trees, logs, and with moderate-to-dense canopy cover.

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning; the presence of a suitable cavity appears to be more important than the species of tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (more than 100 years) may be needed for a tree to attain sufficient size and develop a cavity large enough for a female fisher and her young. Although the number of den and rest structures needed by fishers is not well known, a substantial reduction in these important habitat elements within a given area would likely reduce the fitness of fishers inhabiting that area.

Primary threats to fishers within the both California ESUs include habitat alteration, toxicants, wildfire, and climate change. In the SSN ESU, small population size is also a threat. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests although fishers occupy public and private lands harvested for timber. The long-term viability of fishers across their range in California will depend on the presence of den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California, although the recruitment of additional high quality habitat in the SSN Fisher ESU could increase the population size and help mitigate some of the extinction risks inherent to small populations.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service (USFS) or the National Park Service. Private lands within the NC ESU and the SSN ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher has contracted substantially. This difference is due to the apparent absence of fishers from the central Sierra Nevada, most of the northern Sierra Nevada, and portions of the north Coast Ranges. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Fishers in California are frequently exposed to anticoagulant rodenticides and to other toxicants. Anticoagulant rodenticides used at marijuana cultivation sites have caused the deaths of some fishers and may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN ESUs. The effects of such exposure on California fisher populations remain unknown.

In recent decades the frequency, severity, and extent of wildfires has increased in California. If this trend continues, it could result in increased mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and potentially isolate local populations of fisher. The fisher population in the SSN ESU is at greater risk of being adversely affected by wildfire than fishers in northern California due to its small size and the narrow distribution of available habitat.

Climate research predicts continued climate change through 2100. The climate is projected to change at increasing rates, with an overall trend of warmer temperatures across the range of fishers in the state characterized by warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate-related changes that may occur within the range of fishers in California. The SSN ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU due to its comparatively small population size and susceptibility to fragmentation. Nevertheless, the actual effects of future climate change on fisher populations remain very difficult to predict, and will likely vary throughout the species' range. The severity of those effects will vary depending on the extent and speed with which warming and precipitation changes occur.

The Department has provided a list of management actions to improve the likelihood of the continued existence of the fisher, including the need for: scientific studies to better understand how fishers use landscapes and to determine thresholds for important forest structural elements; implementation of large-scale, long-term monitoring of fisher populations and populations of other forest carnivores including monitoring of health and disease; and collaboration with land management agencies and researches in the southern Sierra Nevada to facilitate population expansion by increasing connectivity between core habitats and through translocation.

The Department provides this status review report to the Commission based on an analysis of the scientific information available pursuant to Fish and Game Code section 2074.6. Based on this information, the Department recommends that the petitioned action to list the fisher as threatened or endangered under CESA within the Northern California ESU is not warranted and within the Southern Sierra Nevada ESU is warranted as threatened at this time.

Regulatory Framework

Petition Evaluation Process

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3). The Commission received the petition and, pursuant to Fish & Game Code Section 2073, referred the petition to the Department for its evaluation and recommendation. On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*[2]) as Threatened or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[3].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[4].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[5]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[6, 7].

---

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

[2] Until recently, the fisher was known by the scientific name *Martes pennanti.*

[3] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[4] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[6] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[8].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA, subject to various terms and conditions[9]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[10]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[11]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (2010 Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its 2010 Status Review and the best science available to the

---

[7] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[8] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

[9] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[10] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[11] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

Department that designating fisher as a threatened or endangered species under CESA was not warranted[12]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[13].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[14]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's 2010 Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's 2010 Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[15]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as

---

[12] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[13] *Id.*, § 670.1, subd. (g).

[14] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

[15] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

an endangered or threatened species under CESA was not warranted[16]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[17].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[18] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[19]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[20]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its 2010 Status Review of the species. This report represents

---

[16] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[17] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[18] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[20] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

the Department’s revised status review, based on its consideration and analysis of scientific and other information available and including independent peer review by scientists with expertise relevant to the status of the fisher.

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) ESU and SSN (southern Sierra Nevada) ESU (Figure 1). The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by California’s Third District Court of Appeal that the term “species or subspecies” as used in CESA (Fish & G. Code, §§ 2062 and 2067) includes Evolutionarily Significant Units[21]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species (Waples 1991).

The Department believes that separate ESUs are warranted for fishers because of the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between those populations. Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events. The boundaries of each ESU represent the Department’s assessment of the current range of fishers in California.

[21] *California Forestry Ass’n v. Fish and Game Commission* (2007) 156 Cal.App.4th 1535, 1547-1548.

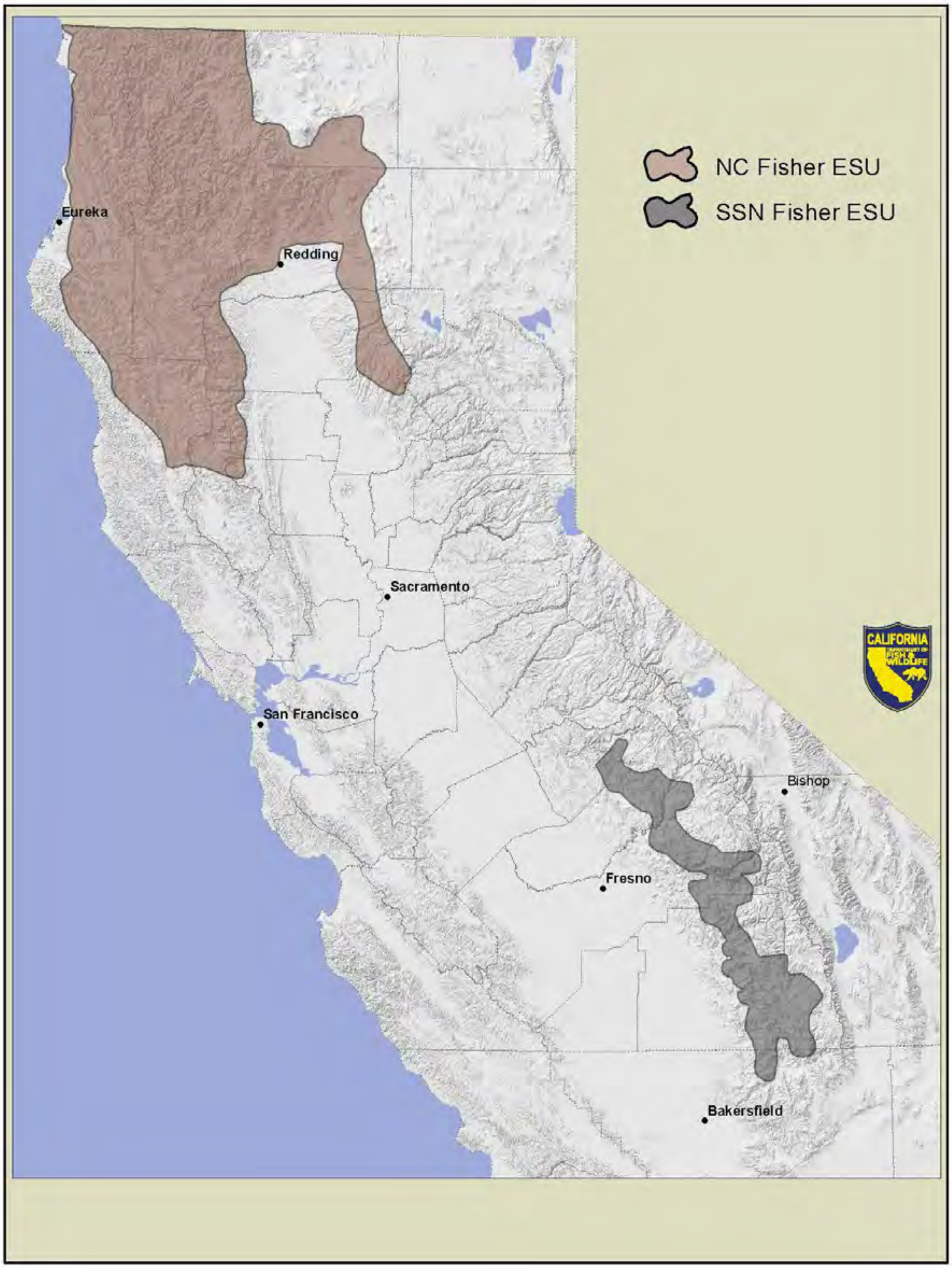


Figure 1. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and Wildlife, 2014.

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail (Douglas and Strickland 1987:511). Though they often appear uniformly black from a distance, they are generally dark brown over most of their bodies with white or cream patches distributed on their undersurfaces (Powell 1993). The fur on the head and shoulder may be grizzled with gold or silver, especially in males (Douglas and Strickland 1999). Fishers have a single molt in late summer and early fall, and shedding starts in late spring (Powell 1993).

The fisher's face is characterized by a sharp muzzle with small rounded ears (Grinnell et al. 1937) and forward facing eyes indicating well-developed binocular vision (Powell 1993). Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0 kg and 2.5 kg (4.4-5.5 lbs) and range in length from 75 cm to 95 cm (28-34 in) and males weigh between 3.5 kg and 5.5 kg (7.7-12.1 lbs) and range from 90 cm to120 cm (35-47 in) long (Powell 1993:3, 4).

Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh from about 0.5 kg to 1.4 kg (1-3 lbs) and range in total length from about 50 cm to 68 cm (20-27 in) (Buskirk and Ruggiero 1994). American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers (Lewis and Stinson 1998).

Even where they are abundant, fishers are seldom seen. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground (Coulter 1966). Females, perhaps because of their smaller body size, are more arboreal than males (Pittaway 1978, Douglas and Strickland 1987, Powell 1993).

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the Mustelidae includes wolverine, marten, weasel, mink, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America: *M. p. pennanti* (Erxleben 1777), *M. p. columbiana* (Goldman 1935), and *M. p. pacifica* (Rhoads 1898). However, the validity of these subspecies has been questioned (Grinnell et al. 1937) and (Hagmeier 1959). More recently, Sato et al. (2012:755) recommended that the subgenus Pekania be elevated to the rank of genus to accommodate the fisher, and that the genus *Martes* be used for the extant martens. In this report, we use *Pekania pennanti* as the taxonomic designation for fishers.

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell (1993) thought the most likely possibility was that the name originated with European settlers. Fitchet, fitche, and fitchew are terms used for polecats and for the European polecat's pelt, which led to the name of the domesticated polecat, "fitch ferret" and possibly to the name "fisher" (R. Powell, pers. comm.). Many other names have been used for fishers including pekan, pequam, wejack, Pennant's marten, black cat, *tha cho* (Chippewayan), *uskool* (Wabanaki), *otchoek* (Cree), and *otschilik* (Ojibwa) (Powell 1993). In the native language of the Hupa people, fishers are known as *'ista:ngq'eh-k'itiqowh*, which translates to "log-along-it scampers" (Baldy et al. 1996:36).

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (less than 5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice (Graham and Graham 1994:58). Wisely et al. (2004*a*) hypothesized that fishers expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Mitochondrial DNA has been used in several studies to describe genetic characteristics of fishers in California (Drew et al. 2003, Wisely et al. 2004*a*, Knaus et al. 2011). Portions of the DNA within mitochondria have been widely used in studies of ancestry because they are rich in mutations which are inherited. Drew et al. (2003) identified three haplotypes[22] (haplotypes 1, 2, and 4) from fishers in California by sequencing portions of their mitochondrial DNA. Haplotype 1 was found in fishers from northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in fishers in British Columbia. Based on these findings, Drew et al. (2003) suggested that gene flow between fishers in British Columbia and California occurred historically, but that these populations were now isolated.

Subsequent investigations, using nuclear microsatellite DNA and based on sequencing the entire mitochondrial genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada (Wisely et al. 2004*a*, Knaus et al. 2011). Wisely et al. (2004*a*:643) analyzed nuclear microsatellite DNA from fishers in northern California and the southern Sierra Nevada and reported that fishers from these areas were genetically distinct and were effectively isolated from each other. Knaus et al. (2011:11) sequenced the whole mitochondrial genome and identified three haplotypes unique to fishers in California what were not previously identified. One of these haplotypes was geographically restricted to the southern Sierra Nevada Mountains and two restricted fishers from northern California. Fisher populations in northern California and the southern Sierra Nevada as represented by haplotypes are genetically distinct and these populations likely separated before Euro-American settlement (Knaus et al. 2011:8,20).

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago (Samuels and Cavin 2013:449). Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) (Eshelman and Grady 1984:59). During the late Holocene, fishers expanded into

[22] The term haplotype is a contraction for ‘haploid genotype’. A haplotype is a group of genes that tend to be inherited together.

western North America (Graham and Graham 1994:58), presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to Euro-American settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 2). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and mixed coniferous forest ecosystems in western North America (Lofroth et al. 2010).

By the 1800s and early 1900s, the fisher's range was generally greatly reduced due to trapping, predator control, and large scale anthropogenic-influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss (Douglas and Strickland 1987:512, 526, Powell 1993:77, Powell and Zielinski 1994, Aubry and Lewis 2003:81–82, Lofroth et al. 2010:41). Fishers have since reoccupied much of their former range, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York in the East (Powell and Zielinski 1994:42).

Native populations of fishers currently occur in Canada, the western United States (southwestern Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada (Lewis et al. 2012:8).

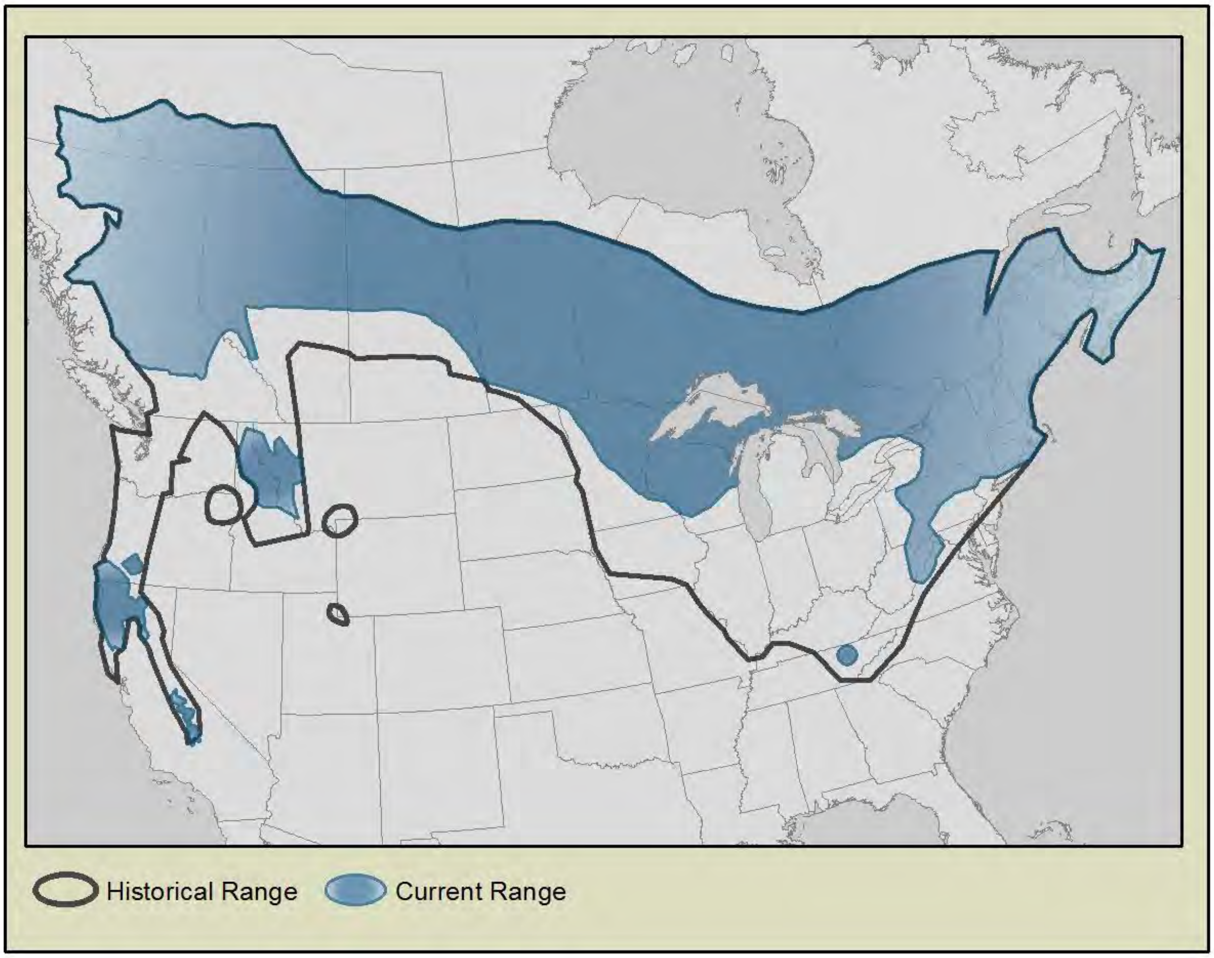


Figure 2. Presumed historical distribution (ca. 1600) and current distribution of fishers in North America. Historical distribution was derived from Gibilisco (1994:60). Refer to Tucker et al. (2012) and Knaus et al. (2011) for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

Historical Range and Distribution in California

Our knowledge of the historical distribution of fishers in California is primarily informed by Grinnell et al. (1937:214–216). They described fishers in California as inhabiting forested mountains primarily at elevations from 610 m to 1824 m (2,000 ft - 5,000 ft) in the northern portions of their range and from 1220 m to 2438 m (4,000 ft - 8,000 ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations[23]. Information presented by Grinnell et al. (1937:219) suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. (1937:219) appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included the area ranging from "the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County" (Grinnell et al. 1937:214–215).

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919 through 1924, as well as a line demarcating what they assumed to be their general range from approximately 1862 to 1937. The authors believed that almost all the locations were accurate; however, they did note that some locations may have reflected the trapper's residence or post office. Grinnell et al. (1937) also described their examination of numerous museum specimens and detailed several anecdotal fisher sightings. Their work remains the best approximation of the distribution of fishers in California prior to the 1930s. The approximate locations of the 1919-1924 trapper reports, museum specimens, anecdotal observations, and general range boundary as mapped by Grinnell et al. (1937) are included in Figure 3.

There are no museum specimens of fishers collected in the Sierra Nevada north of the Tuolumne River. However, anecdotal evidence suggests that fishers were present in parts of the central and northern Sierra at least until the 1920s and perhaps through the 1940s. Zielinski et al. (2005:1403) suggested that the fisher population in the southern Cascades and the northern Sierra Nevada may have been substantially reduced due to trapping and habitat loss by the time Grinnell (1937) and his colleagues assessed its distribution. Price (1894) supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell (1937).

[23] Fisher detections are currently relatively common above 2438 m on the Sequoia National Forest (J. Tucker, unpublished data).

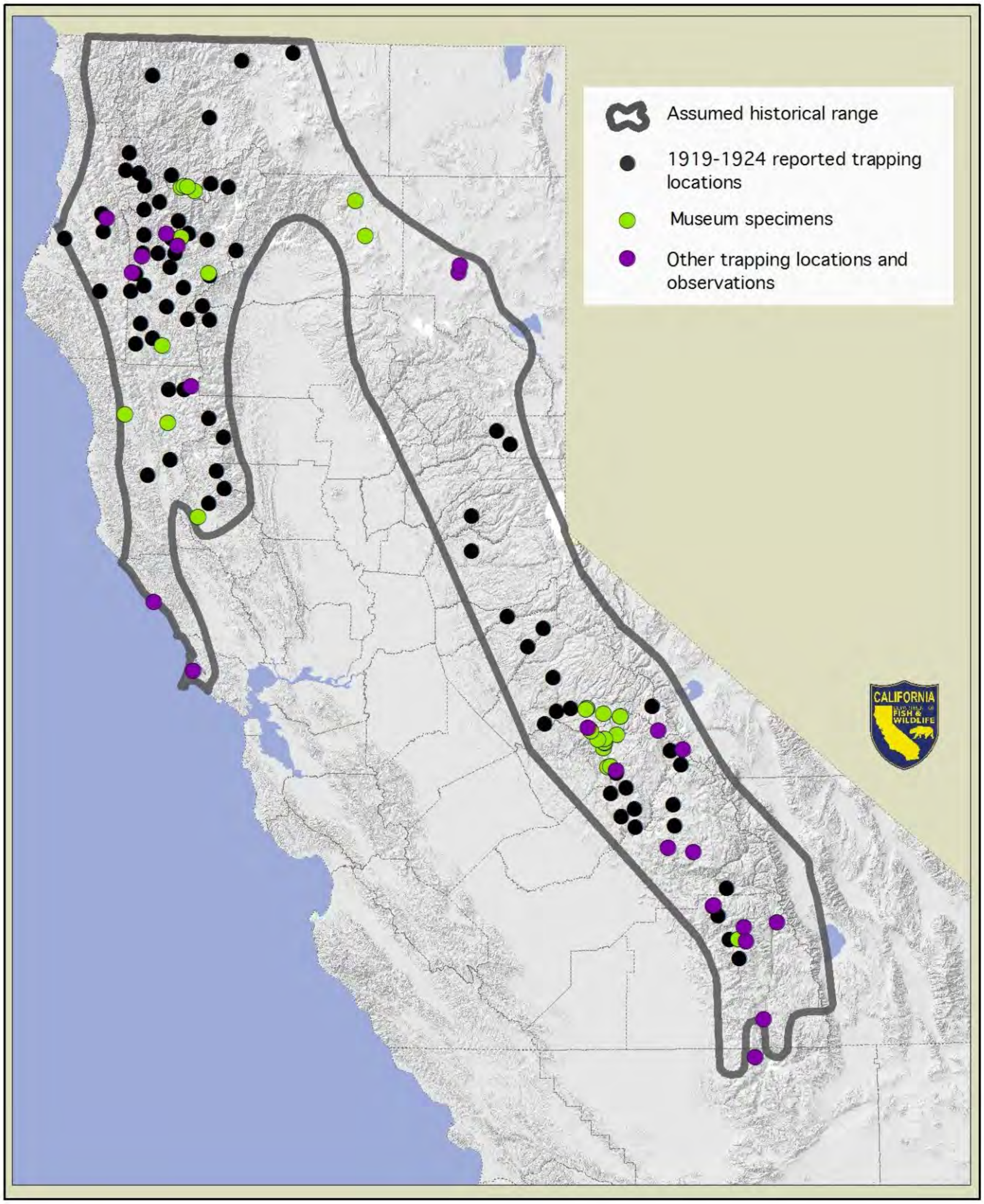


Figure 3. Historical range map of the fisher in California, based on Grinnell et al. (1937). Map includes 1) an outline of the fisher's "assumed general range within past seventy-five years" as drawn by Grinnell et al., 2) the locations of 1919-1924 fisher locations reported by trappers and mapped by Grinnell et al. (1937), 3) museum specimens examined by Grinnell et al. (1937), and 4) other trapping locations and observations mentioned in text but not mapped by the authors. Individual fisher locations were mapped by hand from descriptions of specimens or other anecdotal information.

In an 1894 publication describing his efforts to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada, William Price included notes on species that he did not collect but were "commonly known to the trappers" (Price 1894). His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[24] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred fishers.

In 1914, ten fishers were reportedly killed on the Tahoe National Forest (Our annual catch of furbearing animals. 1916) and a 1915 book on Lake Tahoe noted "the fur bearing and carnivorous animals the otter, fisher, etc., all are uncommon, though some are trapped every year by residents of the Lake" (James 1915). James distinguished fishers from martens on the basis of their relative size, and noted that both species "live in pine trees usually in the deepest forests". Five fishers were reportedly trapped in July 1916 near Placerville in El Dorado County (Winter vs. summer furs. 1917); the article described the poor price paid for the pelts, which were not in prime condition (Winter vs. summer furs. 1917). Grinnell et al. (1937) showed one trapping location in Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County from 1919 to 1924. Jack Foster, a state trapper during the 1940s and 1950s who lived in or near Taylorsville (Plumas County), reported trapping a fisher in the

---

[24] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

Diamond Mountains (near the border of Plumas and Lassen counties) in 1943 (Schempf and White 1977:22)[25].

Historical evidence of fisher presence in the southern Cascades is also relatively sparse. Two fisher specimens collected in 1897 in eastern Shasta County are located in the National Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney. Another undated[26] specimen housed in the National Museum of Natural History was collected near Fort Crook (near modern-day Fall River Mills). Also included in the National Museum of Natural History is a fisher that was collected by C.H. Townsend somewhere in Shasta County in 1883[27]. Grinnell et al. (1937) mentioned that fishers were trapped during the winters of 1920[28] and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. (1930:463) reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National

---

[25] In 1946, Mr. Foster also reportedly captured and subsequently released a fisher that had been cornered by dogs near Taylorsville in Plumas County. This record is included in the California Natural Diversity Database, but CDFW has not yet been able to locate and review the original sources of the record.

[26] This Museum of Natural History label for this specimen indicates that it was collected by "Gardener". A Captain John W.T. Gardner commanded the Army unit that built Fort Crook in 1857. Gardner went on to fight in the Civil War, and the fort was largely abandoned after 1866. Therefore, it is possible that this collection was made at some point during that period.

[27] In addition to the southern Cascades, Shasta County includes suitable fisher habitat within the Klamath Mountains and North Coast Ranges. It is thus possible that this specimen did not come from the southern Cascades. Townsend collected many mammals in Shasta, Siskiyou, Lassen and Tehama counties during 1883-1884. While most of the Shasta County specimens collected by Townsend do not have specific localities, many were made near Baird (on the Sacramento River beneath modern-day Shasta Lake.) During that period Townsend also collected numerous mammals near Mt. Lassen.

[28] This occurrence was not included on the Grinnell et al. (1937) map of 1919-1924 fisher harvest locations reported by trappers.

Park, near the junction of Lassen, Plumas, and Shasta counties. Grinnell et al. (1937:216) also showed one fisher reportedly trapped north of Mt. Shasta near the Klamath River sometime between 1919 and 1924.

Additional anecdotal evidence of fishers in the southern Cascades and/or possibly the northern Sierra is contained in annual “Fish and Game” reports produced by the Lassen National Forest in the 1920s (the Forest is comprised primarily of lands in the southern Cascades, but does include a portion of the northern Sierra). The 1920 report (Butler 1920:4) includes both fishers and martens in a list of furbearing animals found on the forest. The 1925 report (Durbin 1925:9) mentions “the trapping industry is not carried on to any great extent; however, there are a few local trappers who make a business of trapping for marten, fishers, and foxes in the high country each winter….a catch of 20 marten, one or two fox…and a couple of fisher, usually make up the catch….they usually get about $20 for marten and fisher hides…”.

In northwestern California, the “assumed general range within past seventy-five years” map prepared by Grinnell et al. (1937) included portions of Lake, Mendocino, Sonoma, and Marin counties. The inclusion of Lake County and the central and northern parts of Mendocino County were seemingly based on specimens examined and trapper reports compiled by Grinnell et al. (1937). In contrast, southernmost Mendocino, Sonoma and Marin counties were seemingly included based only on two anecdotal sighting reports, one near Fort Ross (Sonoma County) and one near Inverness (Marin County) (Figure 3). To the best of our knowledge there are no other historical or verified contemporary records of fishers in Marin and Sonoma counties.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fishers in California is based on observations of individual animals through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm.). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger (2006) noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of the presence of an animal (remote cameras and track-plate boxes) (McKelvey et al. 2008). In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* (Aubry and Lewis 2003:81) to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be “verified” records. Undoubtedly, reports of fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state. To approximate the current range of fishers in California, observations of fishers with high reliability of 1 and 2 from 1993 to the present were mapped. Using GIS, those locations were overlaid on layers of forest cover and other layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model), and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 4).

In California, fishers inhabit portions of the Coast Range, Klamath Mountains, southern Cascade Mountains, northern Sierra Nevada, and the southern Sierra Nevada. This estimate of current range is approximately 48% of the assumed historical range estimated by Grinnell et al. (1937). In northwestern California, fishers currently occupy much of their historical range, and may have expanded their range into the redwood region of coastal Humboldt and Del Norte counties. Fishers are seemingly absent from southern Mendocino county, southern Lake County, Sonoma, and Marin counties; evidence for their historic distribution in some of these areas is limited. Fishers also appear to be absent from the area east of Montague and north of Highway 97; Grinnell et al.(1937) reported a fisher was trapped in that area in the period spanning 1919-1924.

In the Sierra Nevada mountains, a number of broad scale, systematic surveys for fishers and other forest carnivores were conducted including from 1996 to 2002 (Zielinski et al. 2005:1392) and during 2002 to 2014(Zielinski et al. 2013*a*:8). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. (2005:1402–1403) expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction, due to isolation, than if they were connected to other populations.

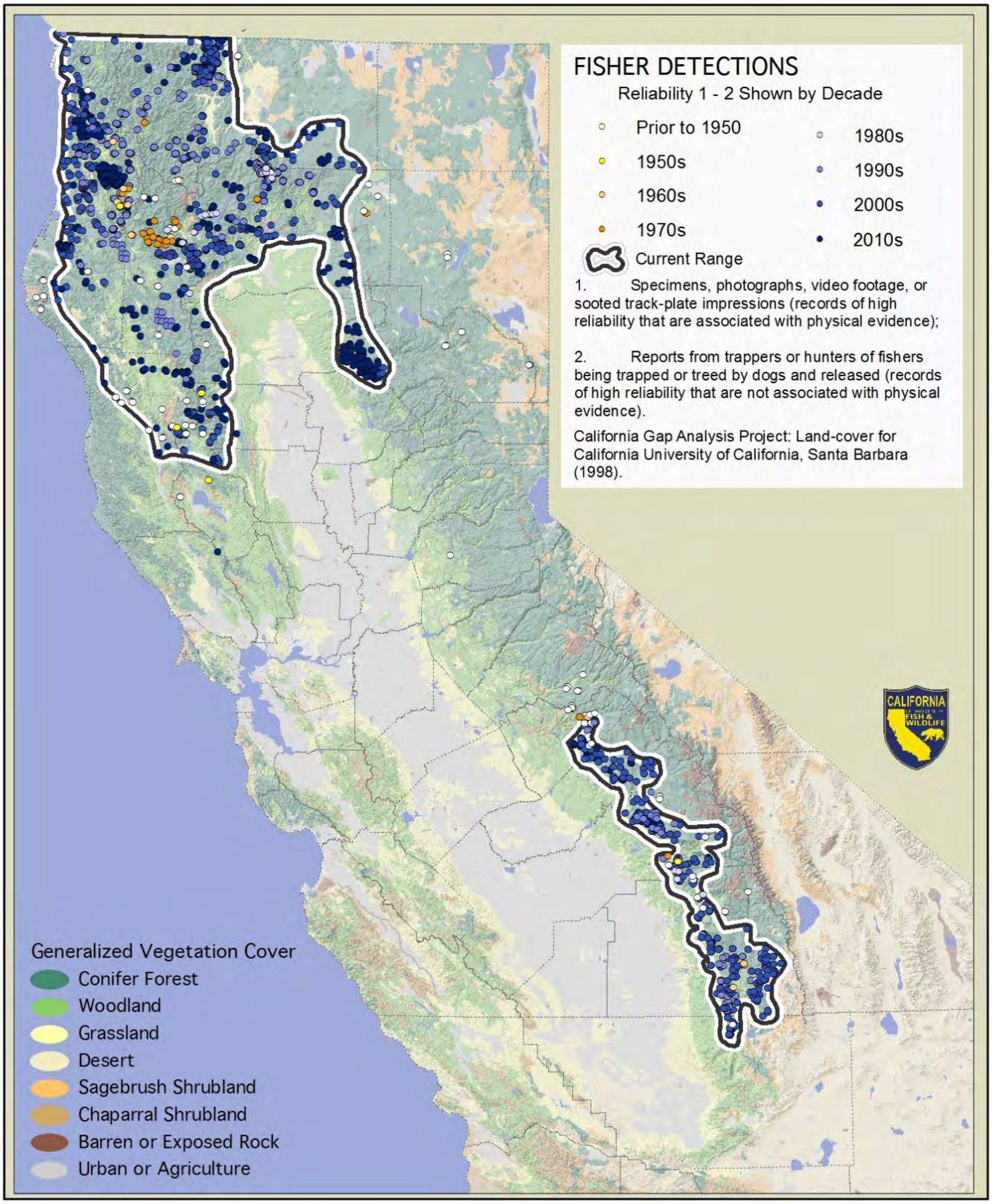


Figure 4. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis (2003) were included. California Department of Fish and Wildlife, 2014.

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the US Department of Agriculture Forest Service (USFS), private timber companies, and others since the 1950s, no verifiable detections of fishers have been made in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River (Zielinski et al. 1995, 2005).

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. (2011) concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error[29]. Despite this uncertainty, Knaus et al. (2011) concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Tucker et al. (2012:7, 8) used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fishers in northwestern California and the southern Sierra Nevada became isolated long before Euro-American settlement and estimated that the population declined substantially over a thousand years ago. This generally supports the conclusion of Knaus et al. (2011) that fishers in northern and southern portions of the state became isolated prior to Euro-American settlement. Tucker et al. (2012:8) also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fishers from disturbance beginning with the Gold Rush through the first half of the 20th century. That portion of the range

[29] This estimate is also in conflict with that of Graham and Graham (1994), who estimated that fishers entered western forests within the past 5,000 years.

appeared to have maintained a stable population while the remainder of the southern Sierra Nevada population of fishers was in decline.

Since Euro-American settlement, the distribution of fishers in the southern Sierra Nevada has seemingly fluctuated. Currently, fishers are present from near the Merced River to the Kern River watershed. Specimens collected in the early 1900s indicate that fishers were present in the Tuolumne River drainage (north of the Merced) at that time. Genetic analyses and recent survey data suggest fisher range may have then contracted to south of the Kings River before expanding northward in recent decades to its current boundary at the Merced (Tucker et al. 2014:131). The fisher population in the southern Sierra Nevada is currently distributed in an elongated, narrow band of suitable habitat on a north-south axis composed of 4-5 core habitat areas divided by narrow corridors across river canyons (Spencer et al. 2015).

Life History

Reproduction and Development: Powell (1993:54, 57) suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April (Coulter 1966, Wright and Coulter 1967, Leonard 1986:39, Powell 1993:43). Females can breed at one year of age, but do not give birth until their second year (Eadie and Hamilton 1958, Powell 1993, Frost and Krohn 1997). They produce, at most, one litter annually and may not breed every year (Douglas and Strickland 1987, Paragi et al. 1994*a*). Reproductive frequency and success depend on a variety of factors including the availability of prey, male abundance, and the age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old (Douglas and Strickland 1987, Arthur and Krohn 1991, Powell 1993, Paragi et al. 1994*a*).

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation (Douglas and Strickland 1987, Mead 1994, Frost et al. 1997). Implantation is delayed approximately 10 months (Wright and Coulter 1967) and occurs shortly before giving birth (parturition) (Frost et al. 1997). Arthur and Krohn (1991:381) considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for approximately 30 to 36 days (Powell 1993:53, Frost et al. 1997). Females give birth from about mid-March to early April (Truex et al. 1998, Aubry and Raley 2006, Higley and Matthews 2006, Self and Callas 2006, Weir and Corbould 2008) and breed approximately 6 to10 days after giving birth (Hall 1942:146, Powell 1993:53, Mead 1994). Ovulation is presumed to be induced by copulation (Powell 1993:47), with estrus lasting 2-8 days (Hall 1942:146). Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition (Powell 1993:53). Lofroth et al. (2010) presented a diagram that illustrates the reproductive cycle of fishers in western North America (Figure 5).

Based on observations of fishers in the wild, litter size range from 1 to 4 kits and averages from several studies range from 1.9 to 2.8 (Paragi et al. 1994*b*:6, York 1996:19, Aubry and Raley 2006:10, Matthews et al. 2013:103). Based on laboratory examination of corpora lutea[30] observed in harvested fishers, average litter size ranged from 2.3 to 3.7 kits (Eadie and Hamilton 1958, Wright and Coulter 1967, Kelly 1977, Leonard 1986, Douglas and Strickland 1987, Crowley et al. 1990, Weir 2003). However, these laboratory based averages may be artificially high. Counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea (Powell 1993:53). Crowley et al. (1990) found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

Raised in dens entirely by the female, young are born with their eyes and ears closed, their bodies only partially covered with sparse growth of fine gray hair, and weigh about 40 g (Hall 1942:147, Coulter 1966:81, Powell and Zielinski 1994:63). The kits' eyes open at 7-8 weeks old. They are completely dependent on milk until 8-10 weeks of age, after which time they are provided prey by their mother. They are capable

---

[30] The corpus luteum is a transient endocrine gland that develops from the follicle following ovulation and produces essentially progesterone required for the establishment and maintenance of early pregnancy (Bachelot and Binart 2005).

of killing their own prey at around 4 months of age (Powell 1993:62–70, Powell and Zielinski 1994:39, Aubry and Raley 2006:12). Juvenile females and males become sexually mature and establish their own home ranges at one year of age (Wright and Coulter 1967, Arthur et al. 1993). Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum (Powell and Zielinski 1994). Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually, reported from several studies in western North America, was 64% (range, 39% - 89%) (Lofroth et al. 2010:55). However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable (Facka et al. 2013:10–15).

A recent study in the Hoopa Valley of California reported that 65% (55 of 85) of denning opportunities were successful in weaning at least one kit from 2005 to 2011 (Matthews et al. 2013). Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, an average of 78% (range, 63% -90%) gave birth to kits annually from 2010 to 2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers (Lofroth et al. 2010:57, Matthews et al. 2013:103).

Many kits die immediately following birth. Frost and Krohn (1997) found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth (Frost and Krohn 1997). In wild populations, kits have been found dead at or near den sites and reproductive females have been documented abandoning their dens indicating their young had died (York 1996, Aubry and Raley 2006, Higley and Matthews 2006, Matthews et al. 2013:103). The number of fishers an individual female is able to raise until they are independent likely depends primarily upon food resources available to them. Paragi (1990) reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female. In British Columbia, average fall recruitment was estimated at 0.58 juveniles per adult female (Weir and Corbould 2008). In northwestern California, Matthews et al. (2013) estimated 0.19 juveniles per adult female were able to successfully establish a home range.

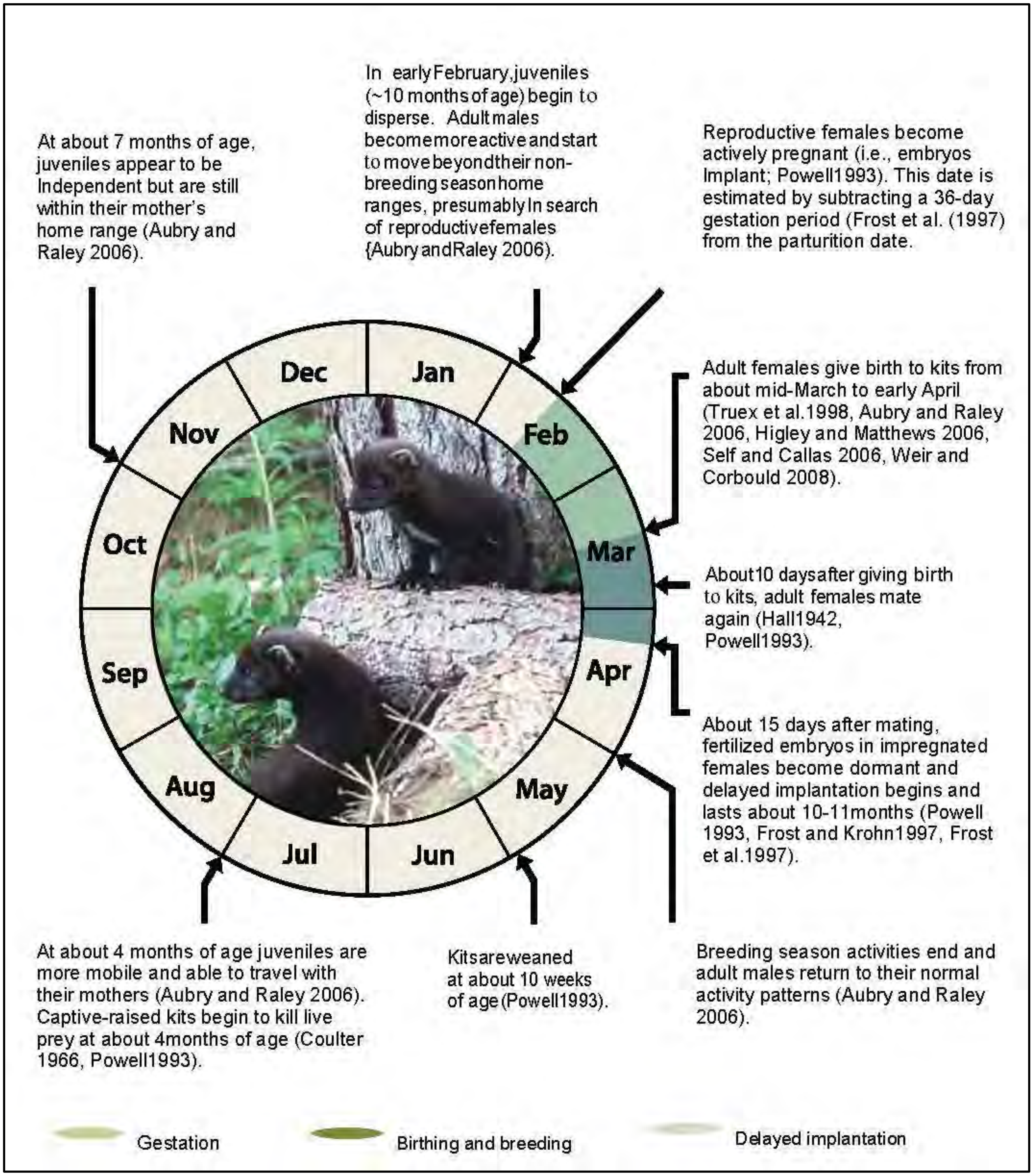


Figure 5. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. (2010).

Survival: There are few studies of longevity of fishers in the wild. Powell (1993:70–71) believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir (2003:2) captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age (Reno et al. 2008). Of 14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age (Aging Experience, Accuracy and Precision n.d.).

In the wild, most fishers likely live far fewer years than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years (Brown et al. 2006, Reno et al. 2008). In northwestern California, 48 radio-collared fishers captured from 2004-2013 were monitored until they died; the average age at death across all years was 4.1 years for males and 4.8 years for females (Higley et al. 2013). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Estimated survival rates of fishers vary throughout their range (Lofroth et al. 2010:59). Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, road density, climatic conditions, habitat quality, and exposure to toxicants. Lofroth et al. (2010:62) summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America (documented by 8 studies), and averaged 68% (3 studies) in eastern Northern America. This difference was presumably due, in part, to the take of fishers by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts).

In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range, 0.61-0.84) for adult females and 0.82 (range, 0.73-0.86) for adult males (Lofroth et al. 2010:62). In the Hoopa Valley area, fisher survival between December 2004 and March 2013 was modeled using both known fate and capture-mark-recapture (CMR) techniques (Higley et al. 2013:24). Both approaches yielded similar results. The known fate analysis for females indicated that annual survival began at 0.77, dropped to 0.60, and then rose to 0.826, while the CMR estimates showed apparent survival increasing from 0.73 to 0.82. Male known fate survival (5 years of data only) began at 1.0, dropped to 0.39, and then rose to 0.63, while the CMR estimate showed male survival beginning at 0.37 and ending at 0.46 (Higley et al. 2013:30). The top models for the known fate analysis showed lower average monthly survival for both sexes in May and June than any other months (Higley et al. 2013:25). A combined analysis using data from the Kings River Fisher Project and Sierra Nevada Adaptive Management Program study areas in the southern Sierra Nevada found annual adult female survival (0.72) was higher than that for males (0.64) (Sweitzer et al. In review*a*). Juvenile survival was 0.83 for females and 0.76 for males, and subadult (12-23 months of age) survival was 0.69 for both males and females. Survival was lower from March to August than September to February.

Food Habits: Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi (Powell 1993:10). Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided (Powell 1993:101). Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey species that may be otherwise impossible to determine by more traditional techniques (Lofroth et al. 2010).

In a review of 13 studies of fisher diets in North America by Martin (1994:309), five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed (Lofroth et al. 2010). The proportion of different food items in the diets of individual fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey (Powell 1993:100–101).

Studies indicate that fishers in California appear to consume a greater diversity of prey than elsewhere in western North America (Zielinski and Duncan 2004, Golightly et al.

2006, Lofroth et al. 2010). This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey (Zielinski and Duncan 2004). Alternatively, the diversity of prey eaten by fishers may indicate that preferred prey is absent or at such low numbers that lower rank prey must be eaten (R. Powell, pers. comm.). Across their range, fishers prey predominately on the largest mammals they can consistently catch (e.g., porcupines, snowshoe hares, gray squirrels, carrion). Slauson and Zielinski (2012) reported that the home range size of fishers decreases as the relative frequency of larger mammalian prey (i.e., greater than 200 g (7 oz)) increases in their diet.

In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats (Zielinski et al. 1999, Golightly et al. 2006). Prey items reported in these studies differed somewhat in frequency of occurrence and included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California (Golightly et al. 2006), where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material (Grenfell and Fasenfest 1979:187, Zielinski et al. 1999:967).

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council (Ca Biodiversity Council Bioregions (INACC Regions) - Data.gov n.d.), Golightly et al. (2006:17) found mammals to be the taxonomic group most frequently contained in fisher scats. Mammals identified most frequently included gray squirrels (*Sciurus griseus*), Douglas squirrels (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), northern flying squirrels (*Glaucomys sabrinus*), deer mice (*Peromyscus* sp), woodrats (*Neotoma* sp.), voles (*Microtus* sp.) and tree voles (*Arborimus* sp.). Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet (Zielinski et al. 1999, Zielinski and Duncan 2004, Golightly et al. 2006). This is likely due to the comparatively low densities of these species in ranges occupied by fishers in California compared to other parts of their range (Zielinski et al. 1999).

In the southern Sierra Nevada, Zielinski et al. (1999) reported that small mammals constituted the majority of the diet of fishers, but insects and lizards were also frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. (1999) also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn. Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available (Powell and Brander 1977, Powell et al. 1997, Zielinski et al. 1999, Golightly et al. 2006). Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers and their ability to capture and handle larger versus smaller prey (Lofroth et al. 2010:76). These differences may also reflect the availability (abundance) of prey, predominant habitat, differences in weather, and abundance of other prey of similar mass (Golightly et al. 2006:37). At interior sites in northern California, Golightly et al. (2006:37) reported the relatively high consumption of squirrels and chipmunks compared to coastal sites. In coastal sites, the relative consumption of woodrats was higher, even though woodrats were available at both study sites.

The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill (Lofroth et al. 2010:76). This has been hypothesized as a mechanism that reduces competition between the sexes for food (Powell 1993:115, Weir et al. 2005:17). Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey (Aubry and Raley 2006:27, Lofroth et al. 2010).

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. (1999:965) found that during summer, the diet of female fishers contained a greater proportion of small mammals compared to the diet of male fishers. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. (2005) reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley (2006:25) found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). Because most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits (Aubry and Raley 2006:27).

In some areas, male fishers have been found with significantly more porcupine quills in their heads, chests, shoulders, and legs than female fishers (Kelly 1977, Kuehn 1989). It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers (Powell 1993:115).

Habitat: Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers (Grinnell et al. 1937:231, de Vos 1951:498, Hamilton et al. 1955, Powell 1979:199) have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments (Lofroth et al. 2010:85). The Department calculated the mean elevation of each Public Land Survey Section (The Public Land Survey System, n.d.) in which fishers were detected in California from 1993 to 2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 6). Habitats at higher elevations may be less favorable for fishers due to snow depth that may constrain their movements (Krohn et al. 1994), limited availability of den and rest structures, or limited prey (Raley et al. 2012:249). Fishers tend to occur at higher elevations in the southern Sierra Nevada than in northern California. On the Sequoia National Forest, near the southern end of the fisher's California range, they are most abundant between ≈1,830 – 2,140 m (6,000 – 7,000 ft) (Spencer et al. 2015:7).

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa

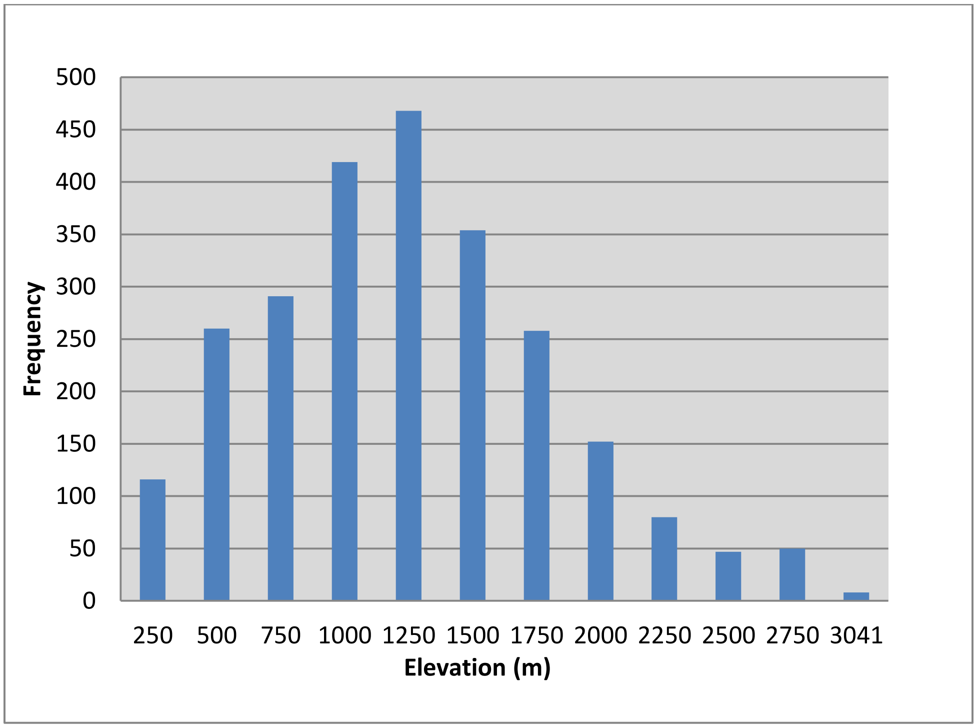


Figure 6. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993 to 2013. California Department of Fish and Wildlife, 2014.

pine (Klug Jr 1997, Truex et al. 1998, Zielinski et al. 2004*a*). Hardwoods are more common in fisher home ranges in California than elsewhere in western North America (Lofroth et al. 2010:94). Tree species' composition may be less important to fishers than forest structural attributes that affect foraging success and provide resting and denning sites (Buskirk and Powell 1994). Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale (Truex et al. 1998, Carroll et al. 1999, Zielinski et al. 2004*a*, Davis et al. 2007) and at the rest and den site scale (Powell and Zielinski 1994, Truex et al. 1998, Carroll et al. 1999, Zielinski et al. 2004*a*). Additional structural attributes considered beneficial to fishers at the stand and site scale include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground (Powell and Zielinski 1994).

Some researchers have hypothesized that fishers require old-growth conifer forests for survival (Buskirk and Powell 1994). However, habitat studies during the past 20 years indicate that fishers do not depend on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available (Raley et al. 2012:248). Raley et al. (2012) suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include relatively high proportions of mid- to late-seral forests, but low proportions of open or nonforested environments.

In the southern Sierra Nevada fisher home ranges include a mosaic of forest successional stages, however, areas of mature forest within home ranges have been considered necessary to provide prey, rest sites, and den sites (Spencer et al. 2015:29). In the coastal redwood region, Slauson and Zielinski (2003:7) detected fishers at track plate stations in old growth significantly less than expected, and in second growth redwood forests significantly more than expected. Within these second growth forests, however, they detected fishers in the oldest age stands that had higher densities of medium and large deadwood structures, including snags, stumps, and downed logs.

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare; most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have been conducted, active fishers were associated with complex forest structures (Raley et al. 2012:241). Raley et al. (2012:241) reviewed several studies (Carroll et al. 1999, Slauson et al. 2003, Weir and Harestad 2003, Campbell 2004) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated (Raley et al. 2012:241). The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers in distinguishing among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions (Raley et al. 2012:241).

During periods when fishers are not actively hunting or traveling, they use structures for resting, which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey (Lofroth et al. 2010:72, Aubry et al. 2013).

Raley et al. (2012:240) analyzed more than 2,260 rest structures documented in studies from 12 geographic regions in western North America and found the characteristics of the structures to be "overwhelmingly consistent". Fishers primarily rested in deformed or deteriorating live trees and to a lesser extent in snags and logs (Raley et al. 2012:240, Green et al. 2013). Live trees, snags, and logs used by fishers for resting are generally much larger than the average size of structures available (Weir and Harestad 2003:78; Zielinski et al. 2004b:485; Purcell et al. 2009:2703). However, fishers were also documented using trees and logs with relatively small diameters indicating large diameter structures may not be essential (Zielinski et al. 2004*b*:485, Purcell et al. 2009:2703).

The species of tree or log used for resting appears less important than the presence of a suitable microstructure in which to rest (e.g., a cavity or, platform) (Raley et al. 2012:240). Microstructures used by fishers for resting include platforms formed as a result of fungal infections, nests or woody debris, cavities in trees or snags, and logs or debris piles created during timber harvest operations (Zielinski et al. 2004b:479, 482; Yaeger 2005:21; Aubry and Raley 2006:20; Weir and Corbould 2008:103; Purcell et al. 2009; Green et al. 2013)(Aubry and Raley 2006:20)(K. B. Aubry and Raley 2006, 20)(K. B. Aubry and Raley 2006, 20). Rest structures appear to be reused infrequently by the same fisher (Stephen M. Arthur et al. 1989:683, Seglund 1995:44, Zielinski et al. 2004*b*:68, Purcell et al. 2009:2700). In southern Oregon, Aubry and Raley (2006:17) located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion. In the southern Sierra Nevada, Purcell et al. (2009) documented the reuse of rest sites on only 4 of 82 occasions (5%). However, in northwest Connecticut, Kilpatrick and Rego (1994:1418) reported that 10% of summer and 24% of all winter rest sites were reused. Of those, seven were located near scavenged carcasses and four were either in or near dens used by porcupines, perhaps indicating that fishers reuse rest sites where they have access to larger food items than can be consumed in one meal.

Studies of rest sites used by fishers based on locations of animals equipped with transmitters may have a bias that is seldom mentioned (R. Powell pers. comm.). Signals from transmitters worn by fishers when resting in trees are generally stronger and more likely to be received by researchers and found compared to rest sites in logs, piles of brush, or underground. It is also possible that rest sites at ground level or in small trees may be more likely to be abandoned by fishers when approached by researchers than when fishers are resting in large trees and high above the ground. This potential bias could skew the findings of some studies of rest sites toward larger structures which may be easier to locate.

A meta-analysis conducted by Aubry et al. (2013) of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. (2012:240)). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (greater than 100 years) for suitable microstructures to develop (Raley et al. 2012:240).

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits (Raley et al. 2012:238). Hollow logs are also occasionally used for reproduction (i.e., maternal dens) (Aubry and Raley 2006:16). Grinnell et al. (1937:226, 227) reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree (Raley et al. 2012:239) (Figure 7).

In the Kings River Fisher Project and Sierra Nevada Adaptive Management Program study areas, California black oaks are the most common tree species used for denning (54% and 43% of all dens, respectively) (R. Green, unpublished data; R. Sweitzer, unpublished data; cited by Spencer et al. (2015)). Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose dens with openings small enough to exclude potential predators and aggressive male fishers (Raley et al. 2012:239).

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times

Figure 7. Fishers frequently shelter their young within cavities in live trees. These images depict examples of trees with cavities used by fishers for denning (left photo Douglas-fir den tree climbed by wildlife technician Matt Palumbo: photo credit J. M. Higley, Hoopa Tribal Forestry; right photo black oak den tree climbed by CDFW Environmental Scientist Pete Figura: photo credit Richard Callas.

larger in diameter on average than other trees in the vicinity of the den [Paragi (1990, 2003, 2008), as cited by Raley et al. (2012:238)]. Conifers and hardwoods used for dens in the southern Sierra Nevada are large; 75% of conifers used for dens equaled or exceeded 89 cm (35 in) dbh[31] in the Kings River Fisher Project and equaled or exceeded 94 cm (37 in) in dbh in the Sierra Nevada Adaptive Management Program study. Seventy-five percent of the oaks used for dens equaled or exceeded 63 cm (25 in) dbh in both studies. Depending on the growing conditions, considerable time is

[31] dbh refers to tree diameter at breast height, 1.4 m (4.5 ft).

needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits.

Information collected from more than 330 dens used by fishers for reproduction indicated that most cavities used were created by decay caused by heart-rot fungi (Reno et al. 2008, Weir and Corbould 2008, Davis 2009). Infection by heart-rot fungi is only initiated in living trees (Bull et al. 1997) and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens (Raley et al. 2012:238). Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age (Davis 2009).

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fishers in California (Carroll et al. 1999, Davis et al. 2007, CDFW 2008, Zielinski et al. 2010). The newest model of landscape scale habitat selection was developed by the USFWS and the Conservation Biology Institute (USFWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the USFWS-CBI model consisted of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

The USFWS-CBI models described the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) (Phillips et al. 2006), based on 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities used were from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

For the southern Sierra Nevada and where it blended into the central and northern Sierra Nevada, the variables used in the USFWS-CBI model were basal-area-weighted canopy height, minimum temperature of the coldest month, tassel-cap greenness[32], and dense forest (percent of forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were total above-ground biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The USFWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables, some of which were not available for use in earlier modeling efforts. Other recent models (Carroll et al. 1999, Zielinski et al. 2010) have primarily been focused on predicting habitat in the northwestern part of California or have been derived from far fewer fisher detections (Davis et al. 2007).

The final USFWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as “high quality,” model values associated with habitats avoided by fishers were designated as “low quality,” and habitats that were neither avoided nor selected were considered “intermediate.” The “low quality” habitat category may include non-habitat (not used) as well as other habitats used infrequently relative to their availability by fishers. The Department considered the USFWS-CBI model to be the best information available depicting the amount and distribution of habitats potentially suitable for fishers within the historical range depicted by Grinnell et al. (1937) and the species’ current range in California. Based on the USFWS-CBI model, approximately 74% of the NC ESU supports habitat predicted to be of intermediate or high value for fishers. This percentage is slightly higher (about 77%) for habitats of intermediate or high value for fishers within the SSN ESU (Figures 8 and 9).

[32] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

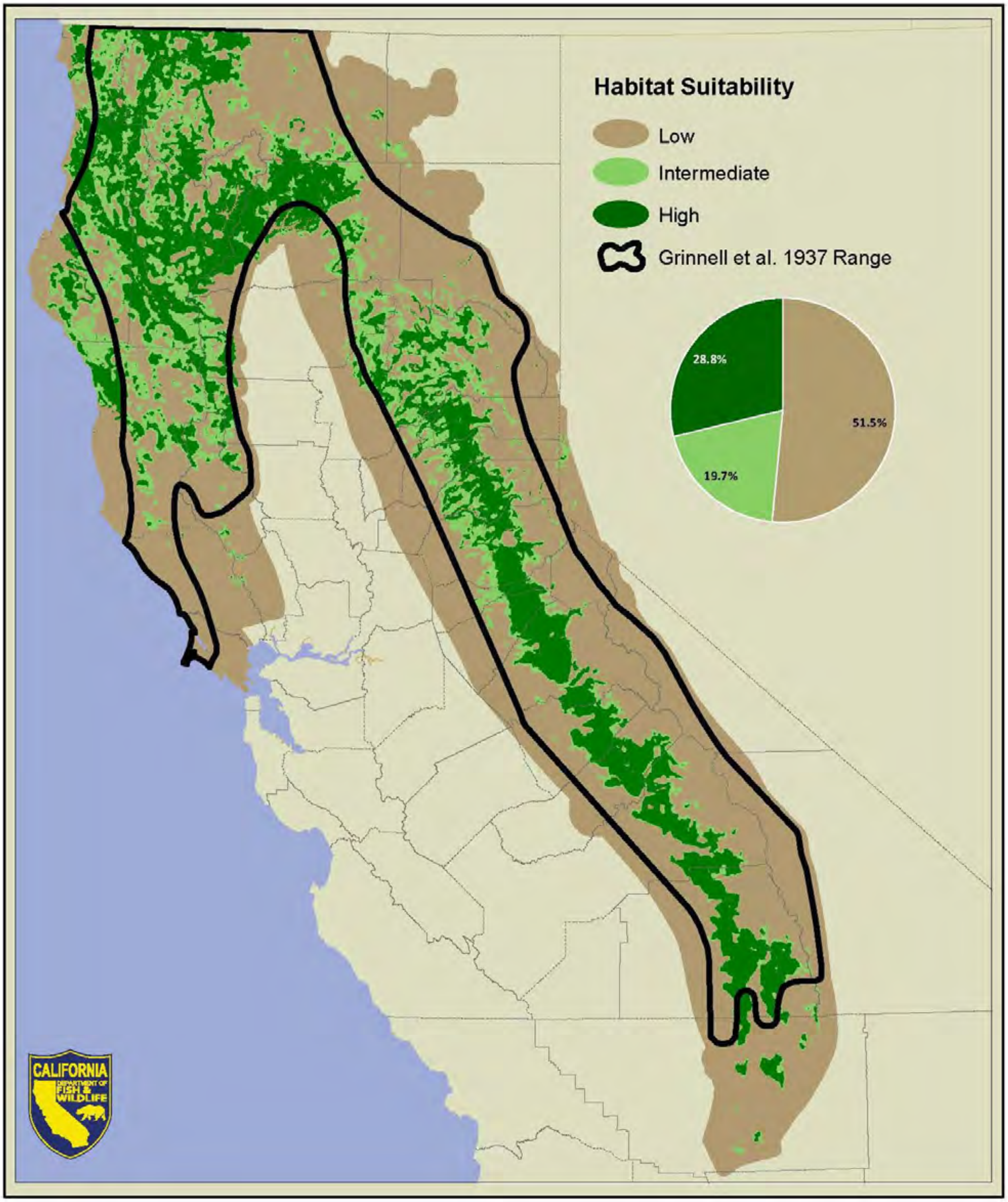


Figure 8. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

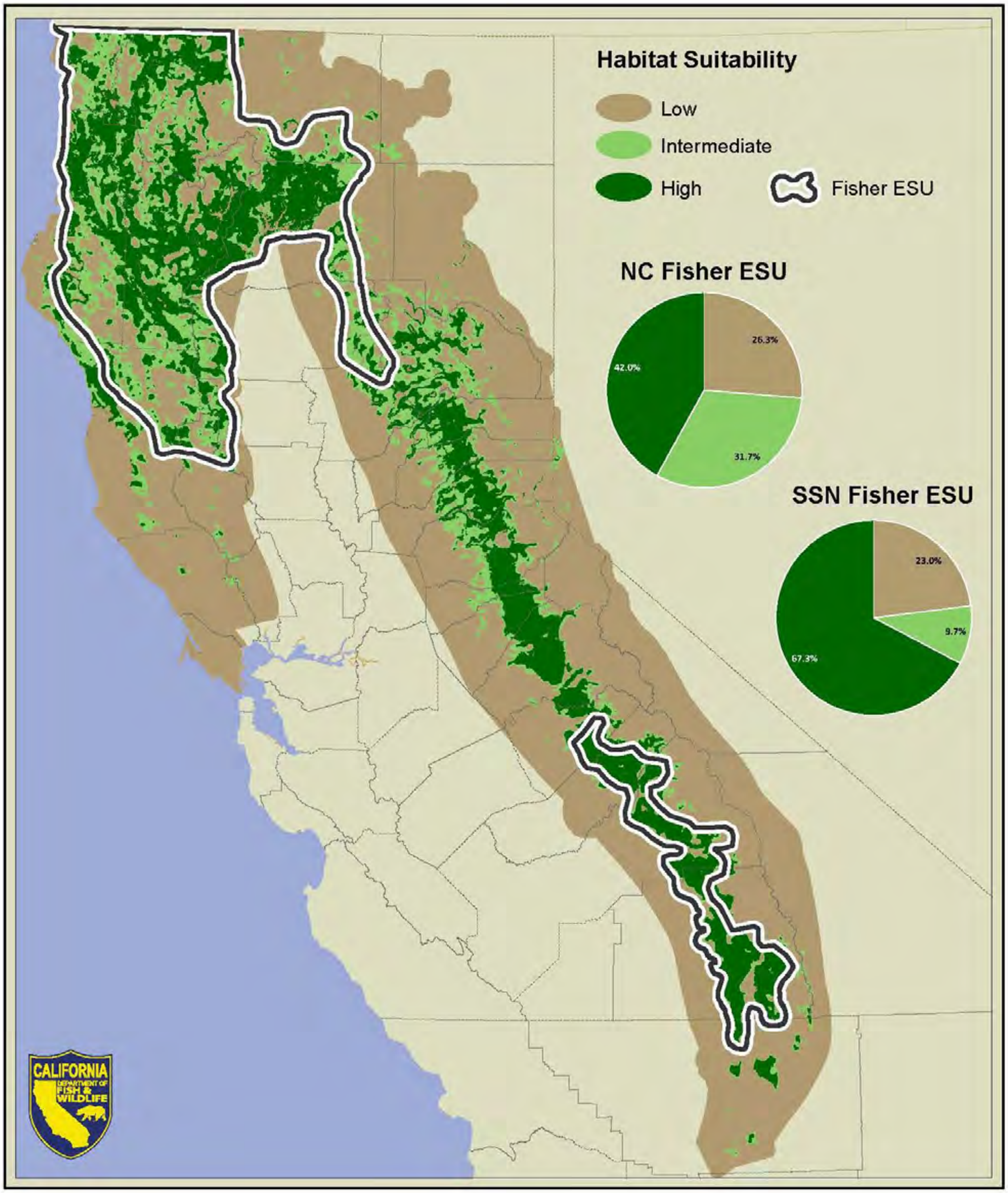


Figure 9. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities (Burt 1943). These areas have been described for fishers and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young (Powell 1993:166). The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not (Powell 1993:172, Powell and Zielinski 1994:59). A male fisher's home range may overlap those of multiple females with the potential benefit of increased reproductive success (Powell 1993:172).

Lofroth et al. (2010:68) summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. In the southern Sierra Nevada, the Sierra Nevada Adaptive Management Project study found that annual adult male home range size averaged 86 km^2 (33 mi^2) and annual female home range size averaged 23 km^2 (9 mi^2), while in the Kings River Project area mean annual adult home ranges of males and females averaged 45 km^2 (17 mi^2) and 11 km^2 (4 mi^2), respectively (Thompson et al. 2010:24, Spencer et al. 2015:18–19).

In 9 studies in western North America the home range sizes of male fishers averaged approximately 3 times larger than the home range sizes of female fishers (Lofroth et al. 2010:68). The variation in home range estimates among studies was due, in part, to differences in sampling effort and analytical methods, making comparisons difficult among geographic regions or studies (Lofroth et al. 2010:67). Nevertheless, differences in home range size, with male fishers using substantially larger areas than females, has been consistently reported (Kelly 1977, Buck et al. 1983, Johnson 1984, S. M. Arthur et al. 1989, Jones 1991, York 1996, Garant and Crete 1997, Zielinski et al. 2004*a*, Yaeger 2005, Aubry and Raley 2006, Koen et al. 2007, Weir and Corbould 2008, Popescu et al. 2014). Lofroth et al. (2010) noted that home range sizes of fishers generally increase from southern to northern latitudes.

Dispersal: Dispersal is a term that describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. (2013) as increasingly recognized to occur in three phases: 1) departing from the natal[33] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to move through the landscape, prey resources, turnover rates of adults (Arthur et al. 1993, York 1996, Weir and Corbould 2008:34) and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities (York 1996, Aubry and Raley 2006:10, Weir and Corbould 2008). During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat (Douglas and Strickland 1987, Powell 1993, Strickland 1994, Weir and Corbould 2008:14). Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females (Mabry et al. 2013). This pattern appears to hold true for fishers (Aubry et al. 2004:201, Aubry and Raley 2006:14, Matthews et al. 2013:105, Tucker 2013*a*). It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories (Aubry et al. 2004:205). Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient (Greenwood 1980, Stephen Dobson 1982).

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age (Lofroth et al. 2010:72). In some studies, juvenile male fishers departed from their natal ranges earlier than females (Matthews et al. 2013:105). Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home

[33] Natal refers to the place of birth.

ranges. This behavior is characterized by higher mortality risk (Weir and Corbould 2008:48).

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. (1993:871), reported mean maximum dispersal distances for male and female fishers of 17.3 km (10.7 mi) and 14.9 km (9.3 mi), respectively. Also in eastern North America, York (1996:56) reported a mean maximum dispersal distance for males of 25 km (15.5 mi) and mean maximum dispersal distance of 37 km (23 mi) for female fishers. The greater dispersal distance for females compared to males reported by York is unusual as, in other studies, males dispersed farther than females. Matthews et al. (2013:104), reported that the average maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [8.1 km (5.0 mi)] than for females [6.7 km (4.2 mi)].

In the interior of British Columbia, Weir and Corbould (2008:44), reported dispersal distances from the centers of natal to the centers of established home ranges of 0.7 km (0.4 mi) and 32.7 km (20.3 mi) for two female fishers and 41.3 km (15.9 mi) for one male fisher. In the southern Oregon Cascade Range, Aubry and Raley (2006:14) reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male and female fishers of 29 km (18 mi) and 6 km (3.7 mi), respectively. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. (2013:104) reported the distance between natal dens to the centroids (geometric center) of home ranges established by a single male fisher of 1.3 km (0.82 mi) and for 7 female fishers to average 4.0 km (2.5 mi).

At the Sierra Nevada Adaptive Management Program study site in the southern Sierra Nevada, 20 juvenile female fishers dispersed an average of 4.9 km (3.0 mi) and 15 juvenile males dispersed an average of 6.9 km (4.4 mi) (Spencer et al. 2015:20). Within this study area 55% (11 of 20) of juvenile female and 40% (6 of 15) of juvenile male fishers exhibited no or limited dispersal movements and established adult home ranges near their natal home ranges (R. Sweitzer, unpublished data, cited by Spencer et al. 2015:20). One male fisher dispersed moved 36 km (22 mi) from the Kings River Project study area to the Sierra Nevada Adaptive Program study area (Spencer et al. 2015:20). In the southern Sierra Nevada, Tucker et al. (2013a:70–71) modeled dispersal in fishers and speculated that landscape features (i.e., dense forest, roads, water) have much less influence on gene flow for males compared to females, indicating that male fishers may cross these potential barriers more readily than female fishers.

Habitat that May be Essential for the Continued Existence of the Species

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists (Price 1894:331, Grinnell et al. 1937:214) and researchers in modern times (De Vos 1952:12, Powell 1993:18, 76, Buck et al. 1994:373–375, Jones and Garton 1994:383, Powell and Zielinski 1994:39, Weir and Corbould 2010:408). Yet, the size, age, structure, and scale of forests essential for fishers are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular forest types (e.g., old-growth conifers) for survival (Buskirk and Powell 1994:296). However, studies of fisher habitat use over the past two decades demonstrate that fishers do not depend on old-growth forests *per se*, nor are they associated with any particular forest type (Raley et al. 2012:248). At finer spatial scales, fishers are associated with structurally complex forests containing large trees, logs, and with moderate-to-dense canopy cover (Raley et al. 2012:251).

Fishers are found in a variety of low- to mid-elevation forest types (Hagmeier 1956, Banci 1989, Powell 1994, Weir and Harestad 2003, Spencer et al. 2011) that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests (Raley et al. 2012:248). These landscapes are suitable for fishers if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey (Raley et al. 2012:248). Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young (Weir and Corbould 2008:155). Aubry and Raley (2006:16) reported that the sizes of den entrances used by female fishers were typically just large enough for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir (2008:157) found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for denning are among the largest available in the vicinity (Reno et al. 2008, Weir and Corbould 2008, Davis 2009).

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning (Raley et al. 2012:242). These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large and considerable time (>100 years) is required for most suitable cavities to develop (Raley et al. 2012:240). Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. Nevertheless, forest structure important for fishers should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers.

Species Status and Population Trends

Distribution Trend

Comparing the historical range of fishers in California estimated by Grinnell et al. (1937) to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This conclusion is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Mendocino, Lake, Sonoma, and Marin counties. Despite extensive surveys from 1989-1995 (Zielinski et al. 1995) and 1996-2002 (Zielinski et al. 2005) for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled. Support for Grinnell et al.'s (1937) inclusion of portions of southernmost Mendocino, Sonoma, and Marin counties within the map of the fisher's "assumed general range within past seventy-five years" appears to have been based primarily on two anecdotal sighting reports[34]. By the 1930s Grinnell et al. seemingly believed fishers no longer to be present in those areas, writing "the fisher is found at the present time [presumably referring to 1937] coastwise from the Oregon line south to southern Mendocino County" (Grinnell et al. 1937:219). Therefore, it is not clear that the contemporary absence of fishers in those areas represents a range contraction.

Recent genetic analyses indicate that the fishers in northwestern California and the southern Sierra Nevada have been genetically isolated from each other for hundreds, if not thousands, of years (Knaus et al. 2011, Tucker et al. 2012). It has thus been suggested that the current "gap" in the distribution of fishers in the Sierra has been long standing and that, contrary to the assertions of Grinnell et al. (1937), fishers did not occur throughout the Sierra at the time of Euro-American settlement (Knaus et al. 2011, Tucker et al. 2012, Tucker 2013*a*). This interpretation is bolstered by the lack of

[34] In one case, in 1913 a resident of Point Reyes "reported that a fisher was active three miles west of Inverness." In the other undated anecdote, a long term resident of Fort Ross "knew of the presence of fishers in that locality in previous years."

museum specimens from the Sierra north of the Tuolumne River. However, it is challenged by substantial anecdotal evidence that fishers were present in the central and northern Sierra and southernmost portions of the Cascades through the 1920s and possibly as late as the 1940s (Price 1894, James 1915, Winter vs. summer furs. 1917, Butler 1920, Durbin 1925, Grinnell et al. 1937, Schempf and White 1977). One possible interpretation of the incongruous genetic and anecdotal distribution data is that fishers historically occurred in the area of the gap, but their distribution was discontinuous. Landscape features relatively resistant to fisher movement (e.g., the numerous east-west trending Sierra river canyons, often with steep, rocky slopes and non-forested vegetation) may have promoted a discontinuous distribution and, in sum, minimized or precluded genetic exchange between fisher populations in northwestern California and the southern Sierra Nevada.

Since the 1990s, detections of fishers appear to have increased along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County. It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier and less extensive surveys. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

In the southern Sierra Nevada, the results of surveys for fishers suggest a relatively recent population expansion. In the 1990s through the early 2000s, fishers were rarely detected in northern portions of the SSN ESU compared to surveys conducted from 2006 to 2009 where fishers were detected considerably more frequently (Tucker et al. 2014:131)

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission (Grinnell et al. 1937:229). In that year, only 34 fishers were reported taken by trappers in the state (Dixon 1925), with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau of Labor Statistics). Grinnell et al. (1937) concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers (Lewis and Zielinski 1996:292–293). Many of the animals were taken in a single trapping season (1920) when 102 fishers were harvested (Dixon 1925:23). Despite concerns about the scarcity of fishers in the state, trapping of fishers was not prohibited until 1946 (Gould 1987).

Grinnell et al. (1937:227) noted that "Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township." They roughly estimated the fisher population in California at fewer than 300 animals statewide. Fisher captures in recent years for scientific study suggest that in many areas fishers are currently more common[35] than they were in the 1930s: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were ultimately captured from widely distributed locations in northwestern California from 2009-2012, as part of that project. Within the translocation area in the northern Sierra Nevada, 19 fishers were captured over a period of 28 days that were likely the offspring of animals translocated to the area in 2012 (Powell et al. 2013).

Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers in the translocation release area was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*). In 2013, fishers were the second most-captured mesocarnivore in the same area (3,172 trap days; spotted skunks were caught at a slightly higher rate), and in 2014 fishers were again the most commonly captured mesocarnivore (2,792 trap days). To capture fishers for the translocation project, project cooperators trapped at a variety of locations in Humboldt, Shasta, Siskiyou, and Trinity counties during 2009-2011 (7,978 trap days). Fishers were the most commonly captured mesocarnivore and represented

[35] Common as in frequently detected by surveys.

39% of all mesocarnivore capture events. The next most frequently captured animals were ringtail (28% of mesocarnivore captures) and gray fox (23% of mesocarnivore captures). (A. Facka, unpublished data).

There are several estimates of fisher population size in northern California. Estimates range from 1,000 to approximately 4,500 fishers statewide. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. He believed the estimate to be useful for general planning and risk assessment. Self et al. (2008) derived two separate “preliminary” estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a “deterministic expert method” and an “analytic model based approach” to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 fishers.

Estimates of the number of fishers in the southern Sierra Nevada indicate the population is small. Lamberson et al. (2000), using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Using previous density estimates (Jordan 2007), data from the USFS regional population monitoring program (USDA Forest Service 2006), and a regional habitat suitability model, Spencer et al. (2008) estimated the southern Sierra Nevada population to contain 160-350 fishers, of which 55-120 were estimated to be adult females. Self et al. (2008) estimated the population size of fishers in the southern Sierra Nevada at 598 animals using their deterministic expert method and 548 animals based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates. More recent work by Spencer et al. (2011) estimated the southern Sierra Nevada fisher population at 300 individuals.

Population Trend in California

No data are available that document long-term trends in fisher populations in California. However, studies in northern California, estimates of fisher occupancy in the southern Sierra Nevada, and genetic studies provide insight into contemporary and historical trends. Tucker et al. (2012:2,7) concluded that fisher populations in California experienced a 90% decline in effective population size[36] more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated Euro-American settlement. No data are available that document long-term trends in fisher populations statewide in California since Euro-American settlement. Population trends over relatively short periods (5-15 years) have been investigated at several study sites in northwestern California, and the southern Sierra Nevada population has been monitored since 2002.

In northern California, Matthews et al. (2011:72) reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. Continued monitoring of this population indicates that the overall the population density had increased by 2012-2013, but only to about half of that estimated in 1998. Modeling based on mark-recapture monitoring at Hoopa from 2005-2013 indicated that the population as a whole was "essentially stable while males are likely increasing and females are possibly increasing" (Higley et al. 2013:29).

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 (Diller et al. 2008). Detection rates increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995,

---

[36] Effective population size describes the size of an "ideal" population that would have the same rate of genetic change as the population being evaluated (Waples 2002:48) and provides a method for calculating the rate of evolutionary change caused by random sampling of allele frequencies in a finite population (i.e., genetic drift) (Charlesworth 2009:195).

lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection rates (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013 (Green Diamond Resource Company, unpublished data). Fishers were detected at 71% of the stations. Of the 7 carnivores documented, only bears were more frequently detected (83%) than fishers (Figure 10). Based on surveys conducted from 1994-2011, Hamm et al. (2012) concluded that fishers were “relatively abundant and well distributed throughout the majority of the ownership”. It is important to note, however, that fisher detection rates at camera stations may not be a reliable indicator of population trends; at the Hoopa Reservation, fisher camera detection rates increased between 1998 and 2005, despite a concurrent and significant decrease in the fisher population density as estimated by a mark-resight technique (Matthews et al. 2011:72).

Swiers et al. (2013:20) collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers (2013) found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of survival and recruitment suggested high population turnover (Swiers 2013:21).

The Department has conducted a large-scale monitoring project for forest carnivores in the Klamath and East Franciscan ecoregions of northwestern California since 2011. Carnivore surveys are conducted using camera traps within forested habitats across a 28,000 km^2 (11,000 mi^2) study area. Occupancy and detection probabilities for fisher were estimated from data collected at 370 survey stations from 2011 to 2014 (Furnas et al. In review). The average occupancy estimate for fisher was 0.414 [90% CI: 0.336-0.469] for camera stations, and 0.632 [90% CI: 0.555-0.718] for pairs of camera stations (i.e., station pairs are 1.6 km (1 mi) apart). The results suggest that fishers are common

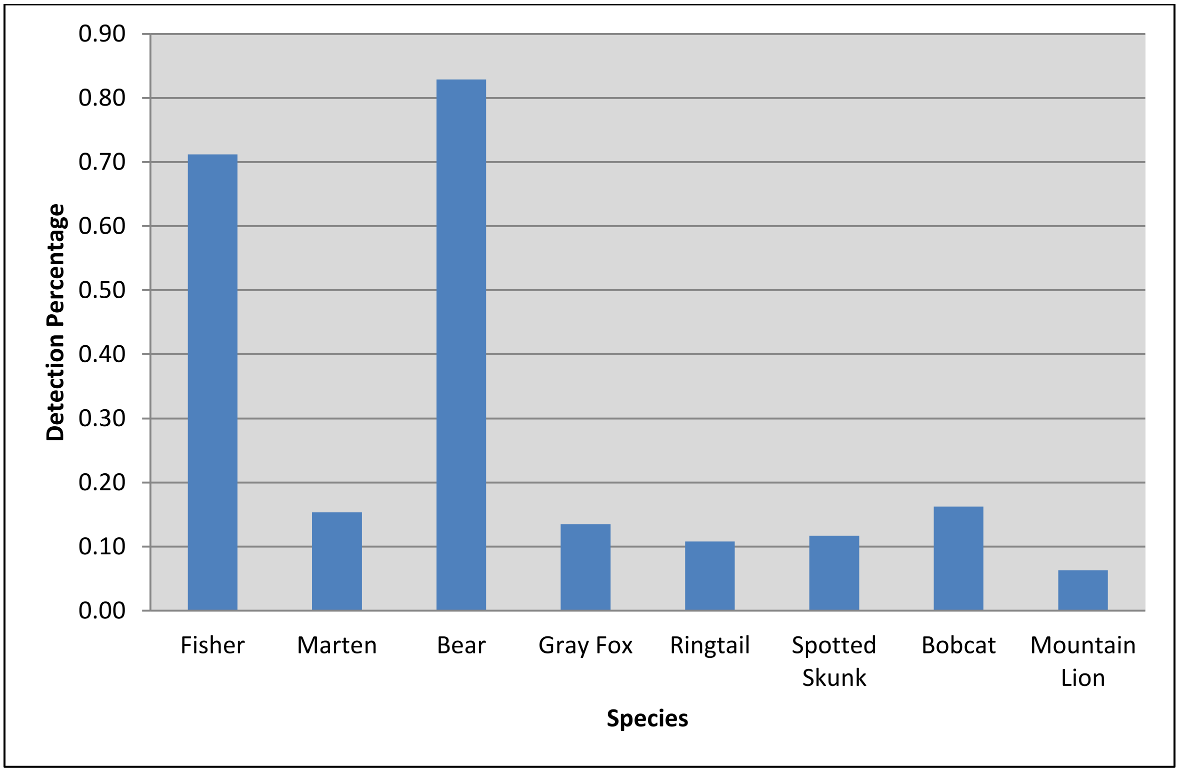


Figure 10. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

(i.e., estimated to occur at about 60% of sample units) and widespread (detected throughout much of the sampled ecoregions) throughout the study area (Figure 11).

Despite genetic evidence indicating a long-standing historical separation of fishers in northern California from those in the southern Sierra Nevada (Tucker et al. 2012), anecdotal evidence suggests fishers occurred in the central and northern Sierra Nevada and the southernmost parts of the Cascades post-Euro-American settlement (Price 1894, James 1915, Our annual catch of furbearing animals. 1916, Winter vs. summer furs. 1917, Butler 1920, Durbin 1925, Grinnell et al. 1937). Their abundance in this region at the time of settlement is unknown. Furthermore, it is possible that by the late 1800s, harvest and habitat changes may have reduced the abundance of fishers in this region to low levels. The relatively few specimens reported taken (and no museum specimens) in this area during the early 1900s (see previous sections for a summary of anecdotal reports) suggest that if present, they were relatively scarce at that time.

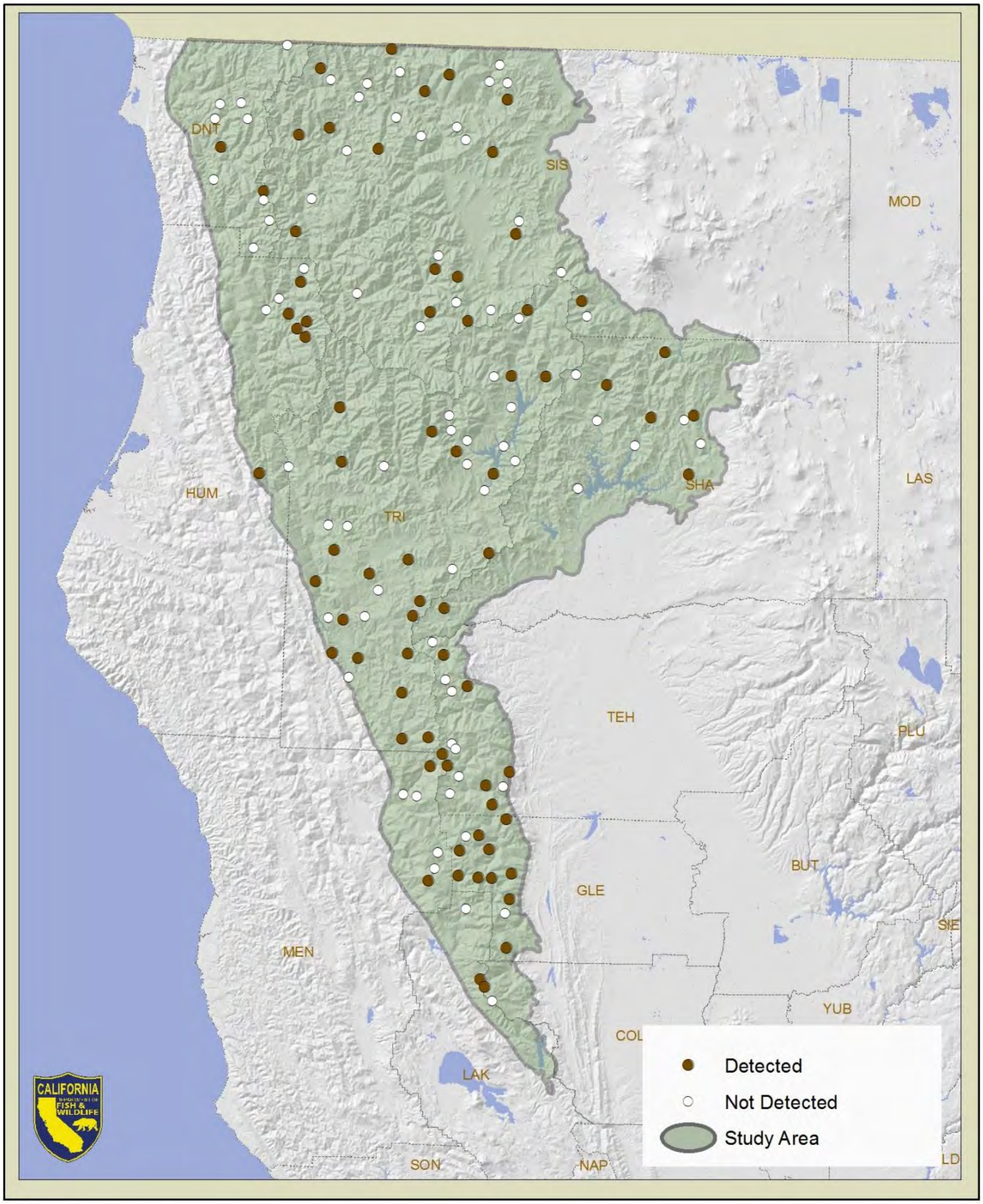


Figure 11. Detections of fishers based on randomly located baited camera trap stations within the Klamath and East Franciscan ecoregions of northwestern California from 2011 through 2013 (Furnas et al. In review). Stations sampled in 2014 are not depicted.

Anthropomorphic changes have been suggested as the likely cause of declining fisher populations in the southern Sierra Nevada during post-settlement (Tucker et al. 2013). Mining and associated human activity in central and northern Sierra was historically extensive (Figure 12). It is likely many miners and other residents of mining camps and towns trapped furbearers to supplement their income. In the early 1900s, Grinnell et al. (1937:11–12) noted that in many rural communities “nearly every boy of school age possesses a few traps which he sets each fall” and also mentioned the efforts of “farm hands, homesteaders, and other persons who use spare time from the usual occupations to tend their lines of traps”. Substantial logging also occurred near these settlements to provide building materials, firewood, and fuel for steam engines (McKelvey et al. 1992:225–227).

In the southern Sierra Nevada, Tucker et al. (2012) also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-Euro-American settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries and descendants of those fishers may have ultimately recolonized the northern parts of the occupied southern Sierra Nevada range. Tucker et al. (2012:10), using genetic techniques, estimated that the total current population size of fishers in northwestern California could range from 258-2,850 and the southern Sierra Nevada population could range from 334-3,380. This similarity in estimates for the size of these populations is surprising, given that the northern population is believed to be larger in total size than the southern Sierra population (Tucker 2013*b*:20).

Zielinski et al. (2013*a*) implemented a monitoring program for fishers in the southern Sierra Nevada over an 8 year period (2002-2009). They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest on the Kern Plateau in the southeastern Sierra Nevada (0.261) and highest on the west slope of the southernmost Sierra Nevada portion of their study area (0.583) (Zielinski et al. 2013*a*:8). They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra Nevada did not appear to be declining. This result should be interpreted cautiously, however, as trends in occupancy

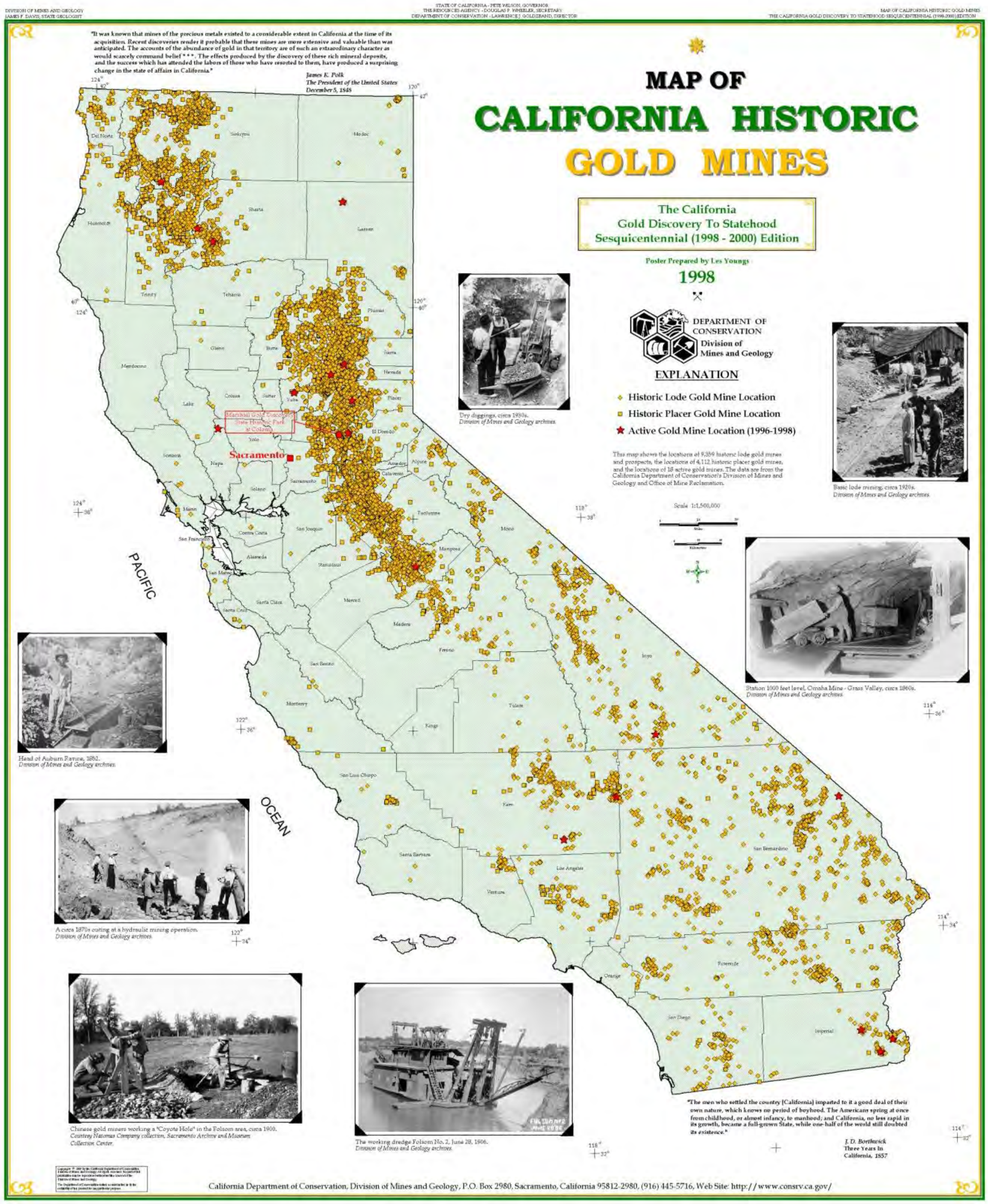


Figure 12. Historical gold mines in California (pre-1996).

may not always be an effective proxy for trends in abundance. Tucker (2013) simulated the ability of a comparable sampling scheme to detect modeled population declines. The results indicated that the relationship between fisher abundance and occupancy were not linear; simulated population declines of 43% and 17% resulted in declines in occupancy estimates of 23% and 6%, respectively. Tucker (2013) concluded that over an eight year period the southern Sierra Nevada fisher monitoring program would likely be able to detect a severe decline, but not a “slower reduction” in size.

Sweitzer et al. (2015) estimated the population size, density, and other demographic parameters of fishers in the northern portion of the southern Sierra Nevada. No trend in fisher population density was detected during 2008-2012. However, based on observed reproductive rates and fisher survival data during the same period, Sweitzer et al. (2015) estimated a slightly negative population growth rate (λ) of 0.97. Although the upper range population growth estimate ($\lambda = 1.16$) suggested stability or growth in some years, the authors noted the overall population trend in conjunction with no increase in density and a small population size warranted concern for their regional viability. Modeling also suggested that a 10% increase in fisher survival would result in a positive population trajectory ($\lambda \approx 1.06$) (Sweitzer et al. 2015).

Factors Affecting the Ability of Fishers to Survive and Reproduce

Population Size and Isolation

Grinnell et al. (1937), considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. Few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century (Zielinski et al. 1995, Drew et al. 2003:59). However, recent work by Knaus et al. (2011) and Tucker et al. (2012) indicates fishers in the southern Sierra Nevada became genetically isolated from northern California populations long before Euro-American settlement. Tucker et al. (2012) concluded the fisher's effective population size in California declined approximately 90% over 1,000 years ago and also hypothesized the fisher distribution in California contracted to the two currently occupied areas prior to Euro-American settlement.

Tucker et al. (2012) pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene (Barnosky et al. 2004); isolation at this time would be consistent with the suggestion of divergence dates of fisher populations in California reported by Knaus et al. (2011) that California fisher populations might have diverged approximately 16,700 years ago. However, in California there were two "mega-droughts" during the Medieval Warm Period that lasted over 200 and 140 years each (832-1074 and 1122-1299 AD, respectively). These droughts may have caused fisher populations to contract, isolating (or further isolating) the northwestern population from fishers in the Sierra Nevada (Tucker et al. 2012:10).

In addition to the apparent early contraction of fisher populations in California, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19th century and early 20th century (Tucker et al. 2012:8). Campbell (2004:4,23) suggested that the absence of fishers from the central Sierra Nevada may have been related to habitat changes (anthropogenic or stochastic) that occurred in the region causing a shift from forests characterized by large, old, widely spaced trees, to dense, mostly even-aged stands of younger, smaller trees. She also hypothesized that differences in human presence and the number of roads in the central Sierra Nevada may explain the absence of fishers from that region. Tucker et al. (2012) suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20th century while the fisher population in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable from 2002 to 2009 (Zielinski et al. 2013*a*:10).

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. The results of recent surveys suggest that fishers in the southern Sierra Nevada have expanded their range northward (Tucker et al. 2014:131). In the 1990s, fishers were routinely detected by surveys in the central and southern portions of the SSN ESU, but were rarely detected in the northern portion of the ESU. More recent surveys (Tucker et al. 2014:131) detected fishers considerably more frequently in the northern portions of the ESU, perhaps indicating that fishers have expanded their range in this region. Although fishers appear to have expanded their range within the SSN ESU in recent time, the population remains effectively isolated from fishers elsewhere in California. Should fishers in the southern Sierra Nevada expand their range north of the Merced River, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, contact in the near-term (50 years) though natural dispersal is unlikely. Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population (Tucker et al. 2012, Tucker 2013*a*:11).

Although fishers in northern California are effectively isolated from fishers in the southern Sierra Nevada, they form the core of a regional population that occurs in eight California counties in six USDA ecoregions (eleven counties and seven ecoregions if the translocated animals near Stirling City are considered) and also extends into southwestern Oregon (Curry, Josephine, and Jackson counties). A fisher that was marked by researchers in Oregon was subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California (Drew et al. 2003, Aubry et al. 2004, Wisely et al. 2004*b*, Farber et al. 2010).

Powell and Zielinski (2005) used the population matrix modeling software VORTEX to evaluate the potential population-level effects of removing fishers from northwestern California for translocation In the process, they also estimated the probability that fishers would become extinct in northwestern California as well as the southern Sierra Nevada during a 100 -year modeling period. Assuming an initial population size of 1,000 fishers in northwestern California and a carrying capacity of 2,000 (±250) animals, Powell and Zielinski (2005) calculated a 5 percent probability of population extinction over a 100 year modeling period. They also calculated the probability of extinction for the southern Sierra Nevada fisher population, using an estimated carrying capacity of 400 fishers, to be 15%. Powell and Zielinski (2005) cautioned that they used estimated probabilities of extinction as an index of population viability, not as dependable estimates of that probability and advocated additional study of fishers in northwestern California to validate their modeling assumptions.

The fisher population in the SSN ESU is likely at greater risk of extirpation than fishers in northern California, due to its small population size, limited geographic range, narrow and linear configuration of available habitat, and isolation. The fisher population in the southern Sierra Nevada may be comprised of fewer than 300 adults (Spencer et al. 2015:7) which, coupled with its isolation, increases its vulnerability to stochastic (random) environmental or demographic events, including catastrophic fire or disease. Small populations are also at greater risk from the loss of genetic diversity, including inbreeding depression (Shaffer 1981).

Present or Threatened Modification or Destruction of Habitat

Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires (Powell and Zielinski 1994, Lewis and Stinson 1998). Buskirk and Powell (1994) found that at the landscape scale, the abundance and distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic (Buskirk and Powell 1994:296, Jones and Garton 1994:384, 386, Zielinski et al. 2004*b*:485, Weir and Corbould 2008:127, Davis 2009:88, 92, Purcell et al. 2009, Lofroth et al. 2010:102) and the home ranges of fishers often include high proportions of mid- to late-seral forests (Raley et al. 2012).

Timber Harvest: Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age composition and structural features of many forests in California. Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. Habitat degradation resulting from timber harvest could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected or through a reduction in key habitat elements.

Generally, timber harvest has substantially simplified the species composition and structure of forests (Franklin et al. 2002:417–418, Thompson et al. 2003:448–449). Habitat elements used by fishers such as microstructures for denning can take decades to develop. It is possible that the density of those elements has been substantially reduced and fisher fitness in those areas may have consequently declined. Timber harvesting often creates non-forested areas (e.g., newly harvested clearcuts) that often have little canopy cover for at least a decade after harvest and subsequent reforestation (James et al. 2012:62). Fishers are known to select against non-forested areas (Jones and Garton 1994:382) and in British Columbia a 5% increase in open areas within a potential fisher home range over 12 years was estimated to decrease its probability of occupancy by 50% (Weir and Corbould 2010:407). Those findings notwithstanding, fishers are regularly detected on industrial timberland ownerships in northern California where clearcuts are commonplace (Reno et al. 2008, Farber et al. 2010, Hamm et al.

2012, Powell et al. 2013, Swiers 2013) and industrial timberland forms the core area for a newly established fisher population in Butte County (Powell et al. 2013). The fitness of fisher populations in these areas is largely unknown, although ongoing study of the translocated population in Butte County (e.g., Powell et al. (2013)) should provide substantial insight regarding fisher habitat use and quality in an intensively managed area.

Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Of the historical range of the fisher in California estimated by Grinnell et al. (1937), nearly 61% is in public ownership and about 37% is privately owned (Figure 13). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (Figure 14). Private lands within the NC ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 15). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades (USDA 2014). Sawtimber volume[37] harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 16 and 17). Still, timber harvesting historically removed some older forest elements (e.g., large trees for resting of denning) used by

---

[37] Sawtimber volume equaled the net volume in board feet of sawlogs harvested from commercial tree species containing at least one at least one 3.7 m (12 ft) sawlog or two noncontiguous 2.4 m (8 ft) sawlogs.

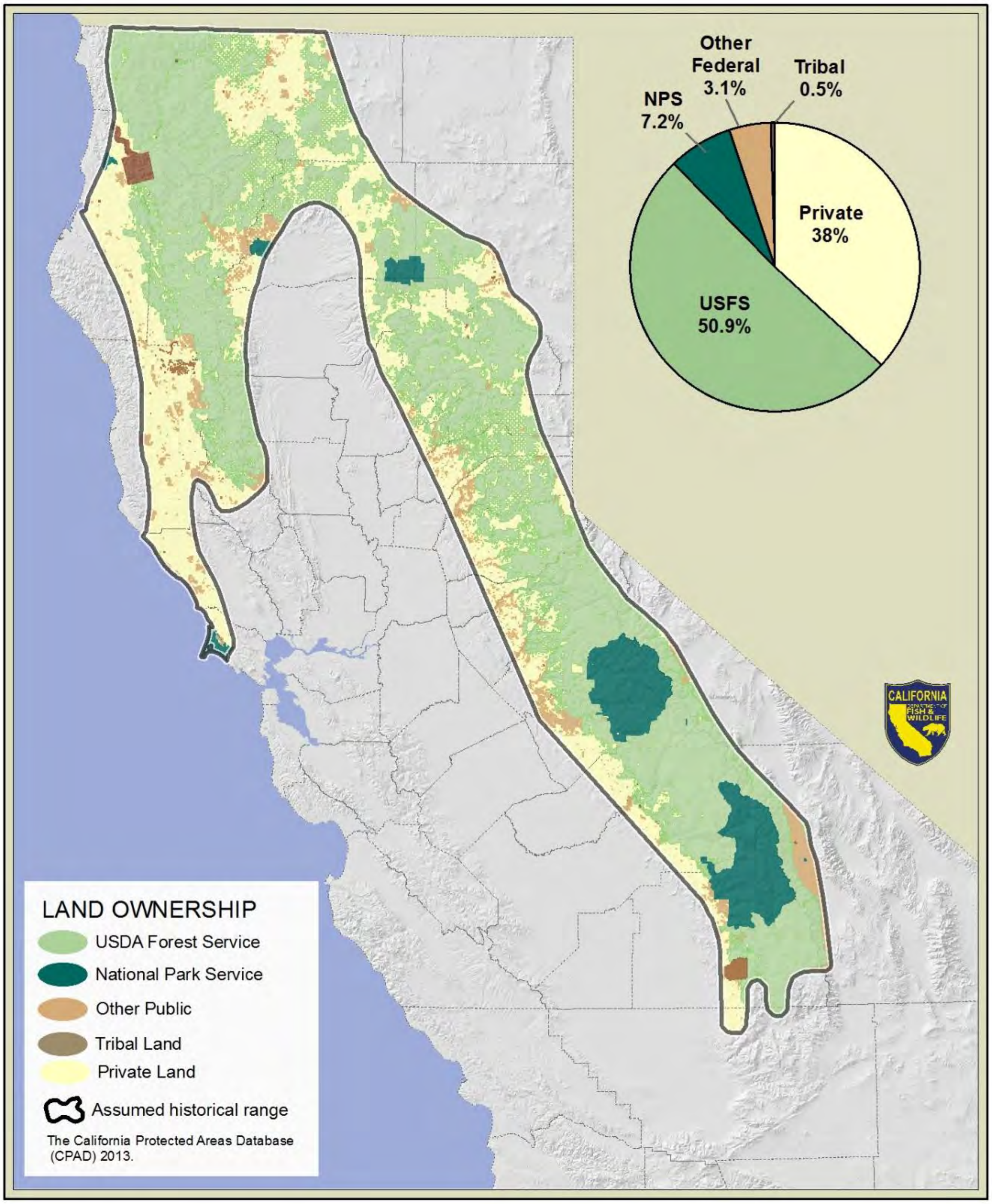


Figure 13. Landownership within the historical range of fishers depicted by Grinnell et al. (1937). California Department of Fish and Wildlife, 2014.

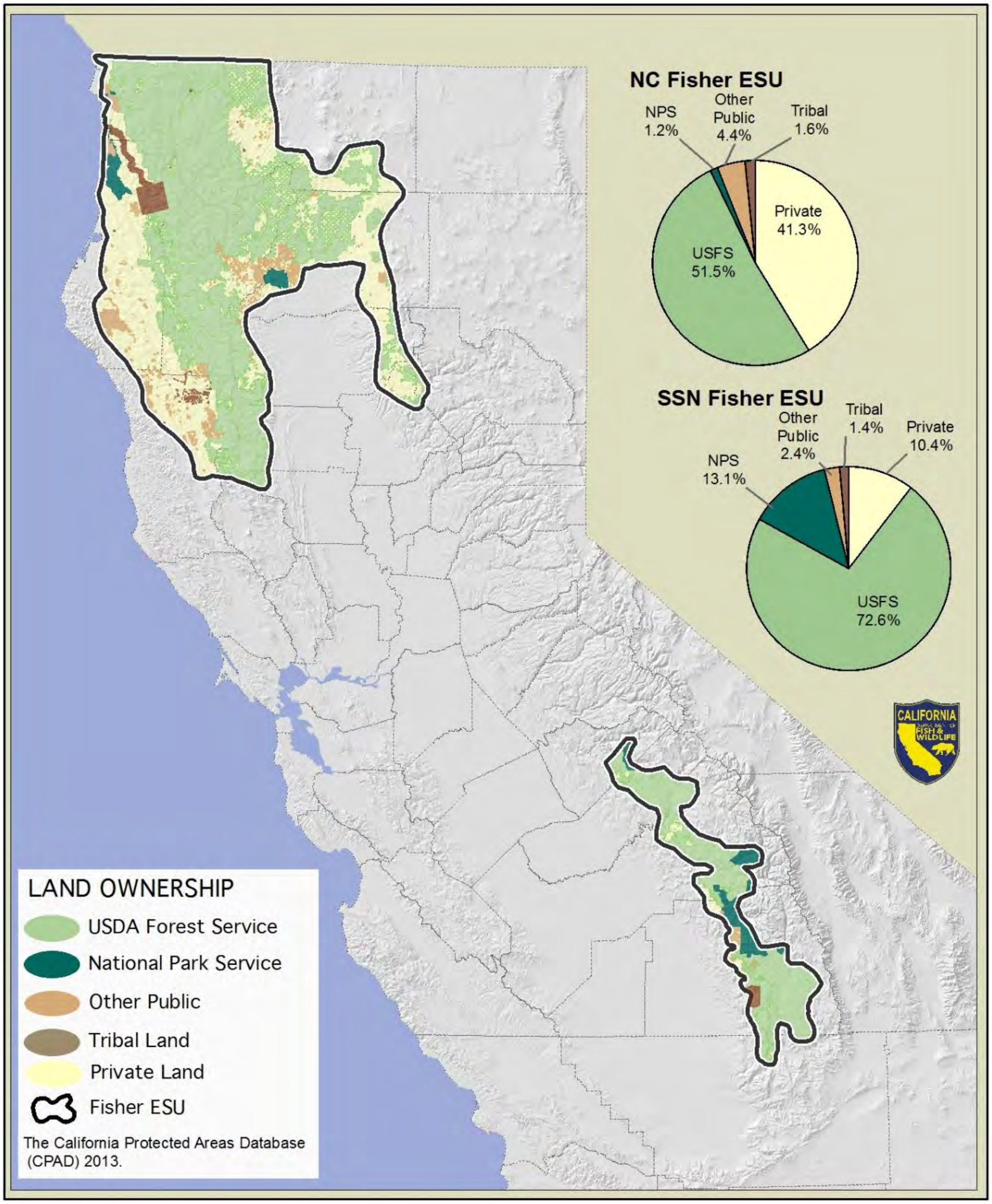


Figure 14. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

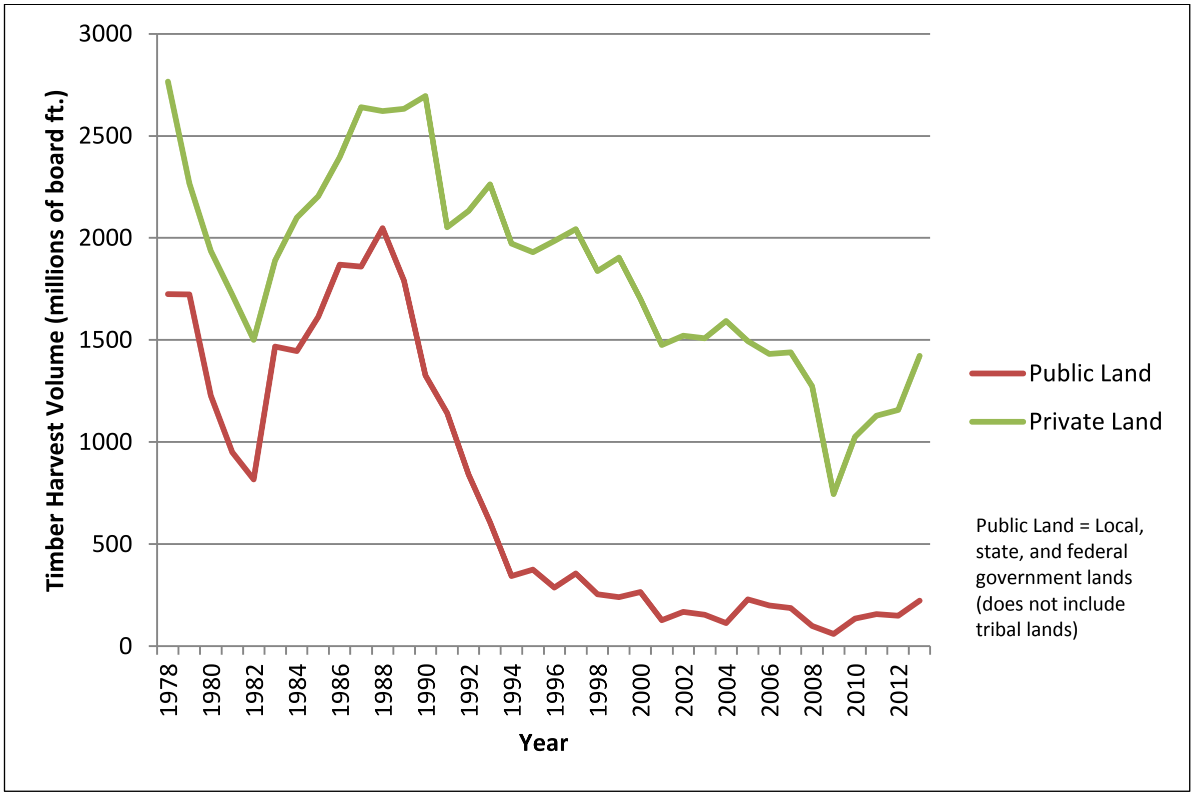


Figure 15. Volume of timber harvested on public and private lands in California (1978-2013) (California Timber Harvest Statistics n.d.).

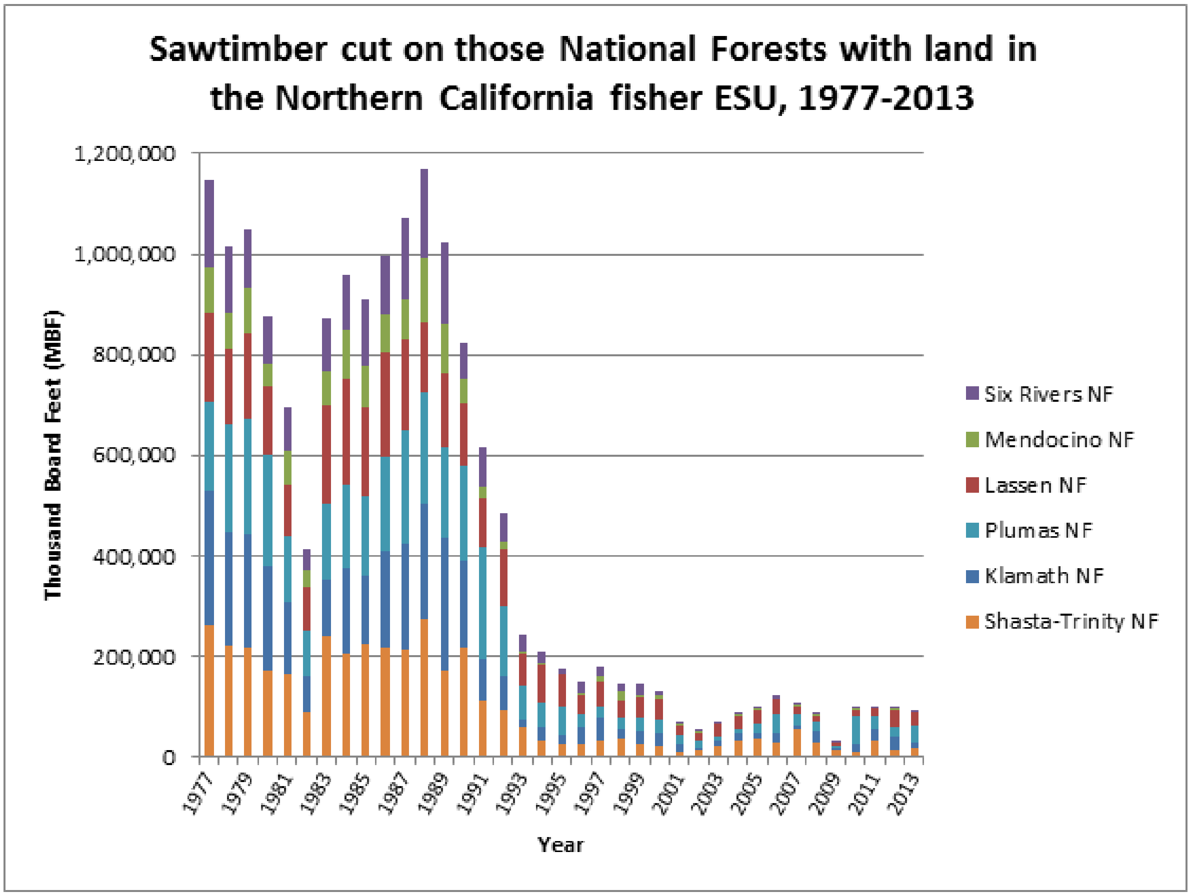


Figure 16. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 (USDA 2014).

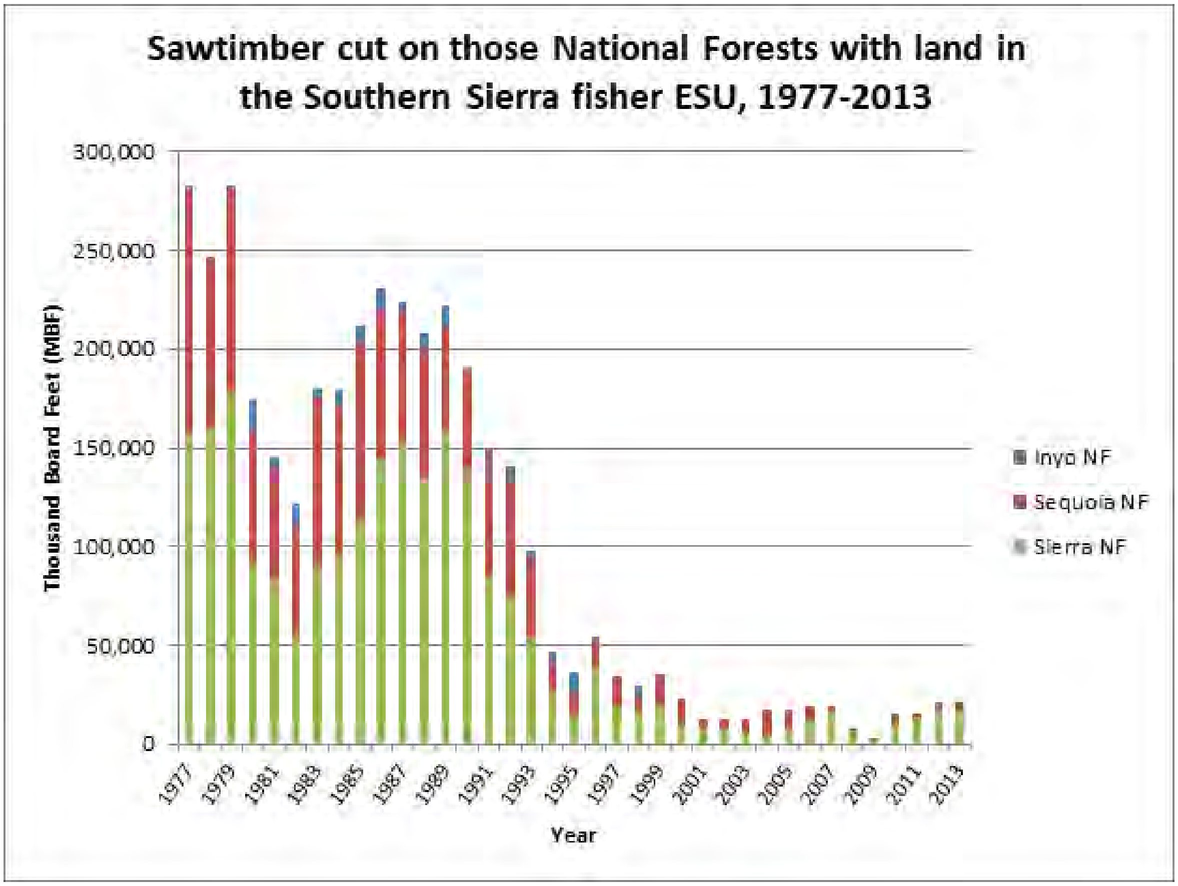


Figure 17. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 (USDA 2014).

fishers and insufficient time has transpired for those trees to be replaced through harvest rotations.

Fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been and are being intensively managed primarily for timber production, including industrial ownerships where ongoing intensive even-aged management is the norm. The long-term viability of fishers across their range in California will depend on the continued presence of suitable denning and resting sites and habitats capable of supporting foraging activities. While such structures and habitats are critical to fisher reproduction and survival, the Department is not aware of evidence indicating that habitat modification resulting from timber harvesting and forest management is currently limiting fisher populations in California.

Fuels Treatment: Decades of fire suppression has led to substantial accumulations of woody fuels in forests and increased the risk of large-scale catastrophic fires within the range of fishers in California. In some cases, the absence of fire has resulted in the development of dense and structurally complex forests used by fishers. Vegetation management projects designed to reduce wildfire fuel loads can degrade fisher habitat by removing forest structures important to fishers, decreasing canopy cover, reducing understory vegetation, and vegetation diversity (Naney et al. 2012:12).

Fuels reduction treatments designed to reduce the risk of catastrophic fires have become a priority for federal land management agencies (Truex and Zielinski 2013). Land managers tasked with reducing the risk of fire in forests and with conserving wildlife are challenged by implementing effective fuels treatments while meeting conservation goals for fisher populations (Garner 2013).

Although the effects of fuels treatments on fishers is largely unknown in northern California, a number of studies have examined the effects of fuel treatments on fishers within the SSN ESU (Powell and Zielinski 2005; Thompson et al. 2011; Garner 2013; Truex and Zielinski 2013; Zielinski et al. 2013b). Garner (2013) reported that the home ranges of fishers radio-collared for the Kings River Fisher Project tended to include a greater proportion of sites treated for fuel than the landscape overall, but fishers tended to avoid sites within 200 m (656 ft) of treated areas in favor of untreated forest. Truex and Zielinski (2013) evaluated the effect of fuels treatments on fishers by predicting resting and foraging habitat value at two sites in the Sierra Nevada. They reported that the type of treatment and timing of treatment affected the predicted value of resting habitat for fishers. Reductions in canopy cover adversely affected the value of resting habitat, but foraging habitat was unaffected by fuels treatments at either study site.

Thompson et al. (2011) simulated the effects of fuels treatments and fire on the home ranges of female fishers within two management units in the Sierra National Forest (compared to the existing distribution of vegetation attributes found within the home ranges of female fishers in the area). Conditions in the untreated or “no action” simulation remained relatively unchanged for about 30 years before habitat heterogeneity declined due to forest succession and habitat conditions began to deviate from those found within currently occupied home ranges. The authors did not speculate as to whether those changes would represent a reduction or an increase in habitat quality. In comparison, a simulated fuel treatment (thinning from below with an 89 cm (35 in) maximum dbh harvest) reduced the distribution of some forest elements below those found within current female home ranges, but resulted in little overall change in habitat suitability. Adding a large simulated wildfire to each scenario resulted in divergence from the reference conditions, with far greater effects in the "no action" (unthinned) simulation.

Zielinski et al. (2013*b*) investigated the tolerance of fishers to the amount of management-related disturbance predicted by fire ecologists that would be needed to reduce the rate at which fires spread and the severity of fires in the southern Sierra Nevada. Disturbance types included thinning, prescribed fire, or timber harvest (e.g., clear cutting, selection harvest). Their findings suggested that areas where disturbance was relatively low (2.6% annually) were consistently occupied by fisher at the highest rate of use. This relatively low level of disturbance was more than predicted by fire experts as needed to reduce fire spread and severity in the southern Sierra Nevada, but less that predicted to be necessary by fire models in other geographic areas (Zielinski et al. 2013*b*). The authors suggested that it may be possible to treat fuels at an extent and rate that achieves fire modeling goals and does not affect occupancy by fishers. Zielinski et al. (2013*b*) cautioned, however, that restorative treatments to reduce fire spread and severity should consider the protection of large conifers and large hardwoods used for denning and resting as well as maintenance of habitat connectivity.

In fire-prone forest types in the southern Sierra Nevada, the risks of carefully considered forest management to sensitive species including fishers is lower than the risks of inaction and continued suppression of fires (North et al. 2009:26). This assessment was supported by Scheller et al. (2011:1499) who modeled the effects of wildfires and fuels management on fisher habitat and population size. They concluded that the positive effects of treatment of fisher habitat exceeded short-term negative effects and indicated that these potential benefits may be particularly important if wildfires become larger and more severe. Generally, it appears that the treatment of fuels within forests in the southern Sierra Nevada to reduce the risk of catastrophic fire and maintain habitat suitable for fishers, provide important habitat elements (e.g., large conifers and hardwoods used for resting and denning) could be accomplished while maintaining habitat connectivity (Garner 2013, Zielinski et al. 2013*b*). Nevertheless, Scheller et al. (2011:1501) advocated a precautionary approach to implementing fuels treatments in areas where they would be maximally effective at reducing fire and/or minimally reducing fisher habitat quality. They also emphasized the large uncertainty in their projections due to stochastic spatial and temporal dynamics of wildfires and fisher populations.

Fire: Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s (Stephens and Sugihara 2006:433). In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression (Stephens and Sugihara 2006:433). In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok (1923) who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act that established fire exclusion as a national policy and formed the basis for USFS and National Park Service policies of absolute suppression of fires until those policies were reconsidered in the 1960s (Stephens et al. 2007:212).

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 1,020 km^2/year (394 mi^2/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 (Stephens et al. 2007:212). Prior to Euro-American settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting (Taylor and Skinner 1998:288) and to reduce catastrophic fires (Anderson 2006:417). Fires set by indigenous people and fires started by lightning have been estimated to have burned from 23,000 km^2 to more than 53,000 km^2 (8,880 mi^2 to more than 20,463 mi^2) annually in California (Martin and Sapsis 1992:150, 152). Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity (USDA 2015) (Figures 18 and 19).

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more

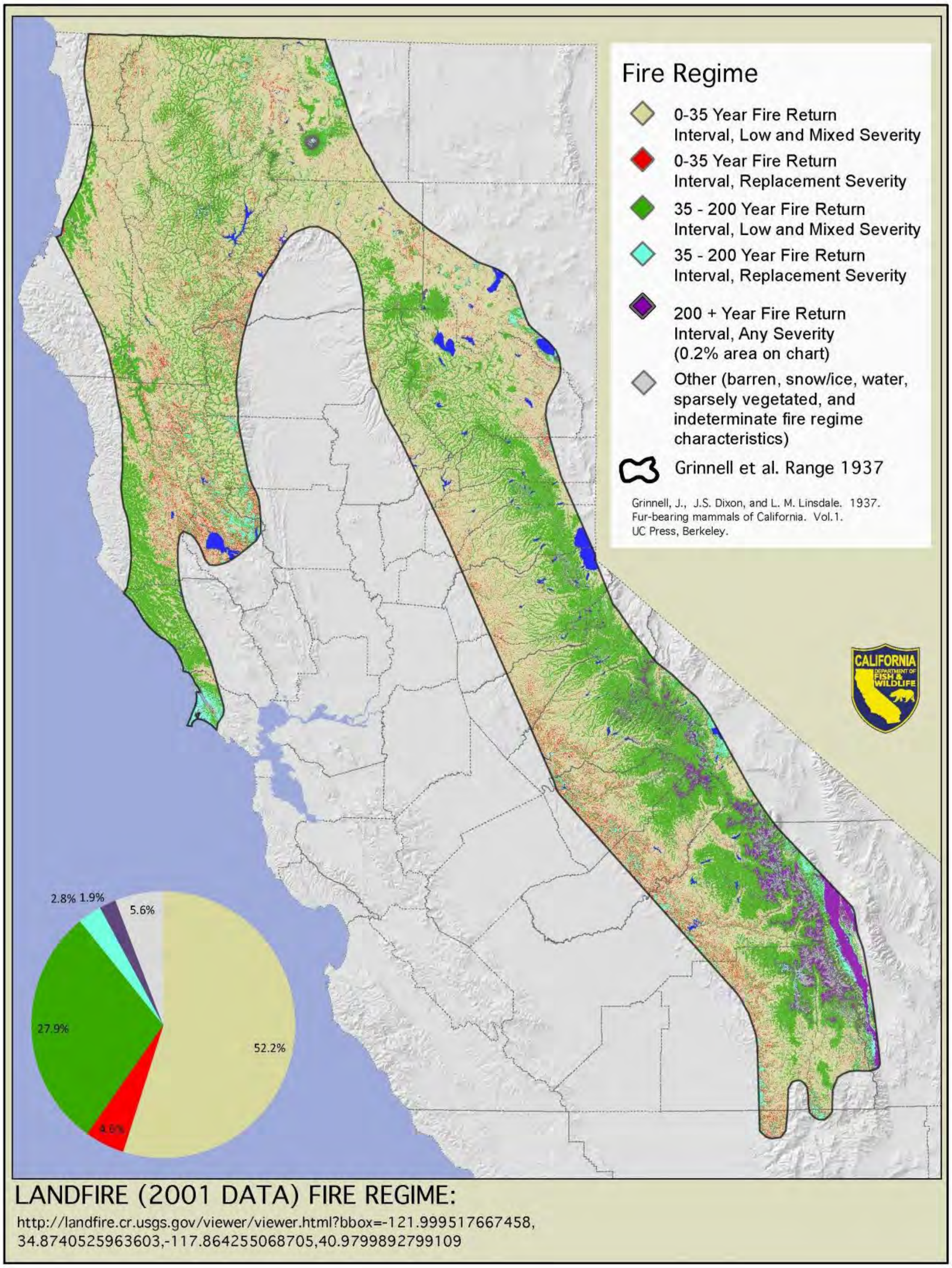


Figure 18. Presumed historical fire regimes within the historical range of fishers in California described by Grinnell et al. (1937). Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools (USDA 2015). California Department of Fish and Wildlife, 2014.

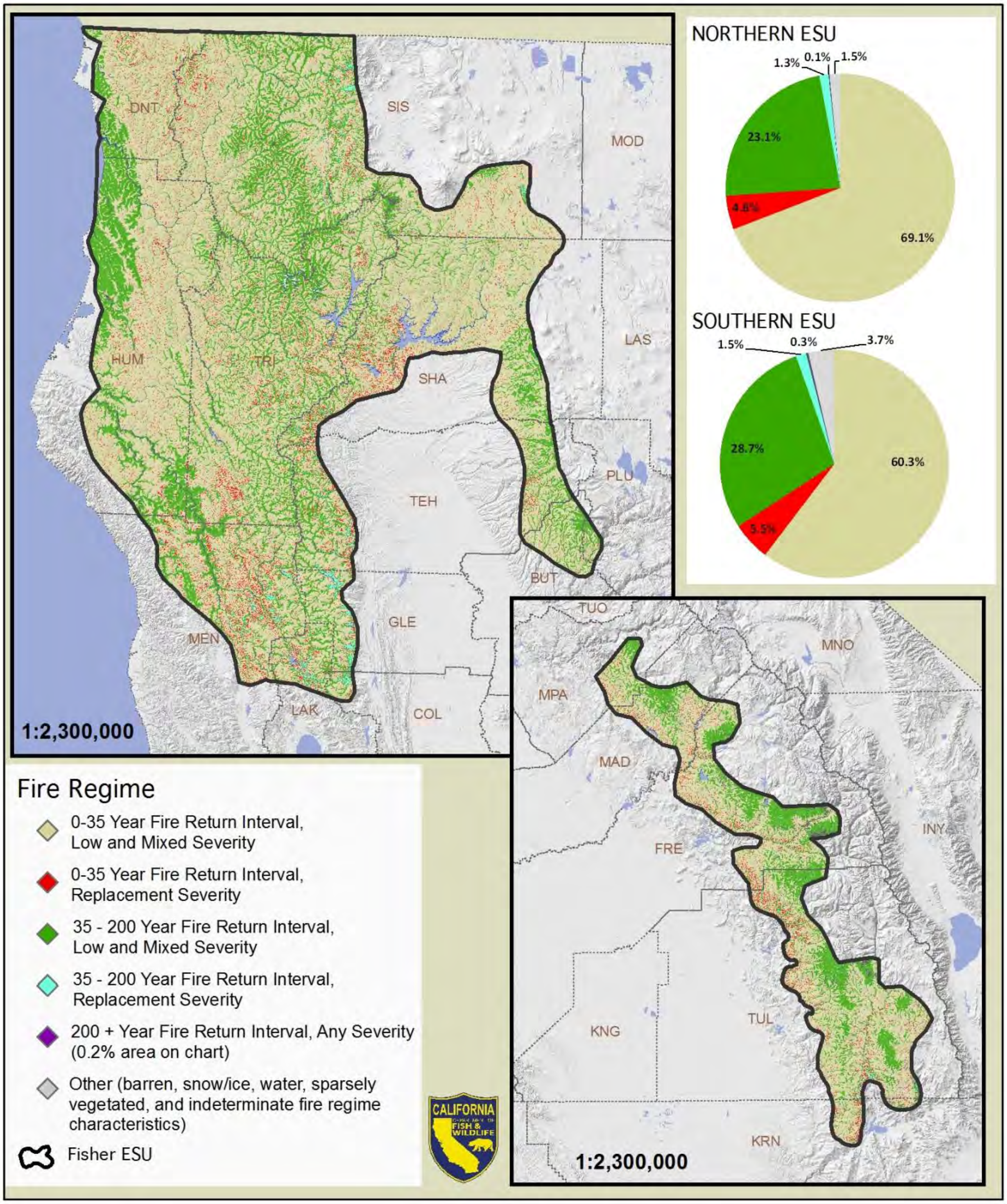


Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools (USDA 2015). California Department of Fish and Wildlife, 2014.

frequent (Miller et al. 2009:16). Westerling et al. (2006:941) found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fishers in California.

The large mixed severity fires in recent years have contributed to concerns that fire exclusion has created an unprecedented threat of uncharacteristically severe fire (Odion et al. 2014:1). To evaluate historical fire regimes in portions of western North America Odion et al. (2014)), compiled evidence of fire severity patterns in ponderosa pine and mixed-conifer forests. This included the Klamath Mountains, southern Cascades, and Sierra Nevada of California. Odion et al. (2014:12) suggested that mixed-severity fire regimes (e.g., fires that included low-, moderate-, and high severity effects) historically were the predominant fire regime for most ponderosa pine and mixed-conifer forests of western North America. They reported that prior to Euro-American settlement and fire exclusion, these forests exhibited much greater structural and successional diversity influenced by ecologically significant amounts of weather-driven, high-severity fire than has typically been assumed.

Baker (2014) tested a number of hypotheses about historical forest structure and fires using General Land Office survey data across 3,300 km^2 (1,274 mi^2) of Sierra mixed-conifer forests in the western Sierra Nevada. Baker (2014) concluded that a number of lines of evidence (early scientific reports, aerial photography, tree-ring reconstructions, analysis of General Land Office surveys in the late 1800s, and age-structure analysis) indicated that high-severity fire and dense forests were a substantial component of historical forests in the Sierra Nevada. Low-severity fire represented only 13% of the northern and 26% of the southern Sierra Nevada (Baker 2014:18). Open forest conditions in the Sierra Nevada represented only 23% of the northern and 33% of the southern Sierra Nevada (Baker 2014:22). Dense forests historically comprised 65% of the northern and 46% of the southern Sierra Nevada and the landscape was not dominated by large trees (i.e., trees exceeding 60 cm (24 in) in diameter. Trees of that size only comprised about 21% and 33% of the northern and southern Sierra Nevada, respectively (Baker 2014:24). Thus, forests in the Sierra Nevada were not largely park-like, but instead were mostly densely vegetated, prone to fires of high- and mixed-severity which, coupled with topography, contributed to a heterogeneous forest structure (Baker 2014:26). Steel et al. (2015) characterized Baker's work as "controversial" and questioned Baker's techniques and findings. The authors also came to different conclusions about historical fire severity in many California forests. Steel et al. (2015) found that the area currently burned at high severity in mixed conifer and mixed evergreen forests (26% and 17%, respectively) is much higher than prior to Euro-American settlement (2-8%). Their work supported the notion that lack of fire in these forest types leads to higher rates of high-severity burning.

Wildfires affect habitats used by fishers and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, the size individual fires, and the geographic location of fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, create habitat conditions that favor predators of fishers, inhibit dispersal, and isolate local populations of fishers. There is little scientific information about the use of burned areas by fishers, but evidence from studies of habitat use and demographics suggests that fishers cannot meet all life requisites within large areas burned by high severity fires (Spencer et al. 2015:59). Wildfire may benefit fishers if it enhances prey populations or have negative effects if it results in a categorical loss of fisher habitat (Hanson 2013:24). In northern California, fisher occupancy and abundance based on random camera trap surveys were associated with the percentage of the 10-km (6.2 mi) radius area surrounding each survey station that had burned over the preceding 50 years (Furnas et al. In review). Both metrics were maximized when approximately 40% of the surrounding area had burned, which was greater than the average frequency (25%) of fire across the study area for these spatial and temporal scales.

High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. (2006:11), believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey. Nevertheless, fire is an important component of landscapes that shapes forest structure, vegetation communities, and the availability of habitat elements important to many species of wildlife. Fire scarring of trees can produce conditions that allow decay organisms to facilitate the formation of cavities (Carey 1983:178) and may provide suitable den sites for fishers (Lofroth et al. 2010:115). In the coastal redwood region on lands managed by Green Diamond Resources, the majority of tree cavities used by fishers as dens result from fire scars. The lack of fire in this region will likely result in the loss of late seral habitat elements important to fishers (L. Diller, pers. comm.)

In the Sierra Nevada, wildfire severity and the extent of area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy (Miller et al. 2009:16). Miller et al. (2012:185) also examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased. However, they found no significant trend in fire severity during the analysis period.

Within the NC ESU, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) in 1992, near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged burned trees and replanted seedlings rapidly after the burn (Zhang et al. 2008). In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, Sierra Pacific Industries unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fishers using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly within areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm.).

In 2013, the Rim Fire burned approximately 1,040 km^2 (402 mi^2) in Tuolumne County and was situated just north of the SSN ESU. This human-caused fire resulted in contiguous areas of stand-replacing fire greater than 12,140 ha (30,000 ac) and represents the largest fire recorded in the Sierra Nevada (USFS unpublished data, cited by Spencer et al. (2015:59)). Approximately 35% of the fire area burned at high severity and another 27% burned at moderate severity. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra Nevada population until the vegetation recovers sufficiently to facilitate its use by fishers. Large areas that burned at high severity during the Rim Fire, resulted in a shift in potential dispersal habitat eastward to higher-elevation forests that did not burn at high severity (Spencer et al. 2015:56). In 2013, the Aspen Fire burned 93 km^2 (36 mi^2) within portions of the southern Sierra Nevada occupied by fishers. This fire burned in a mosaic of mostly low to moderate severity, which some patches that burned at high-severity (Spencer et al. 2015:47).

Despite the occurrence of some large, high intensity fires in the southern Sierra Nevada in recent years (e.g., Rim Fire, Aspen Fire), wildfires in the region are generally heavily suppressed. Hanson (2013:25), investigated fisher habitat using scat detector dogs in the northern Kern Plateau in the southern Sierra Nevada, the majority of which was affected by several large fires of mixed-severity. He did not find evidence of a categorical adverse response of fishers to these large fires which had burned 10-12 years prior to his study. Detection rates for fishers were similar between dense, mature/old mixed conifer forest that had burned with moderate/high severity and unburned dense, mature/old mixed conifer forest. Hanson (2013:27–28) suggested that moderate/higher-severity fire in mature/old forests with moderate to high pre-fire canopy cover was beneficial to fishers due to their high structural complexity and density of prey. Spencer et al. (2015:59) however, was critical of Hanson's work and believed that no conclusions could be made regarding the effects of moderate or severe fire on fisher habitat use. Spencer and his coauthors believed that Hanson did not sample large areas burned at moderate to high severity sufficiently and, therefore, could not draw conclusions about the use of those areas by fishers.

Lawler et al. (2012) predicted that fires will be more frequent but less intense by the end of the 21st century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods (Fried et al. 2004). Westerling et al. (2011:S447), modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California and, in the Sierra Nevada, projected increases were greatest in mid-elevation sites on the west side of the range (Westerling et al. 2011:S459). The authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predictions for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover (Mckenzie et al. 2004:898, Safford 2006:11, Krawchuk and Moritz 2012).

Drought and Insects: An emerging issue in California forests is the mortality of conifers from the effects of prolonged drought and the interaction of drought-stressed trees with insect pests. California's forests are subject to damage from a variety of native insects (bark beetles, wood borers, and defoliators), and increasingly from non-native forest pests (CDF 2010). California forests have experienced bark beetle and woodborer outbreaks nearly every decade since 1949, with the most recent significant outbreak in the mountains of southern California in the early 2000s (CDF 2010). Drought-related insect outbreaks have the potential to alter the structure of large areas of conifer forests. The California Department of Forestry and Fire Protection recently determined that 1.7 million acres of Sierra Mixed Conifer forest was in need of restoration following forest pest infestations, and that the majority of pest-damaged forest was found in the Sierra Nevada, Modoc, and Klamath-North Coast regions (Ibid.).

It is not possible to precisely predict how changes in California's climate will affect forest pests, but a warmer, drier climate would be expected to result in increased overwinter survival of insect pests and a decreased capacity of host trees to repel invading insects (Lawler et al. 2012, Trotter 2013). More complicated relationships between forests, insects, and climate were identified by Trotter (2013), including changes in forest pest organism's geographic distributions, changes in the reproductive capacity of forest pests (e.g. increases in the number of generations produced per year), changes in the synchrony between hosts, pests, and predators, and changes in fire regimes. The interaction between climate, forests, insects, and fire appears to already be driving rapid ecosystem changes in western forests, and appears to have resulted in significant changes in pine (*Pinus* spp.) distribution in the southwestern United States (Lawler et al. 2012). On small scales the mortality of conifers could be expected to improve fisher habitat by providing resting, foraging, and denning structures; however conifer mortality on a large scale would degrade fisher habitat and increase the likelihood of habitat loss from large, severe fires (Ibid.).

Recent (spring of 2015) surveys of the southern Sierra Nevada have detected a dramatic increase in tree mortality from insect outbreaks, primarily in pine trees at lower elevations (USDA 2015). Mortality in southern Sierra pines is largely attributed to western pine beetle (*Dendroctonus ponderosae*) attacks which are estimated to have killed more than five million trees on the Sierra and Sequoia national forests alone (Ibid.). As the southern Sierra received below average precipitation over the winter of 2014/2015 it appears likely that insect outbreaks will expand over the coming summer, and may reach a level that substantially impacts fisher habitat in the southern Sierra.

Human Population Growth and Development: The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance, from 1970 to 2010 (CDOF 1991, 2011) the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state (CDOF 2013*a*) and those numbers are expected to reach approximately 53 million by 2060 (CDOF 2013*b*), an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average (Bunn et al. 2007).

The California Department of Forestry and Fire Protection (CAL FIRE) has estimated that statewide, between 2000 and 2040, about 10,500 km^2 (4,054 mi^2) of private forests and rangelands will be impacted by new development (FRAP 2003:7). New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 3,600 km^2 (1,390 mi^2). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fishers was comparatively low (6%).

By 2030, within the NC and SSN ESUs, human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 20, Table 1). This represents an increase of about 1% in the area developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because most parcels of that size will likely provide some fisher habitat post-development.

Within the NC ESU, most future development is projected to occur in habitats predicted to be of intermediate or high value to fishers however, it is not expected to exceed approximately 2.2% of the NC ESU (Table 2). Similarly, within the SSN ESU, most future development is projected to occur within intermediate and high value habitats for fishers, but this represents less than 3% of the total ESU area (Table 2).
Fishers in the SSN ESU occur in a relatively narrow band of habitat that extends in a north-south corridor in the Sierra Nevada. Development predicted to occur In the vicinity of Shaver Lake in the southern Sierra Nevada by 2030, could adversely affect fishers if it creates a barrier to their dispersal through this region (Figure 20).

Duane (1996:229–330) identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, exposure to toxicants, entrapment in structures, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 21, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). Fishers have occasionally been discovered to have died after becoming entrapped in structures such as uncovered water tanks. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

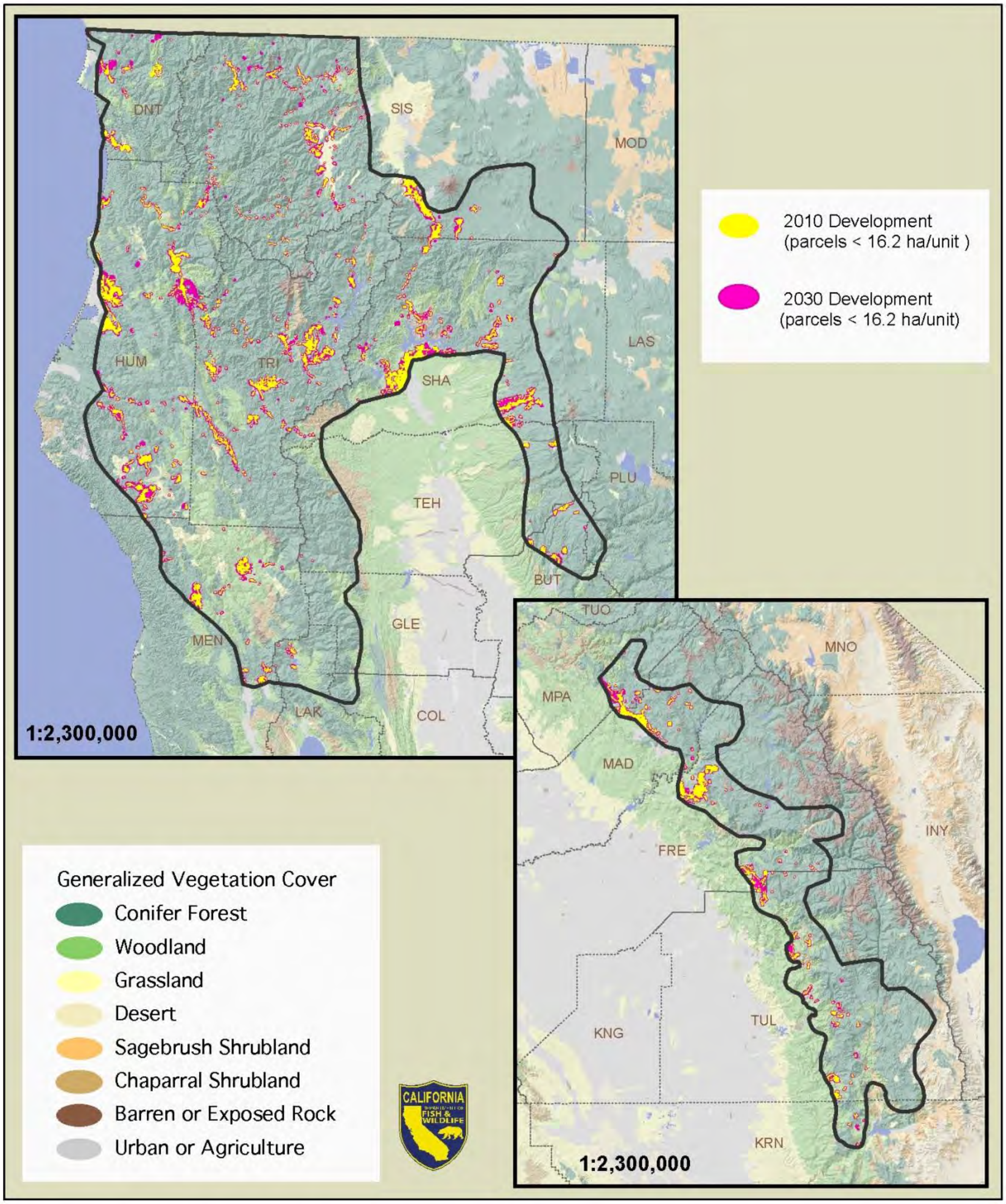


Figure 20. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald (unpublished data). California Department of Fish and Wildlife, 2014.

Table 1. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit (NC ESU) and the Southern Sierra Fisher Evolutionarily Significant Unit (SSN ESU). Areas of contemporary and projected development were based on Theobald (unpublished data).

	Square Kilometers (Square Miles)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of ESU	Projected Development (2030)	Percent of ESU
NC ESU	41,036 (15,844)	1,298 (501)	3%	1,608 (621)	4%
SSN ESU	7,783 (3,005)	324 (125)	4%	358 (138)	5%

Table 2. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit (NC ESU) and the Southern Sierra Nevada Fisher Evolutionarily Significant Unit (SSN ESU). Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald (unpublished data).

	Square Kilometers (Square Miles)					
Evolutionarily Significant Unit	Low	Percent of ESU	Intermediate	Percent of ESU	High	Percent of ESU
NC ESU (2010)	560 (216)	1.4%	331 (128)	0.8%	398 (154)	1.0%
NC ESU (2030)	699 (270)	1.7%	420 (162)	1.0%	480 (185)	1.2%
SSN ESU (2010)	119 (46)	1.5%	42 (16)	0.5%	162 (63)	2.1%
SSN ESU (2030)	142 (55)	1.8%	48 (18)	0.6%	162 (65)	2.2%

Roads: Fishers occupying habitats containing roads occasionally are killed by vehicles (Krohn et al. 1994:140, York 1996:25, Truex et al. 1998:34, Powell et al. 2013:27, Spencer et al. 2015:68). Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data). Of 81 mortalities of fishers documented by the Sierra Nevada Adaptive

Figure 21. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Management and the Kings River Fisher projects, 3.7% were attributed to animals being killed by vehicles on roads (Spencer et al. 2015:13).

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fishers in California and have been hypothesized to be a potential barrier to dispersal (Aubry et al. 2004:204, Lofroth et al. 2010:52, Garroway et al. 2011:3979), they have not been demonstrated to limit fisher populations. Roads have not been shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County (Powell et al. 2013:37). In the southern Sierra Nevada, Tucker (2013*a*:66) found that roads and large water bodies impeded gene flow for female fishers.

Disturbance: Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats typically occupied by fishers. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off road vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be relatively high when transporting kits to new den sites. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied; however, monitoring radio-collared females with young provides some insight into their sensitivity to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. Nevertheless, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. To evaluate the rate of timber harvest on private lands in the Department’s Northern Region (nine northern counties in California), its Timber Conservation Planning Program totaled silvicultural treatments approved under timber harvest plans by planning watershed. Those values were used to calculate the percentage of each watershed harvested from 2002 through 2012. On average, 9.7 %

of each watershed within the area assessed was harvested during this ten-year period (0.97% annually).

Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data). Recreational use of habitats occupied by fishers in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of recreational human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Overexploitation

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable (Lewis and Zielinski 1996). The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917 to 1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers (Grinnell et al. 1937) and were also likely harvested by trappers seeking other furbearers (Lewis and Zielinski 1996).

Since the mid-1800s, the distribution of fishers in North America contracted substantially, due in part to over-trapping and mortality from predator control programs (Lewis et al. 2012:1). Over-trapping of fishers has been considered a significant cause of the species' decline in California (Grinnell et al. 1937:229). By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season (Grinnell et al. 1937:228). Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fishers a prize catch.

The high value trappers obtained for the pelts of fishers in the early 1900s, the vulnerability of fishers to trapping (Douglas and Strickland 1987:523), and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations (Lewis et al. 2012). Fishers were considered to be rare in California by the early 1920s (Dixon 1925:23). Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period (1920-1924) was only 46 animals (Grinnell et al. 1937:228).

Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission (Dixon 1925:25). Grinnell et al. (1937:230) considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of the fisher in California. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue. Despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fishers was not prohibited until 1946 (Gould 1987). Although commercial trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (Lewis and Zielinski 1996:295). Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers (Douglas and Strickland 1987:520), or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations (Douglas and Strickland 1987:526) and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (*Id*, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designees are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 22), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to increase (Gould and Escallier 1989:1). From the early 1980s through the present, license sales have continued to decrease with average sales from 2000 to 2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. Throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators typically work in proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by individuals of certain wildlife

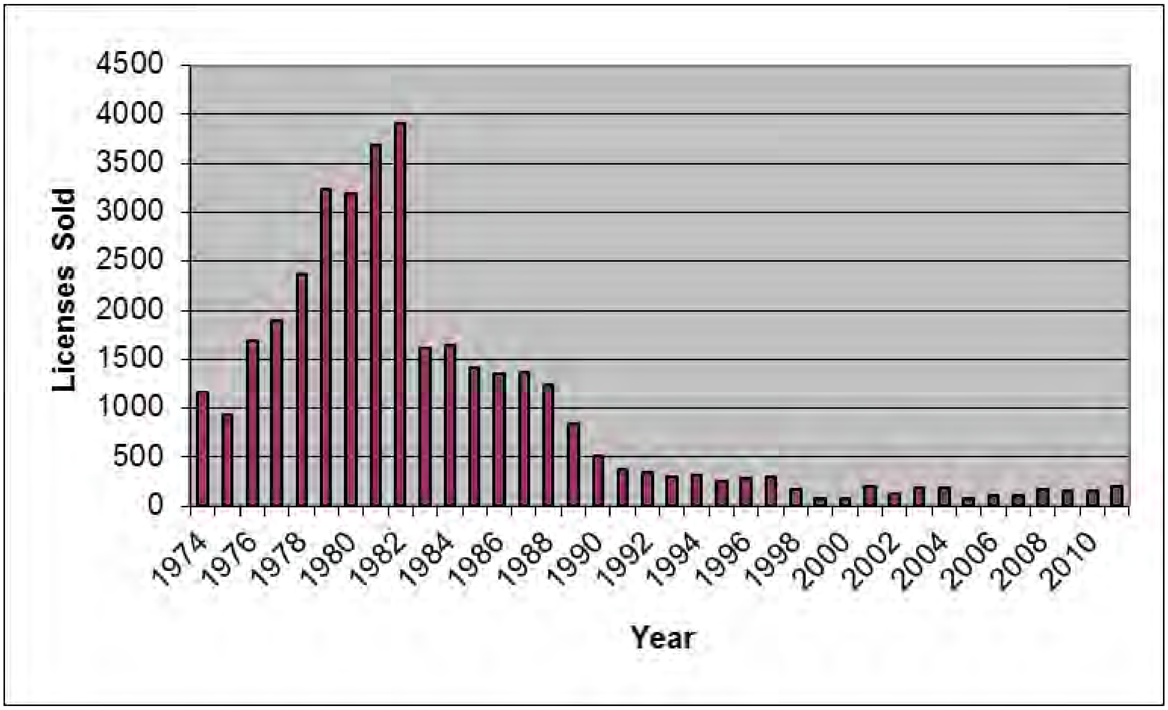


Figure 22. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

species; fishers cannot be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).

Predator control and poisoning efforts, including those for porcupines, may have also impacted fisher populations (Douglas and Strickland 1987:512, 526, Aubry and Lewis 2003:81–82). The distribution of poison to control squirrels, coyotes, and other predators was common throughout much of California in the early part of the 20th century (Linsdale 1931, 1932). Linsdale (1932) summarized the reported observations of 285 people regarding the birds or mammals killed during California pest control campaigns in the 1920s and early 1930s. The summary included six observations of poisoned fishers at locations in Glenn, Tehama, and Shasta counties. One observer remarked "I lived on Log Spring Ridge in the coast mountains of Tehama County since 1919, and the coyote poison campaign has reduced the fur bearers to nothing along the poison line and for one mile or more on each side. Before 1924 I would see a fisher track often but now never see one. Lost two dogs in 1930, because poisoner left poison after season was over".

Efforts to control porcupines in California were widespread in the 1950s and often involved the placement of strychnine-salt blocks in boxes attached to trees (USDA Forest Service 1959). Strychnine baits sometimes incidentally kill non-target mammals (Anthony et al. 1984, Proulx 2011), and some captive mink died after consuming parts of strychnine-killed ground squirrels (Anthony et al. 1984). Anthony et al. (1984) concluded that a mink, marten, or fisher that consumed the stomach contents of a strychnine-killed ground squirrel could be at risk of poisoning.

Predation

Predation appears to be the most significant cause of mortality for fishers in California. In the southern Sierra Nevada, 69% of fisher mortalities at the Sierra Nevada Adaptive Management Program site and 90% of mortalities at the Kings River Fisher Project Site were due to predation. DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project and King's River projects identified bobcats (*Lynx rufus*) as the primary predator (50%). Mountain lions (*Puma concolor*) also killed a significant number of fishers (40%). Coyotes (*Canis latrans*) killed 8% of the predated fishers. One fisher carcass had both bobcat and mountain lion DNA (Wengert et al. 2014). The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes killed an equal number of male and female fishers (Wengert et al. 2014). This finding suggests that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19 of 25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival (Higley et al. 2013:35, Wengert et al. 2014).

The proportion of fisher mortalities caused by predation found by Wengert et al. (2014) was higher than previously reported in California (Buck 1982) and British Columbia (Weir and Corbould 2008). Powell and Zielinski (1994) suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert et al. (2014) indicate that predation is a significant mortality factor for native fisher populations in California. Some forest management practices favor species adapted to disturbed and early seral habitats, some of which are known to prey on fishers (e.g., bobcat, mountain lion). Wengert (2013:99) found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood (Lofroth et al. 2010:10). Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines (Powell and Zielinski 1994, Campbell 2004, Lofroth et al. 2010). Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Fishers may also compete with raptors for certain prey, including the barred owl that has increased significantly in California.

Campbell (2004) compared assemblages of carnivores in the southern Sierra Nevada where fishers occur and in the central Sierra Nevada where they are believed to be absent. She hypothesized that the absence of fishers in the northern and central Sierra Nevada was due to a lack of suitable habitat or to negative interactions with other carnivores. Opossum, gray fox, and striped skunk were detected at sampling stations more frequently outside of the fisher occupied area and suggested this difference may have been due to habitat conditions at those sites being less favorable for fishers (Campbell 2004). She also concluded that elevated densities of species such as gray fox and striped skunk may hinder the recolonization of fishers to portions of their former range. However, fishers translocated to the northern Sierra Nevada in 2009-2011 now co-occur with a number of other carnivore species including raccoon, gray fox, ringtail, spotted skunk, bobcats, and opossum. Fishers are now established within the translocation area and have been live-trapped annually for study after the translocation. Live-trapping occurs in the fall and during two of three years (2012 and 2014) fishers were the most frequently captured carnivore (A. Facka, unpublished data). Spotted skunks were captured at a slightly higher rate than fishers in 2013.

The relative similarities in body size, body shape, and prey between fishers and martens suggest the potential for competition between these species (Lofroth et al. 2010:10). In California, martens often occur at higher elevations than fishers; this spatial separation may minimize competition between the two species in many areas. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have long coexisted with a suite of other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California.

Disease

A number of viral, bacterial, and parasitic diseases have been documented in fishers. Canine distemper virus infection, a cause of significant morbidity and mortality in other carnivore populations (Williams 2001), was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 (Keller et al. 2012). Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal's ability to survive a capture and immobilization event.

In California, mortalities in gray foxes and raccoons caused by canine distemper are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, canine distemper has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) (Williams et al. 1988) and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) (Timm et al. 2009). Furthermore, highly virulent biotypes of canine distemper can be transmitted and cause high mortalities in multiple carnivore species (Origgi et al. 2012).

Although canine distemper can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 4). Of

98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to canine distemper (Gabriel et al. 2010). From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the Sierra Nevada Adaptive Management Project area were exposed to canine distemper (Gabriel et al. 2010). Evidence to date and experiences with other species underscore the fact that canine distemper has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus, both potentially significant pathogens for *Martes* species (Gabriel et al. 2012*b*), have not been documented in fishers in California. Virus shedding[38] of canine parvovirus however, has been documented in fisher (Gabriel et al. 2010), and clinically significant illness due to the virus was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern California are commonly infected with canine parvovirus: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 3).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) and other mustelids (Burns et al. 2003), American minks (*Mustela vision*) (Pridham and Belcher 1958), and southern sea otters (*Enhydra lutris*) (Cole et al. 2000, Kreuder et al. 2003:504). Mortality in fishers resulting from infection with *Toxoplasma gondii* has not been documented. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra Nevada fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania (Larkin et al. 2011).

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) (Brown et al. 2008), but mortalities of fishers from these diseases have not been reported.

[38] Viral release following reproduction in a host-cell.

Table 3. Prevalence of exposure to canine distemper, canine parvovirus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 (Gabriel et al. 2010).

	Canine Distemper Percent (No. sampled)	Canine Parvovirus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

Plague is known to cause mortality in other mustelids, is a serious zoonotic[39] risk (Williams et al. 1994) and is endemic in many parts of California. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers (Gabriel et al. 2012*b*).

Other documented disease-caused fisher mortalities have included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases, infections and infestations are usually associated with minimal morbidity and mortality (Gabriel et al. 2012b). Banci (1989) noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell (1993). Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye

[39]Zoonotic diseases are contagious diseases that can spread between animals and humans.

damage, there were no vision deficits or eye damage noted in these affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions (Weinmann et al. 1974).

In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination (Clifford et al. 2012). Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Toxicants

Fishers in California are frequently exposed to, and sometimes killed by, rodenticides (Gabriel et al. 2012*b*, Thompson et al. 2013). Large amounts of pesticides, including anticoagulant rodenticides, have been found in recent years at illegal marijuana cultivation sites on public, private, and tribal forest lands[40], and some researchers have suggested that such grow sites are the likely source of fisher exposure to toxicants (Gabriel et al. 2013, Thompson et al. 2013). Rodenticides were found at marijuana cultivation sites in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented. Challenges to investigating toxicant threats from marijuana cultivation sites within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, the necessity of law

[40] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As grow sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reported remediating more than 600 large-scale grow sites on just two of California's 17 national forests (Gabriel et al. 2013).

enforcement protection for field researchers, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors (Colvin and Jackson 1991).

Fishers are opportunistic generalist predators and may be exposed to toxicants directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such flavors as sucrose, bacon, fish, cheese, peanut butter, and apple) would likely appeal to fishers (Gabriel et al. 2012*c*). Furthermore, intentional wildlife poisoning has occurred through the distribution of food items such as canned tuna or sardines laced with pesticides (Gabriel et al. 2013). Fishers could also be exposed to toxicants secondarily through consumption of prey. This is likely the primary means of anticoagulant rodenticide exposure because of the toxicant's persistence in the body tissue of poisoned prey; secondary exposure of mustelids to anticoagulant rodenticides has occurred in rodent control operations (Alterio 1996). Tertiary anticoagulant rodenticide exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed (Moriarty et al. 2012) and may be possible in fishers that eat smaller carnivores. Lastly, anticoagulant rodenticide exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer can occur (Gabriel et al. 2012*c*, Moriarty et al. 2012).

Anticoagulant rodenticides cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impairing an animal's ability to produce several key clotting factors. Anticoagulant rodenticides fall into two categories (generations): first and second generation anticoagulant rodenticides. First generation rodenticides, developed in the 1940s, must be consumed for consecutive days by a rodent to achieve a lethal dose. First generation rodenticides have a lower ability to accumulate in biological tissue and are metabolized more rapidly (Fisher et al. 2003, Erickson and Urban 2004). There are currently 73 first generation rodenticide products registered in California (http://www.cdpr.ca.gov/docs/label/chemcode.htm).

Development of second generation rodenticides began in the 1970s as resistance to first generation products began to appear in some rodent populations. Second generation rodenticides have the same mechanism of action as first generation rodenticides, but have a higher affinity for the target enzymes, leading to a relatively greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days)

(Fisher et al. 2003, Erickson and Urban 2004). A lethal dose may be consumed at a single feeding, but the lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are currently 76 second generation products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum.

In 2009, an apparently healthy fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project fisher research team was found dead (Thompson et al. 2013:2). This animal was determined to have died from acute anticoagulant rodenticide poisoning and this discovery prompted the testing of archived liver samples from fishers previously submitted for necropsy as well as samples from other fishers that died elsewhere in California (Gabriel et al. 2012*c*:2–3). Fifty-eight fishers that died from 2006 to 2011 were tested and 79% were determined to have been exposed to anticoagulant rodenticides. The number of different anticoagulant rodenticide compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers (Gabriel et al. 2012*c*). Of the fishers that tested positive for rodenticide exposure, 96% were exposed to the more toxic second generation rodenticides and this exposure was geographically widespread (Gabriel et al. 2012*c*). As of early 2015, thirteen California fishers are known to have died from anticoagulant rodenticide poisoning and three fishers are known to have been killed by other toxicants (M. Gabriel, unpublished data).

In the Hoopa Valley in northern California, 5 of 17 male fisher mortalities from 2005 to 2013 resulted from poisoning (an equal number were confirmed or suspected of being predated) (Higley et al. 2013:62)[41]. The number of toxicant-caused mortalities has varied by location in the southern Sierra Nevada; despite six such mortalities at the Sierra Nevada Adaptive Management Program site, there have been zero within the Kings River Fisher Project site (even though a given fisher was estimated to have a much higher likelihood of encountering a trespass marijuana grow site in the Kings River area) (Sweitzer et al. In review *b*). Eleven of the 13 (85%) confirmed fisher deaths from anticoagulant rodenticides to date in California have been males (Gabriel, unpublished data). Potential causes for such a disparity may be related to greater

[41] As of early 2015, the deaths of seven male and one female fisher at Hoopa have been confirmed as resulting from poisoning.

primary exposure resulting from the comparatively larger ranges of male fishers than female fishers. Thus, male fishers may encounter more grow sites or experience greater secondary exposure by consumption of more prey than females due to greater energy needs (Sweitzer et al. In review*b*).

Predators with liver concentrations of anticoagulant rodenticides as low as 0.03 ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey (Erickson and Urban 2004). In California, levels of some anticoagulants in fishers on average exceeded that level. Gabriel et al. (2012*c*:5) reported levels in fishers of the anticoagulants brodifacoum and bromodiolone to average 0.22 ppm and 0.12 ppm, respectively. Accordingly, fishers exposed to anticoagulant rodenticides may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Although it is well documented that anticoagulant rodenticides used both legally and illegally have caused mortalities of non-target wildlife species, including fishers (Berny et al. 1997, Erickson and Urban 2004, Anderson et al. 2011, Ruder et al. 2011, Gabriel et al. 2012*c*), the question of whether lethal and sublethal exposure to anticoagulant rodenticides or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed. These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival (Ahdaya et al. 1976, Grue et al. 1991, Martin and Solomon 1991, Gordon 1994, Li and Kawada 2006, Janeway et al. 2007, Riley et al. 2007, Vidal et al. 2009, Zabrodskii et al. 2012). Multiple studies have demonstrated that sublethal exposure to anticoagulant rodenticides or organophosphates may impair an animal’s ability to recover from physical injury. Sublethal effects may also include increased susceptibility to disease (Riley et al. 2007), behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes (Cox and Smith 1992:165–170), and reduced reproductive success.

The indirect contribution of anticoagulant rodenticide exposure (and other pesticides found at marijuana cultivation sites) to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer grow sites located within their home ranges (Thompson et al. 2013:8). Anticoagulant related fisher mortalities were concentrated temporally from April to June, which is the denning period for fisher females (Gabriel et al. 2012*c*, Higley et al. 2013). This raises concerns that mothers could expose their kits to anticoagulant rodenticides through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Studies have suggested that embryos are more sensitive to anticoagulants than are adults (Godfrey and Lyman 1980, Munday and Thompson 2003).

Higher anticoagulant related mortalities in spring may be a consequence of greater use of anticoagulant rodenticides to protect young marijuana plants from rodent damage than at other times of the year. Low birth weight, stillbirth, abortion, and bleeding, inappetence and lethargy of neonates have all been documented in other species as a result of exposure to anticoagulant rodenticides, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of marijuana cultivation sites located within an individual’s home range may start to address this question.

To estimate the extent of the current fisher range potentially impacted by illegal marijuana cultivation sites, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi)[42] and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 23) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.
Volunteer reclamation crews reported that anticoagulant rodenticide and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 (Thompson et al. 2013). Sixty-eight kilograms of anticoagulant rodenticide and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. Gabriel et al.

[42] A circle with a radius of 4 km (2.5 mi), approximates the size of an adult male fisher.

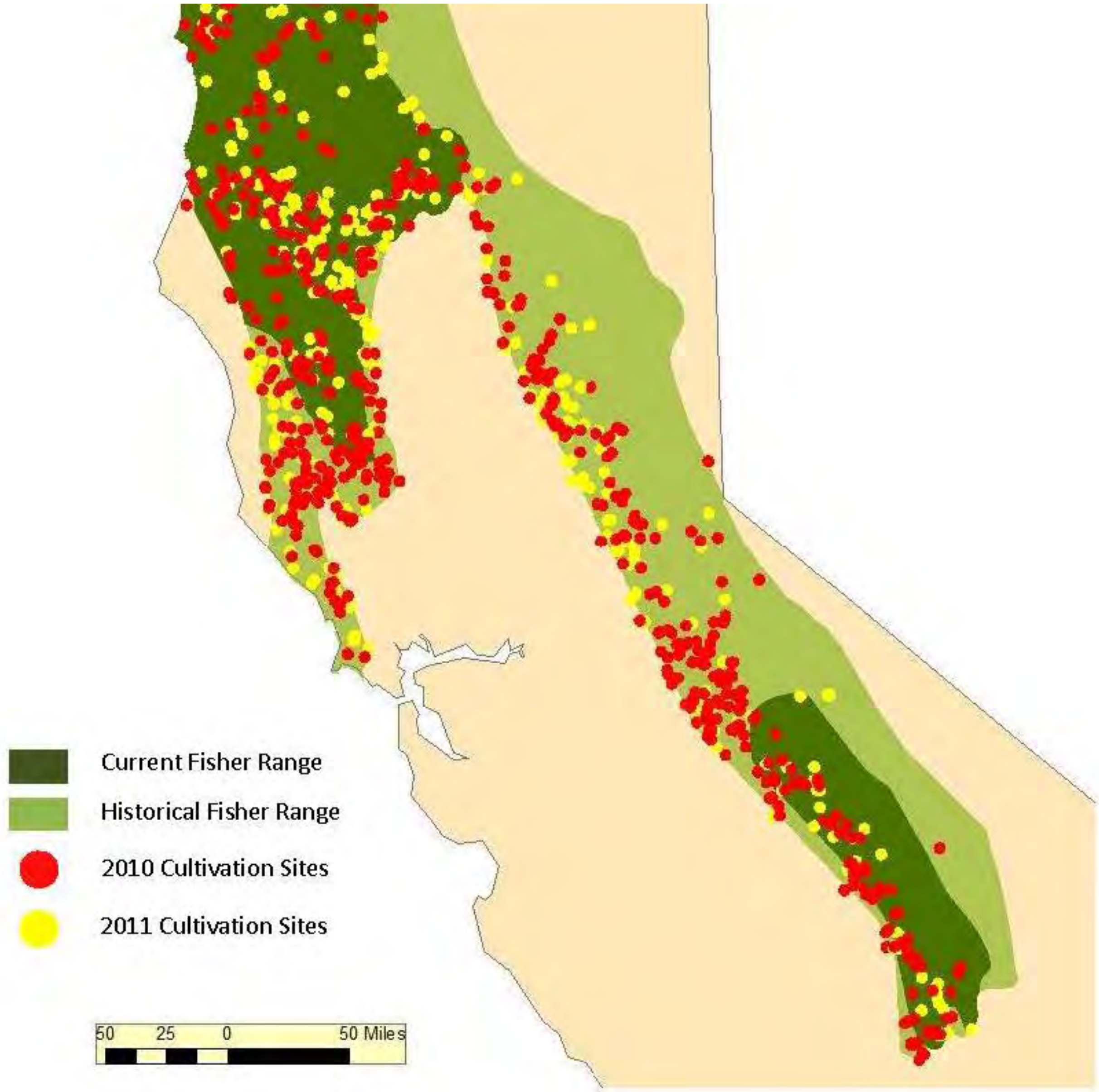


Figure 23. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

(2012*a*) documented the amount of toxicants found at one illegal marijuana cultivation site within occupied fisher territories in Humboldt County. In addition to an insecticide and a molluscicide, 0.68 kg (1.5 lbs) of the brodifacoum and empty containers once containing a total of 2.9 kg (6.5 lbs) of brodifacoum were found. Based on the LD50 value for a 5 kg domestic dog, it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption. Based on the LD50 value for mice, the same material could potentially kill over 9,000 mice. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data statewide have been collected to quantify usage. However, in the southern Sierra Nevada, trail crews reported finding second generation rodenticides at 50% or more of remediated marijuana cultivation sites (Gabriel et al. 2013:48).

Food containers that appear to have been spiked with pesticides and piles of bait have been found at grow sites indicating an intent to poison wildlife (Gabriel et al. 2013). In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort on public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km (Gabriel et al. 2012*c*). Three fishers in northern California were suspected to have died as a result of exposure to pesticides other than anticoagulant rodenticides: one death caused by the carbamate insecticide methomyl, one death caused by the rodenticide cholecalciferol, and one death caused by the rodenticide bromethalin (Gabriel, unpublished data).

Pests at marijuana cultivation sites include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at grow sites that were presumably used to combat them (Table 4). Some of the organophosphates and carbamates used at those sites are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to one such illegal pesticide, carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use (Jansman and van Tulden 2012, Mineau et al. 2012). Organophosphate and carbamate pesticides may cause immediate mortality making their detection difficult compared to toxicants that have sublethal effects and can be detected in animals that die from other causes months after exposure.

Table 4. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (CDFW, Integral Ecology Research Center, High Sierra Volunteer Trail Crew, unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Class	Mammalian Toxicity Range	Relative Frequency of Occurrence at Marijuana Cultivation Sites [1]	Evidence of Exposure or Toxicity (Gabriel et al. unpublished)
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Probable detections
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as “occasional” or “common” based on the highest occurrence for any product in each class.

Pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected. Despite these limitations, Thompson et al. (2013) found a “strong but speculative” association between illegal marijuana cultivation, anticoagulant rodenticide exposure, and fisher mortality fisher survival in the southern Sierra Nevada. For one measure of home range (95% adaptive kernel), female fisher survival was related to the number of marijuana cultivation sites the animal was likely to encounter. For another measure of home range (100% minimum convex polygon using locations from the last six months of life), females with documented exposure to anticoagulant rodenticides had more cultivation sites within their home ranges than females without exposure. (Thompson et al. 2013). They reported finding evidence that the survival of female fishers was related to the number of marijuana cultivation sites females were likely to encounter and that such exposure may predispose them to death from other causes (Thompson et al. 2013:6).

At the Sierra Nevada Adaptive Management Project site, the direct effect of toxicant poisoning was relatively small compared to other sources of mortality (Sweitzer et al. In review*b*). Predators removed 10 times as many fishers (both genders) and 41 times as many female fishers each year than the combined effect of anticoagulant rodenticides and vehicle strikes. In the absence of all fisher deaths from toxicants as well as disease, injury, and vehicle strikes, the base population growth rate within the Adaptive Management Program area was only estimated to increase 1%. These results notwithstanding, the prevalence of anticoagulant rodenticide exposure throughout the state and documented mortalities within both ESUs indicate that toxicants are a potentially significant threat that should be closely monitored.

Reductions in prey availability due to pesticide use at marijuana cultivation sites could potentially impact fisher population vital rates (e.g., births and deaths) through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant (Erickson and Urban 2004), there is potential that grow sites could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species (Knick 1990, Knick et al. 1993, Karanth et al. 2004, Hayward et al. 2012). Nevertheless, the level of small mammal mortality at marijuana cultivation sites remains unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey is also unknown.

On July 1, 2014, second generation products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials in California and can only be sold by licensed dealers and purchased by certified applicators (Prichard 2014). The placement of second generation rodenticide bait will generally be prohibited more than 15 m (50 ft) from man-made structures (CCR, Title 3, § 6471(a)). These new regulations will limit the legal availability of second generation rodenticides, but they may still be obtained outside of California.

It is likely that, with second generation products no longer legally available to the public, other rodenticides that can be purchased by the general public will more frequently be used at marijuana cultivation sites. These could include products containing first generation anticoagulants as well as bromethalin (a neurotoxin). Given the lower toxicity and persistence of first generation products compared to second generation products, there should be no increase in the exposure of fishers to anticoagulants. However, an increase in the amount of bromethalin used on sites may result in an increase in fisher mortalities due to its high toxicity.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s (Pachauri and Reisinger 2007, Solomon et al. 2007). Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years (Lawler et al. 2012:372). Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe (Pachauri and Reisinger 2007:8, 10, 13).

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago (Bonfils et al. 2008:S49, Tingley et al. 2012:8–9). Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase approximately 2.4 C by the 2060s (Pierce et al. 2013*b*:6) and 2-5 C by 2100 (Cayan et al. 2012:5). Projections of precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation (Hayhoe et al. 2004, Christensen et al. 2007, Littell et al. 2011). Conversely, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation (Cayan et al. 2009). Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase (Pierce et al. 2013*a*, *b*). Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack (Halofsky et al. 2011). These patterns are expected to continue (Hayhoe et al. 2004, Salathe et al. 2010, Littell et al. 2011, Cayan et al. 2012) and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 (Ralph 2011). Forests throughout the state will likely become more dry (Halofsky et al. 2011, Littell et al. 2011, Cayan et al. 2012).

Warming is predicted throughout the range of the fisher in California (Lawler et al. 2012:374). Pierce et al. (2013*b*) projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN ESU may experience greater warming than those occupying portions of the NC ESU. The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra Nevada, rest sites are often located near water (Zielinski et al. 2004*b*). Zielinski et al. (2004*b*:488) suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Deep snow has been hypothesized to limit the distribution of fisher populations (Krohn et al. 1997:212). Fishers occur in areas associated with low to intermediate snowfall across a wide range of forest types (Krohn et al. 1997:226) and reductions in snowpack associated with climate changes may allow fishers to exploit habitats at higher elevations than are typically used.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their “climatically suitable” range within California by the year 2100 (Lawler et al. 2012:379). However, the distribution and climate data for those models was assessed using a grid constructed of 50 x 50 km cells; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California’s montane environments, temperature and other climatic variables can change considerably over relatively small distances (Loarie et al. 2009). Thus, the diversity of the physical environment within areas occupied by fishers may buffer some of the projected effects of a changing climate (Moritz and Agudo 2013:504).

Climate change is likely to affect fishers indirectly by altering the species composition and structural components of habitats used by fishers in California (Lenihan et al. 2003, Lawler et al. 2012). Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change (Fried et al. 2004:179, Westerling et al. 2006:942–943, Lawler et al. 2012:385–388). To evaluate future climate-driven changes to habitats used by fishers in the state, Lawler et al. (2012:384) combined model projections of fire regimes and vegetation response in California by Lenihan et al. (2003) with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs for the period 2071-2100, as compared to mean vegetative cover from 1961 to 1990 (Table 5).

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands (Lawler et al. 2012:387). Hayhoe et al. (2004:12427) modeled California vegetation over the same period as Lawler et al. (2012) and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. (2011:S472–S474) predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100.

If woodlands and grasslands within the fisher ESUs expand considerably as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others completely unsuitable. Lawler et al. (2012:394) also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the “floristic conditions” for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. (2012:385) cautioned that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales than used in their model. They further noted that the modeled changes are broad, landscape-scale patterns that will be

Table 5. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. (2012).

Klamath Mountains - land cover percentages					
	Current	Future			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages					
	Current	Future			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

“filtered” by variability in topography, vegetation and other factors. In the southern Sierra Nevada, Koopman et al. (2010:21–22) modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. (2010:21–22) also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas. Burns et al. (2003) assessed potential changes in mammalian species composition within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to occupy Yosemite National Park. Burns et al. (2003:11476) suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such “reshuffling” of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics. The potential effects, positive or negative, of such community restructuring on fishers, their prey, and their predators remain unknown.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health (Littell et al. 2010, Spies et al. 2010, Halofsky et al. 2011). Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward (Trần et al. 2007, Paradis et al. 2008, Safranyik et al. 2010). Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes (Vose et al. 2012). Sudden oak death is a tree disease caused by the pathogen *Phytophthora ramorum* that afflicts tanoak, coast live oak, and black oak trees in the coastal ranges of northern California and southern Oregon (Kliejunas 2011:21, Garbelotto et al. 2014). A warmer climate is expected to increase areas climatically suitable for the pathogen, and a warmer and wetter climate is estimated to result in a high likelihood of increased disease damage (Kliejunas 2011). Changes in forest vegetation due to invasive plant species may impact the composition and abundance of fisher prey. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown and will likely vary throughout its range in the state.

Regulatory and Listing Status

Federal

The fisher is considered a sensitive species by the USFS and the BLM. A sensitive species is a plant or animal species identified by a Regional Forester for which population viability is a concern based on significant current or predicted downward trends in its numbers, density, or habitat capability that reduce its existing distribution (USDA Forest Service n.d.).

On December 5, 2000, the USFWS received a petition from the Center for Biological Diversity and other groups to add the Distinct Population Segment (DPS) of the fisher that includes portions of California, Oregon, and Washington to the list of endangered species pursuant to the Endangered Species Act, and to concurrently designate critical habitat for this DPS (US Fish and Wildlife Service 2014). On April 8, 2004, the USFWS published a 12-month status review (69 FR 18769) finding that the West Coast DPS of fisher was warranted for listing, but was precluded by higher priority actions and through this finding added the fisher to the federal candidate species list[43]. On October 7, 2014, the USFWS published its proposal to list the West Coast DPS of fisher in California, Oregon, and Washington, as a threatened species (US Fish and Wildlife Service 2014).

State

The fisher is currently designated by the Department as a Species of Special Concern and as a state candidate species.

Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has

[43] Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, “Species of Special Concern” is an administrative designation and carries no formal legal status.

A species becomes a state candidate upon the Fish and Game Commission’s determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted (Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2)). During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

Existing Management, Monitoring, and Research

Management of Federal Land

Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The majority of federal actions must comply with National Environmental Policy Act of 1969 (NEPA) (42 U.S.C. § 4321, et seq.). This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

Substantial federal lands are protected or managed specifically for their wildlife resources or other values. These areas include lands in Wilderness Areas, National Parks, and other land designations where timber harvesting is precluded or constrained. Although some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur, considerable area is predicted to provide habitat of intermediate or high quality for fishers (Tables 6 and 7). Approximately 13,400 km^2 (5,100 mi^2) or 33% of the NC ESU area is composed of Wilderness, National Park, Late Successional Reserve, or other land designations predicted to provide habitat of intermediate or high quality for fishers. In the Southern Sierra Nevada, about 5,550 km^2 (2,140 mi^2) or 71% of the SSN ESU area is designated as Wilderness, National Park, Southern Sierra Fisher Conservation Area, or other land predicted to provide intermediate or high quality habitat for fishers.

U.S. Forest Service: The majority (approximately 55%) of land within the current range of the fisher in California is public and the most of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. (1937), encompassed all or portions of the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia National Forests as well as the Tahoe Basin Management Unit.

The status of the fisher as a sensitive species on USFS and BLM lands in California requires that land management plans adopted by these agencies consider fisher. USFS sensitive species, such as fisher, are plant and animal species identified by the

Table 6. Aerial extent of predicted fisher habitat (low, intermediate, and high) on federal lands where timber harvest is restricted or precluded within the Northern California Fisher Evolutionarily Significant Unit[44]. Fisher habitat values were based on a model of potential habitat quality developed by the Conservation Biology Institute and the US Fish and Wildlife Service.

	Square Kilometers (Square Miles)					
NC ESU	Low	Percent of Total ESU	Intermediate	Percent of Total ESU	High	Percent of Total ESU
Congressionally Reserved	1,916 (740)	4.7%	2,257 (871)	5.5%	1,751 (676)	4.3%
Late Successional Reserves	739 (285)	1.8%	1,476 (570)	3.6%	3,546 (1369)	8.6%
Administratively Withdrawn Lands	287 (111)	0.7%	336 (130)	0.8%	654 (252)	1.6%
Northern Spotted Owl Critical Habitat*	234 (90)	0.6%	1,024 (395)	2.5%	2,389 (922)	5.8%
Total	3,176 (1,226)	7.8%	5,093 (1,966)	12.4%	8,340 (3,220)	20.3%

*Only northern spotted owl critical habitat occurring on federal lands was included because spotted owl critical habitat has no effect on private lands unless there is a federal connection.

[44] Congressionally reserved areas include wilderness and National Parks. Within Late Successional Reserves management actions are permitted to benefit late-successional forest characteristics or to reduce the risk of catastrophic loss. Administratively withdrawn areas represent lands excluded from timber harvesting. Critical habitat designations apply to land at the time a species is listed that has the physical or biological features considered by the US Fish and Wildlife Service to be essential for its conservation and that may require special management.

Table 7. Aerial extent of predicted fisher habitat (low, intermediate, and high) on federal lands where timber harvest is restricted or precluded within the Southern Sierra Fisher Evolutionarily Significant Unit[45]. Fisher habitat values were based on a model of potential habitat quality developed by the Conservation Biology Institute and the US Fish and Wildlife Service.

	Square Kilometers (Square Miles)					
SSN ESU	Low	Percent of Total ESU	Intermediate	Percent of Total ESU	High	Percent of Total ESU
Congressionally Reserved	524 (202)	6.7%	304 (117)	3.9%	1,346 (520)	17.3%
Southern Sierra Fisher Conservation Area	630 (243)	8.1%	321 (124)	4.1%	3,449 (1,332)	44.3%
Old Forest Emphasis Area	2 (1)	0%	16 (6)	0.2%	113 (44)	1.5%
Total	1,156 (446)	14.8%	641 (248)	8.2%	4,908 (1,895)	61.6%

Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within the USFS Pacific Southwest Region must receive special management emphasis to ensure their viability and to preclude trends toward endangerment that would result in the need for federal listing (USDA FSM 2672.1).

Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant NEPA, the USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11

[45] Congressionally reserved areas include wilderness and National Parks. The Southern Sierra Fisher Conservation Area encompasses the known occupied range of fishers in the Sierra Nevada. Old Forest Emphasis Areas were established under the Sierra Nevada Forest Plan Amendment and are intended to create forests with structure and function that generally resemble pre-settlement conditions.

National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

Bureau of Land Management: Management of BLM lands is authorized under approved Resource Management Plans prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra Resource Management Plan) include conservation strategies for fishers and other special status species. The Sierra Resource Management Plan contains objectives to sustain and manage mixed evergreen forest ecosystems to support viable populations of fishers by conserving denning, resting, and foraging habitats (USDI Bureau of Land Management 2008:58). It also contains provisions to manage lands within the plan area to support large trees and snags, to provide habitat connectivity among federal lands, and to make acquisition of fisher habitat a priority when evaluating private lands for purchase (USDI Bureau of Land Management 2008:58, 59).

Management of BLM lands within northern spotted owl range is also subject to provisions of the Northwest Forest Plan. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fishers associated with late-successional and old-growth forests (USDA Forest Service and USDI Bureau of Land Management 1994*a*:A–1).

National Park Service: Compared to other public lands which are primarily administered for multiple uses, National Parks are among the most protected lands in the nation (Hannibal 2012). The National Park Service does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

Special Federal Land Designations, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan was adopted by the USFS and BLM to guide the management of over 97,000 km^2 (37,500 mi^2) of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (USDA Forest Service and USDI Bureau of Land Management 1994*b*:entire). Adoption of the Northwest Forest Plan resulted in amendment of USFS and BLM management plans to include measures to conserve the northern spotted owl and other species, including the fisher, on federal lands.

The Northwest Forest Plan created an extensive network of forest reserves (Figure 24). These Late Successional Reserves, Congressionally Reserved Areas, Administratively Withdrawn Areas, and Riparian Reserves are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan; however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, northern spotted owls, and sites occupied by other species.

Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody (USDA Forest Service and USDI Bureau of Land Management 1994*a*:C–30, C–31).

Since the Northwest Forest Plan's inception, the total volume of timber harvested by all national forests and BLM districts from 1995 through 2008 has fluctuated. Timber harvest volumes increased for several years following implementation of the plan, then declined substantially as a result of lawsuits, increased from 2001 through 2005, and declined from 2006 through 2008 (Grinspoon and Phillips 2011:7). This plan created a network of late-successional and old-growth forests that currently provide habitat for fishers and can reasonably be expected to continue to do so in the future. Nonetheless, benefits to fisher populations from implementation of the Northwest Forest Plan have not been demonstrated (B. Zielinski, pers. comm.).

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the northern spotted owl, the USFWS recognized the importance of implementing the Northwest Forest Plan to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the northern

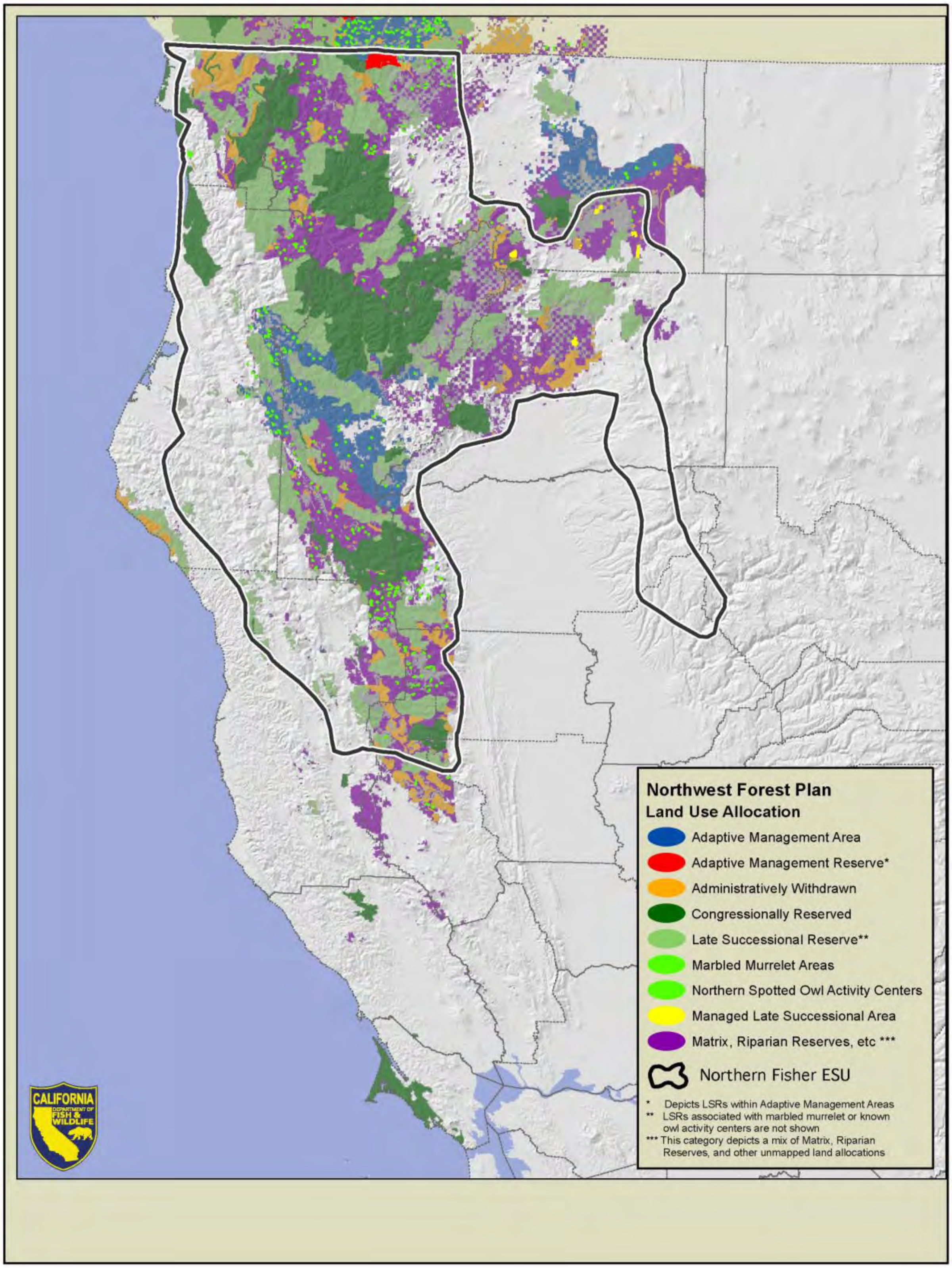


Figure 24. Northwest Forest Plan land use allocations (The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data n.d.). California Department of Fish and Wildlife, 2014.

spotted owl did not alter land use allocations or change the Standards and Guidelines for management under the Plan, nor did the rule establish any management plan or prescriptions for the management of critical habitat. Nevertheless, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the northern spotted owl. Those practices include conservation of older forest, high-value habitat, areas occupied by northern spotted owls, and active management of forests to restore ecosystem health in many parts of the owl's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality northern spotted owl habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised Northern Spotted Owl Recovery Plan. Northern spotted owl critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 25).

Sierra Nevada Forest Plan Amendment: The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the plan amendment by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (Troyer and Blackwell 2004). The Supplemental Environmental Impact Statement also amended Land Management Plans for National Forests within the Sierra Nevada.

In 2014, the US Forest Service reached a U.S. Ninth Circuit court mediated agreement with the Sierra Forest Legacy in response to a lawsuit (Case No. Civ. S-05-0205 MCE/GGH) challenging the Forest Service's adoption of the 2004 Sierra Nevada Forest Plan Amendment. (*Sierra Forest Legacy v. Bonnie*, ___ F.3d ____, dism. purs. to settlement (9th Cir. 2014). In the subsequent settlement, the USFS agreed not to issue a Draft Environmental Impact Statement for the revised forest plans for the Sierra, Sequoia, and Inyo National Forests until the completion of a conservation strategy for fishers. In addition, the USFS (at its sole discretion) agreed to include and analyze an alternative in its Draft Environmental Impact Statement that is consistent with the findings and recommendations in the fisher conservation strategy. The effectiveness of

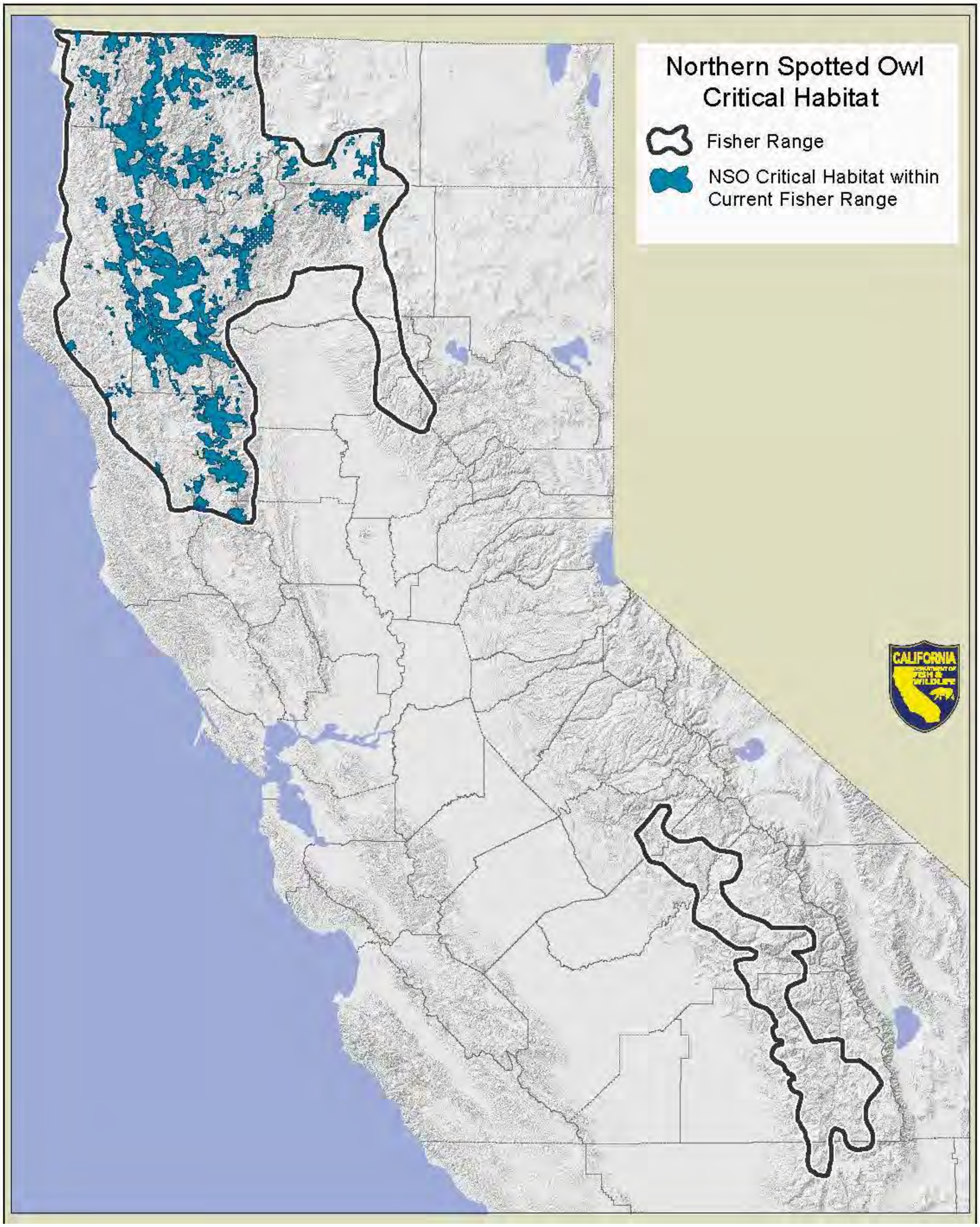


Figure 25. Distribution of northern spotted owl critical habitat within the current estimated range of fishers in California.

the provisions of the Sierra Nevada Forest Plan Amendment with respect to maintaining a viable fisher population in the southern Sierra Nevada has yet to be demonstrated. Nevertheless, some land allocations and specific measures intended to conserve habitat for fishers and other wildlife associated with similar habitats under the amendment are likely to benefit fishers in the southern Sierra Nevada.

The Record of Decision for the Sierra Nevada Forest Plan Amendment contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the plan amendment's conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;
- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and
- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The Sierra Nevada Forest Plan Amendment established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit fishers by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra Fisher Conservation Area

- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 19,800 km^2 (7,650 mi$^{2)}$ within the historical range of the fisher described by Grinnell et al. (1937). Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 14,160 km^2 (5,470 mi^2) and 10 wilderness areas encompassing the southern Sierra Nevada population totaling about 1,680 km^2 (650 mi^2). Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 1,328 km^2 (512 mi^2) Giant Sequoia National Monument is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within Giant Sequoia National Monument are intended to be managed to support viable populations of these species. Land allocations have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (1,259 km^2 (486 mi^2)). The current Management Plan lists specific objectives to study and adaptively manage fishers and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project: This project was initiated in 2005 by the USFS who assembled researchers from the University of California to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health (Sulak and Huntsinger 2012:313). A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments and focused on four response variables, including fishers. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation (Smith 2014).

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007 in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada (Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics n.d.). The project area encompasses about 532 km^2 (205 mi^2) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting structures have been identified (Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics n.d.). Predation has been the primary cause of death of the fishers studied.

State Land

State lands comprise only about 1% of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA) (Pub. Resources Code, § 21000 et seq.). CEQA requires that projects on state lands that may result in significant and adverse impacts to fishers be mitigated, if feasible. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (Cal. Code Regs., tit. 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the Forest Practice Rules) that require the preparation and approval of Timber Harvesting Plans prior to harvesting trees on California timberlands.

Private Timberland

The Department estimates that approximately 39% of current fisher range in California is composed of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act (Pub. Resources Code, §4511 et seq.) and associated Forest Practice Rules promulgated by the State Board of Forestry and Fire Protection. The purpose of the Forest Practice Rules is to implement provisions of the Act in a manner that is consistent with other laws, including the California Environmental Quality Act (CCR, Title 14, § 896(a)).

The Forest Practice Rules are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to State Board's rules; and (2) information and direction to timber operators so they comply with State Board's rules (Cal. Code Regs., tit. 14, § 1034). The preparation and approval of timber harvest plans is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

The Forest Practice Rules promulgated under the Act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. (Cal. Code Regs., tit. 14, § 897, subd. (b)(1)(B). The information about what constitutes the "existing wildlife community" is frequently lacking in timber harvest plans, and specific guidelines to retain habitat for fishers are not provided in the Forest Practice Rules.

Although the Forest Practice Rules do not require measures specifically designed to protect fishers, the Rules do provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fishers may be voluntarily retained by the applicant in order to achieve post-harvest stocking requirements under the Forest Practice Rules subsection relating to "decadent or deformed trees of value to wildlife" (Cal. Code Regs., tit. 14, §§ 912.7, subd. (b)(3), 932.7, subd. (b)(3), 952.7, subd. (b)(3)). Although habitat and habitat elements suitable for fishers may be voluntarily retained under those provisions of the Forest Practice

Rules, they are optional and how frequently this occurs and the benefit to fishers has not been demonstrated. The intervals between harvests on commercial timberlands are typically too short to allow structures in trees of sufficient size to develop and function as suitable den or rest sites, without specific provisions to protect and provide for their long-term recruitment through harvest rotations.

Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (Cal. Code Regs., tit. 14, § 916 et seq.). Watercourse and Lake Protection Zones are defined areas along streams where the Forest Practice Rules restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but these zones may encompass 15 m - 45 m (50-150 ft) on each side of a watercourse, 30m - 91 m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. Generally, within Watercourse and Lake Protection Zones, at least 50% of the tree overstory and 50% of the understory canopy covering the ground and adjacent waters must be retained in a well distributed multi-storied stand composed of a diversity of species similar to that found before the start of timber operations. The residual overstory canopy must be composed of at least 25% of the existing overstory conifers and at least two living conifers per acre must be retained that are at least 40.6 cm (16 in) in dbh and 15.2 m (50 ft) tall within 15.2 m (50 ft) of streams that support fish or non-fish aquatic species. In some locations, Watercourse and Lake Protection Zones constitute 15% or more of a watershed, but this will vary depending on the types of watercourses present and their density within harvested areas (J. Croteau, pers. comm.).

Where Watercourse and Lake Protection Zones allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes. For watersheds that fall within Anadromous Salmonid Protection rules (Cal. Code Regs., tit. 14, §§ 916.9, 936.9, 956.9), the 13 largest trees/acre (live or dead) must be retained. The Anadromous Salmonid Protection Rules are similar to the provisions of Green Diamond Resource Company's Aquatic Habitat Conservation Plan. On its lands in northwestern California, riparian areas can represent from less than 5% to more than 50% of a timber harvest unit based on data from high resolution aerial photographs taken immediately post-harvest (M. House, pers. comm.). The proportion of harvest areas encompassed by these zones is partly a function of stream density and the classification of watercourses present. Over time, implementation of these rules will likely promote the development of trees of sufficient size and structure suitable for use by fishers for resting and denning (J. Croteau, pers. comm.), however, many early season dens occur upslope of Watercourse and Lake Protection Zones (S. Matthews, pers. comm.).

For ownerships encompassing at least 20,234 ha (50,000 ac), the Forest Practice Rules require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (Cal. Code Regs., tit. 14, §§ 1091.1, 913.11, 933.11, 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option may provide forested habitat that is suitable for fishers. Nevertheless, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare timber harvest plans and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The Forest Practice Rules impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees [trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare timber harvest plans and stocking reports (Cal. Code Regs., tit. 14, § 1038, subd. (b)). Timber harvesting under such exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The Forest Practice Rules impose a number of restrictions related to exemptions, including generally prohibiting the harvest of old trees (trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species). Exceptions to this rule are provided in Forest Practice Rules Section 1038(h).

Portions of the Forest Practice Rules (Cal. Code Regs., tit. 14, §§ 895.1, 919.16, 939.16, 959.16) relate to late succession forest stands on private lands. Proposals to harvest such areas are infrequent, probably because few stands on private lands meet the criteria for consideration under the rules[46] (pers. comm., C. Babcock, CDFW). When a late succession stand is proposed for harvest, the Department generally provides recommendations designed to mitigate any potential significant adverse impacts to wildlife. These recommendations are often tied to species such as the fisher and generally involve the retention of late seral stand characteristics (e.g., tree sizes, canopy layers, stand size) and habitat elements (e.g., conifers/hardwoods with cavities or other structures) or changes to proposed silvicultural methods. These measures are incorporated into the harvesting plan at the discretion of CAL FIRE. Where it has been determined that proposed operations will result in significant adverse impacts to fish, wildlife, and listed species associated primarily with late successional forests, feasible measures to mitigate or avoid those effects must be implemented. If it is determined that significant impacts cannot be effectively minimized or avoided, the lead agency (i.e., CAL FIRE), has the authority to deny the timber harvesting plan or approve it based on overriding considerations.

Private timberland owners are not specifically required to retain or recruit hardwoods and, in some cases, their harvest may be required by regulation to meet stocking standards. Hardwoods may also be intentionally killed individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of their habitats. Some hardwood species provide potential den and rest trees and habitat used by fisher prey. On private timberlands, existing regulations also require the retention of snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However,

[46] Under the Forest Practice Rules, late succession forest stands are stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 8 ha (20 ac) in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites and there is no specific requirement to recruit snags.

Some timberland owners (industrial and non-industrial) have instituted voluntary management policies and/or developed management plans that may contribute to conservation of fishers and their habitat. These measures may include the retention of snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs. The retention of forest structure is often valuable to many species of wildlife and fishers have been documented using rest and den structures which were voluntarily retained by landowners within timber harvest units. However, the Department is unaware of any analysis of the effects of these voluntary actions on fisher populations.

Private Timberland – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1993, the Forest Stewardship Council was formed to create a voluntary, market-based approach to improve forest practices worldwide (FSC Forest Stewardship Council U.S. (FSC-US) · Our History n.d.). The Council's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity (FSC Forest Stewardship Council U.S. · Mission and Vision n.d.). In California, approximately 6,475 km^2 (2500 mi^2) of forest lands have been certified by the Forest Stewardship Council (preview.fsc-certified-acres-by-state.a-204.pdf n.d.). Although this certification requires participants to retain habitat elements of value to fishers, the effects of these practices on fisher populations have not been studied.

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to "take," as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq*.), threatened and endangered species. Applicants for incidental take permits under Section 10 of the Endangered Species Act must submit Habitat Conservation Plans that specify, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. A Habitat Conservation Plan may include conservation measures for candidate species, proposed species, and other species not yet listed under the Endangered Species Act at the time the project is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six Habitat Conservation Plans in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods plan specifically addresses fishers, although other plans contain provisions such as retention of late seral habitat elements intended to benefit species such as the northern spotted owl (e.g., Green Diamond Resources Company) should also benefit fishers. The Green Diamond aquatic Habitat Conservation Plan also has provisions that over the next 50 years will set aside approximately 40,460 ha (100,000 ac) of riparian and geologic reserves that should develop late seral elements beneficial to fishers.

Fisher Translocation: A primary conservation concern for fishers has been the reduction in overall distribution in the state. Fishers have been successfully translocated many times to reestablish populations in North America (Lewis et al. 2012), and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California (Callas and Figura 2008).

From late 2009 through late 2011, the Department translocated[47] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra Pacific Industries. This effort, the first of its kind in California, was undertaken in cooperation with Sierra Pacific Industries, USFWS, and North Carolina State University. Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites (Callas and Figura 2008). Those lands represented most of the large, relatively contiguous tracts of Sierra Pacific Industries' property within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto Sierra Pacific Industries' property, including habitat suitability of candidate release sites, prey availability, genetics, impacts to other special status species, disease, predation, and the effects of removing animals on donor populations.

---

[47] Translocation refers to the human-mediated movement of living organisms from one area for release in another area (IUCN and SSC 2013:1).

Table 8. Approved Habitat Conservation Plans (HCPs) within the range of the fisher in California.

HCP Name	Location	Area	Permit Period	Covered Species
Green Diamond Resources Company	Del Norte & Humboldt counties	1,647 km^2 /636 mi^2	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	854 km^2 /330 mi^2	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Green Diamond Resources Company	Humboldt and Del Norte counties	1,688 km^2 /652 mi^2	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander

From late 2009 through late 2011, 40 fishers (24 female, 16 male) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release (Powell et al. 2013). A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young (Powell et al. 2013).

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 had been born on Stirling (Powell et al. 2013). On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California (Powell et al. 2013). Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group represented 47% of the population, suggesting relatively high levels of reproduction and recruitment (Powell et al. 2013).

Candidate Conservation Agreement with Assurances: A "Candidate Conservation Agreement with Assurances for Fisher" between the USFWS and Sierra Pacific Industries regarding translocation of fishers to a portion of Sierra Pacific Industries' lands in the northern Sierra Nevada was approved on May 15, 2008. A Candidate Conservation Agreement with Assurances is intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to Sierra Pacific Industries should USFWS eventually list fishers under the federal Endangered Species Act. This 20-year permit covers timber management activities on Sierra Pacific Industries' Stirling Management Area, an approximately 65,000 ha (160,000 ac) tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fishers. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society and Integral Ecology Research Center to study the ecology of fishers. One hundred and ten fishers (39 male, 71 female) were monitored with radio telemetry from December 2004 to March 2013 and demographic monitoring continues.

Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California. Predation has been the leading cause of mortality for females and toxicosis, primarily from second generation anticoagulant rodenticides, has been the leading cause of mortality for males (Higley et al. 2013).

Tule River Tribe: The Tule River Tribe is located in southeastern Tulare County in the southern Sierra Nevada. The tribe manages approximately 22,400 ha (55,000 ac) (Baker and Stewart 1996:1357). This region supports black oak and ponderosa pine at elevations between approximately 1,200 m - 1,500 m (4,000-5,000 ft), mixed conifer forest to 2,100 m (7,000 ft), and true fir forests at higher elevations on north-facing slopes (Rueger 1992:116). Resource management on the reservation is governed by the Tribal Council (Rueger 1992:116) and exemplifies a multiple use philosophy which balances commodity and non-commodity resources values (Baker and Stewart 1996:1358). Some habitats managed by the Tule River tribe are occupied by fishers and the tribe has cooperated with research comparing marten and fisher home range and habitat characteristics, diet, and interspecific competition (Spencer et al. 2015:3).

Fisher Working Groups

California Fisher Working Group: The primary goal of this group is to share current information about fishers and foster collaboration, with the goal of maintaining healthy, viable fisher populations in California. The focus of the California Fisher Working Group is on recent research and conservation matters related to fishers. Meetings are held annually in conjunction with the Western Section of the Wildlife Society Conference and are well attended. At these meetings, short presentations are made by fisher researchers and most presentations are available online.

Southern Sierra Nevada Fisher Working Group: The mission of this group is to provide a forum for wildlife biologists, scientists, and managers to identify, review, develop and communicate research, management, and conservation information and recommendations that promote the long-term viability of fishers in the southern Sierra Nevada. Members agree to work cooperatively to achieve the working group’s goals and objectives. The goals include: 1) sharing fisher ecological and management information, 2) identifying, promoting, prioritizing, reviewing, and sharing fisher ecological and management research needs, 3) providing technical assistance to managers and policy makers, and 4) developing collaborative relationships that promote the long-term viability of fishers in the southern Sierra Nevada. Several subgroups of this working group have been formed to focus on specific tasks. These subgroups are working on issues such as rodenticides, porcupines, and wildlife vehicle collisions. Probably the most important role of the working group recently has been its involvement in the development of the Southern Sierra Nevada Fisher Conservation Assessment (Spencer et al. 2015). Ultimately, this working group will develop a Conservation Strategy for fishers in the southern Sierra Nevada.

Scientific Determinations Regarding the Status of the Fisher in California

The California Endangered Species Act directs the Department to prepare this report regarding the status of the fisher in California based upon scientific and other information available to the Department. (Fish & G. Code, § 2074.6, subd. (a); Cal. Code Regs., tit. 14, § 670.1, subd. (f).) CESA's implementing regulations identify key factors that are relevant to the Department's analyses. Specifically, a "species shall be listed as endangered or threatened ... if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors: (1) present or threatened modification or destruction of its habitat; (2) overexploitation; (3) predation; (4) competition; (5) disease; or (6) other natural occurrences or human-related activities." (Cal. Code Regs., tit. 14, § 670.1, subd. (i)(1)(A).

The definitions of endangered and threatened species in the Fish and Game Code guide the Department's scientific determination. An endangered species under CESA is one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease." (Fish & G. Code, § 2062). A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]." (*Id.*, § 2067).

Fishers in California occur in two separate and isolated populations that differ geographically and genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units (ESUs) where appropriate in its analysis of listing factors.

The preceding sections of this Status Review report describe the scientific and other information available to the Department, with respect to the key factors identified in the regulations.

Present or Threatened Modification or Destruction of Fisher Habitat

Considerable research has been conducted to understand the habitat associations of the fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types. Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Landscapes supporting mid- to late-seral forests are suitable for fishers if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey. Activities such as timber harvesting, human development, treatment of vegetative fuels in forest, and wildfire can render areas unsuitable for fishers. The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity.

Existing regulatory mechanisms on public and private lands in California, established to protect wildlife and wildlife habitat, vary with respect to their potential effectiveness at maintaining or recruiting habitat for fishers. In some cases statutes, regulations, and policies are specifically aimed to benefit fishers or may be designed for other species with similar habitat requirements. The viability of fishers in California will depend, in part, on the retention and recruitment of habitat elements for denning, resting, and the maintenance of sufficient prey populations in habitats where they can be successfully captured by fishers. Thresholds for these attributes of fisher habitat are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

NC ESU: Within the NC ESU, large areas supporting habitat suitable for fishers are under federal management or are privately owned and managed for timber production. The majority of the land area in the ESU is administered by the USFS (52%) or in private ownership (42%). Of the federal properties within this ESU, about 20% or 13,400 km^2 (5,170 mi^2) are specially designated lands predicted to be of intermediate or high value to fishers where timber harvest is restricted or precluded. The treatment of forest fuels to reduce the risk of catastrophic wildfire may decrease habitat suitability for fishers, but overall the benefits of such actions to fishers appear to outweigh the risks, provided that area treated annually is relatively small. Fishers are widespread and common inhabitants of public and private forested landscapes within the NC ESU. The likelihood that forest management activities will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

Fire suppression and wildfire have influenced the character and suitability of forests occupied by fishers in the NC ESU. Should fires increase in size and intensity throughout mountainous areas of northern California, they will likely decrease the suitability of some habitats for fishers. Fishers long inhabited California landscapes that were influenced by wildfire in ways that differ substantially from modern and likely future fire regimes and there is uncertainty regarding the future effects of fire and fire suppression on fishers. Within the NC ESU, fishers occur over a relatively large area and are common. The likelihood that wildfire will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

Currently human development of fisher habitat within the NC ESU represents a relatively small proportion of the NC ESU and is not predicted to increase substantially in the future. By 2030, approximately 4% of the total area of the ESU is projected to be developed on parcels less than 16.2 ha (40 ac) in size. The likelihood that the alteration or loss of habitat will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

SSN ESU: Within the SN ESU, the majority (86%) of the land area is administered by the USFS or the National Park Service and approximately 10% is privately owned. Of the federal properties within this ESU, about 70% or 5,550 km^2 (2,143 mi^2) are predicted to be of intermediate or high value to fishers and represent designated lands where timber harvest is restricted or precluded. The treatment of forest fuels designed to reduce the risk of catastrophic wildfire may result in some decrease in habitat suitability for fishers, but overall the benefits of such actions to fishers appear to outweigh the risks, provided that area treated annually is relatively small. The likelihood that forest management activities, including fuels treatments, will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is low.

Fire suppression and wildfire have strongly influenced the composition and suitability of forests occupied by fishers in the SSN ESU. Some models of wildfire predict fires of increased size in the future, with the greatest increases occurring within mid-elevations sites on the west slope of the Sierra Nevada. Despite the occurrence of some large, high intensity fires in the southern Sierra Nevada in recent years, wildfires in the region are generally heavily suppressed. Although fuels treatments and fire suppression will likely reduce the size and severity of wildfires in areas occupied by fishers, the effectiveness of these measures in the future is uncertain. The fisher population in the southern Sierra Nevada is vulnerable to habitat loss and fragmentation due to catastrophic fire because of its small size, relatively small geographic area occupied, and the narrow and linear configuration of occupied habitat in the region. Fishers, however, have apparently occupied portions of the southern Sierra Nevada for many centuries, including areas with an extensive history of fire. The likelihood that wildfire will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is moderate.

Currently human development of fisher habitat within the SSN ESU represents a relatively small proportion of the ESU and this is not predicted to increase substantially in the future. By 2030, approximately 5% of the total area of the SSN ESU is projected to be developed on parcels less than 16.2 ha (40 ac) in size. Development predicted to occur in the vicinity of Shaver Lake in the southern Sierra Nevada by 2030, could adversely affect fishers if it creates a barrier to their dispersal and fragments the fisher population in this region. The effect this may have on fishers is unknown and will be influenced by the extent of the development and whether habitat remaining on parcels will function as an effective corridor for fisher movement. The likelihood that human development will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is low.

Overexploitation

Based on the prohibition against commercial or recreational take of fishers, the low level of commercial and recreational trapping and the prohibition of body-gripping traps, the likelihood that overexploitation will threaten the continued existence of fishers within the NC ESU or the SSN ESU in the foreseeable future is low.

Predation

Predation appears to be the most frequent cause of mortality for fishers in California. This result is not unexpected as the forested landscapes inhabited by fishers are also inhabited by a diverse suite of larger, generalist predators (i.e., bobcats, coyotes, and mountain lions).

NC ESU: Fishers remain well-distributed and readily detectable throughout much of the NC ESU, and there is no evidence that the population is currently declining. The likelihood that predation will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

SSN ESU: Studies in the southern Sierra Nevada indicate that predation is the leading cause of death for fishers and currently has a greater effect on population growth in the region than disease, injury, toxicants, and vehicle strikes combined. The Department's concern regarding the vulnerability of the fisher in the southern Sierra Nevada from predation and other sources of mortality is heightened by the population's small size and relatively small geographic area occupied. Nevertheless, fishers have likely been isolated within the region for at least 50 years and appear to have expanded their range in recent decades. The likelihood that predation will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is low.

Competition

Throughout their range in California, fishers compete with a variety of other carnivores including coyotes, foxes, bobcats, American martens, and weasels for food and access to other resources. All of these species use habitats occupied by fishers. Although landscape level habitat changes that favor potential competitors may intensify interspecific competition in some areas, the likelihood that competition will threaten the continued existence of fishers within the NC ESU or the SSN ESU in the foreseeable future is low.

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years and fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or due to exposure from other species of carnivores. Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fishers and may have been responsible for local population declines, there are no studies indicating that disease is significantly limiting fisher populations in California. The likelihood that disease will threaten the continued existence of fishers within the NC ESU or the SSN ESU in the foreseeable future is low.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution and abundance of fishers in California appears to have changed substantially before and after Euro-American settlement. Although its precise distribution and population size prior to the 1800s is unknown, recent genetic evidence indicates the fisher population declined dramatically and contracted into two separate populations at some point long before that time. Further reductions in range and abundance likely occurred after Euro-American settlement due to trapping, predator control, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. At present, and perhaps resulting primarily from the 1946 prohibition on fisher trapping and the 1998 ban on body-gripping traps, the number of fishers in California appears to be greater than it was during the mid-1800s to early 1900s.

NC ESU: Within the NC ESU, fishers are distributed over a large geographic area and are common. Currently, the fisher population is likely substantially larger than it was at the time commercial trapping of fishers was banned nearly 70 years ago. In recent decades, detections of fishers have increased in coastal portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County. A small population of fishers has also been established in the northern Sierra Nevada and southern Cascades in Butte County and those animals or their progeny have been documented in eastern Shasta, Tehama, and western Plumas counties. Fishers within the NC ESU are also largely isolated, although their population is contiguous with a small population in southern Oregon. The likelihood that population size and isolation will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

SSN ESU: The fishers population within the SSN ESU is at risk of decline due to its small size (probably less than 300 adults (Spencer et al. 2015:7), limited geographic range, narrow habitat configuration, and apparent low likelihood that it will expand its range further in the near-term without active management. Furthermore, a recent study at the Sierra Nevada Adaptive Management Project study area estimated the population to be declining slightly (rate of growth 0.97, range 0.79-1.16). Small, isolated populations are at risk of extinction from stochastic (random) environmental or demographic events or the loss of genetic diversity, including inbreeding depression. Events such as drought, high intensity fires, and disease, should they occur, could adversely affect the fisher population in the southern Sierra Nevada due to its small population size and limited geographic area.

The fisher population within the SSN ESU is likely to remain small and occur in a limited geographic area in the foreseeable future due to its inability to rapidly disperse to new suitable habitat; the nearest currently known fishers are found in the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). However, fishers within the SSN ESU have occurred in small numbers in a relatively small geographic area for decades and, in recent years, its distribution appears to have expanded. The likelihood that population size and isolation will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is moderate.

Toxicants: Fishers in California exhibit high rates of exposure to anticoagulant rodenticides and exposure to other toxicants. Illegal marijuana cultivation sites appear to be the primary source of toxicants detected in fishers, and fishers are exposed either directly by consuming tainted baits or secondarily by consuming poisoned prey. Recent regulation changes for rodenticide use in California will likely influence the types and amounts of rodenticides used at illegal marijuana cultivation sites. Rodenticides and other toxicants may kill fishers directly or indirectly by increasing susceptibility to other mortality factors such as disease, predation, and vehicle strikes. However, the actual contributions of the sublethal effects of toxicants to such mortalities remain unclear.

NC ESU: Fishers are exposed to anticoagulant rodenticides within the NC ESU. Although few deaths from exposure to rodenticides and other toxicants have been confirmed, the likelihood of discovering these events is extremely low. Thus, the confirmed deaths represent a portion of actual toxicant-caused fisher mortalities. While toxicant use at marijuana grow sites has been ongoing for at least a decade, recent trends (i.e., since 2010) in their use are unknown. Future trends are difficult to predict, and depend on the future legal status of marijuana, cultivation practices of growers, and location of grow sites. Fishers remain widely distributed and are common within the NC ESU, suggesting that substantial broad-scale population level impacts due to exposure to rodenticides or other toxicants have not occurred. The likelihood that the illegal use of rodenticides or other toxicants will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

SSN ESU: High rates of exposure to anticoagulant rodenticides have been documented within the SSN ESU. Although one study within the ESU associated higher survival of female fishers with home ranges containing fewer grow sites, population level effects have not been demonstrated nor appear likely based on other studies of occupancy, survival, and the causes of fisher mortality in the region.
At the Sierra Nevada Adaptive Management Project site, the direct effect of toxicant poisoning of fishers is small compared to other sources of mortality. Predation removed substantially more fishers from the population in that study than died as result of rodenticide poisoning. The potential growth rate of this population was predicted to increase slightly (1%) in the absence of all deaths from disease, injury, anticoagulant rodenticides, and vehicle strikes. At the Kings River Fisher Project site, none of the known-cause fisher mortalities have resulted from toxicants. The likelihood that the illegal use of rodenticides or other toxicants will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is low.

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant and animal communities (likely including fisher prey species). The effect of warming temperatures on mountain ecosystems will most likely be complex and predicting effects in particular areas is difficult. While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout the range of fishers in the state, and their severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century.

NC ESU: The fisher population within the NC ESU is currently common and widely distributed across its range, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain. Some climate models predict a decrease in conifer forest cover exemplified by an increase in mixed forest and mixed woodland cover. Fires may increase in frequency and intensity if projections of climate warming and changes in precipitation patterns are realized. The likelihood that the ecological effects of climate change will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low.

SSN ESU: The fisher population within the SSN ESU is likely vulnerable to the potentially adverse effects of warming climate due to its small size and relatively narrow and linear distribution. Several studies have modeled climate change effects on vegetation and suggest that conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation). These models make broad predictions at relatively large spatial scales, and that fine scale ecological variation will likely result in actual changes to forests that are relatively nuanced and site specific. It appears that fishers in the SSN ESU, representing the most southerly occurring population of the species range wide, are already selecting micro-habitats to minimize exposure to heat and limit water loss. A substantial increase in temperature or dryness could render the habitat unsuitable. The likelihood that the ecological effects of climate change will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is moderate.

Factors Considered in Combination

Threat factors, while considered individually to be of low or moderate risk for endangerment, may combine to increase the overall risk of extinction. Increased risk from the interaction of threats may be due to the accumulation of threat risks (additive), or to synergistic effects (effects greater than the sum of the individual threats). For example, sub lethal effects of toxicants may lower the ability of fishers to avoid predation or increase risk of roadkill mortality. Wildfire may fragment the suitable habitat such that predation risk is increased due to the lack of cover in which to hide or by increasing the length of travel routes between safe havens. Climate change could exacerbate wildfire intensity, extent or frequency, which in turn may remove the mesic microclimates needed by fishers to adapt to increasing temperature and shifting precipitation patterns predicted as result of climate change. This in turn could reduce fisher fitness and reproduction, causing the population to decline in the foreseeable future. It is difficult to assess the level of increased risk from all the possible combinations of threat factors; however, the potential increase in extinction risk from these combinations is greater for smaller fragmented populations.

NC ESU: While combined effects of multiple threats, including climate change, loss of habitat, toxicants, and predation are expected to occur in the NC ESU, the likelihood that the combined effects will threaten the continued existence of fishers within the NC ESU in the foreseeable future is low due to the size and widespread distribution of the fisher population.

SSN ESU: The SSN ESU's small population size, limited geographic range, narrow habitat configuration, low reproductive capacity, and inability to rapidly disperse to new suitable habitat make the population more vulnerable to the combined effects of multiple threats. Population size could decline precipitously with modest changes in mortality and reproduction due to any one or a combination of factors. The likelihood that the ecological effects from the combined effects of climate change, loss of habitat (particularly due to wildfires), toxicants, and predation will threaten the continued existence of fishers within the SSN ESU in the foreseeable future is high.

Listing Recommendation

CESA directs the Department to prepare this report regarding the status of fisher in California based upon the best scientific information available. CESA also directs the Department based on its analysis to indicate in the status report whether the petitioned action is warranted (Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f)). The Department makes its recommendation in its status report as submitted to the Commission in an advisory capacity based on the best available science.

NC ESU: Based on its consideration and analysis of scientific and other information available and including independent peer review by scientists with expertise relevant to the status of the fisher, as guided by CESA, the Department recommends that designation of the fisher in the Northern California ESU as threatened or endangered is not warranted.

SSN ESU: Based on its consideration and analysis of scientific and other information available and including independent peer review by scientists with expertise relevant to the status of the fisher, as guided by CESA, the Department finds that while not presently threatened with extinction, the Southern Sierra Nevada ESU is likely to become an endangered species in the foreseeable future due to the combination of threat factors, absent the special protections and management efforts required by CESA. The Department recommends that the petitioned action to list the fisher in the Southern Sierra Nevada ESU as threatened is warranted.

Protection Afforded by Listing

CESA defines “take” to mean “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful except as provided by the Fish and Game Code (Fish & G. Code, § 2080).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fishers would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fishers because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Management and Monitoring Recommendations

The Department has implemented a number of actions designed to better understand fishers in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the State Board of Forestry and Fire Protection, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, tribes, and universities, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

1. Support research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term, multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring.

5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations. This should include further study and monitoring of the effects of toxicants on fishers and fisher prey.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends.

7. In the southern Sierra Nevada, collaborate with land management agencies and researchers to expand connectivity between core habitats and to facilitate population expansion.

8. Assess the feasibility of translocating fishers via assisted dispersal of juvenile fishers or movement of adults from the southern Sierra Nevada population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region. If this assessment indicates translocation is feasible, implement a pilot effort by 2020.

Literature Cited

Aging Experience, Accuracy and Precision. n.d. <http://www.matsonslab.com/aging-experience-accuracy-and-precision.html>. Accessed 6 Sep 2014.

Ahdaya, S. M., P. V. Shah, and F. E. Guthrie. 1976. Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicology and applied pharmacology 35:575–580.

Alterio, N. 1996. Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. New Zealand Journal of Zoology 23:331–338.

Anderson, B., S. Borges, K. Graber, C. Hartless, J. Housenger, N. Mastrota, E. Odenkirchen, E. Riley, and M. Wagman. 2011. Risks of non-compliant rodenticides to nontarget wildlife. United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division, Washington D.C., USA.

Anderson, M. K. 2006. The use of fire by Native Americans in California. Page 596 *in* N. G. Sugihara, J. W. Van Wagtendonk, K. E. Shaffer, J. Fites-Kaufman, and A. E. Thode, editors. Fire in California's Ecosystems. University of California Press.

Anthony, R. M., G. D. Lindsey, and J. Evans. 1984. Hazards to golden-mantled ground squirrels and associated secondary hazard potential from strychnine for forest pocket gophers. Proceedings... Vertebrate Pest Conference (USA).

Arthur, S. M., and W. B. Krohn. 1991. Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J. Mammalogy 72–2.

Arthur, S. M., W. B. Krohn, and J. R. Gilbert. 1989. Habitat use and diet of fishers. The Journal of Wildlife Management 680–688.

Arthur, S. M., W. B. Krohn, and J. R. Gilbert. 1989. Home range characteristics of adult fishers. Journal of Wildlife Management 53:674–679.

Arthur, S. M., T. F. Paragi, and W. B. Krohn. 1993. Dispersal of juvenile fishers in Maine. Journal of Wildlife Management 57:868.

Aubry, K. B., and L. A. Jagger. 2006. The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. M. Santos-Reis, J. D. S. Birks, E. C. O'Doherty, and G. Proulx, editors. Martes in Carnivore Communities. Alpha Wildl. Publ., Alberta, Canada.

Aubry, K. B., and J. C. Lewis. 2003. Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biological Conservation 114:79–90.

Aubry, K. B., and C. M. Raley. 2006. Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report, USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory, Olympia, WA.

Aubry, K. B., C. M. Raley, S. W. Buskirk, W. J. Zielinski, M. K. Schwartz, R. T. Golightly, K. L. Purcell, R. D. Weir, and J. S. Yaeger. 2013. Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. The Journal of Wildlife Management 77:965–974.

Aubry, K., S. Wisely, C. Raley, and S. Buskirk. 2004. Zoogeography, Spacing Patterns, and Dispersal in Fishers. Pages 201–220 *in* D. J. Harrison and A. K. Fuller, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. Springer, New York, NY.

Bachelot, A., and N. Binart. 2005. Corpus luteum development: lessons from genetic models in mice. Current Topics in Developmental Biology 68:49–84.

Baker, M., and W. Stewart. 1996. Ecosystems under four different public institutions: A comparative analysis. Pages 1347–1367 *in*. Sierra Nevada Ecosystem Project: Final Report to Congress (DC Erman, ed.). Volume 2. University of California Davis, Centers for Water and Wildland Resources.

Baker, W. L. 2014. Historical forest structure and fire in Sierran mixed-conifer forests reconstructed from General Land Office survey data. Ecosphere 5.

Baldy, R., R. Beck, C. Carpenter, W. Carpenter, V. Golla, J. Jackson, M. McWilliams, R. Elsie, and H. Sherman. 1996. Hupa language dictionary. Second. Hoopa Valley Tribal Council, Hoopa, CA.

Banci, V. 1989. A fisher management strategy for British Columbia. Ministry of Environment, Victoria, British Columbia, Canada.

Barnosky, A. D., P. L. Koch, R. S. Feranec, S. L. Wing, and A. B. Shabel. 2004. Assessing the causes of Late Pleistocene extinctions on the continents. Science 306:70–75.

Berny, P. J., T. Buronfosse, F. Buronfosse, F. Lamarque, and G. Lorgue. 1997. Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35:1817–1829.

Bonfils, C., P. B. Duffy, B. D. Santer, T. M. L. Wigley, D. B. Lobell, T. J. Phillips, and C. Doutriaux. 2008. Identification of external influences on temperatures in California. Climatic Change 87:43–55.

Brown, R. N., M. W. Gabriel, G. Wengert, S. Matthews, J. M. Higley, and Janet E. Foley. 2006. Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Transactions of the Western Section of the Wildlife Society 42:40–46.

Brown, R. N., M. W. Gabriel, G. W. Wengert, S. Matthews, J. M. Higley, and J. E. Foley. 2008. Pathogens associated with fishers. Pathogens associated with fishers

(Martes pennanti) and sympatric mesocarnivores in California, Final Report USFWS-813335G021, Yreka, CA.

Buck, S. G. 1982. Habitat utilization by fisher (Martes pennanti) near Big Bar, California. Master's Thesis, Humboldt State University, Arcata, CA.

Buck, S. G., C. Mullis, A. S. Mossman, and C. Coolahan. 1994. Habitat use by fishers in adjoining heavily and lightly harvested forest. Pages 368–376 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York.

Buck, S., C. Mullis, and A. S. Mossman. 1983. Corral Bottom-Hayfork Bally Fisher Study: final report. Humboldt State University and USDA Forest Service, Arcata, CA.

Bull, E. L., C. G. Parks, and T. R. Torgersen. 1997. Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report, USDA Forest Service, Pacific Northwest Research Station, Portland, OR.

Bunn, D., A. Mummert, M. Hoshovsky, K. Gilardi, and S. Shanks. 2007. California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

Burns, C. E., K. M. Johnston, and O. J. Schmitz. 2003. Global climate change and mammalian species diversity in U.S. national parks. Proceedings of the National Academy of Sciences 100:11474–11477.

Burt, W. H. 1943. Territoriality and home range concepts as applied to mammals. Journal of mammalogy 24:346–352.

Buskirk, S. W., and R. A. Powell. 1994. Habitat Ecology of Fishers and American Martens. Pages 283–296 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, NY. <http://www.cabdirect.org/abstracts/19950611063.html>. Accessed 9 Oct 2013.

Buskirk, S. W., and L. F. Ruggiero. 1994. American Marten. Page 186 *in*. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. RM_254 edition. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Butler, I. C. 1920. Annual Fish and Game Report. Unpublished Report, California Department of Fish and Game.

Ca Biodiversity Council Bioregions (INACC Regions) - Data.gov. n.d. <https://catalog.data.gov/dataset/ca-biodiversity-council-bioregions-inacc-regions58ab8>. Accessed 5 Apr 2015.

California Department of Forestry and Fire Protection (CDF). 2010. California's Forests and Rangelands: 2010 Assessment. Sacramento, CA. 341pp. <http://frap.fire.ca.gov/assessment/2010/document.php>

California Timber Harvest Statistics. n.d. <http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf>. Accessed 6 Sep 2014.

Callas, R. L., and P. Figura. 2008. Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. California Department of Fish and Game, Sacramento, California.

Campbell, L. A. 2004. Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada. University of California.

Carey, A. B. 1983. Cavities in Trees in Hardwood Forests1. Page 167 *in*. Snag habitat management: proceedings of the symposium, June 7-9, 1983, Northern Arizona University, Flagstaff. Volume 99. US Dept. of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Carroll, C., W. J. Zielinski, and R. F. Noss. 1999. Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conservation Biology 13:1344–1359.

Cayan, D., M. Tyree, M. Dettinger, H. Hidalgo, T. Das, E. Maurer, P. Bromirski, N. Graham, and R. Flick. 2009. Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. California Climate Change Center CEC-500-2009-014-D.

Cayan, D., M. Tyree, D. Pierce, and T. Das. 2012. Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

CDFW. 2008. California Wildlife Habitat Relationships System. California Department of Fish and Wildlife: California Interagency Wildlife Task Group, Sacramento, California.

CDOF. 1991. E-6 County Population Estimates and Components of Change—July 1, 1970–1990. State of California, Department of Finance.

CDOF. 2011. E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. State of California, Department of Finance, Sacramento, California.

CDOF. 2013*a*. E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance.

CDOF. 2013*b*. Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance.

Christensen, J. H., B. Hewitson, A. Busuioc, A. Chen, X. Gao, R. Held, R. Jones, R. K. Kolli, W. K. Kwon, R. Laprise, V. M. Rueda, L. Mearns, C. G. Menendez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton. 2007. Regional climate projections. S. Susan, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and

H. L. Miller, editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Volume 4. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Clifford, D. L., L. Woods, M. W. Gabriel, V. Tkach, E. Hoberg, R. Callas, R. N. Brown, J. M. Higley, and M. W. Gabriel. 2012. Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

Cole, R. A., D. S. Lindsay, D. K. Howe, C. L. Roderick, J. P. Dubey, N. J. Thomas, and L. A. Baeten. 2000. Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). Journal of Parasitology 86:526–530.

Colvin, B. A., and W. . Jackson. 1991. Secondary poisoning hazards associated with rodenticide use. E. . Magallona, editor. 11th International Congress Plant Protection. Manila, Phillipines.

Coulter, M. . 1966. The ecology and management of fishers in Maine. University, Syracuse, Syracuse, New York, USA.

Cox, P., and 165-170 Smith. 1992. Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. Proceedings of the 15th Vertebrate Pest Conference. University of California, Davis, CA, USA.

Crowley, S. K., W. B. Krohn, and T. F. Paragi. 1990. A comparison of fisher reproductive estimates. Pages 36–42 *in*. Transactions of the Northeast Section of the Wildlife Society. Volume 47. <http://www.citeulike.org/group/15497/article/9675237>. Accessed 2 Mar 2015.

Davis, F. W., C. Seo, and W. J. Zielinski. 2007. Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecological Applications 17:2195–2213.

Davis, L. R. 2009. Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau. Dept. of Biological Sciences-Simon Fraser University. <http://summit.sfu.ca/item/9870>. Accessed 10 Oct 2013.

Diller, L., K. Hamm, D. Lamphear, and J. Thompson. 2008. Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Green Diamond Resource Company, Korbel, CA.

Dixon, J. S. 1925. A closed season needed for fisher, marten, and wolverine. California Fish and Game 11:23–25.

Douglas, C. W., and M. A. Strickland. 1987. Fisher. M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources, Ontario, Canada.

Douglas, C. W., and M. A. Strickland. 1999. Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

Drew, R. E., J. G. Hallett, K. B. Aubry, K. W. Cullings, S. M. Koepf, and W. J. Zielinski. 2003. Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Molecular Ecology 12:51–62.

Duane, T. P. 1996. Human Settlement 1850-2040. W. R. Center, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. University of California, Davis, CA, USA.

Durbin, W. G. 1925. Fish and Game Annual Report. Forest Supervisor, Lassen National Forest. Unpublished Report, California Department of Fish and Game.

Eadie, W. R., and W. J. Hamilton. 1958. Reproduction in the fisher in New York. New York Fish and Game Journal 5:77–83.

Erickson, W. A., and D. J. Urban. 2004. Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

Erxleben, J. C. P. 1777. Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

Eshelman, R., and F. Grady. 1984. Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. Pages 43–70 *in* J. N. McDonald and S. O. Bird, editors. The Quaternary of Virginia - A symposium volume. Volume 75. VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Charlottsville, Virginia.

Facka, A. N., R. A. Sweitzer, S. M. Matthews, and R. A. Powell. 2013. A note on standardization of reproductive and survival rates for populations of Martes. Martes Working Group.

Farber, S., R. L. Callas, J. S. Yaeger, M. K. Schwartz, K. Pilgrim, R. A. Powell, and R. Swiers. 2010. Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report, USDI Fish and Wildlife Service, Yreka Fish and Wildlife Office, Yreka, California.

Fisher, P., C. O'Connor, G. Wright, and C. T. Easton. 2003. Persistence of four anticoagulant rodenticides in livers of laboratory rats. DOC Science Internal Series 139, New Zealand Department of Conservation.

Franklin, J. F., T. A. Spies, R. V. Pelt, A. B. Carey, D. A. Thornburgh, D. R. Berg, D. B. Lindenmayer, M. E. Harmon, W. S. Keeton, and D. C. Shaw. 2002. Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. Forest Ecology and Management 155:399–423.

FRAP. 2003. The changing California: Forest and range 2003 assessment. California Department of Forestry and Fire Protection.

Fried, J. S., Torn, and E. Mills. 2004. The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Climatic Change 64:169–191.

Frost, H. C., and W. B. Krohn. 1997. Factors affecting the reproductive success of captive female fishers. Pages 100–109 *in* G. Proulx, H. N. Bryant, and P. M. Woodward, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB.

Frost, H. C., W. B. Krohn, and C. R. Wallace. 1997. Age-specific reproductive characteristics in fishers. Journal of Mammalogy 78:598–612.

FSC Forest Stewardship Council U.S. (FSC-US) · Our History. n.d. <https://us.fsc.org/our-history.180.htm>. Accessed 2 Sep 2014.

FSC Forest Stewardship Council U.S. · Mission and Vision. n.d. <https://us.fsc.org/mission-and-vision.187.htm>. Accessed 2 Sep 2014.

Furnas, B. J., R. H. Landers, H. E. Barrett, and R. L. Callas. In review. Monitoring fisher (Pekania pennanti) and other forest carnivores across a large geographic area using camera traps and hierarchical models of detection/non-detection data. In Review: Journal of Wildlife Management.

Gabriel, M. W., J. M. Higley, S. Matthews, G. W. Wengert, and R. Poppenga. 2012*a*. Discovery of anticoagulant rodenticides dispersed in an illegal marijuana grow site within several fisher territories in northern California. Unpubl. report, Integral Ecology Research Center, Arcata, CA.

Gabriel, M. W., G. M. Wengert, S. M. Matthews, J. M. Higley, J. E. Foley, A. Blades, M. Sullivan, and R. N. Brown. 2010. Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). Journal of wildlife diseases 46:966–970.

Gabriel, M. W., G. W. Wengert, and R. N. Brown. 2012*b*. Pathogens and parasites of Martes species: Management and conservation implications. Pages 138–185 *in* K. B. Aubry, W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Cornell University Press, Ithaca, New York.

Gabriel, M. W., G. W. Wengert, J. M. Higley, and S. Krogan. 2013. Silent forests? Rodenticides on illegal marijuana crops harm wildlife. The Wildlife Professional Spring.

Gabriel, M. W., L. W. Woods, R. Poppenga, R. A. Sweitzer, C. Thompson, S. M. Matthews, J. M. Higley, S. M. Keller, K. Purcell, R. H. Barrett, G. M. Wengert, B. N. Sacks, and D. L. Clifford. 2012*c*. Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

Garant, Y., and M. Crete. 1997. Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Canadian field-naturalist. Ottawa ON 111:359–364.

Garbelotto, M., E. R. Maddison, and D. Schmidt. 2014. SODmap and SODmap Mobile: Two Tools to Monitor the Spread of Sudden Oak Death. Forest Phytophthoras 4.

Garner, J. D. 2013. Selection of disturbed habitat by fishers (Martes pennanti) in the Sierra National Forest. Humboldt State University.

Garroway, C. J., J. Bowman, and P. J. Wilson. 2011. Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Molecular ecology 20:3978–3988.

Gibilisco, C. J. 1994. Distributional dynamics of modern Martes in North America. S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, , Ithaca, New York, USA.

Godfrey, M. E. R., and C. P. Lyman. 1980. Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). New Zealand journal of experimental agriculture 8:1–5.

Goldman, F. A. 1935. New American mustelids of the genera Martes, Gulo, and Lutra. Proceedings Biological Society of Washington 48:175–186.

Golightly, R. T., T. F. Penland, W. J. Zielinski, and J. M. Higley. 2006. Fisher diet in the Klamath/north coast bioregion. Final Report to US Fish and Wildlife Service and Scotia Pacific. Humboldt State Sponsored Programs Foundation, Arcata, California.

Gordon, C. J. 1994. Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicology and teratology 16:427–453.

Gould, G. I., and J. Escallier. 1989. Licensed trapper’s and dealer’s report. California Department of Fish and Game, Sacramento, California.

Gould, G. I., Jr. 1987. Forest Mammal Survey and Inventory. Nongame Wildl. Investigations Report, Calif. Dept. of Fish and Game.

Graham, R. W., and M. A. Graham. 1994. The late Quaternary distribution of Martes in North America. S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

Green, R. E., K. L. Purcell, and C. Thompson. 2013. A photographic field guide to fisher rest and den sites in teh Sierra National Forest. USDA Forest Service PSW Research Station.

Greenwood, P. J. 1980. Mating systems, philopatry and dispersal in birds and mammals. Animal behaviour 28:1140–1162.

Grenfell, W. E., and M. Fasenfest. 1979. Winter food habits of fisher (Martes pennanti) in northwestern California. California Fish and Game 65:186–189.

Grinnell, J., J. Dixon, and M. Linsdale. 1930. Vertebrate natural history of a section of northern California through the Lassen Peak region. 35, University of California Publications in Zoology.

Grinnell, J., J. S. Dixon, J. M. Linsdale, B. University of California, and Museum of Vertebrate Zoology. 1937. Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. University of California press, Berkeley, Calif.

Grinspoon, E., and R. Phillips. 2011. Northwest Forest Plan the first 15 years (1994-2008): socioeconomic status and trends. Tech. Paper, UDSA Forest Serice, Pacific Northwest Region.

Grue, C. E., A. D. M. Hart, and P. Mineau. 1991. Biological consequences of depressed brain cholinesterase activity in wildlife. Pages 151–209 *in* P. Mineau, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Elsevier Science Publishers, Amsterdam, Netherlands.

Hagmeier, E. M. 1956. Distribution of marten and fisher in North America. Canadian Field Naturalist 70:149–168.

Hagmeier, E. M. 1959. A reevaluation of the subspecies of fisher. Canadian Field Naturalist 73:185–197.

Hall, E. R. 1942. Gestation period in the fisher with recommendations for the animal's protection in California. California Fish and Game 28:143–147.

Halofsky, J. E., D. L. Peterson, K. A. O'Halloran, and C. Hawkins-Hoffman. 2011. Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report, US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Hamilton, W. J., A. H. Cook, and W. F. Hamilton. 1955. The biology and management of the fisher in New York. New York Fish and Game Journal 2:13–35.

Hamm, K. A., L. V. Diller, D. W. Lamphear, and D. A. Early. 2012. Ecology and management of Martes on private timberlands in north coastal California. <http://ftp.fs.fed.us/psw/publications/documents/psw_gtr238/psw_gtr238_419.pdf>. Accessed 9 Mar 2015.

Hannibal, M. E. 2012. America's Next Best Idea: The National Park System Looks to the Future. The George Wright Forum 29:380–384.

Hanson, C. T. 2013. Habitat Use of Pacific Fishers in a Heterogeneous Post-Fire and Unburned Forest Landscape on the Kern Plateau, Sierra Nevada, California. Open Forest Science Journal 6:24–30.

Hayhoe, K., D. Cayan, C. B. Field, P. C. Frumhoff, E. P. Maurer, N. L. Miller, S. C. Moser, S. H. Schneider, K. N. Cahill, and E. E. Cleland. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America 101:12422–12427.

Hayward, M. W., W. Jedrzejewski, and B. Jedrzewska. 2012. Prey preferences of the tiger Panthera tigris. Journal of Zoology 286:221–231.

Higley, J. M., and S. Matthews. 2006. Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report, Hoopa Valley Tribe and Wildlife Conservation Society.

Higley, J. M., G. W. Wengert, S. M. Matthews, and K. M. Rennie. 2013. Bobcat Ecology and relationship with and influence on fisher survival on the Hoopa Valley Indian Reservation, California. Final Report, Hoopa Valley Tribe, Hoopa, CA.

IUCN, and SSC. 2013. Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. IUCN Species Survival Commission, Gland, Switzerland.

James, C. E., B. Krumland, and D. W. Taylor. 2012. Comparison of Floristic Diversity between Young Conifer Plantations and Second-Growth Adjacent Forests in California's Northern Interior. Western Journal of Applied Forestry 27:60–71.

James, G. W. 1915. The Lake of the Sky: Lake Tahoe in the high Sierras of California and Nevada. L. C. Page and Company, Boston.

Janeway, C. A., P. Travers, and M. Walport. 2007. Immunobiology. 7th edition. Garland Science, New York, New York, USA.

Jansman, H., and P. van Tulden. 2012. Persecution and poisoning of birds of prey in the Netherlands. Pages 139–142 *in* N. Richards, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons.

Johnson, S. A. 1984. Home range, movements, and habitat use of fishers in Wisconsin. University of Wisconsin–Stevens Point.

Jones, J. L. 1991. Habitat use of fisher in northcentral Idaho. University of Idaho.

Jones, J. L., and E. O. Garton. 1994. Selection of successional stages by fishers in north-central Idaho. Pages 377–387 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, NY.

Karanth, K. U., J. D. Nichols, N. S. Kumar, W. A. Link, and J. E. Hines. 2004. Tigers and their prey: predicting carnivore densities from prey abundance. Proceedings of the National Academy of Sciences of the United States of America 101:4854–4858.

Keller, S. M., M. Gabriel, K. A. Terio, E. J. Dubovi, E. VanWormer, R. Sweitzer, R. Barret, C. Thompson, K. Purcell, and L. Munson. 2012. Canine distemper in an isolated population of fishers (Martes pennanti) from California. Journal of wildlife diseases 48:1035–1041.

Kelly, G. M. 1977. Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas. University of Massachusetts.

Kilpatrick, H. J., and P. W. Rego. 1994. Influence of season, sex, and site availability on fisher (Martes pennanti) rest-site selection in the central hardwood forest. Canadian Journal of Zoology/Revue Canadienne de Zoologie 72:1416–1419.

Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics. n.d. <http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/>. Accessed 1 Sep 2014.

Kliejunas, J. T. 2011. A risk assessment of climate change and the impact of forest diseases on forest ecosystems in the Western United States and Canada. USDA Forest Service, General Technical Report, USDA Forest Service.

Klug Jr, R. R. 1997. Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections. Humboldt State University.

Knaus, B. J., R. Cronn, A. Liston, K. Pilgrim, and M. K. Schwartz. 2011. Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC ecology 11:10.

Knick, S. T. 1990. Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildlife Monographs 3–42.

Knick, S. T., E. C. Hellgren, and U. S. Seal. 1993. Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Canadian Journal of Zoology/Revue Canadienne de Zoologie 71:1448–1453.

Koen, E. L., J. Bowman, C. S. Findlay, and L. Zheng. 2007. Home Range and Population Density of Fishers in Eastern Ontario. Journal of Wildlife Management 71:1484–1493.

Koopman, M. E., R. S. Nauman, and J. L. Leonard. 2010. Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

Krawchuk, M. A., and M. A. Moritz. 2012. Fire and Climate Change in California. California Energy Commission. Publication number: CEC-500-2012-026.

Kreuder, C., M. A. Miller, D. A. Jessup, L. J. Lowenstine, M. D. Harris, J. A. Ames, T. E. Carpenter, P. A. Conrad, and J. A. K. Mazet. 2003. Patterns of mortality in southern sea otters (Enhydra lutris nereis) from 1998-2001. Journal of Wildlife Diseases 39:495–509.

Krohn, W. B., S. M. Arthur, and T. F. Paragi. 1994. Mortality and vulnerability of a heavily trapped fisher population. S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

Krohn, W. B., W. J. Zielinski, R. B. Boone, and others. 1997. Relations among fishers, snow, and martens in California: results from small-scale spatial comparisons. Martes: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmington, Alberta, Canada 211–232.

Kuehn, D. W. 1989. Winter foods of fishers during a snowshoe hare decline. The Journal of Wildlife Management 688–692.

Lamberson, R. H., R. L. Truex, W. J. Zielinski, and D. Macfarlane. 2000. Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata, CA: Humboldt State University.

Larkin, J. L., M. Gabriel, R. W. Gerhold, M. J. Yabsley, J. C. Wester, J. G. Humphreys, R. Beckstead, and J. P. Dubey. 2011. Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. Journal of Parasitology 97:425–429.

Lawler, J. J., H. D. Safford, and E. H. Girvetz. 2012. Martens and fishers in a changing climate. Pages 371–397 *in* K. B. Aubry, W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. Martens, Sables, and Fishers: A New Synthesis. Cornell University Press, Ithaca, NY.

Lenihan, J. M., R. Drapek, D. Bachelet, and R. P. Neilson. 2003. Climate change effects on vegetation distribution, carbon, and fire in California. Ecological Applications 13:1667–1681.

Leonard, R. D. 1986. Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Canadian field-naturalist. Ottawa ON 100:32–44.

Lewis, J. C., R. A. Powell, and W. J. Zielinski. 2012. Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7:n/a.

Lewis, J. C., and D. W. Stinson. 1998. Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

Lewis, J. C., and W. J. Zielinski. 1996. Historical harvest and incidental capture of fishers in California. Northwest Science 70:291–297.

Linsdale, J. M. 1931. Facts concerning the use of thallium in California to poison rodents: its destructiveness to game birds, song birds and other valuable wild life. Condor 92–106.

Linsdale, J. M. 1932. Further facts concerning losses to wild animal life through pest control in California. Condor 121–135.

Li, Q., and T. Kawada. 2006. The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cellular & molecular immunology 3:171–178.

Littell, J. S., M. M. Elsner, G. Mauger, E. Lutz, A. F. Hamlet, and E. Salathé. 2011. Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. Climate Impacts Group, University of Washington, College of the Environment.

Littell, J. S., E. E. Oneil, D. McKenzie, J. A. Hicke, J. A. Lutz, R. A. Norheim, and M. M. Elsner. 2010. Forest ecosystems, disturbance, and climatic change in Washington State, USA. Climatic Change 102:129–158.

Loarie, S. R., P. B. Duffy, H. Hamilton, G. P. Asner, C. B. Field, and D. D. Ackerly. 2009. The velocity of climate change. Nature 462:1052–1055.

Lofroth, E. C., C. M. Raley, L. L. Finley, and R. H. Naney. 2010. Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

Mabry, K. E., E. L. Shelley, K. E. Davis, D. T. Blumstein, and D. Hv. Vuren. 2013. Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

Martin, P. A., and K. R. Solomon. 1991. Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pesticide Biochemistry and Physiology 40:117–127.

Martin, R. E., and D. B. Sapsis. 1992. Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

Matthews, S. M., J. M. Higley, K. M. Rennie, R. E. Green, C. A. Goddard, G. M. Wengert, M. W. Gabriel, and T. K. Fuller. 2013. Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. Journal of Mammalogy 94:100–108.

Matthews, S. M., J. Mark Higley, J. Scott Yaeger, and T. K. Fuller. 2011. Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildlife Society Bulletin 35:69–75.

McKelvey, K. S., K. B. Aubry, and M. K. Schwartz. 2008. Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58:549–555.

McKelvey, K. S., J. D. Johnston, and others. 1992. Historical perspectives on forests of the Sierra Nevada and the Transverse Ranges of southern California: forest conditions at the turn of the century. J. Verner, KS McKelvey, BR Noon, RJ Gutiérrez, GI Gould, Jr., and TW Beck, technical coordinators. The California Spotted Owl: A Technical Assessment of its Current Status. USDA Forest Service, Pacific Southwest Research Station. General Technical Report PSW-GTR-133 225–246.

Mckenzie, D., Z. Gedalof, D. L. Peterson, and P. Mote. 2004. Climatic Change, Wildfire, and Conservation. Conservation Biology 18:890–902.

Mead, R. A. 1994. Reproduction in Martes. Pages 404–422 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York.

Miller, J. D., H. D. Safford, M. Crimmins, and A. E. Thode. 2009. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12:16–32.

Miller, J. D., C. N. Skinner, H. D. Safford, E. E. Knapp, and C. M. Ramirez. 2012. Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecological Applications 22:184–203.

Mineau, P., L. Lyon, and S. McMillin. 2012. Impacts of carbofuran on birds in Canada and the United States. Pages 219–222 *in* N. Richards, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons.

Moriarty, J. G., S. P. D. Riley, L. E. Serieys, J. A. Sikich, C. M. Schoonmaker, and R. H. Poppenga. 2012. Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: From mountain lions to rodents. 25th Vertebrate Pest Conference (March 5-8 2012), Monterey, California, USA.

Moritz, C., and R. Agudo. 2013. The Future of Species Under Climate Change: Resilience or Decline? Science 341:504–508.

Munday, J. S., and L. J. Thompson. 2003. Brodifacoum toxicosis in two neonatal puppies. Veterinary Pathology Online 40:216–219.

Naney, R. N., L. L. Finley, E. C. LoFroth, P. J. Happe, A. L. Krause, C. M. Raley, R. L. Truex, L. J. Hale, J. M. Higley, A. D. Kosic, J. C. Lewis, S. A. Livingston, D. C. MacFarlane, A. M. Myers, and J. S. Yaeger. 2012. Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California--Volume III: Threats Assessment. USDI Bureau of Land Management.

North, M., P. Stine, K. O'Hara, W. Zielinski, and S. Stephens. 2009. An Ecosystem Management Strategy for Sierran Mixed-conifer Forests. USDA Forest Service Gen. General Technical Report, USDA Forest Service, Pacific Southwest Research Station, Albany, CA.

Odion, D. C., C. T. Hanson, A. Arsenault, W. L. Baker, D. A. DellaSala, R. L. Hutto, W. Klenner, M. A. Moritz, R. L. Sherriff, T. T. Veblen, and M. A. Williams. 2014. Examining Historical and Current Mixed-Severity Fire Regimes in Ponderosa Pine and Mixed-Conifer Forests of Western North America. PLoS ONE 9.

Origgi, F. C., P. Plattet, U. Sattler, N. Robert, J. Casaubon, F. Mavrot, M. Pewsner, N. Wu, S. Giovannini, and A. Oevermann. 2012. Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Veterinary Pathology Online 49:913–929.

Our annual catch of furbearing animals. 1916. California Fish and Game 2:34–35.

Pachauri, R. K., and A. Reisinger. 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change 1.

Paradis, A., J. Elkinton, K. Hayhoe, and J. Buonaccorsi. 2008. Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitigation and Adaptation Strategies for Global Change 13:541–554.

Paragi, T. F. 1990. Reproductive biology of female fishers in southcentral Maine. University of Maine at Orono.

Paragi, T. F., S. M. Arthur, and W. B. Krohn. 1994*a*. Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Canadian field-naturalist. Ottawa ON 108:52–57.

Paragi, T. F., W. B. Krohn, and S. M. Arthur. 1994*b*. Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildlife 51:1–11.

Phillips, S. J., R. P. Anderson, and R. E. Schapire. 2006. Maximum entropy modeling of species geographic distributions. Ecological modelling 190:231–259.

Pierce, D. W., D. R. Cayan, T. Das, E. P. Maurer, N. L. Miller, Y. Bao, M. Kanamitsu, K. Yoshimura, M. A. Snyder, and L. C. Sloan. 2013*a*. The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. Journal of Climate.

Pierce, D. W., T. Das, D. R. Cayan, E. P. Maurer, N. L. Miller, Y. Bao, M. Kanamitsu, K. Yoshimura, M. A. Snyder, L. C. Sloan, G. Franco, and M. Tyree. 2013*b*. Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Climate Dynamics 40:839–856.

Pittaway, R. J. 1978. Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Le Naturaliste Canadien 105:487–489.

Popescu, V. D., P. Valpine, and R. A. Sweitzer. 2014. Testing the consistency of wildlife data types before combining them: the case of camera traps and telemetry. Ecology and evolution 4:933.

Powell, R. A. 1979. Ecological energetics and foraging strategies of the fisher (Martes pennanti). The Journal of Animal Ecology 195–212.

Powell, R. A. 1993. The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

Powell, R. A. 1994. Structure and spacing of Martes populations. Pages 101–121 *in*. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Powell, R. A., and R. B. Brander. 1977. Adaptations of fishers and porcupines to their predator prey system. Pages 45–53 *in*. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula.

Powell, R. A., A. N. Facka, D. L. Clifford, C. Beach, and K. Smith. 2013. Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

Powell, R. A., and W. J. Zielinski. 1994. Fisher. The Scientific Basis for Conserving Forest Carnivores: American marten, fisher, lynx, and wolverine, General Technical Report, USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Powell, R. A., and W. J. Zielinski. 2005. Evaluating the demographic factors that affect the success of reintroducing fishers (Martes pennanti), and the effect of removals on a source population. Final Report.

Powell, S. M., E. C. York, and T. K. Fuller. 1997. Seasonal food habits of fishers in central New England. Pages 279–305 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. Martes: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

preview.fsc-certified-acres-by-state.a-204.pdf. n.d. <https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf>. Accessed 2 Sep 2014.

Price, W. W. 1894. Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE: a biological journal 4:315–332.

Prichard, A. M. 2014. Notice of final decision concerning bordifacoum (second generation anticoagulant rodenticide): California Notice 2014-09P. California Department of Pesticide Regulation.

Pridham, T. J., and J. Belcher. 1958. Toxoplasmosis in mink. Canadian journal of comparative medicine and veterinary science 22:99–106.

Proulx, G. 2011. Field evidence of non-target and secondary poisoning by strychnine and chlorophacinone used to control Richardson’s ground squirrels in southwest Saskatchewan. P Ninth Prairie Conserv Endang Species C 128–134.

Purcell, K. L., A. K. Mazzoni, S. R. Mori, and B. B. Boroski. 2009. Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. Forest Ecology and Management 258:2696–2706.

Raley, C. M., E. C. Lofroth, R. L. Truex, J. S. Yaeger, and J. M. Higley. 2012. Habitat ecology of fishers in western North America. K. B. Aubry, W. J. Zielinski, M. G. Raphael, G. Proulx, and S. W. Buskirk, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Cornell University Press, Ithaca, New York.

Ralph, M. 2011. Water supply and flooding. D. W. Pierce, editor. California Climate Extremes Workshop Report. Scripps Institution of Oceanography, La Jolla, CA.

Reno, M. A., K. Rulon, and C. James. 2008. Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

Rhoads, S. N. 1898. Contributions to a revision of the North American beavers, otters and fishers. Transactions of the American Philosophical Society 19:417–439.

Riley, S. P. D., C. Bromley, R. H. Poppenga, F. A. Uzal, and et al. 2007. Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. Journal of Wildlife Management 71:1874–1884.

Ruder, M. G., R. H. Poppenga, J. A. Bryan, M. Bain, J. Pitman, and M. K. Keel. 2011. Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. Journal of wildlife diseases 47:212–216.

Rueger, B. 1992. Giant sequoia management strategies on the Tule River Indian Reservation. Volume PSW-GTR-151. USDA Forest Service PSW Research Station, Visalia, CA.

Safford, H. D. 2006. Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report, USDA Forest Service, Pacific Southwest Region, Vallejo, California.

Safranyik, L., A. L. Carroll, J. Regniere, D. W. Langor, W. G. Riel, T. L. Shore, B. Peter, B. J. Cooke, V. G. Nealis, and S. W. Taylor. 2010. Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Canadian Entomologist 142:415–442.

Salathe, E. P., Lr. Leung, Y. Qian, and Y. Zhang. 2010. Regional climate model projections for the State of Washington. Climatic Change 102:51–75.

Samuels, J. X., and J. Cavin. 2013. The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. Journal of Vertebrate Paleontology 33:448–454.

Sandra Martin. 1994. Feeding ecology of American martens and fishers. Pages 297–315 *in* S. W. Buskirk, A. S. Harestad, R. A. Raphael, and R. A. Powell, editors. Martens, sables and fishers: biology and conservation. Cornell University Press, Ithaca, New York.

Sato, J. J., M. Wolsan, F. J. Prevosti, G. D'Elía, C. Begg, K. Begg, T. Hosoda, K. L. Campbell, and H. Suzuki. 2012. Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Molecular Phylogenetics and Evolution 63:745–757.

Scheller, R. M., W. D. Spencer, H. Rustigian-Romsos, A. D. Syphard, B. C. Ward, and J. R. Strittholt. 2011. Using stochastic simulation to evaluate competing risks of wildfires and fuels management on an isolated forest carnivore. Landscape Ecology 26:1491–1504.

Schempf, P. F., and M. White. 1977. Status of six furbearer populations in the mountains of northern California. US Department of Agriculture, Forest Service, California Region.

Seglund, A. E. 1995. The use of resting sites by the Pacific fisher. Humboldt State University.

Self, S., and R. Callas. 2006. Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pacific Industries and California Department of Fish and Game.

Self, S. E., E. Murphy, and S. Farber. 2008. Preliminary estimate of fisher populations in California and Southern Oregon. Sierra Pacific Industries, P.O. Box 496014, Redding CA 96049.

Shaffer, M. L. 1981. Minimum Population Sizes for Species Conservation. BIO. SCIENCE. 31:131–134.

Shaw, M. R., L. Pendleton, D. R. Cameron, B. Morris, D. Bachelet, K. Klausmeyer, J. MacKenzie, D. R. Conklin, G. N. Bratman, J. Lenihan, E. Haunreiter, C. Daly, and P. R. Roehrdanz. 2011. The impact of climate change on California's ecosystem services. Climatic Change 109:465–484.

Show, S. B., and E. I. Kotok. 1923. Forest fires in California, 1911-1920: an analytical study. US Department of Agriculture, Washington D.C., USA.

Slauson, K. M., and W. J. Zielinski. 2003. Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final report, USDA Forest Service Pacific Southwest Research Station, Arcata, California, USA.

Slauson, K. M., and W. J. Zielinski. 2012. Effects of diet composition on home range size by fishers in California.

Slauson, K. M., W. J. Zielinski, and G. W. Holm. 2003. Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final report, USDA Forest Service Pacific Southwest Research Station, Arcata, California, USA.

Smith, T. 2014. What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. <http://snamp.cnr.berkeley.edu/teams/fisher>. Accessed 1 Sep 2014.

Solomon, S., D. Qin, M. Manning, R. ALLEY, T. BERNTSEN, N. BINDOFF, Z. CHEN, A. CHIDTHAISONG, J. GREGORY, and G. et al. HEGERL. 2007. Technical Summary. Pages 19–91 *in* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and H. L. Miller, editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, USA.

Spencer, W. D., H. Rustigian, J. R. Strittholt, R. Scheller, and A. Syphard. 2008. Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

Spencer, W. D., S. Sawyer, H. Romsos, W. Zielinski, R. A. Sweitzer, C. Thompson, K. L. Purcell, D. L. Clifford, L. Cline, H. D. Safford, S. Britting, and J. M. Tucker. 2015. Southern Sierra Nevada fisher conservation assessment. Conservation Biology Institute.

Spencer, W., H. Rustigian-Romsos, J. Strittholt, R. Scheller, W. Zielinski, and R. Truex. 2011. Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biological Conservation 144:788–803.

Spies, T. A., T. W. Giesen, F. J. Swanson, J. F. Franklin, D. Lach, and Kn. Johnson. 2010. Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landscape Ecology 25:1185–1199.

Steel, Z. L., H. D. Safford, and J. H. Viers. 2015. The fire frequency-severity relationship and the legacy of fire suppression in California forests. Ecosphere 6:art8.

Stephen Dobson, F. 1982. Competition for mates and predominant juvenile male dispersal in mammals. Animal behaviour 30:1183–1192.

Stephens, S. L., R. E. Martin, and N. E. Clinton. 2007. Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. Forest Ecology and Management 251:205–216.

Stephens, S. L., and N. G. Sugihara. 2006. Fire management and policy since European settlement. Pages 431–443 *in*. Fire in California's Ecosystems. University of California Press, Berkeley, California.

Strickland, M. A. 1994. Harvest management of fishers and American martens. Pages 149–164 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York.

Sulak, A., and L. Huntsinger. 2012. Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. Journal of Forestry 110:312–317.

Sweitzer, R. A., V. D. Popescu, R. H. Barrett, K. L. Purcell, and C. M. Thompson. 2015. Reproduction, abundance, and population growth for a fisher (Pekania pennanti) population in the Sierra National Forest, California. Journal of Mammalogy.

Sweitzer, R. A., C. M. Thompson, R. E. Green, K. L. Purcell, and R. H. Barrett. In review*a*. Survival of fishers in the southern Sierra Nevada region of California. Journal of Mammalogy.

Sweitzer, R. A., C. M. Thompson, K. L. Purcell, G. W. Wengert, M. W. Gabriel, L. W. Woods, and R. H. Barrett. In review*b*. Influence of natural and human-linked mortalities on survival and population growth of fishers in the Sierra National Forest, California. Journal of Wildlife Management.

Swiers, R. C. 2013. Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. North Carolina State University, [Raleigh, North Carolina].

Taylor, A. H., and C. N. Skinner. 1998. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. Forest Ecology and Management 111:285–301.

The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data. n.d. <http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml>. Accessed 5 Sep 2014.

The Public Land Survey System (PLSS). n.d. <http://nationalatlas.gov/articles/boundaries/a_plss.html>. Accessed 4 Sep 2014.

Thompson, C. M., K. L. Purcell, J. D. Garner, and R. E. Green. 2010. Kings River fisher project progress report 2007-2010. USDA Forest Service, Pacific Southwest Research Station, Fresno, CA.

Thompson, C. M., W. J. Zielinski, and K. L. Purcell. 2011. Evaluating management risks using landscape trajectory analysis: a case study of California fisher. The Journal of Wildlife Management 75:1164–1176.

Thompson, C., R. Sweitzer, M. Gabriel, K. Purcell, R. Barrett, and R. Poppenga. 2013. Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conservation Letters.

Thompson, I. D., J. A. Baker, and M. Ter-Mikaelian. 2003. A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. Forest Ecology and Management 177:441–469.

Timm, S. F., L. Munson, B. A. Summers, K. A. Terio, E. J. Dubovi, C. E. Rupprecht, S. Kapil, and D. K. Garcelon. 2009. A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). Journal of Wildlife Diseases 45:333–343.

Tingley, M. W., M. S. Koo, C. Moritz, A. C. Rush, and S. R. Beissinger. 2012. The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Global Change Biology 18:3279–3290.

Trần, J. K., T. Ylioja, R. F. Billings, J. Régnière, and M. P. Ayres. 2007. Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecological Applications 17:882–899.

Trotter, Talbot. 2013. Relationships among climate, forests, and insects in North America: Examples of the importance of long-term and broad-scale perspectives. In: Camp, Ann E.; Irland, Lloyd C.; Carroll, Charles J.W. Long-term silvicultural and ecological studies. Results for science and management: volume 2.GISF Res. Pap. 013. New Haven, CT: Yale University, School of Forestry and Environmental Studies, Global Institute of Sustainable Forestry: 161-177.

Troyer, J., and J. A. Blackwell. 2004. Sierra Nevada forest plan amendment: final supplemental environmental impact statement. USDA Forest Service, Pacific Southwest Region.

Truex, R. L., and W. J. Zielinski. 2013. Short-term effects of fuel treatments on fisher habitat in the Sierra Nevada, California. Forest Ecology & Management 293:85–91.

Truex, R. L., W. J. Zielinski, R. T. Golightly, R. H. Barrett, and S. M. Wisely. 1998. A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft report submitted to California Department of Fish and Game. United States Forest Service, Pacific Southwest Research Station, Arcata, California.

Tucker, J. M. 2013*a*. Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada. The University of Montana.

Tucker, J. M. 2013*b*. Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada.

Tucker, J. M., M. K. Schwartz, R. L. Truex, K. L. Pilgrim, and F. W. Allendorf. 2012. Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS one 7.

Tucker, J. M., M. K. Schwartz, R. L. Truex, S. M. Wisely, and F. W. Allendorf. 2014. Sampling affects the detection of genetic subdivision and conservation implications for fisher in the Sierra Nevada. Conservation Genetics 15:123–136.

USDA. 2014. Forest Management: Cut and sold reports. <http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml>. Accessed 22 Aug 2014.

USDA. 2015. LANDFIRE-Fire Regime Product Descriptions. LANDFIRE. <http://www.landfire.gov/NationalProductDescriptions13.php>. Accessed 4 Sep 2014.

USDA Forest Service. 2015. Forest Health Protection Survey Aerial Detection Survey April 15-17 (southern Sierra Nevada). <http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=stelprd3836640>

USDA Forest Service. 1959. Notes from porcupine control meeting. Modoc National Forest. Unpublished.

USDA Forest Service. n.d. Threatened, Endangered, and Sensitive Plants and Animals. Chaper 2670, Manual, US Forest Service.

USDA Forest Service, and USDI Bureau of Land Management. 1994*a*. Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

USDA Forest Service, and USDI Bureau of Land Management. 1994*b*. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team].

USDI Bureau of Land Management. 2008. Sierra Resource Management Plan and Record of Decision. Bureau of Land Management, Folsom, CA.

US Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants; Threatened Species Status for West Coast Distinct Population Segment of Fisher. Vol. 79, No. 194, Federal Register, US Fish and Wildlife Service.

Vidal, D., V. Alzaga, J. J. Luque-Larena, R. Mateo, L. Arroyo, and J. Vinuela. 2009. Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Science of the Total Environment 408:267–271.

De Vos, A. 1951. Overflow and dispersal of marten and fisher from wildlife refuges. The Journal of Wildlife Management 15:164–175.

De Vos, A. 1952. The ecology and management of fisher and marten in Ontario. <http://www.citeulike.org/group/15497/article/9675279>. Accessed 21 Aug 2014.

Vose, J. M., D. L. Peterson, and T. Patel-Weynand. 2012. Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Waples, R. 1991. Definition of a “species” under the Endangered Species Act: Application to Pacific salmon. Technical menorandum, NOAA.

Weinmann, R., H. J. Raskas, and R. G. Roeder. 1974. Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proceedings of the National Academy of Sciences 71:3426–3430.

Weir, R. D. 2003. Status of the fisher in British Columbia. BC Minist. Sustainable Resour. Manage., Conservation Data Centre, and BC Minist. Water, Land and Air Protection, Biodiversity Branch, Victoria, BC. Wildl. Bull. No. B-105. 38pp 3.

Weir, R. D., and F. B. Corbould. 2008. Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Peace/Williston Fish & Wildlife Compensation Program, Prince George, British Columbia, Canada.

Weir, R. D., and F. B. Corbould. 2010. Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. Journal of Wildlife Management 74:405–410.

Weir, R. D., and A. S. Harestad. 2003. Scale-dependent habitat selectivity by fishers in south-central British Columbia. Journal of Wildlife Management 67:73–82.

Weir, R. D., A. S. Harestad, and R. C. Wright. 2005. Winter Diet Of Fishers In British Columbia. Northwestern Naturalist 86:12–19.

Wengert, G. M. 2013. Ecology of intraguild predation on fishers (Martes pennanti) in California. Ph.D., University of California, Davis, United States -- California.

Wengert, G. M., M. W. Gabriel, S. M. Matthews, J. M. Higley, R. A. Sweitzer, C. M. Thompson, K. L. Purcell, R. H. Barrett, L. W. Woods, R. E. Green, and others. 2014. Using DNA to describe and quantify interspecific killing of fishers in California. The Journal of Wildlife Management 78:603–611.

Westerling, A. L., B. P. Bryant, H. K. Preisler, T. P. Holmes, H. G. Hidalgo, T. Das, and S. R. Shrestha. 2011. Climate change and growth scenarios for California wildfire. Climatic change 109:445–463.

Westerling, A. L., H. G. Hidalgo, D. R. Cayan, and T. W. Swetnam. 2006. Warming and earlier spring increase western US forest wildfire activity. Science 313:940–943.

Williams, E. S. 2001. Canine distemper. Page 50 *in* E. S. Williams and R. I. C. K. Barker, editors. Infectious diseases of wild mammals. Third. Iowa State University Press, Ames, Iowa.

Williams, E. S., K. Mills, D. R. Kwiatkowski, E. T. Thorne, and A. Boerger-Fields. 1994. Plague in a black-footed ferret (Mustela nigripes). Journal of Wildlife Diseases 30:581–585.

Williams, E. S., E. T. Thorne, M. J. Appel, and D. W. Belitsky. 1988. Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. Journal of Wildlife Diseases 24:385–398.

Winter vs. summer furs. 1917. California Fish and Game.

Wisely, S. M., S. W. Buskirk, G. A. Russell, K. B. Aubry, and W. J. Zielinski. 2004*a*. Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. Journal of Mammalogy 85:640–648.

Wisely, S. M., S. W. Buskirk, G. A. Russell, K. B. Aubry, and W. J. Zielinski. 2004*b*. Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. Journal of Mammalogy 85:640–648.

Wright, P. L., and M. W. Coulter. 1967. Reproduction and growth in Maine fishers. The Journal of Wildlife Management 70–87.

Yaeger, J. S. 2005. Habitat at fisher resting sites in the Klamath Province of northern California. Master's Thesis, Humboldt State University, Arcata, CA.

York, E. C. 1996. Fisher population dynamics in north-central Massachusetts. University of Massachusetts at Amherst.

Zabrodskii, P. F., V. G. Lim, and E. V. Strel'tsova. 2012. Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksperimental'naia i klinicheskaia farmakologiia 75:35.

Zhang, J., J. Webster, R. F. Powers, and J. Mills. 2008. Reforestation after the Fountain Fire in Northern California: An Untold Success Story. Journal of Forestry 106:425–430.

Zielinski, W. J., J. A. Baldwin, R. L. Truex, J. M. Tucker, and P. A. Flebbe. 2013*a*. Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. Journal of Fish and Wildlife Management 4:3–19.

Zielinski, W. J., and N. P. Duncan. 2004. Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. Journal of Mammalogy 85:470–477.

Zielinski, W. J., N. P. Duncan, E. C. Farmer, R. L. Truex, Clevenger, and R. H. Barrett. 1999. Diet of fishers (Martes pennanti) at the southernmost extent of their range. Journal of Mammalogy 80:961–971.

Zielinski, W. J., J. R. Dunk, J. S. Yaeger, and D. W. LaPlante. 2010. Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. Forest Ecology and Management 260:1579–1591.

Zielinski, W. J., T. E. Kucera, and R. H. Barrett. 1995. Current distribution of the fisher, Martes pennanti, in California. California Fish and Game 81:104–112.

Zielinski, W. J., C. M. Thompson, K. L. Purcell, and J. D. Garner. 2013*b*. An assessment of fisher (Pekania pennanti) tolerance to forest management intensity on the landscape. Forest Ecology and Management 310:821–826.

Zielinski, W. J., R. L. Truex, F. V. Schlexer, L. A. Campbell, and C. Carroll. 2005. Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. Journal of Biogeography 32:1385–1407.

Zielinski, W. J., R. L. Truex, G. A. Schmidt, F. V. Schlexer, K. N. Schmidt, and R. H. Barrett. 2004*a*. Home Range Characteristics Of Fishers in California. Journal of Mammalogy 85:649–657.

Zielinski, W. J., R. L. Truex, G. A. Schmidt, F. V. Schlexer, K. N. Schmidt, and R. H. Barrett. 2004*b*. Resting habitat selection by fishers in California. Journal of Wildlife Management 68:475–492.

PUBLIC NOTICE

March 26, 2013

TO WHOM IT MAY CONCERN:

NOTICE IS HEREBY GIVEN that the California Department of Fish and Wildlife has reinitiated status review of the Pacific fisher (*Martes pennanti*) pursuant to Fish and Game Code section 2074.6, and is providing this notice pursuant to Fish and Game Code section 2074.4 to solicit data and comments on the petitioned action from interested and affected parties.

The Department has reinitiated status review pursuant to court order following related action by the Fish and Game Commission. (*Center for Biological Diversity v. California Fish and Game Commission and California Department of Fish and Game,* (Super. Ct. San Francisco County, 2012, No. CGC-10-505205).) Consistent with that order, on November 7, 2012, the Fish and Game Commission set aside its September 15, 2010 findings that listing the fisher as threatened or endangered was not warranted. Having provided related notice, the fisher is now a candidate species under the California Endangered Species Act (Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085).

The Department has 12 months to review the petition, evaluate the available information, and report back to the Commission whether or not the petitioned action is warranted (Fish & G. Code, § 2074.6). The Department's recommendation must be based on the best scientific information available to the Department.

Therefore, **NOTICE IS FURTHER GIVEN** that anyone with data or comments on the taxonomic status, ecology, biology, life history, management recommendations, distribution, abundance, threats, habitat that may be essential for the species in California, or other factors related to the status of the above species, is hereby requested to provide such data or comments to:

California Department of Fish and Wildlife
Attn: Fisher Status Report
1812 Ninth Street
Sacramento, California 95811

Please submit a hard copy and a digital/electronic copy if submitting by surface mail.
Comments may also be sent via email to: Wildlifemgt@wildlife.ca.gov

Responses and information received by **May 27, 2013** will be evaluated for possible incorporation in the Department's final report to the Fish and Game Commission. The Department's written report will indicate, based on the best scientific information available, whether the Department concludes that the petitioned action is warranted or not warranted. Receipt of the report will be placed on the agenda for the next available meeting of the Commission after delivery. The report will be made available to the public at that time. Following receipt of the Department's report, the Commission will allow a 30-day public comment period prior to taking any action on the Department's recommendation.

If you have any questions, please contact the Department via email at wildlifemgt@wildlife.ca.gov or at the address above.

###

Appendix 2
Peer Review Solicitation Letters

October 1, 2014

Dr. Lowell Diller
Lowell Diller Environmental Consulting
VIA EMAIL: ldillerconsulting@gmail.com

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Diller:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Mourad Gabriel
Integral Ecology Research Center
VIA EMAIL: mgabriel@iercecology.org

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Gabriel:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before December 15, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important. If you are unable to review the entire document, we ask that you focus your attention on sections related to the effects of disease and toxicants on fisher. Your research on those topics is cited in document and your assessment of our interpretation of your work and other relevant literature will be helpful.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Mr. Mark Higley
Hoopa Tribal Forestry
VIA EMAIL: mhigley@hoopa-nsn.gov

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Mr. Higley:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Sean Matthews
Wildlife Conservation Society
VIA EMAIL: smatthews@wcs.org

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Matthews:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Roger Powell
North Carolina State University
VIA EMAIL: newf@ncsu.edu

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Powell:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Wayne Spencer
Conservation Biology Institute
VIA EMAIL: wdspencer@consbio.org

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Spencer:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Craig Thompson
USDA Forest Service
Pacific Southwest Research Station
VIA EMAIL: cthompson05@fs.fed.us

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Thompson:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes]* *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Jody Tucker
USDA Forest Service
Pacific Southwest Research Station
VIA EMAIL: jtucker@fs.fed.us

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Tucker:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes] pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

October 1, 2014

Dr. Bill Zielinski
USDA Forest Service
Pacific Southwest Research Station
VIA EMAIL: bzielinski@fs.fed.us

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Dr. Zielinski:

Thank you for agreeing to serve as a scientific peer reviewer for the Department of Fish and Wildlife's (Department) Draft Status Report of the fisher (*Pekania* [*Martes*] *pennanti*). A copy of this report, dated October 1, 2014, is enclosed for your use in that review. The Department seeks your expert analysis regarding the scientific validity of the report and its assessment of the status of fisher in California. The Department would appreciate receiving your peer review input on or before November 1, 2014.

The Department seeks your review as part of formal proceedings pending before the California Fish and Game Commission (Commission) under the California Endangered Species Act (CESA). As you may know, the Commission, as a constitutionally established entity distinct from the Department, exercises exclusive statutory authority under CESA to add species to the state lists of endangered and threatened species (Fish & G. Code, § 2070). The Department serves in an advisory capacity during listing proceedings, charged by the Fish and Game Code to use the best scientific information available to make related recommendations to the Commission (Fish & G. Code, § 2074.6).

The Commission first received the petition to list fisher as threatened or endangered on January 23, 2008. (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275.) The Commission accepted the petition for further consideration and the species was formally designated as a candidate species on April 24, 2009. (Cal. Reg. Notice Register 2009, No. 17-Z, p. 609). On June 23, 2010, the Commission found that designating fisher as an endangered or threatened species under CESA was not warranted. (Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2074.2, 2085.) Following related litigation, the fisher became a candidate once again in 2013. (Cal. Reg. Notice Register 2013, No. 12-Z, pp. 487-488.)

The peer review draft Status Report forwarded to you today reflects the Department's effort over the past year to identify and analyze the scientific information available regarding the status of fisher in California. At this time, the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted. We underscore, however, that scientific peer review plays a critical role in the Department's effort to develop

and finalize its recommendation to the Commission as required by the Fish and Game Code.

Again, because of the importance of your effort, we ask you to focus your review on the scientific information available regarding the status of fisher in California. As with our own effort to date, your peer review of the science and analysis regarding each of the listing factors prescribed in CESA (Cal. Code Regs., tit. 14, § 670.1(i)(1)(A))(*i.e.*, present or threatened habitat modification, overexploitation, predation, competition, disease, and other natural occurrences or human-related activities that could affect the species) are particularly important.

Please note that the Department releases this peer review report to you solely as part of the peer review process, and it is not yet public.

For ease of review, I invite you to use "track changes" in WORD, or provide comments in list form by page and line number of the report. Please submit your comments electronically to Richard Callas at richard.callas@wildlife.ca.gov, or by telephone at (530) 340-5977.

If there is anything the Department can do to facilitate your review, please let me know. Thank you again for your contribution to the status review effort and the important input it provides during the Commission's related proceedings.

Sincerely,

Eric Loft
Chief, Wildlife Branch

Enclosure(s)

cc: Richard Callas
Department of Fish and Wildlife
Richard.Callas@wildlife.ca.gov

Appendix 3

Peer Review Comments

GREEN DIAMOND RESOURCE COMPANY

Comments from L.Diller

November 5, 2014

Dr. Eric Loft

Chief Wildlife Branch
California Department of Fish and Wildlife
1416 Ninth Street
Sacramento, CA 95814

RE: FISHER (*PEKANIA [MARTES] PENNANTI*); DEPARTMENT OF FISH AND WILDLIFE, PEER REVIEW STATUS REPORT

Dear Eric:

I would like to begin by thanking the California Department of Fish and Wildlife for the opportunity to review the draft Status Review of the Fisher in California. The species has been one of the focal species of my professional career for over 20 years and it is very important to me both personally and professionally to make a contribution towards the conservation of fishers.

I reviewed on all scientific and technical elements of the fisher status review, but most of my comments are restricted to those areas where I have the most experience. Although my comments only reflect my personal views and conclusions, they have largely developed from field experience and data collected while working as an employee for Green Diamond Resource Company. Interactions with other fisher researchers and reading the scientific literature has also be instrumental in shaping my knowledge and views of fisher ecology.

Respectfully submitted,

Lowell V. Diller

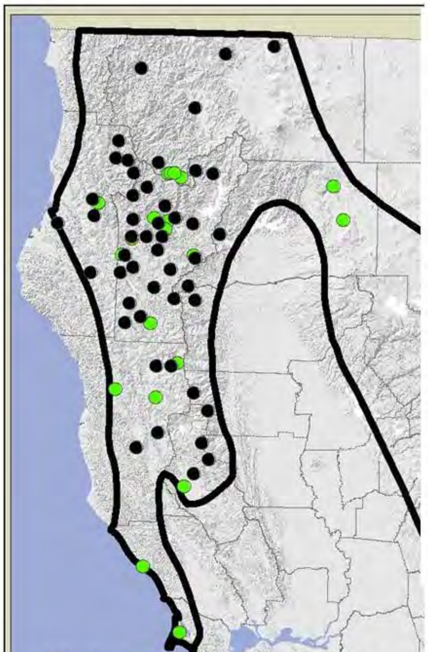
Lowell V. Diller, Ph.D.
Senior Biologist, retired
Green Diamond Resource Company
PO Box 68
Korbel, CA, 95550

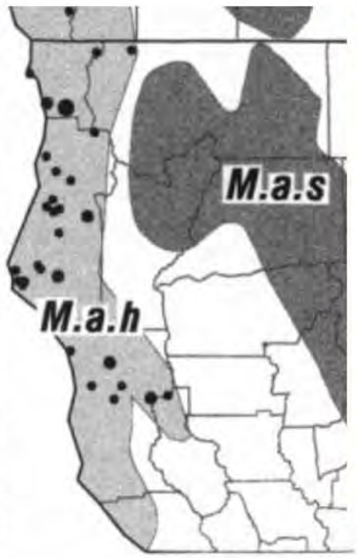
General comments: It is my opinion that CDFW has done a thorough and exhaustive review of the available literature and information on fishers from California. Furthermore, I think the conclusions in the status review are based on a reasoned approach and the best available science. The document is well written and I do not believe that it is critical to incorporate any major deletions or additions to the status review. However, I have provided some general comments and discussions below that CDFW may wish to incorporate a some level in the fisher status review.

Fishers in the redwood region

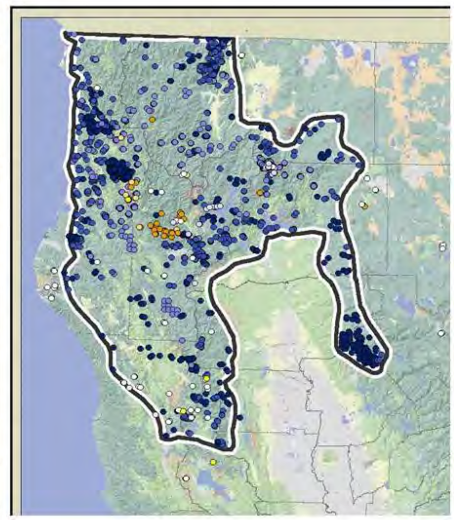
My first recommendation is to incorporate a brief discussion of an interesting phenomenon that has occurred in the redwood region of the fisher's range. To a more limited extent in California, but more so in the West Coast region, the fisher's range has contracted, but the redwood region is an area in which there is compelling evidence that fishers have increased in both range and abundance. This is not a large area, and it may not have much significance relative to the overall status of fishers in the Northern California Fisher ESU, but I believe it provides some very useful insights relative to the habitat needs and ecology of fishers in California.

My conclusions are based on the historical Grinnell maps of fisher and Humboldt marten distributions and the current range of NC fisher distribution provided in the status review (panel of three figures below). As stated in the status review, historically, fishers were highly prized for their fur and actively trapped until it was banned by the state. Despite this, there were virtually no fishers trapped in redwood forests with the most coastal locations in the more interior Douglas-fir/hardwood forest based on Grinnell's map. Presumably, this was not a case of lack of trapping effort in the region since Grinnell also provided a map of Humboldt martens that were primarily captured in the coastal redwood forests. Clearly, trappers would not have passed up fishers if they could have been trapped in the same region as the Humboldt marten.


Historical fisher distribution



Historical Humboldt marten distribution


Current fisher distribution

The current distribution of fishers in the NC ESU indicates that fishers are now commonly found throughout the redwood forest literally within sight of the Pacific Ocean. Thompson (2008) estimated that this region had some of the highest reported densities of fishers anywhere in the West Coast region. Fishers are described in the status review as being “seldom seen”, but in this area their density is such that fisher sightings by biologists (myself included) and foresters is a regular occurrence including getting into a dumpster at Green Diamond’s truck shop in Crannell.

This is also a region that was subjected to some of the most intensive logging activities anywhere in the range of the fisher in California. Historical logging of the coastal old growth forests began around the turn of the 19th century and the photographs archived in the Berkeley Fritz-Metcalf collection provide a glimpse of the early logging practices.

The picture on the left was taken in the 1920's near Arcata, CA in the Fickle Hill area and the one on the right was a 1950 photograph of timber harvesting progressing up the North Fork Mad River. There are many more photographs that I have viewed from this early logging area, but what stands out to me is that although the early logging looked devastating by modern standards and tended to extend over entire watersheds, there was substantial amounts of downed large wood and residual trees left behind. Second growth harvesting of these same regions generally began in the 1980's and now many of the watersheds in this region have substantial amounts of third growth forest. What is intriguing about this coastal redwood region is that not only have fishers persisted in this area, but they have expanded their range and almost certainly are much more abundant now than what was described by Grinnell.

While this is speculation on my part, the key is almost certainly related to the high levels of residual structure left from the early logging and the fact that clearcutting redwood forests results in high densities of dusky-footed woodrats (Hamm 1995, Hamm and Diller 2009). This is the only region in which woodrats are reported to be a major component of fisher's diet (Golightly et al. 2006). It was probably also important that while the early logging and trapping almost certainly decimated the fisher population in this entire coastal region, there were no barriers to recolonization for the rugged and remote wilderness areas to the east where logging did not occur and trapping pressure was probably minimal.

The historical logging of the region was the equivalent of a large crude "experiment", which provided insights into what is most likely limiting for sustaining fisher populations. This experiment indicated that if fishers have access to an area that has adequate residual structure for den and rest sites, and plenty of prey to eat, they will likely do well. In redwood forests, fishers are found to be more abundant in the second than old growth forests (Slauson et al. 2003). Furthermore, an ongoing collaborative study by the USFS Redwood Sciences Lab and Green Diamond focused on martens in the Lower Klamath River region has shown that fishers tend to increase in recently harvested areas similar to bobcats and gray foxes (K. Slauson, Humboldt State University wildlife seminar, October 23, 2014).

The point of this discussion is that land management activities that reduce the key habitat elements or the prey of fishers will likely have negative impacts, but it is actually possible to improve fisher habitat through timber harvesting if it is done in such a way as to conserve the late seral habitat elements while increasing their prey.

CEQA

I also have a general comment on the role of CEQA relative to the implementation of the FPRs on private lands. In the fisher status review, CEQA is only mentioned relative to state lands and only the FPRs are discussed as a mechanism to regulate harvesting practices on private lands. In reality, CEQA is the umbrella document under which the FPRs are promulgated and a timber harvest plan (THP) is legally considered the functional equivalent of an EIR under CEQA. That means as the lead agency on wildlife issues, CDFW has the authority, and regularly uses it, to cite a potential significant adverse impact under CEQA based on what is being proposed for harvest in a THP or what is observed on the ground in a pre-harvest inspection. If for example, the landowner is proposing to harvest too many large trees, or harvest hardwood species where they are judged to be in low abundance, CDFW can and does site potential direct or cumulative negative adverse impacts under CEQA. So while the FPRs do not specifically require the protection of various fisher habitat elements for fishers, CDFW can, and commonly does invoke CEQA to protect snags, large wildlife trees, hardwoods and downed large wood.

The key limitation to CEQA as a regulatory mechanism is that its use appears to be somewhat discretionary by the different offices of CDFW. Technically, all THPs have to be compliant with CEQA, but the extent to which this results in recommendations in THPs is not consistent in my experience. For example, if the FPRs require a 150’ buffer on a stream, then Cal Fire and CDFW will insure that a THP is compliant. However, although CEQA requires that a THP not have any significant direct, indirect or cumulative adverse impacts on fishers (or any other fish, wildlife or plant species), this may lead to some offices of CDFW actively pursuing the issue, while in other areas it seems to largely overlooked. From my personal experience, it was the authority of CEQA that the Eureka office of CDFW used to negotiate with Green Diamond what was originally called the Deadwood Management Plan. This plan provides a scoring system to insure that all important wildlife trees and snags are retained despite what economic value that they may have.

My primary point of this discussion is that CEQA is an important regulatory tool that can play an important role in maintaining fisher habitat on private timberlands, but it is my opinion that its effectiveness would be improved if it were more consistently applied throughout all CDFW regions.

Additional specific comments are recorded in Track Changes in the draft fisher status review.

Literature Cited

Hamm, K. A. 1995. Abundance of dusky-footed woodrats in managed forests of north coastal California. M.S. Thesis, Humboldt State University, Arcata, CA. 46 p.

Hamm, K. A. and L. V. Diller. 2009. Forest management effects on abundance of woodrats in northern California. Northwestern Naturalist 90:97-106.

Golightly, R.T., T.F. Penland, W.J. Zielinski and J.M. Higley. 2006 Fisher diet in the Klamath/North Coast Bioregion. Final Report to U.S. Fish and Wildlife Service and Scotia Pacific. Humboldt State Sponsored Programs Foundation, Arcata, California.

Slauson, K.M., Zielinski, W.J. and G.W. Holm. 2003. Distribution and habitat associations of the Humboldt marten (*Martes americana humboldtensis*), and Pacific fisher (*Martes pennanti pacifica*) in Redwood National and State Parks: A report to Save-the-Redwoods League. USDA Pacific Southwest Research Station, Redwood Sciences Laboratory. Arcata, CA. 29 pp.

Thompson, J.L. 2008. Density of fisher on managed timberlands in north coastal California. Thesis, Humboldt State University, Arcata, California.

Comments from L. Diller

STATE OF CALIFORNIA

NATURAL RESOURCES AGENCY

DEPARTMENT OF FISH AND WILDLIFE

CONFIDENTIAL DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [*Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

October 1, 2014

Table of Contents

List of Figures

List of Tables

List of Appendices

(to be completed)

Acknowledgments

(to be completed)

This report was prepared by: ________________________

Cover photograph © J. Mark Higley, Hoopa Tribal Forestry, used with permission.

Report to the Fish and Game Commission
A Status Review of the Fisher in California
_______, 2014

Executive Summary

This document describes the current status of the fisher (Pekania pennanti) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act. On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department of Fish and Game, as it was then named (now called the Department of Fish and Wildlife) (Department), commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Despite being the most valuable furbearer in the state, trappers only reported taking 46 animals from 1920-1924. In addition to trapping, the decline of fishers has also been attributed to logging activities which may render habitats unsuitable for them.

Early researchers believed that the range of fishers in the late 1800s extended from the Oregon border south to Marin County through the Klamath Mountains and the Coast Range as well as through the southern Cascades to the southern Sierra Nevada Mountains. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to European settlement. The location and size of the gap separating these populations is unknown. However, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Currently fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population). Fishers are also found in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN Fisher ESU) from fishers in northern California (NC Fisher ESU) and the degree of genetic differentiation between them. Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals.

Early work on fishers appeared to indicate that fishers required particular forest types (e.g., old-growth conifers) for survival. However, studies of fishers over the past two decades have demonstrated that they are not dependent on old-growth forests per se, nor are they associated with any particular forest type. Fishers are typically found at low- to mid-elevations characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used for resting (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning and the presence of a suitable cavity appears to be more important than the species of

tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (> 100 years) may be needed for trees to attain sufficient size and for a cavity large enough for a female fisher and her young to develop. Although the number of den and rest structures needed by fisher is not well known, a substantial reduction in these important habitat elements would likely reduce the distribution and abundance of fisher in the state.

Primary threats to fishers within the NC and SSN Fisher ESUs include habitat loss, toxicants, wildfire, and climate change. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests. However, fishers are widespread on public and private lands harvested for timber. A concern for the long-term viability of fishers across their range in California is the presence of suitable den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service or the National Park Service. Private lands within the NC Fisher ESU and the SSN Fisher ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher contracted substantially. This difference is due to the apparent absence of fishers from the central, and portions of the northern, Sierra Nevada. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and to other toxicants. ARs used at illegal marijuana cultivation sites have caused the deaths of some fishers and ARs may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population.

In recent decades the frequency, severity, and extent of wildfires has increased in California. This trend could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due to that population's small size, the linear distribution of the habitat available, and the potential for fires to increase in frequency under scenarios where the climate warms.

Climate research predicts continued climate change through 2100, with rates of change faster than occurred during the previous century. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate related changes that may occur within the range of the fisher in California. The SSN Fisher ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU, due to its comparatively small population size and susceptibility to fragmentation. However, the effects of climate change on fisher populations are unknown, will likely vary throughout the species' range, and the severity of those effects will vary depending on the extent and speed with which warming occurs.

Regulatory Framework

Petition Evaluation Process

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3) The Commission received the petition and, pursuant to Fish & G. Code § 2073, referred the petition to the Department for its evaluation and recommendation. (*Id.*, § 2073) On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*) as Threatened

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[2].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[3].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[4]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[5, 6].

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[7].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (APA) (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA,

---

[2] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[3] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[4] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

[6] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[7] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

subject to various terms and conditions[8]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[9]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[10]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its Status Review and the best science available to the Department that designating fisher as a threatened or endangered species under CESA was not warranted[11]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[12].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[13]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related

---

[8] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[9] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[10] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

[11] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[12] *Id.*, § 670.1, subd. (g).

[13] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[14]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as an endangered or threatened species under CESA was not warranted[15]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[16].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[17] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

---

[14] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

[15] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[16] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[17] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[18]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[19]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its February 2010 status review of the species. This report represents the Department's revised status review, based on the best scientific information available and including independent peer review by scientists with expertise relevant to the status of the fisher (Appendix X).

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail [1]. (I suspect this particular format is required for this status review, but it is very difficult to keep track of what scientific literature is being cited with this "number system.") They typically appear uniformly black from a distance, but in fact are dark brown over most of their bodies with white or cream patches distributed on their undersurfaces [2]. The fur on the head and shoulder may be grizzled with gold or silver, especially in males [1]. The fisher's face is characterized by a sharp muzzle with small rounded ears [3] and forward facing eyes indicating well developed binocular vision [2]. Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0-2.5 kg (4.4-5.5 lbs) and range in length from

[18] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

70-95 cm (28-34 in) and males weigh between 3.5-5.5 kg (7.7-12.1 lbs) and range from 90-120 cm (35-47 in) long [2].
Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh about 500-1400 g (1-3 lbs) and range in total length from about 50-68 cm (20-27 in) [4]. Fishers have a single molt in late summer and early fall, and shedding starts in late spring [2]. American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers [5].

Fishers are seldom seen, even where they are abundant. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground [6]. Females, perhaps because of their smaller body size, are more arboreal than males [2,7,8].

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the mustelidae includes wolverine, marten, weasel, mink, skunk, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America; *M. p. pennanti* [9], *M. p. columbiana* [10]; and *M. p. pacifica* [11]. However, the validity of these subspecies has been questioned [3] and [12].

More recently, genetic studies indicate that the fisher is more closely related to wolverine (*Gulo gulo*) and tayra (*Eira barbara*) of Central and South America than to other species of *Martes* [13–19]. Based on those findings, fishers have been reclassified along with wolverine and tayra into the genus *Pekania* [15,19]. In this report, we use *Pekania pennanti* as the taxonomic designation for native fishers in California.

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell [2] thought the most likely possibility was that the name originated with European settlers who noted the similarity between fishers and European polecats, which were also known as fitch ferrets. Many other names have been used for fisher including pekan, pequam, wejack, Pennant’s marten, black cat, tha cho (Chippewayan), uskool (Wabanaki), otchoek (Cree), and otschilik (Ojibwa) [2]. In the native language of the Hoopa people, fisher are known as ’ista:ngq’eh-k’itiqowh [20].

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago [21]. Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) [22]. During the late Holocene which began about 4,000 years ago, fishers expanded into western North America [23], presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to European settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 1). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and coniferous forest ecosystems in western North America [24].

By the 1800s and early 1900s the fisher's range was generally greatly reduced due to trapping and large scale anthropogenic influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss [2,24,25]. However, fishers have reoccupied much of the area lost during the early 1900s, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York [25].

Native populations of fisher currently occur in Canada, the western United States (Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada [26].

Historical Range and Distribution in California

Our knowledge of the distribution of fishers in California is primarily informed by Grinnell et al. [3]. They described fishers in California as inhabiting forested mountains

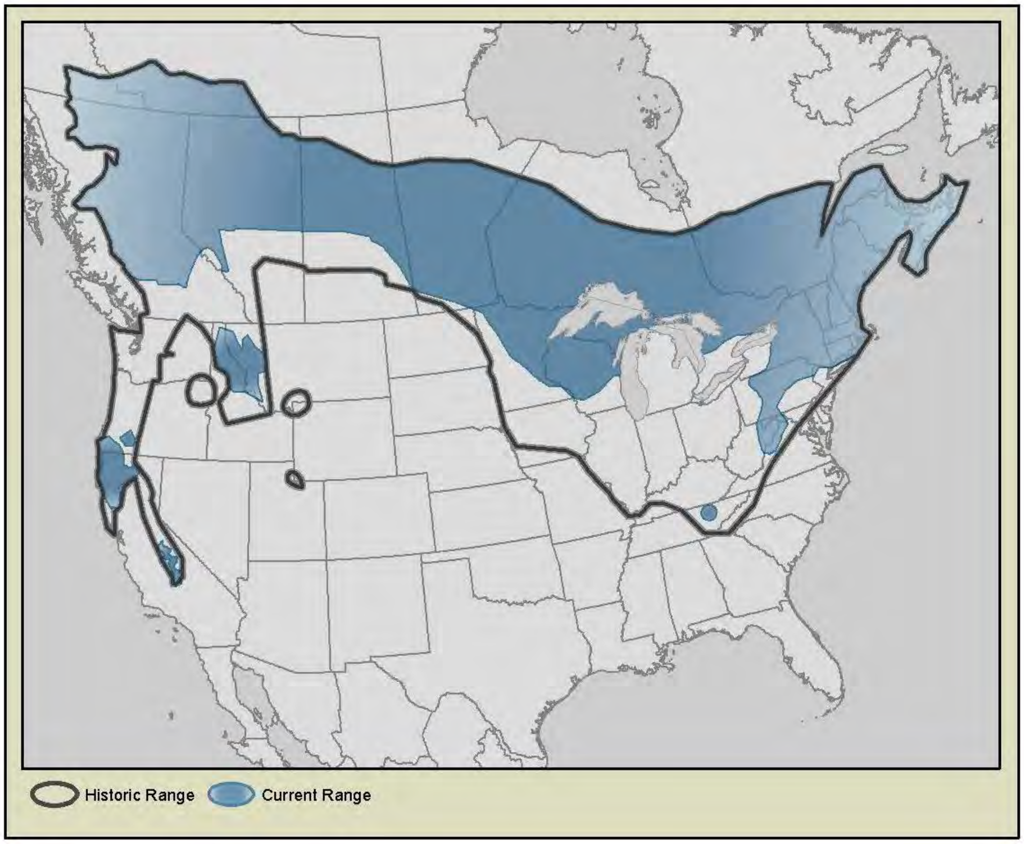


Figure 1. Presumed historical distribution (ca. 1600) and current distribution of fisher in North America. Historical distribution was derived from Giblisco [27]. Refer to Tucker et al. [28] and Knaus et al. [29] for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

.

primarily at elevations between 610 m to 1824 m (2,000 - 5,000 ft) in the northern portions of their range and 1220 m to 2438 m (4,000 ft - 8,000 ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations. Fishers were believed to have ranged from the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County [3].

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919-1924, as well as a line demarcating what they assumed to be general range from approximately 1862-1937 (Figure 2). The point locations on the map were based on reports by trappers and the authors believed that almost all the locations were accurate, although they pointed out that some may have reflected the trapper's residence or post office. The map remains the best approximation of the distribution of fishers in California at that time, although it likely included areas unsuitable for fishers and excluded portions of the state occupied by the species.

Information presented by Grinnell et al. [3] suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. [3] appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included Lake, Marin, and Kern counties.

Evidence of fishers occupying the central and northern Sierra during the mid-1800s through the early 1900s is limited. In the northern Sierra, Grinnell et al. [3] showed two collections from Sierra County from 1919-1924. During that period in the central Sierra, Grinnell et al. reported one collection from Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County. All of these records, as well as one other record from northwestern Tuolumne County in the Tuolumne River watershed, are north of the current northern limit of the southern Sierra fisher population in the Merced River watershed.

In the southern Cascades, Grinnell et al. [3] mentioned that fishers were trapped during the winters of 1920 and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. [30] reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National Park, near the junction of Lassen, Plumas, and Shasta counties. Additional historic records of fishers in the southern Cascades include two collections in 1897, from eastern Shasta County, that are located in the National Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney.

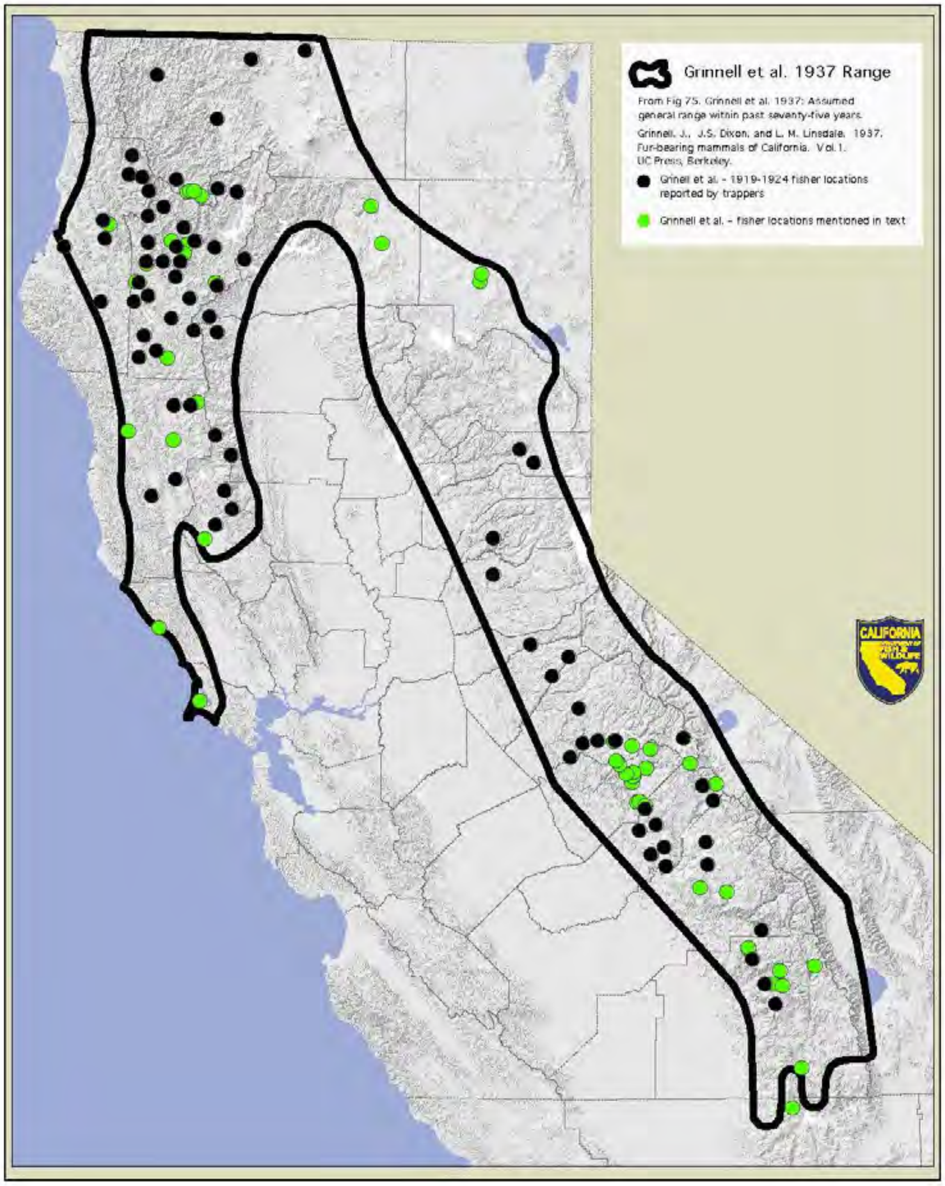


Figure 2. Assumed general range of the fisher in California from ~1850 -1925 from Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Anecdotal evidence of fishers in the northern Sierra is provided in an 1894 publication describing the efforts of William Price to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada [31]. Price included notes on species that he did not collect but were "commonly known to the trappers." His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[20] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Additionally, when relevant, Price discusses more distant geographic localities for some species and their close relatives. If the fishers referenced were trapped at distant locations (e.g., the southern Sierra) it is likely those locations would have been mentioned. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred animals.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fisher in California is based on observations of the species through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of

[20] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger [32] noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of species presence (remote cameras and track-plate boxes) [33]. In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* [34] to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be "verified" records (Figure 3). Undoubtedly, reports of

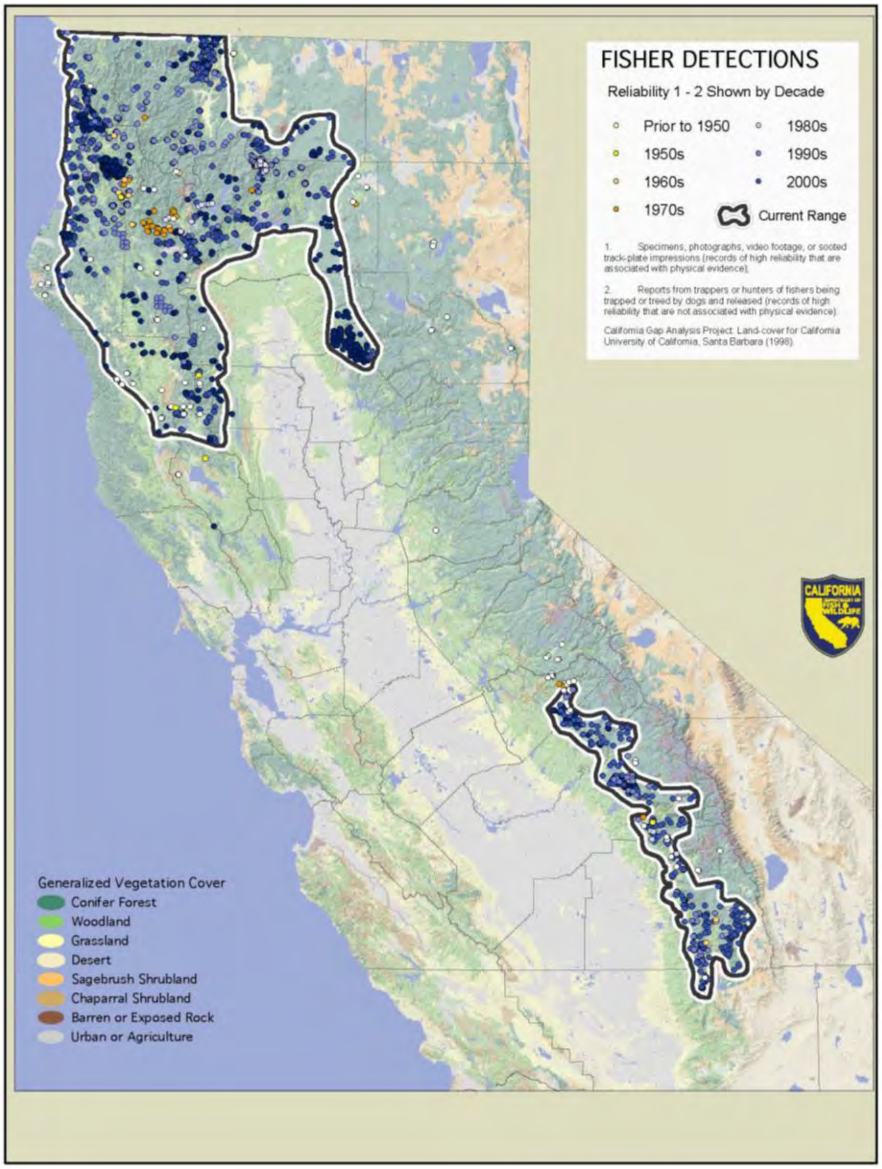


Figure 3. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis [34] were included. California Department of Fish and Wildlife, 2014.

fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state.

A number of broad scale, systematic surveys for fisher and other forest carnivores in the Sierra Nevada Mountains were conducted from 1989-1994 [35], from 1996-2002 [35], and from 2002-2009 (USDA 2006, USDA 2008, Truex et al. 2009). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. [35] expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction due to isolation than if they were connected to other populations. They offered several explanations to account for the lack of fishers in the region including trapping and elimination of habitat through railroad logging.

Zielinski et al. [35] could find no reason to suspect that fisher at one time did not occur where habitat was suitable throughout the Sierra Nevada and thought it likely that the fisher population had already been reduced by the time Grinnell [3] and his colleagues assessed its distribution. Price [31] supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell [3].

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the USDA Forest Service (USFS), private timber companies, and others, since the 1950s no verifiable detections of fishers have occurred in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River [35,36].

To approximate the current range of fishers in California, observations of fishers with high reliability were mapped from 1993 to the present. Those locations were overlaid using GIS on layers of forest cover and layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model) and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 3). This estimate of

current range is approximately 48% of the assumed historical range estimated by Grinnell et al. [3].

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (<5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice sheets [23]. By the late Holocene, records of fishers on the Pacific coast were common [37]. Wisely et al. [37] hypothesized that fishers then expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Currently, fishers in California occur in the northwestern portions of the state, the northern Sierra Nevada, and in the southern Sierra Nevada. Mitochondrial DNA (mtDNA) has been used in several studies to describe the genetic structure of fishers in the state [29,37,38]. Mitochondria are small maternally inherited structures in most cells that produce energy. Portions of the DNA contained within mitochondria known as D-loop regions contain nonfunctional genes and have been widely used in studies of ancestry because they are rich in mutations which are inherited. Early genetic studies of fishers by Drew et al. [38] identified three haplotypes[21] in California (haplotypes 1, 2, and 4) by sequencing mtDNA. Haplotype 1 was found in northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in extant fisher populations in British Columbia. Based on these findings, Drew et al. [38] suggested that gene flow between fishers in British Columbia and California must have occurred historically, but that these populations were now isolated.

Subsequent genetic investigations using nuclear microsatellite DNA and based on sequencing the entire mtDNA genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada [29,37]. Knaus et al. [29] identified three distinct haplotypes unique to fishers in California; one geographically

[21] A haplotype is a set of DNA variations (allele), or polymorphisms, that tend to be inherited together [39].

restricted to the southern Sierra Nevada Mountains and two restricted to the Siskiyou and Klamath mountain ranges. The magnitude of the differentiation between haplotypes of fishers in northern and southern California populations was substantial and considered comparable to differences exhibited among subspecies [29].

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. [29] concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error. Despite this uncertainty, Knaus et al. [29] concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Tucker et al. [40] used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fisher in northwestern California and the southern Sierra Nevada became isolated long before European settlement and estimated that the population declined substantially over a thousand years ago. This generally supports the conclusion of Knaus et al. [29] that fishers in northern and southern portions of the state became isolated prior to European settlement.

Tucker et al. [40] also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fisher from disturbance beginning with the Gold Rush through the first half of the twentieth century. That portion of the range appeared to have maintained a stable population while the remainder of the southern Sierra Nevada occupied by fisher was in decline.

Reproduction and Development

Powell [2] suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April [2,6,41,42]. Females can breed at one year of age, but do not give birth until their second year [2,43,44]. They produce, at most, one litter annually and may not breed every year [8,45]. Reproductive frequency and success depend on a variety of factors including prey availability, male presence or abundance, and age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old [2,8,45,46].

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation [8,47,48]. Implantation is delayed approximately 10 months [41] and occurs shortly before giving birth (parturition) [48]. Arthur and Krohn [46] considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for an average period of 30 to 36 days [2,48]. Females give birth from about mid-March to early April [49–53] and breed approximately 6-10 days after giving birth [2,47,54]. Ovulation is presumed to be induced by copulation [2], with estrus lasting 2-8 days [54]. Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition [2]. Lofroth et al. [24] developed an excellent diagram that illustrates the reproductive cycle of fishers in western North America (Figure 4).

Studies of wild fishers have reported litter sizes to range from 1-4 kits and average 1.8-2.8 (typically an average is reported as a single number – are these means from different studies?) [49,55–57]. Based on laboratory examination of corpora lutea[22] observed in harvested fishers, average litter size ranged from 2.3-3.7 kits [8,41–43,59–61]. These averages may be high and counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea [2]. Crowley et

[22] The corpus luteum is a transient endocrine gland that develops from the follicle following ovulation and produces essentially progesterone required for the establishment and maintenance of early pregnancy [58].

al. [60] found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

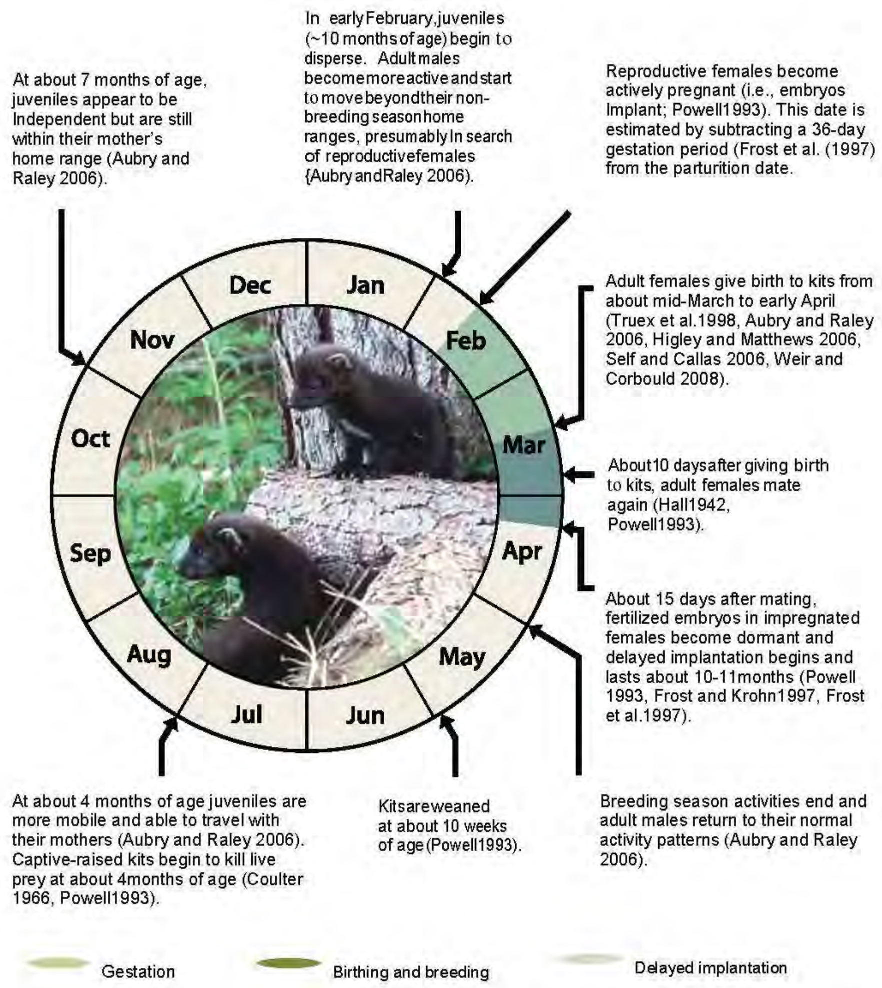


Figure 4. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. [22].

Raised in dens entirely by the female, young are born with their with eyes and ears closed, their bodies only partially covered with sparse growth of fine gray hair, and weigh about 40 g [6,25,54]. The kits' eyes open at 7-8 weeks old. They remain dependent on ~~milk~~ nursing until 8-10 weeks of age, after which time they are provided prey by their mother and are capable of killing their own prey at around 4 months [2,25]. Juvenile females and males become sexually mature and establish their own home ranges at one year of age [41,62]. Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum [25]. Fishers have a relatively low annual reproductive capacity [5]. Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually reported from several studies in western North America was 64% (range = 39 – 89%) [24]. However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable.

A recent study in the Hoopa Valley of California reported that 62% (29 of 47) of denning opportunities were successful in weaning at least one kit from 2005-2008 [63]. Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, ~~most (~~~~$\bar{x}$ =~~an average of 78%, (range = 63-90%) ~~produced young~~gave birth to kits annually from 2010-2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers [24].

Many kits die immediately following birth. Frost and Krohn [48] found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth [44]. In wild populations, kits have been found dead near den sites and reproductive females have been documented abandoning their dens indicating their young had died [49,50,56]. The number of fishers an individual female is able to raise until they are independent depends primarily upon food resources available to them [64]. Paragi [65] reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.

Survival

There are few studies of longevity of fishers in the wild. Powell [2] believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir [61] captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age [66]). Of 14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age [67].

In the wild, most fishers likely live far less than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years, although one of those animals lived to at least 10 years of age [66,68]. From 2009-2011, a total of 67 fishers were live-trapped in northern California as part of an effort to translocate the species to the southern Cascades and northern Sierra. The median age of those individuals was 2 years (range = 0.6 – 6). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Estimated survival rates of fishers vary throughout their range [24]. Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, and road density. Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation). Lofroth et al. [24] summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America documented by 8 studies, and averaged 68% for 3 studies in eastern Northern America. This difference was presumably due, in part, to the take of fisher by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts). In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range = 0.61-0.84) for adult females and 0.82 (range = 0.73-0.86) for adult males [24].

Food Habits

Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi [2]. Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided [2]. Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey species that may be otherwise impossible to determine by more traditional techniques [24].

In a review of 13 studies of fisher diets in North America by Martin [69], five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed [24]. The proportion of different food items in the diets of fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey [2].

In California, studies indicate fishers appear to consume a greater diversity of prey than elsewhere in western North America [24,70,71]. This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey [70]. In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats [71,72]. Diets reported in these studies differed somewhat in the frequency of occurrence of specific prey items, but included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California [71], where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material [72,73].

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council [74], Golightly et al. [71] found mammals, particularly gray squirrels (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), ~~and~~ ground squirrels (*Spermophilus* sp.) and woodrats (*Neotoma* sp.), to be the most frequently consumed prey by fishers. Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet [70–72]. This is likely due to the comparatively low

Formatted: Font: Italic

densities of these species in ranges occupied by fishers in California compared to other parts of their range [72].

In the southern Sierra Nevada, Zielinski et al. [72] reported that small mammals comprised the majority of the diet of fishers. However, insects and lizards were also frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. [72] also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn.

Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available [71,72,75,76]. Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers their ability to capture and handle larger versus smaller prey [24]. For example, Golightly et al. [71] reported that high ingestion of sciurids at interior northern California sites was replaced with more numerous woodrats at coastal sites, in spite of sciurids still being available. The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill. This has been hypothesized as a mechanism that reduces competition between the sexes for food [2]. Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey [24].

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. [72] found that during summer, the diet of female fishers compared to the diet of male fishers contained a greater proportion of small mammals. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. [77] reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley [49] found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). However, since most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits [49]. In some areas, male fishers have been found with significantly ($P<0.1$) more porcupine quills in their heads, chests, shoulders, and legs than female fishers [59,78]. It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers [2].

Movements

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities [79]. These areas have been described for fisher and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young [2]. The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not [2]. Although the home range of a female generally only overlaps the home range of a single male, a male's home range may overlap those of multiple females with the potential benefit of increased reproductive success [2].

Lofroth et al. [24] summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. This difference in home range size, with male fishers using substantially larger areas than females, has been consistently reported [49,52,56,59,80–87]. In 9 studies in western North America the home range sizes of male fishers were 3 times larger than the home range sizes of female fishers [24]. Lofroth et al. [24] noted that home range sizes of fishers generally increase from southern to northern latitudes. Some factors that may influence the suitability of home ranges include landscape scale fragmentation, heterogeneity, and edge ecotones, but these attributes have not been well studied [88].

Dispersal: Dispersal describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. [89] as increasingly recognized to occur in three phases: 1) departing from the natal[23] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to move through the landscape, prey resources, turnover rates of adults [52,56,62] and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities [49,52,56]. During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat [2,8,52,90]. Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females [89]. This pattern appears to hold true for fishers [49,57,91]. It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories [91]. Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient [92,93].

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age [24]. In some studies, juvenile male fishers departed from their home ranges earlier than females [57]. Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home ranges. This behavior is characterized by higher mortality risk [52].

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. [62], reported

[23] Natal refers to the place of birth.

mean maximum dispersal distances for male fishers [$\bar{x}$ =17.3 km (10.7 mi), range=10.9-23.0 km (6.8-14.3 mi), n=8] and for females [$\bar{x}$ =14.9 km (9.3 mi), range=7.5-22.6 km (4.7-14.0 mi), n=5]. York [56] reported mean maximum dispersal distances for males [$\bar{x}$ =25 km (15.5 mi), range=10-60 km (6.2-37.3 mi), n=10]) and for females [$\bar{x}$ =37 km (23 mi), range=12-107 km (7.5-66.5 mi), n=19]. The greater dispersal distance for juvenile females compared to males reported by York is unusual as, in other studies, males dispersed farther than females.

In the interior of British Columbia, Weir and Corbould [52], reported a mean dispersal distance from the centers of natal and established home ranges of 24.9 km (9.6 mi) for two females and 41.3 km (15.9 mi) for one male. In the southern Oregon Cascade Range, Aubry and Raley [49] reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male fishers [$\bar{x}$ = 29 km (18 mi), range 7-55 km (4.4-34.2 mi), n = 3] and female fishers [$\bar{x}$ = 6 km (3.7 mi), range 0-17 km (0-10.6 mi, n = 4]. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. [57], reported that the mean maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [$\bar{x}$ = 8.1 km (5.0 mi), range = 5.9–10.3 km (3.7-6.4 mi), n = 2) than females [$\bar{x}$ = 6.7 km (4.2 mi), range = 2.1–20.I km (1.3-12.5 mi), n = 12]. They also reported the distance between natal dens and the centroids (geometric center) of home ranges established by a single male [1.3 km (0.82 mi)] and 7 females [$\bar{x}$ = 4.0 km (2.5 mi), range 0.8-18 km (0.5-11.2 mi)].

Habitat Use

Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers [3,94–96] have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

In their comprehensive synthesis of the habitat ecology of fishers in North America, Raley et al. [88] used a hierarchical ordering process proposed by Johnson [97] to assess habitat associations of fishers at multiple scales (Table 1). They described the fisher's geographical distribution (first-order selection) as the ecological niche occupied by the species, which is further refined at the home range scale (second-order selection). Ultimately, the selection of different environments (third-order) and of resources (fourth-order) is constrained by landscape scale processes and conditions

Table 1. Summary of habitats used by fishers categorized by hierarchical order (Johnson 1980) and a synthesis of fisher habitat studies by Raley et al. [88].

.

First-order	Geographic distribution	Fisher distribution has consistently been associated with expanses of low- to mid-elevation mixed conifer or conifer-hardwood forests with relative dense canopies.
Second-order	Selection or composition of home ranges with the geographic distribution	Characterized by a mosaic of forest types and seral stages, with relatively high proportions of mid- to late-seral conditions, but low proportions of open or non-forested habitats.
Third-order	Selection or use of different environments within home ranges	Rest Sites: Fisher consistently selected sites for resting that have larger diameter conifer and hardwood trees, larger diameter snags, more abundant large trees and snags, and more abundant logs than at random sites. Sites used for foraging, traveling, seeking mates: Although results indicate complex vertical and horizontal structure is important to fishers, strong patterns of use or habitat selection were not found.
Fourth-order	Selection or use of specific resources within home ranges	Rest Structures: Fishers primarily used deformed or deteriorating live trees and snags for resting. The species of tree used appeared less important than the presence of a suitable microstructure (e.g., mistletoe brooms, cavities, nests of other species) for resting. Dens: Female fishers use cavities in trees to give birth and shelter their young. Den trees used for reproduction were old and were always among the largest diameter trees in the vicinity.

[88]. We have adopted this hierarchical approach to describe habitats selected by fishers.

Some researchers have hypothesized that fishers require old-growth conifer forests for survival [98]. However, habitat studies during the past 20 years demonstrate that fishers are not dependent on old-growth forests *per se*, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. In the coastal redwood region, Slauson et al. (2003) found the relationship between fishers and old growth was reversed with fishers showing selection for second old growth forests. Raley et al. [88] suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include high proportions of mid- to late-seral forests.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments [24]. The Department calculated the mean elevation of each Public Land Survey [99] section in which fishers were detected in California from 1993-2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 5). Habitats at higher elevations may be less favorable for fishers due to the

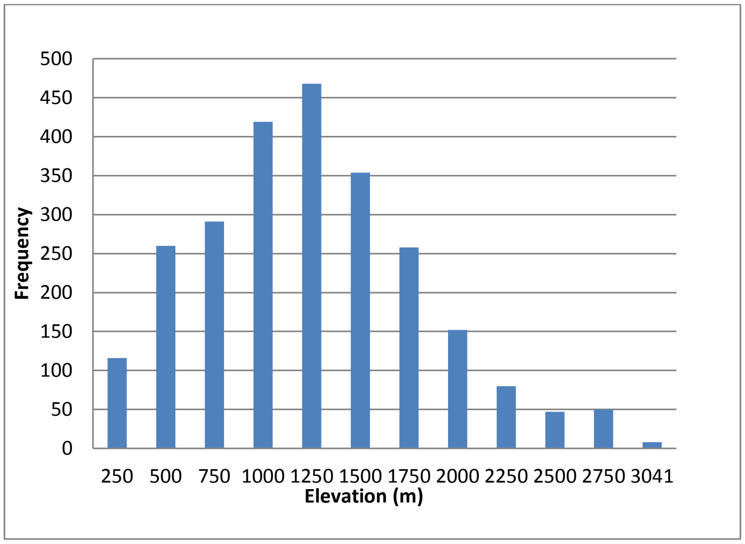


Figure 5. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993-2013. California Department of Fish and Wildlife, 2014.

depth of the winter snowpack that may constrain their movements [100], because the abundance of den, structure, rest structures, and prey may be limited [88], or for other unknown reasons.

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa pine [53,85,101]. Tree species' composition may be less important to fishers than components of forest structure that affect foraging success and provide resting and denning sites [98]. Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale ([53,85,102,103].

Hardwoods were more common in fisher home ranges in California compared elsewhere in western North America, [24]. This may be related to the use of hardwoods for resting and their importance as habitat for prey. In general, based on a number of studies in eastern North America and in California, high canopy closure is an important component of fisher habitat, especially at the rest site and den site level [25,53,85,102]. At the stand and site scale, forest structural attributes considered beneficial to fishers include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground [25].

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare and most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have occurred, active fishers were associated with complex forest structures [88]. Raley et al. ([88]) reviewed several studies ([102,104–106]) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated [88]. The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers to distinguish among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions [88].

During periods when fishers are not actively hunting or traveling, they use structures for resting which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey [24,107]. Fishers typically rest in large deformed or deteriorating live trees, snags, and logs and the forest conditions surrounding these sites frequently include structural elements of late-seral forests [88]. The characteristics of rest structures used by fishers are extremely consistent in western North America, based on an extensive review by Raley et al. [88]. They summarized the results of studies from 12 different geographic regions of more than 2,260 rest structures in western North America and reported that secondarily, fishers rested in snags and logs. The species of tree or log used for resting appeared to be less important than the presence of a suitable microstructure in which to rest (e.g., cavity, platform) [88]. Microstructures used by fishers for resting include: platforms formed as a result of fungal infections, nests, or woody debris; cavities in trees or snags; and logs or debris piles created during timber harvest operations [49,52,86,108,109][49]. Rest structures appear to be reused infrequently by the same fisher. In southern Oregon, Aubry and Raley [49] located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion.

A meta-analysis conducted by Aubry et al. [107] of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. [88]). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (> 100 years) for suitable microstructures to develop [88].

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits [88]. However, hollow logs are used for reproduction (i.e., maternal dens) occasionally [49] and Grinnell et al. [3] reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree [88]. Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose dens with openings small enough to exclude potential predators and aggressive male fishers [88].

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times larger in diameter on average than other trees in the vicinity of the den [52,65,104] as cited by Raley et al. [88]. Depending on the growing conditions, considerable time may be needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits. Information collected from more than 330 dens used by fishers for reproduction indicates that most cavities used were created by decay caused by heart-rot fungi [52,66,110]. Infection by heart-rot fungi is only initiated in living trees [111,112] and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens [88]. Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age [110].

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fisher in California [102,103,113,114]. The newest model was developed by the Conservation Biology Institute and the USFWS (FWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the FWS-CBI model consists of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

The FWS-CBI models predict the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) [109], 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities utilized was from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

For the southern Sierra Nevada and where it blended into the northern Sierra Nevada, the variables used in the FWS-CBI model were basal-area-weighted canopy height, minimum temperature of the coldest month, tassel-cap greenness[24], and dense forest (percent in forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The FWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables. Other recent models [96, 106] have primarily been focused on predicting habitat in the

[24] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

northwestern part of California or have been derived from far fewer fisher detections [97].

The final FWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as “high quality”, model values associated with habitats avoided by fishers were designated as “low quality”, and habitats that were neither avoided nor selected were considered “intermediate”. The “low quality” habitat category may include non-habitat (not used) as well as areas used infrequently by fishers relative to its availability. This FWS-CBI model was considered to be the best information available depicting the amount and distribution of habitats potentially suitable for fisher within the historical range depicted by Grinnell et al. [3] and the species’ current range in California (Figures 6 and 7).

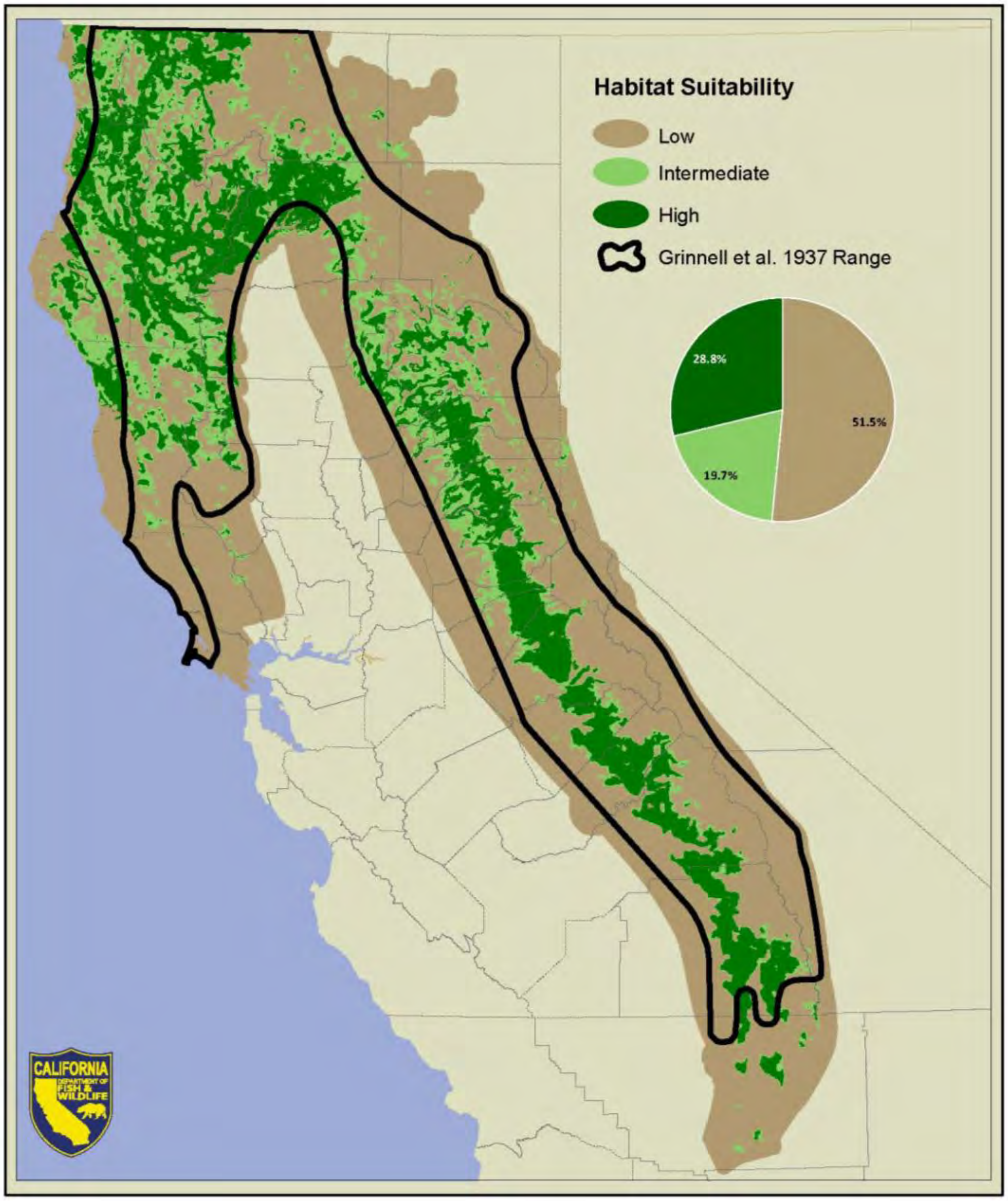


Figure 6. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

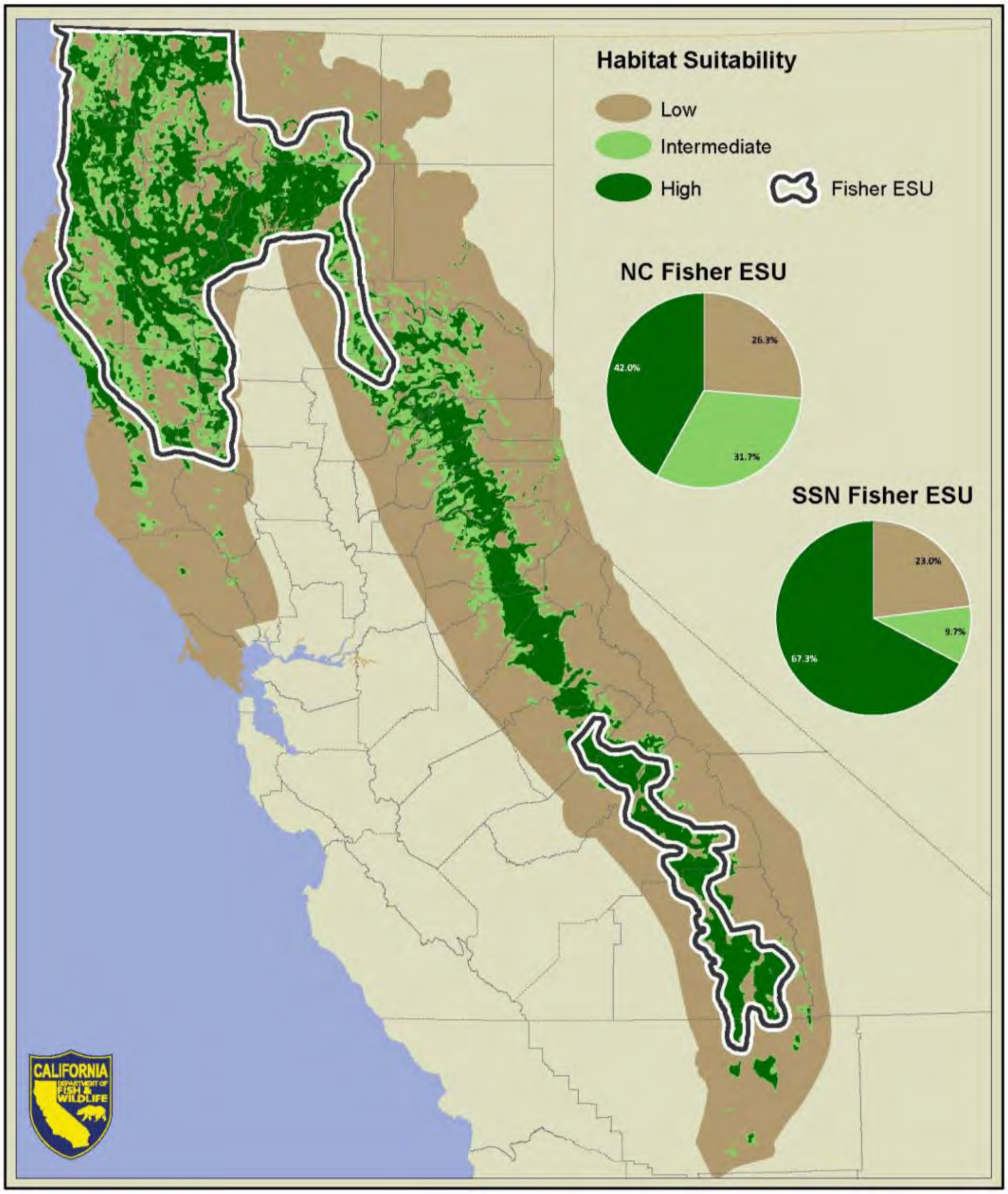


Figure 7. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Conservation Status

Regulatory Status

The fisher is currently designated by the Department as a Species of Special Concern[25] and as a candidate species at both the state[26] and federal[27] levels. Fishers are considered a sensitive species by the USFS and the Bureau of Land Management.

Habitat Essential for the Continued Existence of the Species

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists [3,31] and researchers in modern times [2,25,115–118]. However, the size, age, structure, and scale of forests essential for fisher are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular

---

25 Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, "Species of Special Concern" is an administrative designation and carries no formal legal status.

26 A species becomes a state candidate upon the Fish and Game Commission's determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted [California Code of Regulations (Cal. Code Regs), tit. 14, § 670.1(e)(2)]. During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

27 Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

forest types (e.g., old-growth conifers) habitat for survival [98]. However, studies of fisher habitat use over the past two decades demonstrate that they are not dependent on old-growth forests *per se*, nor are they associated with any particular forest type [88]. Fishers are found in a variety of low- to mid-elevation forest types [105,119–122] that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. These landscapes are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Most studies of habitat use and selection by fishers have focused on structures used for denning and resting, in part because those aspects of fisher ecology are more easily studied than habitat selection for foraging. Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young [52]. Aubry and Raley [49], reported that the sizes of den entrances used by female fishers were typically just large enough ~~to~~ for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir [52], found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110]. True, but it is my experience that this only holds if comparing conifer and hardwood species separately.

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning [88]. These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large and considerable time (>100 years) ~~may be~~is required for most suitable cavities to develop [88].

Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. However, forest structure important for fishers should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers [28] .

Distribution Trend

Comparing the historical range of fishers in California estimated by Grinnell et al. [3] to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Lake and Marin counties. However, recent genetic analyses indicate some of the area considered to be a modern gap [35,36] in the historical distribution of fishers in the northern and central Sierra Nevada ~~may have been long standing and~~ pre-dated European settlement [29,40]. (If there are no genetic data inconsistent with this finding, why would it be stated as if there is uncertainty about the conclusion?) Yet, Grinnell et al. [3] and Price [31] suggest that fishers were present in this region post European settlement. This indicates that the gap was narrower historically than during contemporary times.

Despite extensive surveys from 1989-1995 [36] and 1996-2002 [35] for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled.

Following a major increase in survey effort in~~Since~~ the 1990s, high detections of fishers have ~~increased~~ been reported along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County (Figure 3). (This is a bit misleading since there was a big jump in fisher surveys beginning in the early 1990's following the first petition to list the fisher.) It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier surveys. (Grinnell's distribution for fisher's in northern Humboldt and Del Norte counties extends further west than any reported trapping locations. Furthermore, there are numerous trapping locations for marten in this area, which indicates there was trapping pressure in this region. Considering the value of fisher pelts, trappers would not have passed up fishers if they were present. This suggests that Grinnell drew the range map based on a presumption of where fishers should occur. This indicates that almost certainly fishers have extended their range to the west in this portion of their range. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [3]. In that year, only 14 fishers were reported taken by trappers in the state, with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau- of Labor Statistics). Grinnell et al. [3] concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers [123]. Most animals were taken in a single trapping season (1920) when 120 fishers were harvested [124]. Despite concerns about the scarcity of fishers in the state, trapping of fisher was not prohibited until 1946 [125].

Grinnell et al. [3] noted that "Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township." They roughly estimated the fisher population in California at fewer than 300 animals statewide with a density of 1 or 2 animals per township [93 km^2 (36 mi^2)] in good fisher range. For perspective, substantially higher numbers of fisher are captured for radio-collaring/study purposes in various studies in the present day: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were captured as part of an effort to translocate the species to the Southern Cascades and northern Sierra Nevada from 2009-2012 from widely distributed locations in northern California. Over a period of 28 days in 2012, 19 fishers were captured in vicinity of the translocation release site in the northern Sierra Nevada that were likely the offspring of animals translocated to the area [126]. Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers during this effort was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*).

Despite the paucity of empirical data, there are several estimates of fisher population size in northern California. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. However, he believed the estimate to be useful for general planning and risk assessment.

Self et al. (2008 SPI comment information) derived two separate “preliminary” estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a “deterministic expert method” and an “analytic model based approach” to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 (95% confidence interval [CI]: 1,848 - 4,550) fishers. Estimates for the southern Sierra Nevada population were 598 using the deterministic expert method and 548 (95% CI: 247 – 849) fishers based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates.

Thompson (2008) employed a capture-resight technique to quantify the abundance and density of fisher on two separate 100 km^2 study sites on Green Diamond’s ownership in coastal northern California. The estimated population density of fishers on Green Diamond’s ownership based on these two study areas and two estimation techniques was 0.23 fisher/km^2 (sexes combined). Applying this average across the ownership, Green Diamond estimated a population of 335 fishers within its 1,457 km^2 (360,000 acre) ownership assessment area. Using the same mean fisher density estimate with a

20 km buffer around its ownership to represent the area of likely fisher ingress and egress, Green Diamond estimated a regional fisher population of almost 2,000 fishers.

Estimates of the number of fishers in the southern Sierra Nevada indicate that despite using different approaches, the population is quite small. Lamberson et al. [127], using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Spencer et al. [128] estimated the size of the fisher population in the southern Sierra Nevada by extrapolating previous density estimates of Jordan [129], using data from the USFS regional population monitoring program (USDA Forest Service 2006), and linking a regional habitat suitability model to life history attributes. Using these data, they estimated 160-350 fishers in the southern Sierra Nevada population, of which 55-120 were estimated to be adult females. More recent work by Spencer et al. [119] estimated the southern Sierra Nevada fisher population at 300 individuals. Estimates of the number of fishers in California vary depending on the source, but range from 1,000 to approximately 4,500 fishers statewide.

Population Trend in California

No data are available that document long-term trends in fisher populations statewide in California. Despite genetic evidence indicating a long-standing historical separation of fishers in northern California from those in the southern Sierra Nevada [28], fishers reportedly occurred in the central and northern Sierra Nevada post-European settlement [3,31], but were likely not abundant based on the scarcity of records from this region. By the late 1800s, habitat changes and harvest by trappers may have reduced the abundance of fishers in this region to low levels. The apparent scarcity of fishers in the central and northern Sierra Nevada by the early 1900s is supported by the work of Grinnell et al. [3] and the lack of specimens from that region.

In northern California, Matthews et al. [130] reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. However, continued monitoring of this population indicates that overall the population density has increased by 2012-2013, but only to about half of that estimated in 1998.

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 [131]. Detection rates at segments increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995, lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection ratios (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed.

Swiers et al. [132], collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers et. al. found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of abundance and population growth indicated that the population size was stable, although estimates of survival and recruitment suggested high population turnover [132].

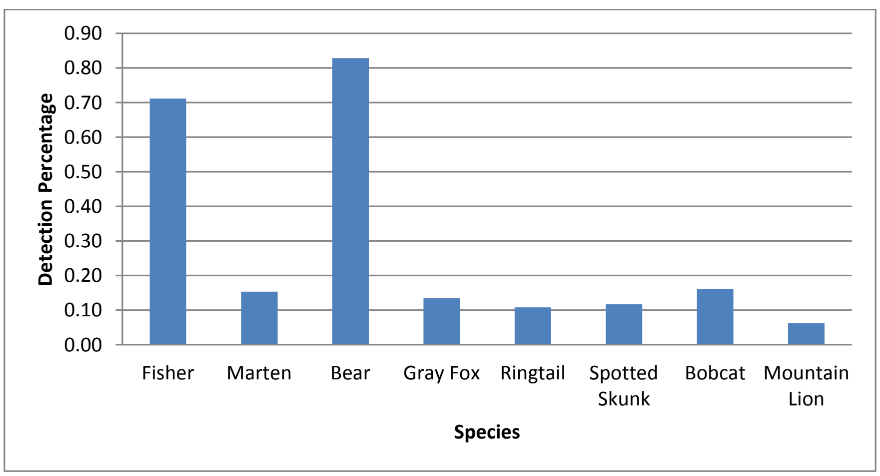


Figure 8. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

Tucker et al. [28] concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated European settlement. Tucker et al. [28] also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-European settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries. The southern extent of fisher habitat in the southern Sierra may have contained sufficient high quality habitat to serve as a refugium supporting enough fishers to constitute a founding population (J. Tucker, pers. comm.). Tucker et al. [28] using genetic techniques estimated that the total current population size of fishers in northwestern California could range from 258-2850 and the southern Sierra Nevada population could range from 334-3380.

Monitoring of fisher populations in northern California has been limited, but several studies are providing insight into the distribution and trends in occupancy rates of fishers in the state. Estimates of trends in occupancy have been used as surrogates for trends in abundance for some species of wildlife [133], in part, because it is more cost effective and feasible than monitoring direct measures of abundance. Zielinski et al. [134] implemented a monitoring program for fishers in the southern Sierra Nevada over an 8 year period (2002-2009) and modeled trends in occupancy by combining the effects of detection probability and occupancy. They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest in the southeastern portion of their study area (0.261) and highest in the western portions of their study area (southwestern zone = 0.583) [134]. They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra did not appear to be declining.

The Department has conducted a large-scale monitoring project for forest carnivores, including fishers, as part of its Ecoregion Biodiversity Monitoring (EBM) program in the

Klamath and East Franciscan ecoregions of northern California since 2011. EBM surveys for carnivores were conducted using camera traps within hexagons established by the Forest and Inventory Assessment system [135]. All the sites selected for survey occurred in forested habitats and were selected randomly (although land ownership, road access, and safety issues occasionally precluded completely random placement of plots). A Bayesian hierarchical model was used to estimate occupancy and detection probabilities for fisher across stations nested within plots within ecoregions (Furnas et al. unpublished manuscript). A total of 85 plots containing 169 stations were surveyed across the entire 2.8 million-ha study area during 2011 and 2012. The overall occupancy estimate for fisher was 0.438 [90% CI: 0.390-0.493] for stations, and 0.622 [90% CI: 0.569-0.685] for station pairs. The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.

Threats (Factors Affecting the Ability of Fishers to Survive and Reproduce)

Evolutionarily Significant Units

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) Fisher ESU and SSN (southern Sierra Nevada) Fisher ESU. The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by the Third District Court of Appeal that the term "species or subspecies" as used in sections 2062 and 2067 of the CESA includes Evolutionarily Significant Units[28]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species [136].

---

[28] 156 Cal.App.4th 1535, 68 Cal.Rptr.3d 391

ESU boundaries for fisher represent the Department's assessment of the current range of the species in the state, considering the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between them (Figure 9). Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events.

Habitat Loss and Degradation

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic [24,52,98,108–110,117]. Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers particularly vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires [5,25]. Buskirk and Powell [98] found that at the landscape scale, the abundance and distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.

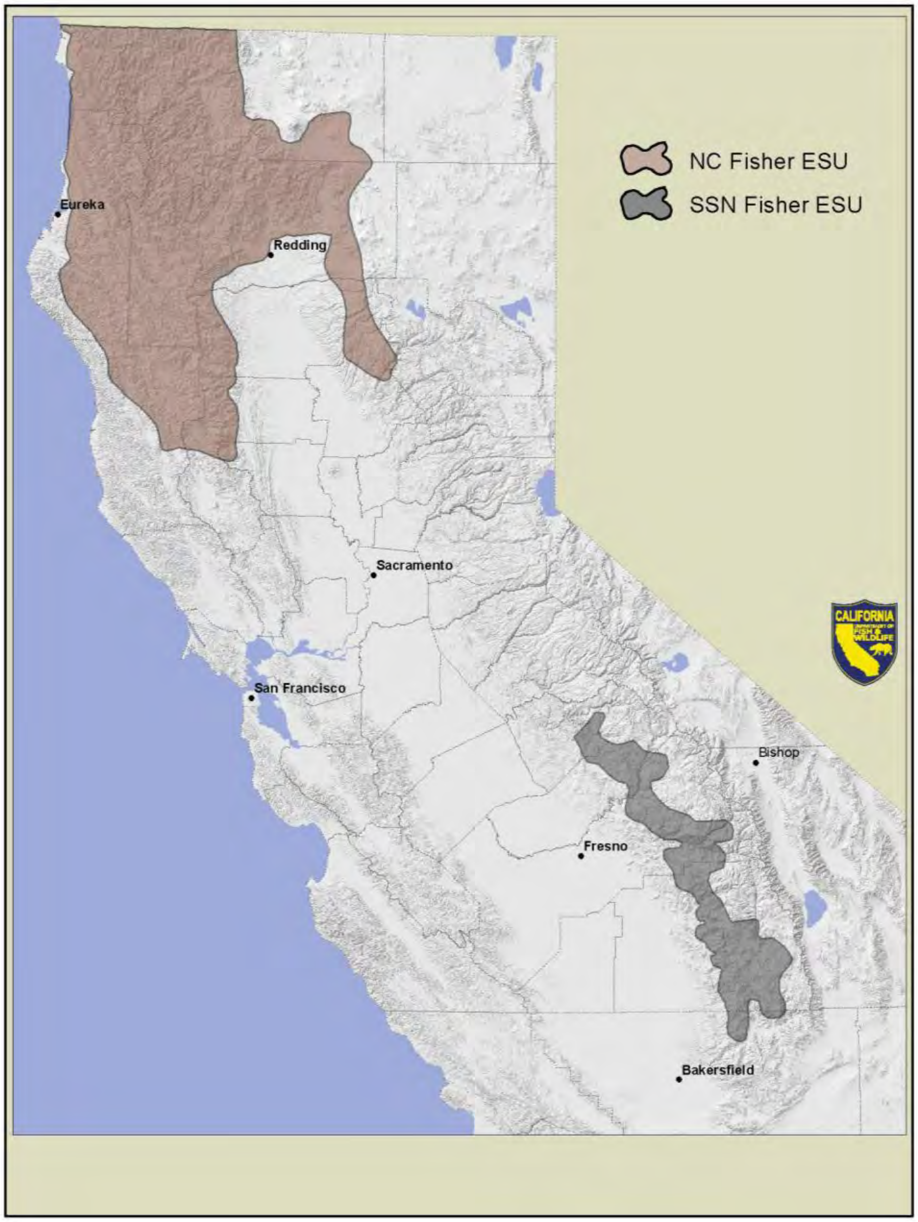


Figure 9. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and Wildlife, 2014.

Fishers have frequently been associated with old-growth forests and some researchers have hypothesized that they require those forests for survival. Habitat studies in recent decades demonstrate that fishers are not dependent on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. However, the home ranges of fishers often include high proportions of mid- to late-seral forests [88].

Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age and structural features of many forests in California. Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. Besides the direct removal of trees through timber harvest, management practices and policies have had many indirect effects on forested landscapes [24]. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Generally, timber harvest has substantially simplified the species composition and structure of forests [137,138]. Habitat elements used by fishers such as microstructures for denning can take decades to develop and a substantial reduction in the density of these elements from landscapes supporting fisher would likely reduce the distribution and abundance of fisher in the state.

Of the historical range of the fisher in California estimated by Grinnell et al. [3], nearly 61% is in public ownership and about 37% is privately owned (Figure 10). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (NPS) (Figure 11). Private lands within the NC Fisher ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 12). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades [139]. Sawtimber volume (net volume in board feet of sawlogs harvested from commercial tree species containing at least one 12-foot sawlog or two noncontiguous 8 foot sawlogs) harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 13 and 14).

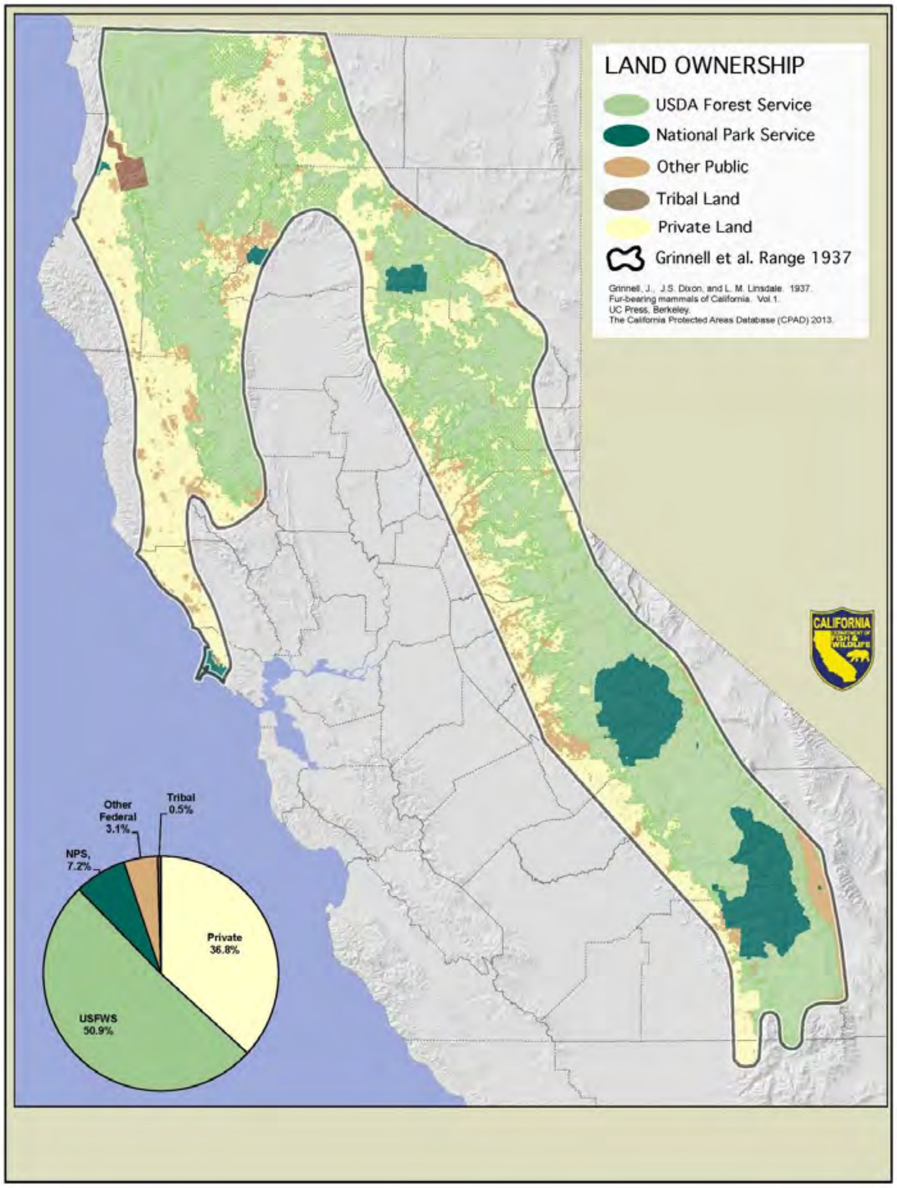


Figure 10. Landownership within the historical range of fisher depicted by Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

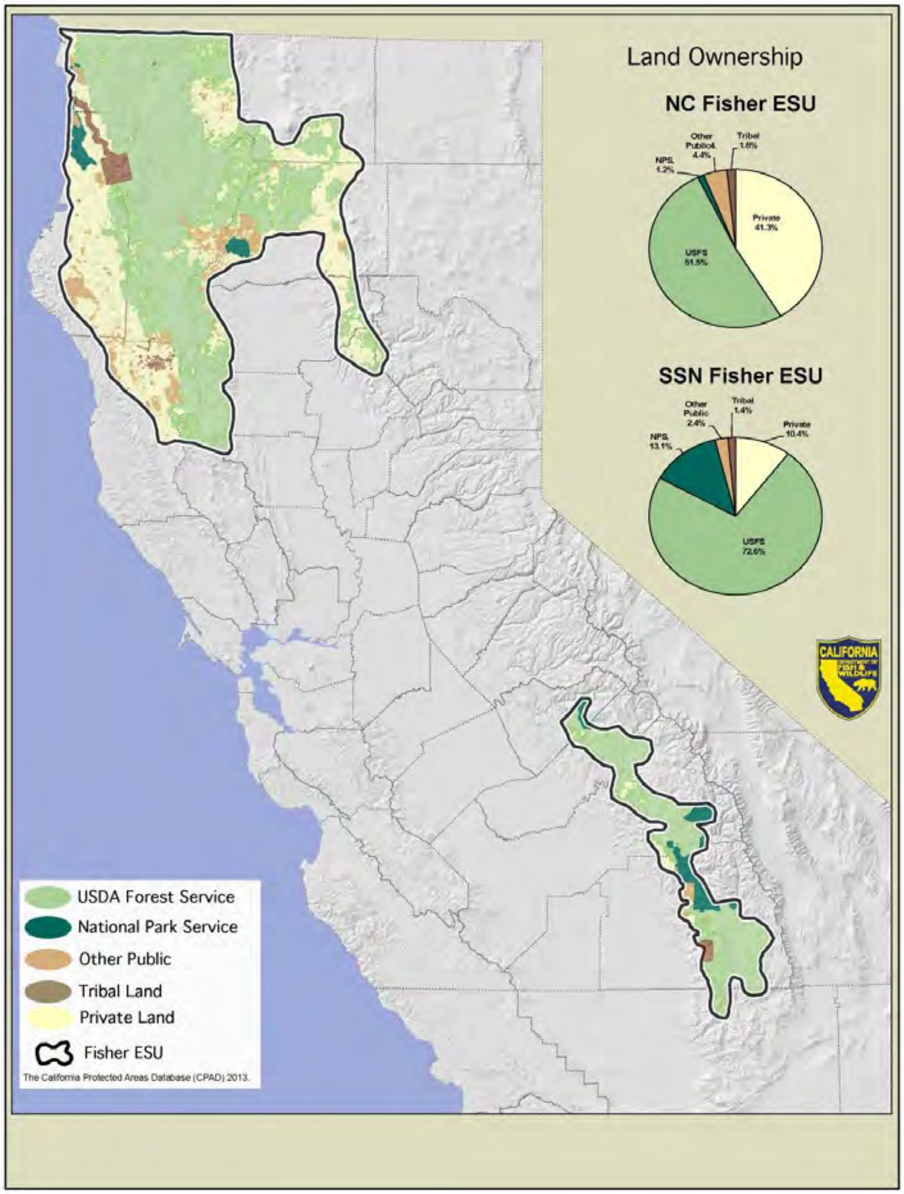


Figure 11. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

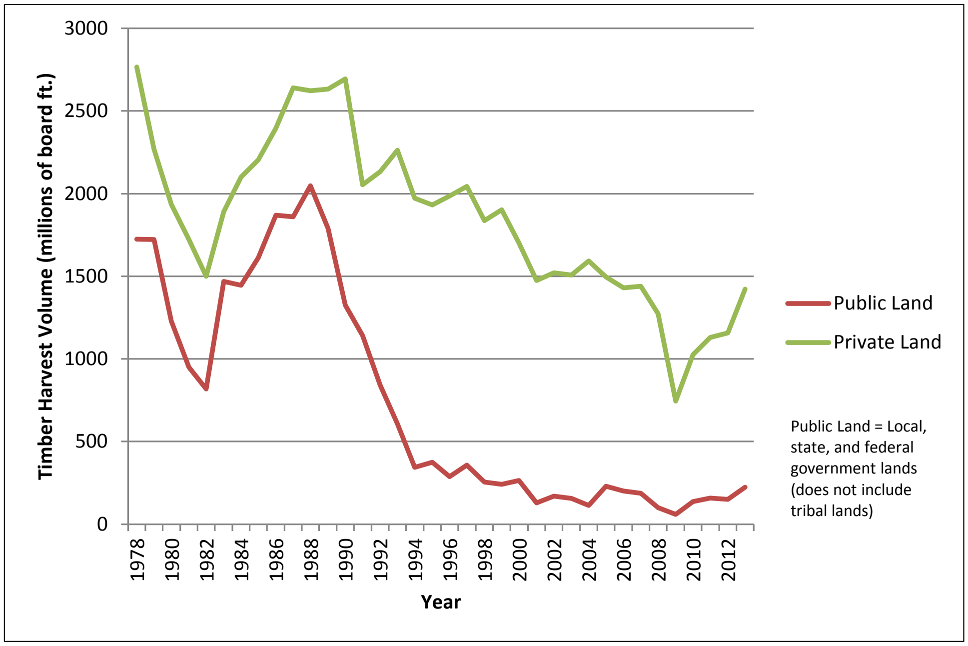


Figure 12. Volume of timber harvested on public and private lands in California (1978-2013) [140].

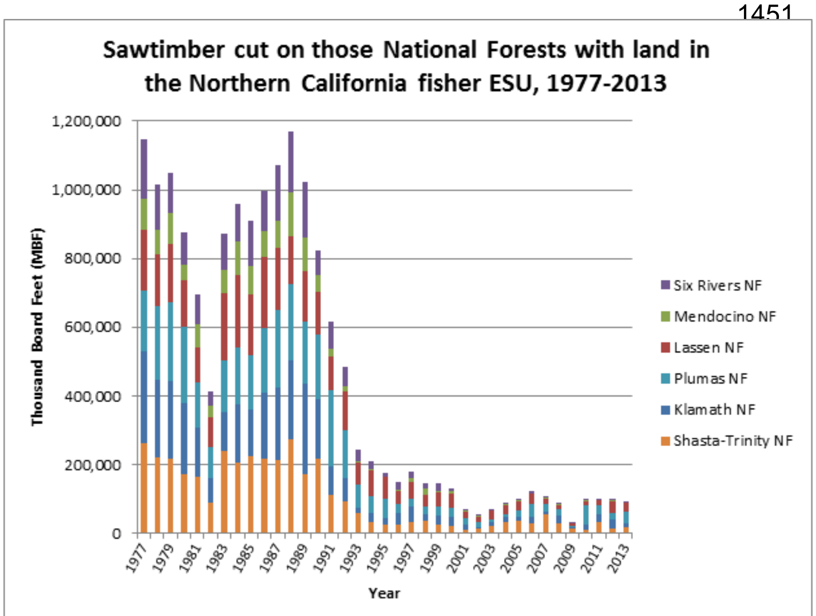


Figure 13. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 [139].

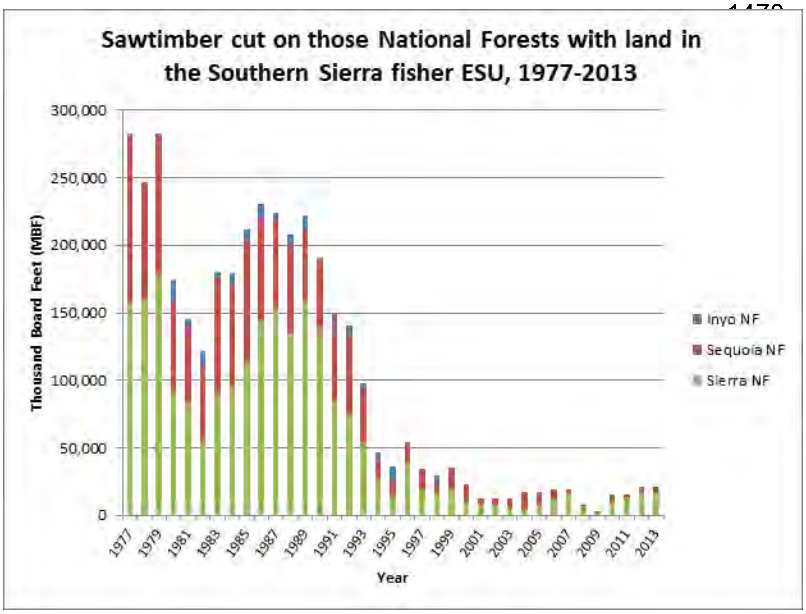


Figure 14. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 [139].

Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. This could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected. However, fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been intensively managed for timber production (Figure 15).

A more proximal concern for the long-term viability of fishers across their range in California is the presence of suitable denning and resting sites and habitats capable of supporting foraging activities. However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California.

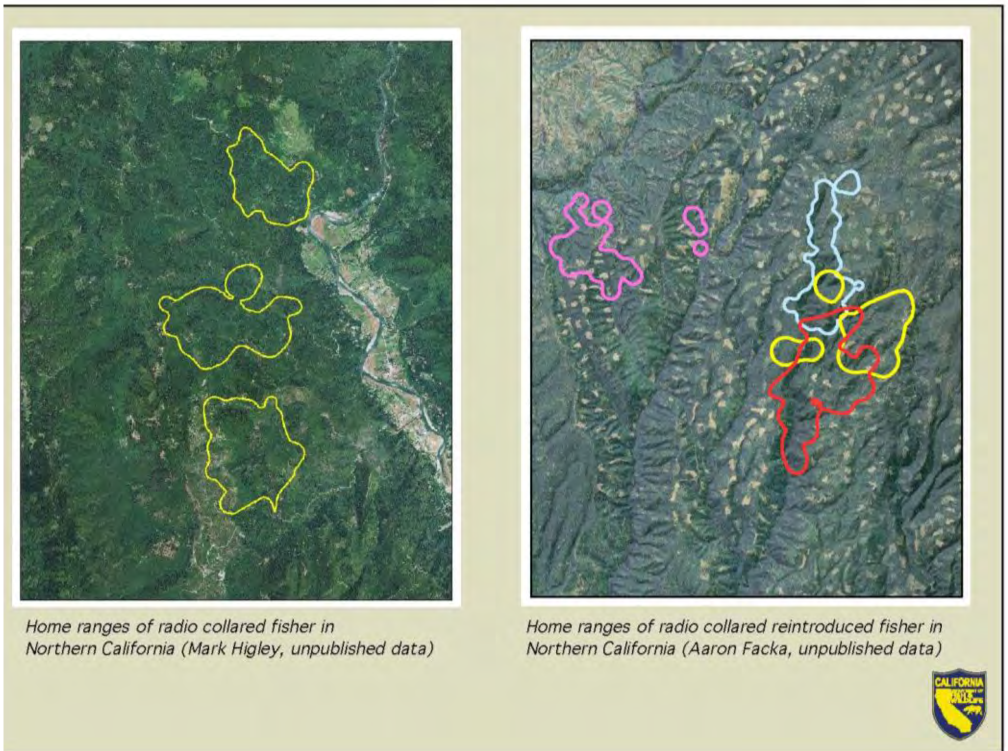


Figure 15. Home ranges of female fishers on managed landscapes in northern California and the northern Sierra Nevada, 2014.

Population Size and Isolation

Grinnell et al. [3], considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. However, few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century [36,38]. However, recent genetic work by Knaus et al. [29] and Tucker et al. [28] indicates fishers in the southern Sierra Nevada became isolated from northern California populations long before European settlement.

Based on Tucker et al. [28], the fisher population in California experienced a significant decline of approximately 90% long before European Settlement, resulting in the isolation of fisher populations in northern California from fishers in the Sierra Nevada. Tucker et al. [28] pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene [141] and would be consistent with the divergence dates of fisher populations in California reported by Knaus et al. [29]. However, in California there were two “mega-droughts” during the Medieval Warm Period (MWP) that lasted over 200 and 140 years each from 832-1074 and 1122-1299 AD, respectively. These droughts may have caused fisher populations to contract isolating the population in the Sierra Nevada from fishers elsewhere in the state [28].

In addition to this early population contraction, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19th century and early 20th century [28]. Tucker et al. [40] suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20th century while fisher in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable based on estimates of occupancy from 2002-2009 [134].

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. Fishers in the southern Sierra Nevada are geographically isolated from breeding populations of fishers elsewhere in the state and do not appear to be expanding their range northward. Should fishers in the southern Sierra Nevada expand their range northward, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, fishers in either location do not appear to be dispersing towards each other and natural contact in the near-term (50 years) is unlikely.

Although fishers in northern California are effectively isolated from fishers in the southern Sierra Nevada, they are part of a regional population that extends into southern Oregon. A fisher that was marked by researchers in Oregon was

subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California [38,91,142,143].

Although fishers do not fully occupy their assumed historical distribution, their population is likely higher than when densities of fishers were estimated by Grinnell et al. [3] at 1-2 per township in good habitat.

Predation and Disease

Predation and disease (including toxins) appear to be the most significant causes of mortality for California fishers. Since 2007, the causes of mortality for radio-collared and opportunistically found fishers from one area in northern California (Hoopa) and the southern Sierra Nevada have been analyzed through gross necropsies, histology, toxicology, and molecular methods. In a sample of 128 fishers from these two populations that died between 2007-2012, predation was the most common cause of mortality (52%), followed by disease/toxins (24%), and vehicular strikes (8%) (M. Gabriel, unpublished data). The proportion of fishers dying from each cause did not differ among these monitored populations, or by sex, which suggests that the relative impact of each source of mortality is similar for both male and female fishers and throughout fisher range in California (M. Gabriel, unpublished data). Preliminary assessment of mortality data from 2010-2013 for the northern Sierra Nevada population recently established through translocation is also consistent with these findings (D. Clifford, M. Gabriel and C. Wengert, unpublished data).

Predation: DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project (SNAMP) and King's River projects identified bobcats (*Lynx rufus*) as the predator of 25 sampled fishers (50%), mountain lions (*Puma concolor*) as the predator of 20 sampled fishers (40%) and coyotes (*Canis latrans*) as the predator of 4 fishers (8%). The single remaining carcass had both bobcat and mountain lion DNA present [144].

The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes

killed an equal number of male and female fishers [144]. This finding suggests that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19/25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival [144].

The proportion of fisher mortalities caused by predation found by Wengert [144] is higher than previously reported in California [145] and British Columbia [52]. Powell and Zielinski [25] suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert [144] indicate that predation is a significant mortality factor for native fisher populations in California. Whether or not some forest management practices favor the existence of more generalist predators (like bobcats) over specialist predators like fishers is not known. However, Wengert [146] found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Disease: A number of viral, bacterial, and parasitic diseases have been documented in fisher. Canine distemper virus (CDV) infection, a cause of significant morbidity and mortality in other carnivore populations [147], was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 [148]. Three of these animals died within a 2-week period from April 22-May 5 and were found within 20 km (12.4 mi) of each other, while the fourth fisher died during an immobilization event 4 months later approximately 70 km (43.5 mi) away from the initial cases. Infection with CDV decreases immune function, thus vital capacity co-infections with other pathogens are common [147].

Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal’s ability to survive a capture and immobilization event. The source of the infections in these fishers, as well as pertinent transmission routes remain unclear, but the temporal and spatial distribution of the fisher CDV mortalities, as well as the similarity of the virus isolates, suggest two spillover events from one or multiple other sympatric carnivore species.

In California, CDV mortalities in gray foxes and raccoons are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, CDV has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) [149] and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) [150]. Furthermore, highly virulent biotypes of CDV can be transmitted and cause high mortalities in multiple carnivore species [151] . This scenario was evident by a 2009 CDV outbreak in Switzerland that killed red foxes (*Vulpes vulpes*), Eurasian badgers (*Meles meles*), stone (*Martes foina*) and pine (*Martes martes*) martens, a Eurasian lynx (*Lynx lynx*) and a domestic dog [151].

Although CDV can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 3). Of 98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to CDV [152]. From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the SNAMP area were exposed to CDV [152]. Evidence to date and experiences with other species underscore the fact that CDV has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus (CPV), both potentially significant pathogens for *Martes* species [153], have not been documented in fishers in California. However, virus shedding[29] of CPV has been documented in fisher [152], and clinically significant illness due to CPV was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern California are commonly exposed to and infected with CPV: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 2).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) [154], American minks (*Mustela vision*) [155], and free-ranging southern sea

[29] Viral release following reproduction in a host-cell.

otters (*Enhydra lutris*) [156]. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania [157].

Table 2~~3~~. Prevalence of exposure to canine distemper, canine parvo virus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 [140].

	Canine Distemper Percent (No. sampled)	Canine Parvo Virus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) [158], but mortalities of fishers from these diseases have not been reported. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers [153]. Plague is known to cause mortality in other mustelids, is a serious zoonotic[30] risk [159] and is endemic in many parts of California.

Other documented disease-caused fisher mortalities included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers and other *Pekania* and *Martes* species harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases,

[30]Zoonotic diseases are contagious diseases that can spread between animals and humans.

infections and infestations are usually associated with minimal morbidity and mortality [153]. Banci [121] noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell [2].

Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye damage, there were no vision deficits or eye damage noted in affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions [160]. In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination [161]. Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fisher and may have been responsible for local declines in fishers, the Department is not aware of studies indicating that disease is significantly limiting fisher populations in California.

Human Population Growth and Development

The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance from 1970 to 2010 [162,163], the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state [164] and those numbers are expected to reach approximately 53 million by 2060 [165], an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average [166].

The California Department of Forestry and Fire Protection (CAL FIRE) estimated that statewide, between 2000 and 2040, about 2.6 million acres of private forests and

rangelands will be impacted by new development [167]. New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 890,000 ha (2.2 million acres). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fisher was comparatively low (6%).

Within the NC and SSN Fisher ESUs, future human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 16, Table 4). This represents an increase of about 1% in the acres developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because parcels of that size likely provide some fisher habitat post-development. In the NC Fisher ESU, slightly more than half of development as of 2010 occurred in habitats predicted to be of intermediate or high value to fishers (Table 5). That percentage is not expected to change substantially by 2030. Within the SSN Fisher ESU, about 60% of past development occurred in habitats predicted to be of intermediate or high value to fishers and that proportion is also not predicted to change substantially by 2030.

Duane [168] identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 17, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). However, the effects of future development on fishers are uncertain. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

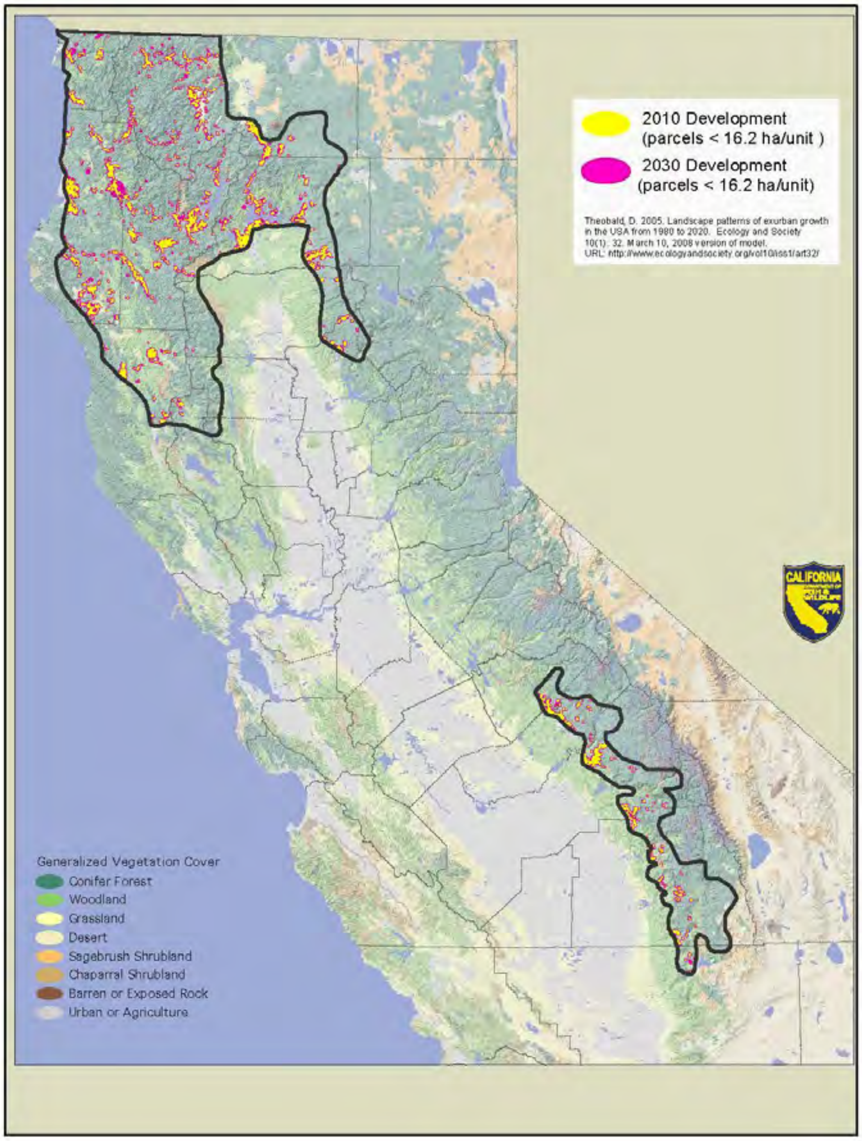


Figure 16. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169]. California Department of Fish and Wildlife, 2014.

Table 34. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of Total	Projected Development (2030)	Percent of Total
NC Fisher	4,103,639 (10,140,312)	129,764 (320,654)	3%	160,757 (397,240)	4%
SSN Fisher	778,273 (1,923,155)	32,361 (79,966)	4%	35,845 (88,576)	5%

Table 4~~5~~. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)					
Evolutionarily Significant Unit	Low	Percent of Total	Intermediate	Percent of Total	High	Percent of Total
NC Fisher (2010)	55,954 (138,264)	43%	33,065 (81,706)	26%	39,831 (98,425)	31%
NC Fisher (2030)	69,856 (172,617)	44%	41,952 (103,666)	26%	48,030 (118,684)	30%
SSN Fisher (2010)	11,942 (29,510)	37%	4,213 (10,411)	13%	16,205 (40,044)	50%
SSN Fisher (2030)	14,158 (34,986)	39%	4,758 (11,758)	13%	16,929 (41,832	47%

Figure 17. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Disturbance

Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats the species typically occupies. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off road vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be comparatively high. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied, however, monitoring radio-collared females with young provides some insight into their sensitivity

to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. However, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. Most watersheds on private timberlands are harvested at a rate of 1-3% annually (J. Croteau, pers. comm.). Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data).

Recreational use of habitats occupied by fisher in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Roads

Fishers occupying habitats containing roads occasionally are struck by vehicles and killed [53,56,100,126]. Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data).

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fisher in California and have been hypothesized to be a potential barrier to dispersal [24,91,170], they have not been demonstrated to limit fisher populations. Roads have not shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County [126].

Fire

Wildfires are a natural part of California's forest ecology and most frequently start as a result of lightning strikes. Wildfires affect habitats used by fisher and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, and the extent of individual fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. [171], believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey. (I think it should also be mentioned the potential beneficial effects of fire in terms of creating fisher den and rest site structure. In the coastal redwood region, the majority of den structures are the result of fire scars that produce internal cavities. And in fact, I believe the lack of fire in this region will likely result in long term loss of fisher late seral habitat elements despite the fact that many thousands of acres are being set aside to allow trees to get large and old.)

Formatted: Not Highlight

Formatted: Not Highlight

Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s [172]. In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression [172]. In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok [173] who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act that established fire exclusion as a national policy and formed the basis for USFS and NPS policies of absolute suppression of fires until those policies were reconsidered in the 1960s [174].

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 102,000 ha/year (252,047 ac/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 [174]. This was based on an estimate of the high fire return interval and was assumed to be similar to the fire rotation [174]. Prior to European settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting [175] and to reduce catastrophic fires [176]. Fires set by indigenous people and fires started by lightning have been estimated to have burned from 2.3 to greater than 5.3 million ha (5.6 to > 13 million acres) annually in California [177].

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more frequent [178]. Westerling et al. [179] found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fisher in California.

In the Sierra Nevada, the severity and the area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy [178]. Miller et al. [180] examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased.

In 1992, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged post-fire and replanted trees rapidly after the burn [181]. In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, SPI unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fisher using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly comprised of areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm).

The Rim Fire burned approximately 104,000 ha (257,000 ac) in Tuolumne County in August 2013. This fire was situated just north of the SSN ESU. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra population until the vegetation recovers sufficiently to facilitate its use by fishers.

While the frequency and extent of wildfires in the California have increased in recent years, the area burned annually is substantially smaller than in pre-historic (pre-1800) times when 1.8 – 4.8 million ha (4.4 – 11.9 million ac) of the state burned annually [174]. Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity [182] (Figures 18 and 19).

Lawler et al. [183] predicted that fires will be more frequent but less intense by the end of the 21st century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods [184].

Westerling et al. [185], modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California, and potential increases in burned area in the Sierra Nevada

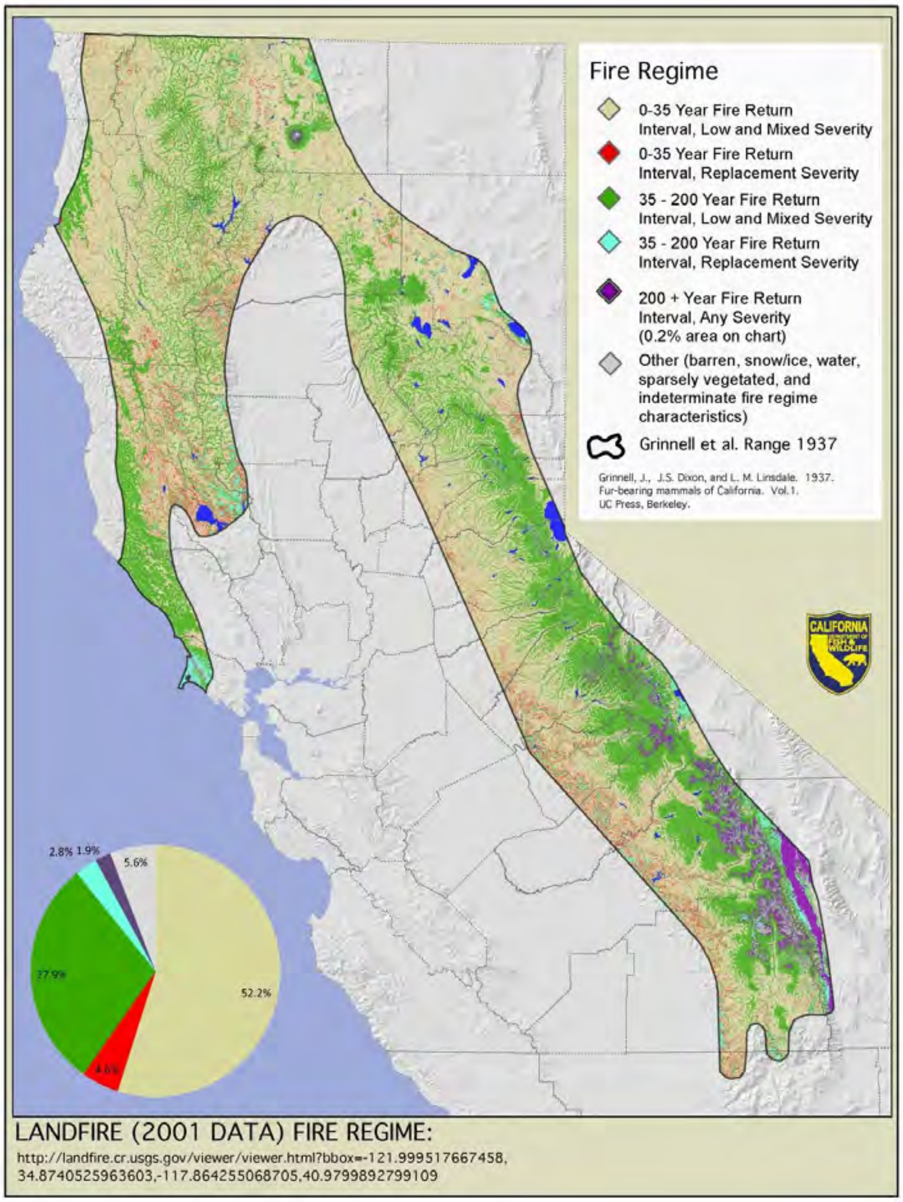


Figure 18. Presumed historical fire regimes within the historical range of fisher in California described by Grinnell et al. [3]. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

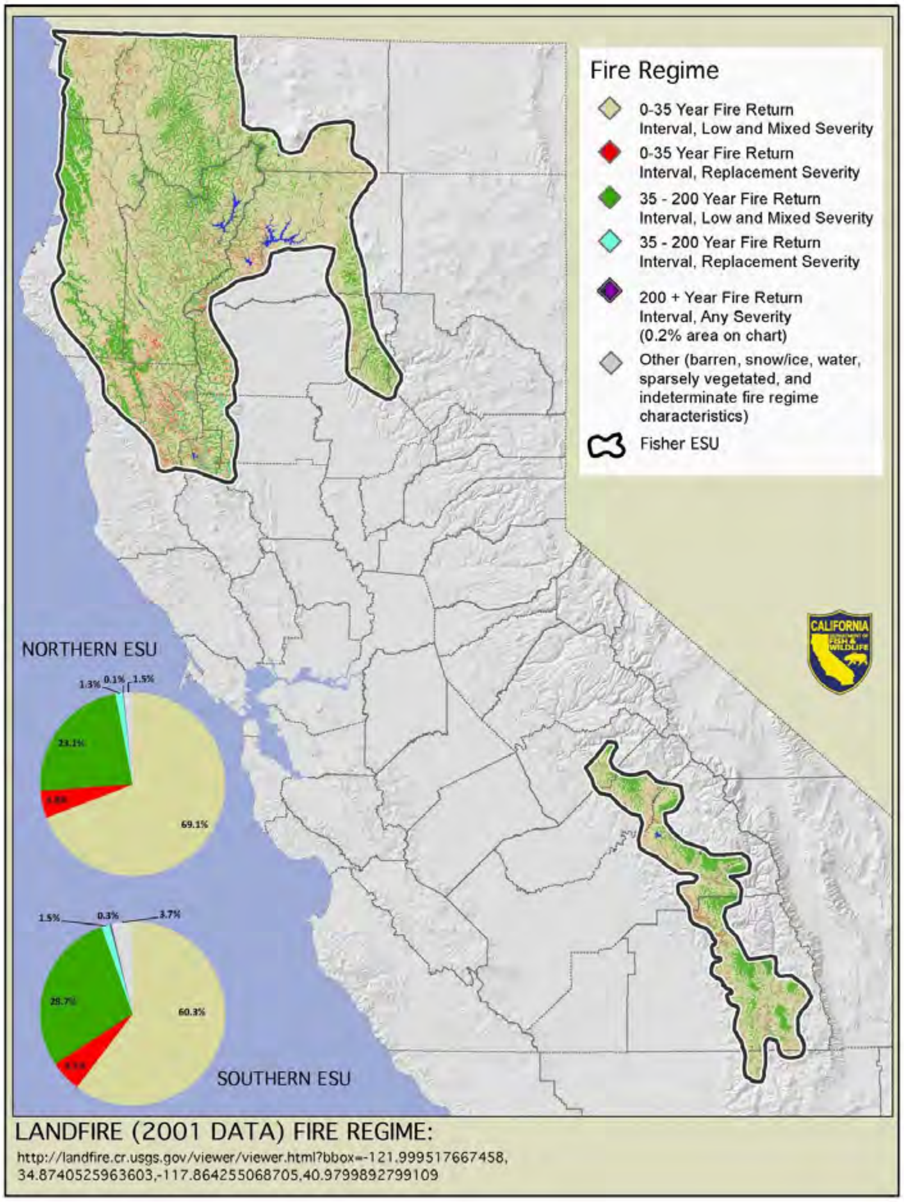


Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

appeared greatest in mid-elevation sites on the west side of the range [185]. However, the authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predications for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover [171,186,187].

Toxicants

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs) in California fisher populations has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range [153]. Although the source of toxicants to fishers has not been conclusively determined, numerous reports from remediation operations of illegal marijuana cultivation sites (MJCSs) on public, private, and tribal forest lands indicate the presence of a large amount of pesticides, including ARs, at these sites.[31] The presence of a large number of MJCSs within habitat occupied by fisher populations and the lack of other probable sources of ARs suggest that the AR exposure is largely occurring on the cultivation sites.

Fishers are opportunistic generalist predators and can be exposed to toxicants through several routes. They can be exposed directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such tastes as sucrose, bacon, cheese, peanut butter and apple) would also likely appeal to fishers [189]. Furthermore, there have been reports of intentional wildlife poisoning by adding

[31] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As growth sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reports remediating more than 600 large-scale MJCSs on just two of California's 17 national forests [188].

pesticides to food items such as canned tuna or sardines [188]. Many of the pesticides found at MJCSs are liquid formulations that can easily be mixed into food.

As carnivores, fishers could also be exposed to toxicants secondarily through prey. This is likely the primary means of AR exposure because of the toxin's persistence in the body tissue of poisoned prey items; secondary exposure of mustelids to ARs has occurred in rodent control operations [190]. Tertiary AR exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed [191] and may be possible in fishers that eat smaller carnivores. Lastly, AR exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer has occurred [189,191].

Anticoagulant Rodenticides: ARs cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impair an animal's ability to produce several key clotting factors. ARs fall into two categories (generations) based on toxicological characteristics and use patterns: first and second generation anticoagulant rodenticides (FGARs and SGARs, respectively). FGARs, developed in the 1940s, are less toxic than SGARs, and require consecutive days of intake by a rodent to achieve a lethal dose. FGARs have a lower ability to accumulate in biological tissue and are metabolized more rapidly [192,193]. There are 60 FGAR products registered in California. Labeled uses of FGARs are commensal rodent (house mice, Norway rats, and roof rats) control and agricultural field rodent control.

Development of SGARs began in the 1970s as resistance to FGARs began to appear in some rodent populations. SGARs have the same mechanism of action as FGARs but have a higher affinity for the target enzymes, leading to greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days) [192,193]. A lethal dose may be consumed at a single feeding. The several days' lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are 79 SGAR products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum. Labeled uses are for the control of commensal rodents in and around residences, agricultural buildings, and industrial facilities, such as food processing facilities and commercial facilities. SGAR products must be placed within 100 feet of man-made structures and may not be used for control of field rodents.

The unexpected discovery of AR residues in a fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project research team prompted monitoring of AR exposure in carcasses of fishers submitted for necropsy from research projects located throughout the fisher's range in California. The livers of 58 fishers that died from 2006-2011 were tested; 79% were positive for AR exposure. Four of these fishers died from AR poisoning. The number of different AR compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers [189]. Of the fishers tested, 96% were exposed to SGARs and the exposure of fishers to ARs was geographically widespread [189].

Gabriel et al. [189] documented the amount of toxicants found at one illegal MJCS in Humboldt County. Among other toxicants, 0.68 kg (1.5 lbs) of brodifacoum, as well as 2.9 kg (6.5 lbs) worth of empty AR bait containers were found. Based on the LD50 value for a domestic dog, it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption.

The sublethal impacts of AR exposure to fishers are not fully known. Sublethal effects may include increased susceptibility to disease [194], behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes [195], and reduced reproductive success. The contribution of AR (and other pesticides found on MJCSs) exposure to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer MJCSs located within their home ranges [196]. Studies have suggested that embryos are more sensitive to anticoagulants than are adults [197–199]. AR-related fisher mortalities were concentrated temporally in mid-April and mid-May which is the denning period for fisher females [189]. This raises concerns that mothers could expose their kits to ARs through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Higher AR-related mortalities in spring may be a consequence of more ARs being used at this time to protect young marijuana plants from rodent damage than at other times of the year.

On July 1, 2014, SGARs products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials and their legal use was limited to certified private applicators, certified commercial applicators, or those under their direct supervision. The placement of SGAR bait will generally be prohibited more than

15 m (50 ft) from man-made structures. These new regulations may limit the availability of SGARs, but how effective they will be at reducing the use of SGARs at MJCSs is unknown.

Other Potential Toxicants: Other pesticides deployed at MGCSs have likely caused fisher mortalities: 3 fishers in northern California were suspected to have died as a result of exposure to the carbamate toxin-methomyl cholecalciferol and bromethalin (Gabriel, unpublished data). Pests include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at MJCSs that were presumably used to combat them (Table 6). Some of the organophosphates and carbamates used on MJCSs are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use [200,201]. Volunteer reclamation crews reported that AR and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 [196]. Sixty-eight kilograms of AR and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort in public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km [189].

ARs are persistent in liver tissue, thus the compounds can be detected in liver tissue of sublethally exposed animals for several months following the exposure. Other pesticides such as carbofuran and methamidophos, which are present at the same sites, are more likely to cause immediate mortality, but are much less likely to be detected in fishers because carcasses would need to be recovered at MJCSs to confirm exposure.

Population-level Impacts: Although it is well documented that anticoagulant rodenticides (ARs) used both legally and illegally have caused mortalities of non-target wildlife species, including fishers [189,192,202–204], the question of whether or not lethal and sublethal exposure to ARs or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed.

To estimate the extent of the current fisher range potentially impacted by MJCSs, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi) and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 20) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.

Table 5~~6~~. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (MJCSs) (CDFW, IERC, HSVTC unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Class	**Mammalian Toxicity Range**	**Relative Frequency of Occurrence at MJCSs[1]**	**Evidence of Exposure or Toxicity (Gabriel et al. unpublished)**
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Not Detected
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as “occasional” or “common” based on the highest occurrence for any product in each class.

Although AR poisoning resulting in mortality has been documented in four fishers from two geographically separated populations and AR exposure is highly prevalent and geographically widespread [189], the cumulative impact of individual toxicity and exposure is hard to quantify at the population level. Determination of poisoning and exposure usually requires collection of carcasses, and therefore data are only available

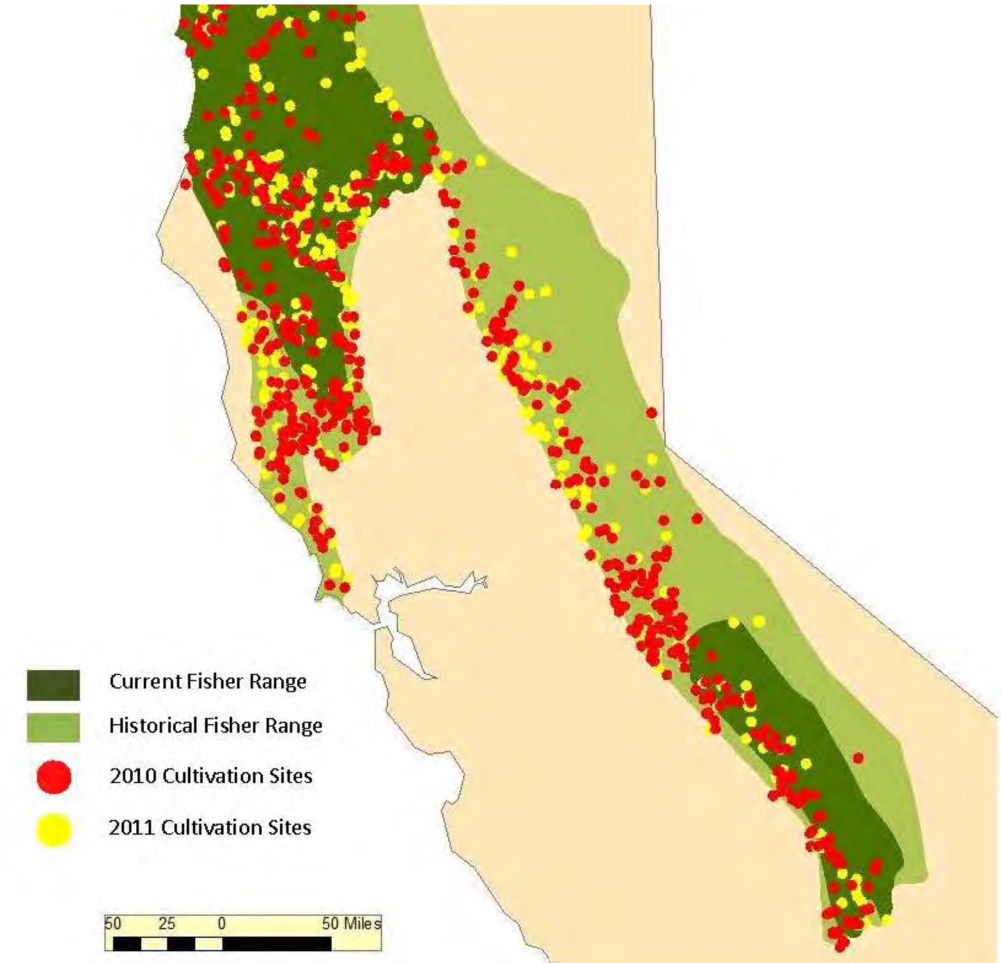


Figure 20. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

for fisher populations where ongoing intensive research (often involving a substantial number of radio collared animals) is conducted. Accordingly, pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected.

Despite these limitations, recent research from the well-monitored southern Sierra Nevada fisher population in California has revealed that female fishers with more MJCSs in their home ranges had higher rates of mortality and a higher likelihood of being exposed to one or more AR compounds [196]. Despite this association, further study is needed to demonstrate that chronic or sublethal AR or other pesticide exposure could predispose a fisher to death from another cause (aka indirect effect). These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival [194,205–212].

Exposure to AR through either milk or placental routes was identified in a dependent fisher kit that died after its mother was killed [189]. Additionally, Gabriel and colleagues observed that AR mortalities occurred in the spring (April-May), a time when adult females are rearing dependent young. Low birth weight, stillbirth, abortion, and bleeding, inappetance and lethargy of neonates have all been documented in other species as a result of exposure to ARs, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of MJCSs located within an individual's home range may start to address this question.

Reductions in prey availability due to pesticide use at MJCSs could potentially impact fisher population vital rates through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant [192], there is potential that MJCSs could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species [213–216]. However, the level of small mammal mortality at MJCSs remains largely unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey remain speculative.

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. A sublethal dose of AR can produce significant clotting abnormalities and some hemorrhaging (Eason and Murphy 2001). Predators with liver concentrations of ARs as low as 0.03ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey [192]. Accordingly, fishers exposed to ARs may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Challenges to investigating toxicant threats from MJCSs within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors [217].

The high prevalence of AR exposure in fishers and other species throughout California indicates the potential for additive and synergistic associations with pesticide exposure at MJCSs and consequently increased mortality from other causes. Small, isolated fisher populations, such as occurs in the SSN Fisher ESU, are of concern because they are more vulnerable to stochastic events than larger populations and a reduction in survivorship may cause a decline or inhibit growth.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s [218,219]. Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years [183]. Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe [218].

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago [220,221]. Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase in California by approximately 2.4 C in California by the 2060s (Pierce et al. [222]) and by 2 to 5 C by 2100 (Cayan et al. [223]). Projections of

precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation [224–226]. However, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation [227]. Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase [222,228]. Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack [229]. These patterns are expected to continue [223–225,230] and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 [231]. Forests throughout the state will likely become more dry [223,224,229].

The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra, rest sites are often located near water [108]. Zielinski et al. [108] suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Warming is predicted throughout the range of the fisher in California [183]. Pierce et al. [222] projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN Fisher ESU may experience greater warming than those occupying portions of the NC Fisher ESU.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their "climatically suitable" range within California by the year 2100 [183]. However, the distribution and climate data for those models was assessed at a 50 x 50 km grid; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California's montane environments, temperature and other climatic variables

can change considerably over relatively small distances [232]. Thus, the diversity of the physical environment within areas occupied by fisher may buffer some of the projected effects of a changing climate [233].

Climate change is likely to indirectly affect fishers by altering the species composition and structural components of habitats used by fishers in California [183,234]. Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change [179,183,184]. To evaluate potential future climate-driven changes to habitats used by fisher in the state, Lawler et al. [183] combined model projections of fire regimes and vegetation response in California by Lenihan et al. [234] with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs by 2071-2100, as compared to mean cover from 1961-1990 (Table 7).

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands [183]. If woodlands and grasslands within the fisher ESUs expand considerably in the future as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others unsuitable. However, Lawler et al. [183] also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the “floristic conditions” for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. [183] cautioned that their habitat modeling was based on a 10 x 10 km grid, which was a “high resolution for this type of model” and that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales. They further noted that the modeled changes are broad, landscape-scale patterns that will be “filtered” by variability in topography, vegetation and other factors.

Table 6~~7~~. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. [183].

Klamath Mountains - land cover percentages

	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages

	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

Hayoe et al. [225] modeled California vegetation over the same period as Lawler et al. [183] and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. [235] predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100. In the southern Sierra, Koopman et al. [236] modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. [236] also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas.

Burns et al. [237] assessed potential changes in mammal species within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to Yosemite

National Park. Burns et al. [237] suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such "reshuffling" of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health [229,238,239]. Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward [240–242]. Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes [243]. Changes in forest vegetation due to invasive plant species may impact fisher prey species composition and abundance. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state.

Existing Management, Monitoring, and Research Activities

U.S. Forest Service

The majority of land within the current range of the fisher in California is public (approximately 55%) and the majority of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. [3], encompassed all or portions of 13 National Forests including the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia as well as the Tahoe Basin Management Unit.

USFS sensitive species, such as fisher, are plant and animal species identified by the Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within the USFS Pacific Southwest Region are treated as though they were federally listed as threatened or endangered (USDA 1990).

Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA), USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11 National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

U.S. Forest Service – Specially Designated Lands, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan (NWFP) was adopted to guide the management of over 24 million acres of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (NSO) [244]. Adoption of the NWFP resulted in amendment of USFS and the Bureau of Land Management (BLM) management plans to include measures to conserve the NSO and other species, including the fisher, on federal lands.

The NWFP created an extensive and large network of late-successional and old-growth forest (Figure 21). These lands are designated as Congressionally Reserved Areas and Late Successional Reserves and are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan (But the reality is there has been far less timber harvesting than what was intended for the matrix lands. I have read reviews indicating the NWFP has not been successful in achieving the predicted harvest levels while protecting other resources.); however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, NSOs, and sites occupied by other species. Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody ([245]).

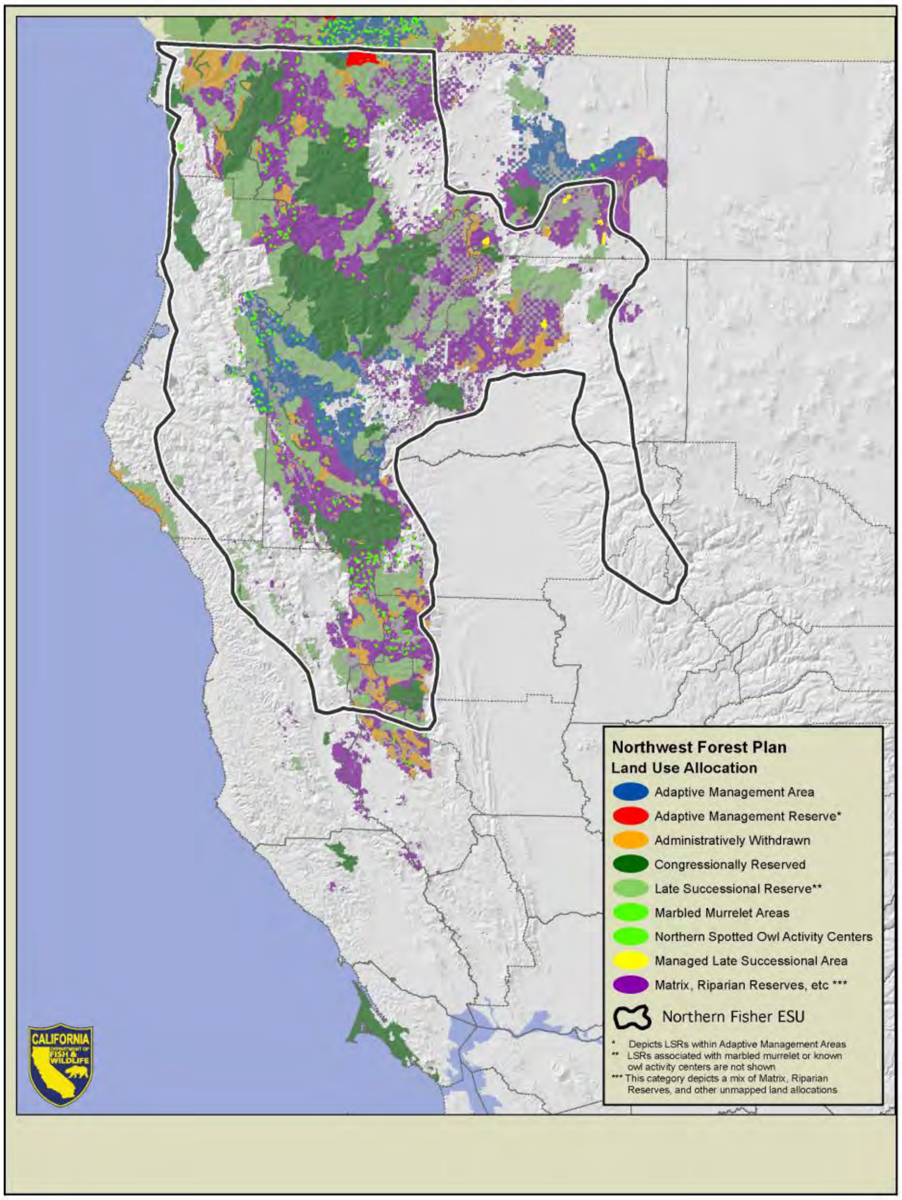


Figure 21. Northwest Forest Plan land use allocations [246]. California Department of Fish and Wildlife, 2014.

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the NSO, the US Fish and Wildlife Service recognized the importance of implementation of the NWFP to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the NSO did not alter land use allocations or change the Standards and Guidelines for management under the NWFP, nor did the rule establish any management plan or prescriptions for the management of critical habitat. However, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the NSO. Those include conservation of older forest, high-value habitat, areas occupied by NSOs, and active management of forests to restore ecosystem health in many parts of the NSO's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality NSO habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised NSO Recovery Plan. NSO critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 22).

Sierra Nevada Forest Plan Amendment (SNFPA): The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the SNFPA by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (USDA 2004). It also amended Land Management Plans for National Forests within the Sierra Nevada.

The Record of Decision for the SNFPA contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the SNFPA conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;

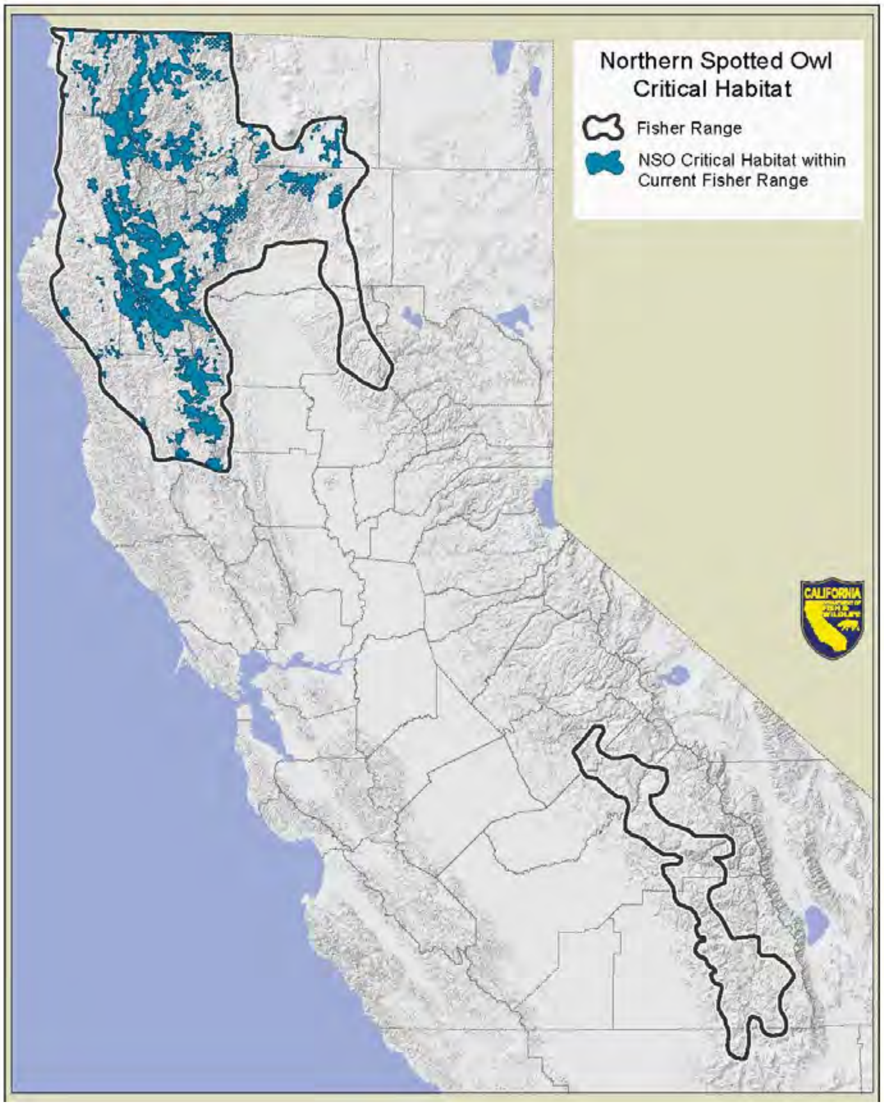


Figure 22. Distribution of northern spotted owl critical habitat within the current estimated range of the fisher in California.

- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and

- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The SNFPA established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit them by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra fisher conservation area
- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 4.9 million acres within the historical range of the fisher described by Grinnell et al. [3]. Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 3.5 million acres and 10 wilderness areas encompassing the southern Sierra population totaling about 416,000 acres. Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 328,315 acre Giant Sequoia National Monument (Monument) is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within the Monument are intended to be managed to support viable populations of these species. Three categories of land allocations within the Monument have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (311,150 acres). The current Management Plan for the Monument lists specific objectives to study and adaptively manage fisher and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project (SNAMP): The SNAMP was initiated in 2005 to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health [247]. A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) and focused on four response variables, including fishers. Researchers are studying factors that may limit the fisher population within SNAMP's study site in the southern Sierra Nevada. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation [248].

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007, in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada [249]. The project area encompasses about 53,200 ha (131,460 ac) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting structures have been identified [249]. Predation has been the primary cause of death of the fishers studied.

Bureau of Land Management

Management of Bureau of Land Management (BLM) lands are authorized under approved Resource Management Plans (RMPs) prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra RMP) include conservation strategies for fishers and other special status species. The Sierra RMP contains objectives to sustain and manage mixed evergreen forest ecosystems in to support viable populations of fisher by conserving denning, resting, and foraging habitats [250]. This plan contains provisions to manage lands within the RMP to support large trees and snags, to provide habitat connectivity among federal lands, and making acquisition of fisher habitat a priority when evaluating private lands for purchase [250].

Management of BLM lands within NSO range are also subject to provisions of the NWFP. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fisher associated with late-successional and old-growth forests [245].

National Park Service

Compared to other public lands which are primarily administered for multiple uses, national parks are among the most protected lands in the nation [251]. The National Park Service (NPS) does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

State Lands

State lands comprise only about one percent of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA). During CEQA review for proposed projects on state lands within fisher range and where suitable habitat is present, potential impacts to fishers are specifically evaluated because the

species is a Department of Fish and Wildlife Species of Special Concern. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (CCR, Title 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the FPRs) that require the preparation and approval of Timber Harvesting Plans (THPs) prior to harvesting trees on California timberlands. (CEQA applies equally to private timberlands and in fact is typically the most important regulation that comes in to play on factors such as retention of late seral elements not specifically covered by FPRs.)

Private Timberlands

The Department estimates that approximately 39% of current fisher range in California is comprised of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act and associated FPRs promulgated by the State Board of Forestry and Fire Protection (BOF). The FPRs are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans (THPs) prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to BOF's rules; and (2) information and direction to timber operators so they comply with BOF's rules (CCR, Title 14, § 1034). The preparation and approval of THPs is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

Under the FPRs (CCR, Title 14, § 897(b)(1)(B)), forest management shall "maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed." Although the FPRs do not require measures specifically designed to protect fishers, elements of these rules provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fisher may be voluntarily retained to achieve post-harvest stocking requirements under the FPR subsection relating to "decadent or deformed trees of value to wildlife" (FPR 912.7(b)(3), 932.7(b)(3), 952.7(b)(3)). Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (WLPZs).

WLPZs are defined areas along streams where the FPRs restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but WLPZs may encompass 15 – 45 m (50-150 ft) on each side of a watercourse 30-91m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. In some locations, WLPZs may constitute 15% or more of a watershed (Green Diamond data indicate a minimum of 25% of coastal watersheds are in riparian reserves. Although GD is operating under an aquatic HCP, similar amounts of riparian reserve would be required in all watersheds that fall within the Anadromous Salmonid Protection, ASP, rules.) (J. Croteau, pers. comm.). Drier regions of the state with lower stream densities have a much lower proportion of the landscape in WLPZs. Where WLPZs allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes. (ASP rules require that the 13 largest trees/acre be retained which would protect and promote fisher rest and den trees. Outside the ASP zones, the rules simply require retaining 2 trees/acre 16" dbh or larger.)

Timberland owners with relatively small acreages [<1,012 ha (2,500 acres)] may prepare Non-Industrial Timber Management Plans (NTMPs) designed to provide long-term forest cover on enrolled ownerships which may provide habitat suitable for use by fishers.

For ownerships encompassing at least 50,000 acres, the FPRs require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (CCR, Title 14, § 1091.1, § 913.11, § 933.11, and § 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option is likely to provide forested habitat that is suitable for fishers. However, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare THPs and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of

10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The FPRs impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees [trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Portions of the FPRs (CCR, Title 14, §§ 919.16, 939.16, and 959.16) relate to late succession forest stands[32] on private lands. Proposals to harvest late successional stands where the stands' amount, distribution, or functional wildlife habitat value will be reduced and result in a significant adverse impact on the environment must include a discussion of how the species primarily associated with late successional stands will be affected. When long-term significant adverse effects on fish, wildlife, and listed species associated primarily with late successional forests are identified, feasible mitigation measures to mitigate or avoid adverse effects must be incorporated into THPs, Sustained Yield Plans, or NTMPs. Where these impacts cannot be avoided or mitigated, measures taken to reduce them and justification for overriding concerns must be provided. (The reality is that there are no longer any late successional stands that are being harvested. Any proposed harvest of a late seral stand is judged to be an significant adverse impact under CEQA.)

Some private companies, including large industrial timberland owners and non-industrial timber owners, have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These may include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs. (Although they are termed "voluntary", it is my experience that they typically are the result of timberland owners being faced with frequent impasses on THPs with CDFW that resulted in development of management plans to avoid significant adverse impacts of wildlife structure under CEQA.)

---

[32] Late Succession Forest Stands refers to stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

Private Timberlands – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1992, the Forest Stewardship Council (FSC) was formed to create a voluntary, market-based approach to improve forest practices worldwide [252]. FSC's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity [253]. In California, approximately 1.6 million acres of forest lands are FSC certified [254].

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to "take," as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq.*)(ESA), threatened and endangered species. Applicants for incidental take permits under Section 10 of the ESA must submit an HCP that specifies, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. An HCP may include conservation measures for candidate species, proposed species, and other species not listed under the ESA at the time an HCP is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six HCPs in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods HCP specifically addresses fisher, although other HCPs contain provisions such as retention of late seral habitat elements intended to benefit species such as NSO (e.g., Green Diamond Resources Company and Fruit Growers Supply Company) that ~~may~~ should also benefit fishers. The Green Diamond aquatic HCP also has provisions that over the next 50 years will set aside more than 100,000 acres of riparian and geologic reserves that should develop late seral elements beneficial to fishers.

Fisher Translocation: From 2009-2012, the Department translocated[33] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra-Pacific Industries (SPI). This effort, the first of its kind in California, was undertaken in cooperation with SPI, USFWS, and North Carolina State University. A primary conservation concern for fisher has been the apparent reduction in overall distribution in

[33] Translocation refers to the human-mediated movement of living organisms from one area for release in another area [255].

the state. Fishers have been successfully translocated many times to reestablish the species in North America [26], and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California [256].

Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites [256]. Those lands represented most of the large, relatively contiguous tracts of SPI land within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto SPI's property, including habitat suitability of candidate release sites, prey availability, genetics, potential impacts to other species with special status, disease, predation, and the effects of removing animals on donor populations.

Table 7~~8~~. Approved Habitat Conservation Plans within the range of the fisher in California.

HCP Name	**Location**	**Area (acres)**	**Permit Period**	**Covered Species**
Green Diamond Resources Company	Del Norte & Humboldt counties	407,000	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	211,000	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Fruit Growers Supply Company	Siskiyou County	152,000	2012-2062 (50 years)	• coho salmon (Southern Oregon/Northern California Coasts ESU) • steelhead (Klamath Mountains Province ESU) • Chinook salmon (Upper Klamath and Trinity Rivers ESU) • northern spotted owl • Yreka phlox

Green Diamond Resources Company	Humboldt and Del Norte counties	417,000	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander
Fisher Family	Mendocino County	24	2007-2057 50 years	• Behren's silverspot butterfly • Point Arena mountain beaver
AT&T	Mendocino County	11	2002-2012 10 years	• Point Arena mountain beaver

From late 2009 through late 2011, 40 fishers (24F, 16M) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release [126]. A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young [126].

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 were born on Stirling [126]. On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California [126]. Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group comprised 47% of the population, suggesting relatively high levels of reproduction and recruitment [126]. (Would it make sense to compare this to the translocation in Olympic National Park that was comparatively much less successful?)

Candidate Conservation Agreement with Assurances: A "Candidate Conservation Agreement with Assurances for Fisher" (CCAA) between the USFWS and SPI regarding translocation of fisher to a portion of SPI's lands in the northern Sierra Nevada was approved on May 15, 2008. CCAAs are intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to SPI should USFWS eventually list fisher under the federal ESA. This 20-year permit covers timber management activities on SPI's Stirling Management Area, an approximately 160,000-acre tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fisher. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society to study the ecology of fishers. Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California. (Wouldn't it be important to note that their continued monitoring has documented a fluctuating but high density of fishers on a landscape managed for multiple use including timber harvest?)

Management and Monitoring Recommendations

The Department has implemented a number of actions designed to better understand fisher in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the BOF, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, and university researchers, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

1. Support independent research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term, multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.
5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations, potential effects of toxicants and their potential effects on fisher and fisher prey. It may be possible to partner with existing studies and surveys to collect some of the data needed.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends. Fishers translocated elsewhere in North America have rarely been monitored and this translocation is the first effort of its kind in the state. Continued monitoring is critical to answer questions about how fishers use managed landscapes and to determine if the project is successful in the long-term and, if not, why it failed.

7. In the southern Sierra Nevada, collaborate with land management agencies

and researchers to expand connectivity between core habitats and to facilitate population expansion.

8. Assess the potential for assisted dispersal of juvenile fishers or translocation of adults from the southern Sierra population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region.

Summary of Listing Factors

CESA directs the Department to prepare this report regarding the status of the fisher in California based upon the best scientific information. Key to the Department's analyses are six relevant factors highlighted in regulation. Under the California Code of Regulations, Title 14, § 670.1, subd. (i)(1)(A), a "species shall be listed as endangered or threatened...if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:"

(1) present or threatened modification or destruction of its habitat;
(2) overexploitation;
(3) predation;
(4) competition;
(5) disease; or
(6) other natural occurrences or human-related activities

Also key are the definitions of endangered and threatened species, respectively, in the Fish and Game Code. CESA defines endangered species as one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease." (Fish & G. Code, § 2062.) A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]." (*Id.*, § 2067.)

Fishers in California occur in two separate and isolated populations that differ genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units where appropriate in its analysis of listing factors.

Present or Threatened Modification or Destruction of its Habitat

Considerable research has been conducted to understand the habitat associations of fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types [105,119–122] (Wouldn't Klug's thesis #101 also be relevant here?). Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. Forested landscapes with these characteristics are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Thresholds for these attributes for fishers are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

Management of Federal Lands: Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The majority of federal actions must comply with NEPA. This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

The status of fisher as a sensitive species on USFS and BLM lands in California provides consideration for the species as guided by land management plans adopted by these agencies. As a result, substantial federal lands currently occupied by fishers in the state are managed to provide habitat for fishers, although specific guidelines are frequently lacking. Federal lands designated as wilderness areas or as National Parks are likely to provide long-term protection of fisher habitat. However, some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur.

Management of Private Lands: Timber harvest activities on private lands are regulated by various provisions of the Z'Berg Nejedly Forest Practice Act of 1973 and additional rules promulgated by the State Board of Forestry and Fire Protection. These rules are enforced by CAL FIRE and, although some timber harvest activities are exempt from these rules, they apply to all commercial harvesting activities on private lands.

The FPRs promulgated under the act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. However, information about what constitutes the "existing wildlife community" is frequently lacking in THPs, and specific guidelines to retain habitat for fishers and other terrestrial mammals are not incorporated into the FPRs. (However, CDFW has the authority under CEQA to require such guidelines be developed by timber landowners.)

Timber management activities subject to the FPRs can reduce the suitability of habitats used by fishers or render some areas unsuitable. These changes may be short-term or long-term, depending on a number of factors including the type of silviculture used, intermediate treatments conducted while forests regrow, timber site growing potential, and the time between timber rotations. (I think the single most important factor is whether or not late seral habitat elements (e.g., large snags and green wildlife trees) are retained and recruited, which you note in the paragraph below. This is not a not a function of silviculture used, because all types of silviculture can eliminate late seral habitat elements unless it is specifically targeted for retention and recruitment.)

Fishers are able to utilize a diversity of forest types and seral stages. An aspect of forest management important to the suitability and long-term viability of fishers is the retention and recruitment of habitat elements for denning, resting, and to support prey populations in sufficient number and in locations where they can be successfully captured by fisher. The FPRs require the retention of unmerchantable snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However, live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites. No provision is provided in the rules to specifically recruit snags. (This is true, but CEQA can, and often is invoked to protect late seral habitat elements.)

The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. The time interval between harvests may also affect the distribution and abundance of habitat structures used by fishers. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity [88]. (I don't think rotation age has much to do with den or rest site structure for fishers within any commercial timberlands. Except possibly for some hardwood species, it simply takes too long for these structures to develop. It's all about provisions to protect and provide for long term recruitment of this structure. Furthermore, fire is an important factor in producing fisher habitat, which has been largely eliminated as a management tool on most timberlands.) Frequent harvest entries to salvage dead, dying, and diseased trees likely reduce the availability of these habitat elements. Retention of forest cover and large trees is a requirement of the FPRs along streams (i.e., WLPZs), with the width of these areas determined by stream class, slope, and the presence of anadromous salmonids.

The FPRs do not specifically require the retention or recruitment of hardwoods and, in some cases, their harvest may be required to meet stocking standards. Hardwoods may also be intentionally killed ("hack-and-squirt" herbicide application or felled) individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of habitats used by the species. Various hardwood species provide potential den and rest trees and habitat used by fisher prey. Although the FPRs do not require retention of hardwoods, the Department is not aware of data indicating that their removal on commercial timberlands has substantially affected the distribution or abundance of fishers in California. (Once again, CEQA is the "hook" to provide for retention of hardwoods.)

Depending on their location, WLPZs may comprise up to 15-25 percent of private ownerships managed for timber production. Drier regions of the state with lower stream densities have a much lower proportion of the landscape designated as WLPZs. Where they are managed to retain or recruit trees suitable for denning and resting, WLPZs may provide a network of older forest structure within managed forest landscapes beneficial to fishers and provide denning, resting, and foraging habitat for fishers. Outside of WLPZs, trees suitable for denning or resting by fishers are not required to be retained; however they may be intentionally left by landowners (or required under CEQA to avoid significant adverse impacts) to meet post-harvest stocking requirements.

The effects of future timber harvest activities on habitats used by fishers cannot be accurately predicted as changes in regulations, policies, and market conditions influence management intensity. Independent of the FPRs and CEQA, trees of value to fishers may remain on landscapes through timber rotations because they are unmerchantable, are located in areas where access is infeasible, or because of company policies. Some private companies have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Fire: In recent decades the frequency, severity, and extent of fires has increased in California. This has varied statewide, with the greatest increases in fires severe enough to eliminate forest stands occurring in the Sierra Nevada, southern Cascades, and Klamath Mountains. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. However, the contemporary extent of wildfires burning annually in California is considerably less than the estimated 1.8 million ha (4.5 million ac) that burned annually in the state prehistorically (pre 1800) [174].

The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due its small size, the comparatively linear distribution of the habitat available, and predicted future climate changes. Timber harvest activities in portions of the southern Sierra Nevada occupied by fisher are largely under federal management. These National Forests in the SSN ESU have adopted specific guidelines to protect habitats used by fishers.

Within the NC Fisher ESU, fishers are comparatively widespread across a matrix of public and private forest lands. With the exceptions of Lake, Sonoma, and Marin counties, fishers currently occur throughout much of the historical range assumed by Grinnell et al. [3].

Overexploitation

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable ([123]. The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917-1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers [3] and were also likely harvested by trappers seeking other furbearers [123].

Since the mid-1800s, the distribution of fisher in North America contracted substantially, in part, due to over-trapping and mortality from predator control programs [26]. Over-trapping of fisher has been considered a significant cause of its decline in California [3]. By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season [3]. Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fisher a prize catch.

Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period from 1920-1924 was only 46 animals [3]. Fishers were considered to be rare in California by the early 1920s [124]. Grinnell et al. [3] considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of fisher in California [3]. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue.

The high value trappers obtained for the pelts of fisher in the early 1900s, the species' vulnerability to trapping [8], and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations [26]. Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [124]. However, despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fisher was not prohibited until 1946 [125]. Although commercial trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (see Lewis et al. [123]).

Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers [8], or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations [8] and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (Fish & G. Code, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designee are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 23), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to

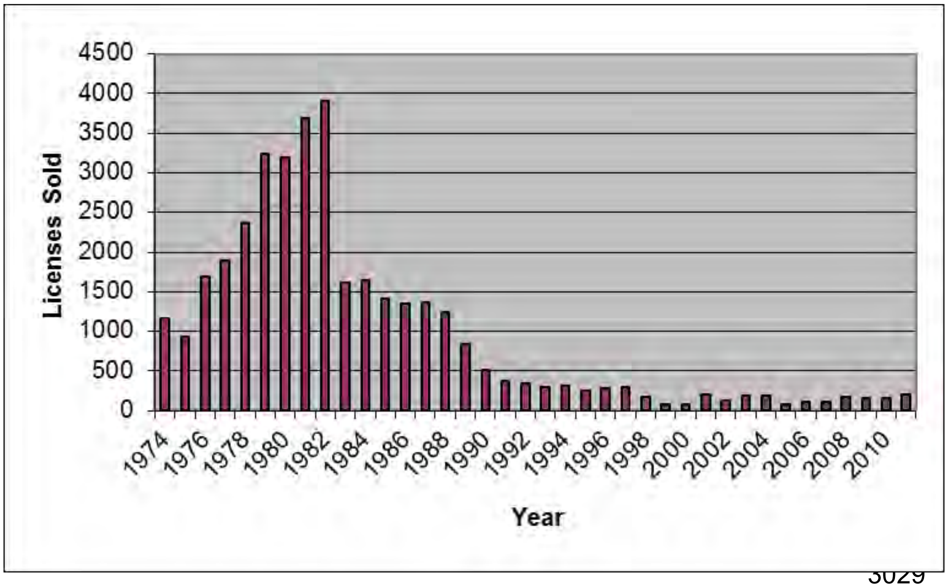


Figure 23. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

increase [257]. From the early 1980s through the present, license sales have continued to decrease with average sales from 2000-2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. However, throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators typically work in close proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by certain species of wildlife. However, fishers are not permitted to be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).

Currently and in the foreseeable future, the likelihood of fishers being overexploited in California is low, based on the prohibition against commercial or recreational take of fishers, low level of commercial and recreational trapping and prohibition of body-gripping traps. The Department is not aware of any data indicating that the potential risk to fisher populations from incidental take due to trapping differs significantly for populations in NC or SSN Fisher ESUs.

Predation

Recent research indicates predation is a substantial cause of mortality for fishers in California [144]. This research, using DNA amplified from fisher carcasses, identified bobcat, mountain lion, and coyote as predators of fishers, with predation attributed to bobcat being the most frequent (50%).

The risk of predation is likely heightened when fishers occupy habitats in close proximity to open and brushy habitats (G. Wengert, pers. comm.), both habitats used extensively by bobcats. Female fishers are more likely to be predated by bobcats and this occurs most frequently during the breeding season when young fishers are dependent on their mothers for survival. Fragmentation of forested landscapes may increase the abundance of some small mammal species used by fishers as prey, but it may also favor potential predators adapted to early successional habitats. However, fishers have co-evolved with the suite of predators naturally occurring within their range and adverse population level effects on fishers due to predation have not been documented.

Currently, there is no information indicating differential risk of predation to fisher in the NC or SSN Fisher ESUs. Based on a sample of 50 fisher carcasses from these regions, no difference in the relative frequencies of predation by bobcat or mountain lion was found. Fishers in the SSN Fisher ESU are likely at greater risk of population level effects of predation due to the small size of their population compared to northern California. However, fishers in the southern Sierra Nevada have apparently been isolated in that region for decades or longer and, at times, their numbers may have been smaller than they are today. The abundance of potential predators of fishers during those periods is unknown, but they likely co-occurred with fisher populations in the region.

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood [24]. Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines [24,25,106]. Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Also, the relative similarities in body size, body shape, and prey between fisher and martens suggest the potential for competition between these species [24]. However, in California, martens typically occur at higher elevations than fisher and thus may have evolved strategies to minimize competition by separation and by exploiting somewhat different habitats. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have evolved with other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California. There is no evidence that fisher populations in either NC or SSN Fisher ESUs are adversely affected by competition with other species. However, landscape level habitat changes that favor population increases in competitors may intensify interspecific competition.

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years [152,158,161,258]. Fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or spill over from other species of carnivores.

Canine distemper virus (CDV) is common in gray fox and raccoon populations in California and both species occur in habitats occupied by fishers. Although studies have shown that fisher may survive CDV infections, outbreaks of highly virulent biotypes have been responsible for the near extirpation of other carnivore species including other mustelids. Deaths caused by other pathogens potentially significant for *Martes* (i.e., rabies, canine parvo virus), have not been documented for fisher in California. Although

canine parvo virus has been documented to cause clinical disease in fishers, testing to date indicates that the disease is circulating in California fishers without causing population level impacts.

Exposure of fishers to *Toxoplasma gondii* in both northern California and the southern Sierra Nevada has been documented. Although this parasite has caused mortality in other mustelids, it has not been documented as a source of mortality in fisher. This is also the case for known vector borne pathogens. Fisher harbor numerous ecto- and endoparasites and, although some can serve as vectors for other diseases, they are usually associated with minimal morbidity and mortality.

There is no evidence indicating that the prevalence of pathogens potentially affecting fishers in the state differs significantly between populations within the NC and SSN Fisher ESUs. The fisher population in the southern Sierra Nevada is likely at a higher risk of diseases that cause significant morbidity or mortality due to the population's isolation and comparatively small size. Although there is no evidence that CDV has caused substantial population declines in fisher, it is a pathogen of conservation concern for fisher and health surveillance of populations is prudent to detect and intervene to the extent possible, if needed.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution of fisher in California appears to have changed substantially before and after European Settlement. Although its precise distribution prior to the 1800s is unknown, based on recent genetic evidence, the fisher population in the state declined dramatically and contracted into two separate populations long before that time. Further reductions in range and abundance were likely post-European Settlement due to over trapping, predator control programs, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. Since trapping of fishers was prohibited in 1946 and the use of body-gripping traps was banned in 1998, the number of fishers in California has increased to levels likely higher than existed during the period of unregulated trapping in the mid-1800s to early 1900s.

The fisher population within the SSN Fisher ESU is likely at greater risk of extirpation due to its small size (recently estimated at <250 individuals [134]), limited geographic range, and isolation compared to fishers in northern California. Small, isolated

populations are subject to an increased risk of extinction from stochastic (random) environmental or demographic events. Small populations are also at greater risk of adverse impacts resulting from the loss of genetic diversity, including inbreeding depression. The probability of this occurring in fisher occupying either the NC Fisher ESU or the SSN Fisher ESU is unknown. Events such as drought, high intensity fires, and disease, should they occur, have a higher probability of adversely affecting the fisher population in the southern Sierra Nevada. Currently, fishers nearest to the southern Sierra Nevada population are those translocated to the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). Fishers within the SSN Fisher ESU are likely to remain isolated in the foreseeable future due to that distance and potential barriers to movement.

Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population [40]. Fishers within the NC Fisher ESU are also largely isolated from other populations of fishers, although their population is contiguous with a small population in southern Oregon. Despite its isolation, the fisher population in northern California is comparatively large, distributed over a large geographic area, and its distribution has apparently not contracted, and may have slightly expanded, in recent decades. Over the last 8 years, occupancy rates of fishers in the southern Sierra have been stable [134]. Although long-term monitoring of population abundance and trends is lacking for fishers within the NC Fisher ESU, surveys from this region and recent estimates of relatively high rates of occupancy indicate that the population has not declined substantially in recent decades.

Toxicants

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and potentially to other toxicants. ARs have caused the deaths of some fishers, and within the SSN Fisher ESU there is a correlation between the presence of MJCSs within a fisher’s home range and reduced survival. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data have been collected to quantify usage. In addition, use practices are largely unknown. Food containers that appear to have been spiked with pesticides and piles of bait have been found on MJCSs indicating intended poisoning of wildlife. However, containers are often found onsite without signs of where the material was

applied. In addition, it is important that MJCSs be searched for fisher and other wildlife carcasses, that these be quantified, and that the appropriate body tissues be analyzed for residues of contaminants.

There is incomplete understanding of effects of contaminants on fishers. Also unknown is the effect of multiple exposures of the same contaminant, similar contaminants, and contaminants with different modes of action. It is also unknown if there are potentially additive effects of contaminants with other stressors on individual fishers. ARs may also have indirect effects by predisposing fishers to other sources of mortality such as predation or accidents. AR toxicants were found at MJCSs in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented.

Although limited population level monitoring of fishers has occurred, the species' distribution in California does not appear to have changed appreciably in decades. If toxicant use has been widespread, long-term, and caused substantial mortality, it is likely that new gaps in the range of fishers or declines in capture rates would have been observed due to the extensive efforts conducted since the early 1990s to detect and study the species. However, evidence of exposure in fishers and the documented deaths of a number of animals indicate this is a potentially significant threat that should be closely monitored and evaluated. Exposure to toxicants at MJCSs has been documented in both the NC and SSN Fisher ESU, but there is insufficient information to determine the relative risk to either population. However, the potential risk to fishers within the SSN Fisher ESU may be greater due to its comparatively small population size.

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant communities. The effect of warming

temperatures on mountain ecosystems will most likely be complex and predicting how ecosystems will be affected in particular areas is difficult. Some bioclimatic modeling (Lawler et al. [183]) broadly predicts that the climate in much of California may be unsuitable for fishers by 2100. Several papers that have modeled vegetation change suggest that within those portions of California currently occupied by fishers, conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation) [183,225,235]. These predictions notwithstanding, they are based on long-term models that utilize broad climate and vegetation parameters that largely do not reflect the fine-scale variation (in both climate and vegetation diversity) typically found in the topographically and ecologically diverse montane habitats of California.

Fishers within the SSN Fisher ESU are likely more vulnerable to the potentially adverse effects of warming climate than fishers in northern California. The comparatively small size of the population in the southern Sierra, its linear distribution, and potential barriers to dispersal (the 2013 Rim Fire area, river canyons, etc.) increase the likelihood that it will become fragmented and decline in size during this century. The fisher population within the NC Fisher ESU is comparatively large and well distributed geographically, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain.

While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state, and its severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century. As the 21st century progresses and population data continue to be compiled, scientists will become better informed as to effects of a warming environment on California's fisher population. Continued monitoring of fisher distribution and survival over the ensuing decades will provide information about the immediacy of this threat.

Listing Recommendation

"Endangered species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (FGC §2062). "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter" (FGC §2067).

The Department recommends that designation of the fisher in California as threatened/endangered is _______.

Protection Afforded by Listing

CESA defines "take" to mean "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill." (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful absent take authorization from the Department (FGC §§ 2080 et seq. and 2835). Take can be authorized by the Department pursuant to FGC §§ 2081.1, 2081, 2086, 2087 and 2835 (NCCP).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and

ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fisher would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fisher because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Economic Considerations

The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).

Literature Cited

1. Douglas CW, Strickland MA (1999) Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

2. Powell RA (1993) The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

3. Grinnell J, Dixon JS, Linsdale JM, University of California B, Museum of Vertebrate Zoology (1937) Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. Berkeley, Calif.: University of California press.

4. Buskirk SW, Ruggiero LF (1994) American Marten. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 186.

5. Lewis JC, Stinson DW (1998) Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

6. Coulter M. (1966) The ecology and management of fishers in Maine Syracuse, New York, USA: University, Syracuse.

7. Pittaway RJ (1978) Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Nat Can 105: 487–489.

8. Douglas CW, Strickland MA (1987) Fisher. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. Ontario, Canada: Ontario Ministry of Natural Resources.

9. Erxleben JCP (1777) Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

10. Goldman FA (1935) New American mustelids of the genera Martes, Gulo, and Lutra. Proc Biol Soc Wash 48: 175–186.

11. Rhoads SN (1898) Contributions to a revision of the North American beavers, otters and fishers. Trans Am Philos Soc 19: 417–439.

12. Hagmeier EM (1959) A reevaluation of the subspecies of fisher. Can Field Nat 73: 185–197.

13. Hosoda T, Suzuki H, Harada M, Tsuchiya K, Han S-H, et al. (2000) Evolutionary trends of the mitochondrial lineage differentiation in species of genera Martes and Mustela. Genes Genet Syst 75: 259–267.

14. Stone KD, Cook JA (2002) Molecular evolution of Holarctic martens (genus Martes, Mammalia: Carnivora: Mustelidae). Mol Phylogenet Evol 24: 169–179.

15. Koepfli K-P, Deere K, Slater G, Begg C, Begg K, et al. (2008) Multigene phylogeny of the Mustelidae: resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biol 6: 10.

16. Sato JJ, Wolsan M, Minami S, Hosoda T, Sinaga MH, et al. (2009) Deciphering and dating the red panda’s ancestry and early adaptive radiation of Musteloidea. Mol Phylogenet Evol 53: 907–922.

17. Wolsan M, Sato JJ (2010) Effects of data incompleteness on the relative performance of parsimony and Bayesian approaches in a supermatrix phylogenetic reconstruction of Mustelidae and Procyonidae (Carnivora). Cladistics 26: 168–194.

18. Nyakatura K, Bininda-Emonds OR (2012) Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. BMC Biol 10: 12.

19. Sato JJ, Wolsan M, Prevosti FJ, D’Elía G, Begg C, et al. (2012) Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Mol Phylogenet Evol 63: 745–757.

20. Baldy R, Beck R, Carpenter C, Carpenter W, Golla V, et al. (1996) Hupa language dictionary. Second. Hoopa, CA: Hoopa Valley Tribal Council. 131 p.

21. Samuels JX, Cavin J (2013) The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. J Vertebr Paleontol 33: 448–454. doi:10.1080/02724634.2013.722155.

22. Eshelman R, Grady F (1984) Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. In: McDonald JN, Bird SO, editors. The Quaternary of Virginia - A symposium volume. Charlottsville, Virginia: VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Vol. 75. pp. 43–70.

23. Graham RW, Graham MA (1994) The late Quaternary distribution of Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

24. Lofroth EC, Raley CM, Finley LL, Naney RH (2010) Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

25. Powell RA, Zielinski WJ (1994) Fisher. General Technical Report. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Available: http://treesearch.fs.fed.us/pubs/27328. Accessed 11 October 2013.

26. Lewis JC, Powell RA, Zielinski WJ (2012) Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7: n/a. doi:http://dx.doi.org/10.1371/journal.pone.0032726.

27. Gibilisco CJ (1994) Distributional dynamics of modern Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables,

and fishers: biology and conservation. , Ithaca, New York, USA: Cornell University Press.

28. Tucker JM, Schwartz MK, Truex RL, Pilgrim KL, Allendorf FW (2012) Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS One 7.

29. Knaus BJ, Cronn R, Liston A, Pilgrim K, Schwartz MK (2011) Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC Ecol 11: 10.

30. Grinnell, J, Dixon J, Linsdale M (1930) Vertebrate natural history of a section of northern California through the Lassen Peak region. University of California Publications in Zoology. 594 p.

31. Price WW (1894) Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE Biol J 4: 315–332.

32. Aubry KB, Jagger LA (2006) The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. In: Santos-Reis M, Birks JDS, O'Doherty EC, Proulx G, editors. Martes in Carnivore Communities. Alberta, Canada: Alpha Wildl. Publ.

33. McKelvey KS, Aubry KB, Schwartz MK (2008) Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58: 549–555.

34. Aubry KB, Lewis JC (2003) Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biol Conserv 114: 79–90. doi:http://dx.doi.org/10.1016/S0006-3207(03)00003-X.

35. Zielinski WJ, Truex RL, Schlexer FV, Campbell LA, Carroll C (2005) Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. J Biogeogr 32: 1385–1407.

36. Zielinski WJ, Kucera TE, Barrett RH (1995) Current distribution of the fisher, Martes pennanti, in California. Calif Fish Game 81: 104–112.

37. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

38. Drew RE, Hallett JG, Aubry KB, Cullings KW, Koepf SM, et al. (2003) Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Mol Ecol 12: 51–62.

39. Talking Glossary: "Haplotype" (n.d.). Available: http://www.genome.gov/glossary/index.cfm?id=99. Accessed 4 September 2014.

40. Tucker JM (2013) Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada The University of Montana.

41. Wright PL, Coulter MW (1967) Reproduction and growth in Maine fishers. J Wildl Manag: 70–87.

42. Leonard RD (1986) Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Can Field-Nat Ott ON 100: 32–44.

43. Eadie WR, Hamilton WJ (1958) Reproduction in the fisher in New York. N Y Fish Game J 5: 77–83.

44. Frost HC, Krohn WB (1997) Factors affecting the reproductive success of captive female fishers. In: Proulx G, Bryant HN, Woodward PM, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB. pp. 100–109.

45. Paragi TF, Arthur SM, Krohn WB (1994) Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Can Field-Nat Ott ON 108: 52–57.

46. Arthur SM, Krohn WB (1991) Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J Mammal: 72–2.

47. Mead RA (1994) Reproduction in Martes. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 404–422.

48. Frost HC, Krohn WB, Wallace CR (1997) Age-specific reproductive characteristics in fishers. J Mammal 78: 598–612.

49. Aubry KB, Raley CM (2006) Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report. Olympia, WA: USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory.

50. Higley JM, Matthews S (2006) Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report. Hoopa Valley Tribe and Wildlife Conservation Society.

51. Self S, Callas R (2006) Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pac Ind Calif Dep Fish Game.

52. Weir RD, Corbould FB (2008) Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Prince George, British Columbia, Canada: Peace/Williston Fish & Wildlife Compensation Program.

53. Truex RL, Zielinski WJ, Golightly RT, Barrett RH, Wisely SM (1998) A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft Rep Submitt Calif Dep Fish Game U S For Serv Pac Southwest Res Stn Arcata Calif.

54. Hall ER (1942) Gestation period in the fisher with recommendations for the animal$\backslash$’s protection in California. Calif Fish Game 28: 143–147.

55. Paragi TF, Krohn WB, Arthur SM (1994) Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildl 51: 1–11.

56. York EC (1996) Fisher population dynamics in north-central Massachusetts University of Massachusetts at Amherst.

57. Matthews SM, Higley JM, Rennie KM, Green RE, Goddard CA, et al. (2013) Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. J Mammal 94: 100–108.

58. Bachelot A, Binart N (2005) Corpus luteum development: lessons from genetic models in mice. Curr Top Dev Biol 68: 49–84. doi:10.1016/S0070-2153(05)68003-9.

59. Kelly GM (1977) Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas University of Massachusetts. Available: http://agris.fao.org/agris-search/search/display.do?f=2013/US/US2013054260005426.xml;US201300542658. Accessed 11 October 2013.

60. Crowley SK, Krohn WB, Paragi TF (n.d.) A comparison of fisher reproductive estimates. Trans Northeast Sect Wildl Soc 47: 36–42.

61. Weir RD (2003) Status of the fisher in British Columbia. BC Minist Sustain Resour Manage Conserv Data Cent BC Minist Water Land Air Prot Biodivers Branch Vic BC Wildl Bull No B-105 38pp: 3.

62. Arthur SM, Paragi TF, Krohn WB (1993) Dispersal of juvenile fishers in Maine. J Wildl Manag 57: 868.

63. Higley JM, Matthews S (2009) Fisher habitat use and population monitoring on the Hoopa Valley Reservation, California Final Report USFWS TWG U-12-NA-1. Hoopa Val Tribe Hoopa Calif USA.

64. King CM, Powell RA, Powell C (2007) The natural history of weasels and stoats: ecology, behavior, and management. Oxford University Press New York.

65. Paragi TF (1990) Reproductive biology of female fishers in southcentral Maine University of Maine at Orono. Available: http://www.library.umaine.edu/theses/theses.asp?Cmd=abstract&ID=MARC1647. Accessed 11 October 2013.

66. Reno MA, Rulon K, James C (2008) Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

67. Aging Experience, Accuracy and Precision (n.d.). Available: http://www.matsonslab.com/aging-experience-accuracy-and-precision.html. Accessed 6 September 2014.

68. Brown RN, Gabriel MW, Wengert G, Matthews S, Higley JM, et al. (2006) Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Trans West Sect Wildl Soc 42: 40–46.

69. Sandra Martin (1994) Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael RA, Powell RA, editors. Martens, sables and

fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 297–315.

70. Zielinski WJ, Duncan NP (2004) Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. J Mammal 85: 470–477.

71. Golightly RT, Penland TF, Zielinski WJ, Higley JM (2006) Fisher diet in the Klamath/north coast bioregion. Final Rep US Fish Wildl Serv Scotia Pac Humboldt State Spons Programs Found Arcata Calif.

72. Zielinski WJ, Duncan NP, Farmer EC, Truex RL, Clevenger, et al. (1999) Diet of fishers (Martes pennanti) at the southernmost extent of their range. J Mammal 80: 961–971.

73. Grenfell WE, Fasenfest M (1979) Winter food habits of fisher (Martes pennanti) in northwestern California. Calif Fish Game 65: 186–189.

74. Bioregions of California (n.d.). Available: http://biodiversity.ca.gov/bioregions.html. Accessed 5 September 2014.

75. Powell RA, Brander RB (1977) Adaptations of fishers and porcupines to their predator prey system. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula. pp. 45–53.

76. Powell SM, York EC, Fuller TK (1997) Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta, Edmonton. pp. 279–305.

77. Weir RD, Harestad AS, Wright RC (2005) Winter Diet Of Fishers In British Columbia. Northwest Nat 86: 12–19. doi:http://dx.doi.org/10.1898/1051-1733(2005)086[0012:WDOFIB]2.0.CO;2.

78. Kuehn DW (1989) Winter foods of fishers during a snowshoe hare decline. J Wildl Manag: 688–692.

79. Burt WH (1943) Territoriality and home range concepts as applied to mammals. J Mammal 24: 346–352.

80. Buck S, Mullis C, Mossman AS (1983) Corral Bottom-Hayfork Bally Fisher Study: final report. Arcata, CA: Humboldt State University and USDA Forest Service.

81. Johnson SA (1984) Home range, movements, and habitat use of fishers in Wisconsin University of Wisconsin–Stevens Point.

82. Arthur SM, Krohn WB, Gilbert JR (1989) Home range characteristics of adult fishers. J Wildl Manag 53: 674–679.

83. Jones JL (1991) Habitat use of fisher in northcentral Idaho University of Idaho.

84. Garant Y, Crete M (1997) Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Can Field-Nat Ott ON 111: 359–364.

85. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Home Range Characteristics Of Fishers in California. J Mammal 85: 649–657.

86. Yaeger JS (2005) Habitat at fisher resting sites in the Klamath Province of northern California [Master's Thesis]. Arcata, CA: Humboldt State University. Available: http://www.fws.gov/yreka/fisher/Literature/Yaeger%202005.pdf. Accessed 11 October 2013.

87. Koen EL, Bowman J, Findlay CS, Zheng L (2007) Home Range and Population Density of Fishers in Eastern Ontario. J Wildl Manag 71: 1484–1493. doi:http://dx.doi.org/10.2193/2006-133.

88. Raley CM, Lofroth EC, Truex RL, Yaeger JS, Higley JM (2012) Habitat ecology of fishers in western North America. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press.

89. Mabry KE, Shelley EL, Davis KE, Blumstein DT, Vuren DHv (2013) Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

90. Strickland MA (1994) Harvest management of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 149–164.

91. Aubry K, Wisely S, Raley C, Buskirk S (2004) Zoogeography, Spacing Patterns, and Dispersal in Fishers. In: Harrison DJ, Fuller AK, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. New York, NY: Springer. pp. 201–220.

92. Greenwood PJ (1980) Mating systems, philopatry and dispersal in birds and mammals. Anim Behav 28: 1140–1162.

93. Stephen Dobson F (1982) Competition for mates and predominant juvenile male dispersal in mammals. Anim Behav 30: 1183–1192.

94. De Vos A (1951) Overflow and dispersal of marten and fisher from wildlife refuges. J Wildl Manag 15: 164–175.

95. Hamilton WJ, Cook AH, Hamilton WF (1955) The biology and management of the fisher in New York. N Y Fish Game J 2: 13–35.

96. Powell RA (1979) Ecological energetics and foraging strategies of the fisher (Martes pennanti). J Anim Ecol: 195–212.

97. Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

98. Buskirk SW, Powell RA (1994) Habitat Ecology of Fishers and American Martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 283–296. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

99. The Public Land Survey System (PLSS) (n.d.). Available: http://nationalatlas.gov/articles/boundaries/a_plss.html. Accessed 4 September 2014.

100. Krohn WB, Arthur SM, Paragi TF (1994) Mortality and vulnerability of a heavily trapped fisher population. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

101. Klug Jr RR (1997) Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections Humboldt State University.

102. Carroll C, Zielinski WJ, Noss RF (1999) Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conserv Biol 13: 1344–1359.

103. Davis FW, Seo C, Zielinski WJ (2007) Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecol Appl 17: 2195–2213.

104. Slauson KM, Zielinski WJ, Holm GW (2003) Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final Rep USDA For Serv Pac Southwest Res Stn Arcata Calif USA.

105. Weir RD, Harestad AS (2003) Scale-dependent habitat selectivity by fishers in south-central British Columbia. J Wildl Manag 67: 73–82.

106. Campbell LA (2004) Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada University of California. Available: http://www.fs.fed.us/psw/programs/snrc/staff/campbell/campbell_dissertation.pdf. Accessed 11 October 2013.

107. Aubry KB, Raley CM, Buskirk SW, Zielinski WJ, Schwartz MK, et al. (2013) Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. J Wildl Manag 77: 965–974.

108. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Resting habitat selection by fishers in California. J Wildl Manag 68: 475–492.

109. Purcell KL, Mazzoni AK, Mori SR, Boroski BB (2009) Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. For Ecol Manag 258: 2696–2706.

110. Davis LR (2009) Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau Dept. of Biological Sciences-Simon Fraser University. Available: http://summit.sfu.ca/item/9870. Accessed 10 October 2013.

111. Bull EL, Parks CG, Torgersen TR (1997) Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

112. Manion PD (n.d.) Tree disease concepts. Second. New Jersey, USA: Prentice Hall Career and Technology.

113. Zielinski WJ, Dunk JR, Yaeger JS, LaPlante DW (2010) Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. For Ecol Manag 260: 1579–1591.

114. California Wildlife Habitat Relationships System (2008). Sacramento, California: California Department of Fish and Wildlife: California Interagency Wildlife Task Group.

115. Weir RD, Corbould FB (2010) Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. J Wildl Manag 74: 405–410.

116. Buck SG, Mullis C, Mossman AS, Coolahan C (1994) Habitat use by fishers in adjoining heavily and lightly harvested forest. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 368–376.

117. Jones JL, Garton EO (1994) Selection of successional stages by fishers in north-central Idaho. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 377–387.

118. De Vos A (1952) The ecology and management of fisher and marten in Ontario. Available: http://www.citeulike.org/group/15497/article/9675279. Accessed 21 August 2014.

119. Spencer W, Rustigian-Romsos H, Strittholt J, Scheller R, Zielinski W, et al. (2011) Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biol Conserv 144: 788–803.

120. Hagmeier EM (1956) Distribution of marten and fisher in North America. Can Field Nat 70: 149–168.

121. Banci V (1989) A fisher management strategy for British Columbia. Victoria, British Columbia, Canada: Ministry of Environment.

122. Powell RA (1994) Structure and spacing of Martes populations. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA. pp. 101–121.

123. Lewis JC, Zielinski WJ (1996) Historical harvest and incidental capture of fishers in California. Northwest Sci 70: 291–297.

124. Dixon JS (1925) A closed season needed for fisher, marten, and wolverine. Calif Fish Game 11: 23–25.

125. Gould GI Jr (1987) Forest Mammal Survey and Inventory. Calif. Dept. of Fish and Game.

126. Powell RA, Facka AN, Clifford DL, Beach C, Smith K (2013) Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

127. Lamberson RH, Truex RL, Zielinski WJ, Macfarlane D (2000) Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata CA Humboldt State Univ.

128. Spencer WD, Rustigian H, Strittholt JR, Scheller R, Syphard A (2008) Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

129. Jordan MJ (2007) Fisher ecology in the Sierra National Forest, California Berkeley, Calif.: University of California, Berkeley. Available: http://www.carnivoreconservation.org/files/thesis/jordan_2007_phd.pdf. Accessed 11 October 2013.

130. Matthews SM, Mark Higley J, Scott Yaeger J, Fuller TK (2011) Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildl Soc Bull 35: 69–75.

131. Diller L, Hamm K, Lamphear D, Thompson J (2008) Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Korbel, CA: Green Diamond Resource Company.

132. Swiers RC (2013) Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. [Raleigh, North Carolina]: North Carolina State University,.

133. Noon BR, Bailey LL, Sisk TD, McKelvey KS (2012) Efficient Species-Level Monitoring at the Landscape Scale. Conserv Biol 26: 432–441.

134. Zielinski WJ, Baldwin JA, Truex RL, Tucker JM, Flebbe PA (2013) Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. J Fish Wildl Manag 4: 3–19.

135. Bechtold WA, Patterson PL (2005) The enhanced forest inventory and analysis program: national sampling design and estimation procedures. General Technical Report. Asheville, North Carolina: US Department of Agriculture Forest Service, Southern Research Station.

136. Waples R (1991) Definition of a “species” under teh Endangered Species Act: Application to Pacific salmon. Technical menorandum. NOAA.

137. Franklin JF, Spies TA, Pelt RV, Carey AB, Thornburgh DA, et al. (2002) Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. For Ecol Manag 155: 399–423.

138. Thompson ID, Baker JA, Ter-Mikaelian M (2003) A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. For Ecol Manag 177: 441–469.

139. USDA Forest Service (2014) Forest Management: Cut and sold reports. Available: http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml. Accessed 22 August 2014.

140. California Timber Harvest Statistics - harvyr2.pdf (n.d.). Available: http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf. Accessed 6 September 2014.

141. Barnosky AD, Koch PL, Feranec RS, Wing SL, Shabel AB (2004) Assessing the causes of Late Pleistocene extinctions on the continents. Science 306: 70–75.

142. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

143. Farber S, Callas RL, Yaeger JS, Schwartz MK, Pilgrim K, et al. (2010) Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report. Yreka Fish and Wildlife Office, Yreka, California: USDI Fish and Wildlife Service.

144. Wengert GW, Gabriel MW, Matthews SM, Higley JM, Sweitzer R, et al. (2013) Intraguild Predation on Fishers in California: Patterns of Predation by Three Larger Carnivores. Rev J Wildl Manag.

145. Buck SG (1982) Habitat utilization by fisher (Martes pennanti) near Big Bar, California [Master's Thesis]. Arcata, CA: Humboldt State University.

146. Wengert GM (2013) Ecology of intraguild predation on fishers (Martes pennanti) in California UNIVERSITY OF CALIFORNIA, DAVIS. Available: http://gradworks.umi.com/36/14/3614292.html. Accessed 4 September 2014.

147. Williams ES (2001) Canine distemper. In: Williams ES, Barker RICK, editors. Infectious diseases of wild mammals. Ames, Iowa: Iowa State University Press. p. 50.

148. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

149. Williams ES, Thorne ET, Appel MJ, Belitsky DW (1988) Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. J Wildl Dis 24: 385–398.

150. Timm SF, Munson L, Summers BA, Terio KA, Dubovi EJ, et al. (2009) A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). J Wildl Dis 45: 333–343.

151. Origgi FC, Plattet P, Sattler U, Robert N, Casaubon J, et al. (2012) Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Vet Pathol Online 49: 913–929.

152. Gabriel MW, Wengert GM, Matthews SM, Higley JM, Foley JE, et al. (2010) Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). J Wildl Dis 46: 966–970.

153. Gabriel MW, Wengert GW, Brown RN (2012) Pathogens and parasites of Martes species: Management and conservation implications. In: Aubry KB, Zielinski WJ,

Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press. pp. 138–185.

154. Burns R, O'Toole ESWD, 2003 JPD (n.d.) Toxoplasma gondii infections in captive black-footed ferrets (Mustela nigripes), 1992–1998: clinical signs, serology, pathology, and prevention. J Wildl Dis 39: 787–797.

155. Pridham TJ, Belcher J (1958) Toxoplasmosis in mink. Can J Comp Med Vet Sci 22: 99–106.

156. Cole RA, Lindsay DS, Howe DK, Roderick CL, Dubey JP, et al. (2000) Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). J Parasitol 86: 526–530.

157. Larkin JL, Gabriel M, Gerhold RW, Yabsley MJ, Wester JC, et al. (2011) Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. J Parasitol 97: 425–429. doi:http://dx.doi.org/10.1645/GE-2623.1.

158. Brown RN, Gabriel MW, Wengert GW, Matthews S, Higley JM, et al. (2008) Pathogens associated with fishers. Final Report USFWS-813335G021. Yreka, CA.

159. Williams ES, Mills K, Kwiatkowski DR, Thorne ET, Boerger-Fields A (1994) Plague in a black-footed ferret (Mustela nigripes). J Wildl Dis 30: 581–585.

160. Weinmann R, Raskas HJ, Roeder RG (1974) Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proc Natl Acad Sci 71: 3426–3430.

161. Clifford DL, Woods L, Gabriel MW, Tkach V, Hoberg E, et al. (2012) Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

162. CDOF (2011) E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. Sacramento, California: State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-6/2000-10/.

163. CDOF (1991) E-6 County Population Estimates and Components of Change— July 1, 1970–1990. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/view.php#objCollapsiblePanelEstimatesAnchor.

164. CDOF (2013) E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php.

165. CDOF (2013) Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

166. Bunn D, Mummert A, Hoshovsky M, Gilardi K, Shanks S (2007) California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

167. FRAP (2003) The changing California: Forest and range 2003 assessment. CalFire. Available: http://frap.fire.ca.gov/data/assessment2003/index.html.

168. Duane TP (1996) Human Settlement 1850-2040. In: Center WR, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. Davis, CA, USA.: University of California.

169. Theobald D (2005) Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecol Soc 10.

170. Garroway CJ, Bowman J, Wilson PJ (2011) Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Mol Ecol 20: 3978–3988.

171. Safford HD (2006) Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report. Vallejo, California: USDA Forest Service, Pacific Southwest Region.

172. Stephens SL, Sugihara NG (2006) Fire management and policy since European settlement. Fire in California's Ecosystems. Berkeley, California: University of California Press. pp. 431–443.

173. Show SB, Kotok EI (1923) Forest fires in California, 1911-1920: an analytical study. Washington D.C., USA: US Department of Agriculture. Available: http://scholarsarchive.library.oregonstate.edu/jspui/handle/1957/11024. Accessed 11 October 2013.

174. Stephens SL, Martin RE, Clinton NE (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. For Ecol Manag 251: 205–216. doi:http://dx.doi.org/10.1016/j.foreco.2007.06.005.

175. Taylor AH, Skinner CN (1998) Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. For Ecol Manag 111: 285–301.

176. Anderson MK (2006) The use of fire by Native Americans in California. In: Sugihara NG, Van Wagtendonk JW, Shaffer KE, Fites-Kaufman J, Thode AE, editors. Fire in California's Ecosystems. University of California Press. p. 596.

177. Martin RE, Sapsis DB (1992) Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

178. Miller JD, Safford HD, Crimmins M, Thode AE (2009) Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12: 16–32.

179. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW (2006) Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

180. Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecol Appl 22: 184–203.

181. Zhang J, Webster J, Powers RF, Mills J (2008) Reforestation after the Fountain Fire in Northern California: An Untold Success Story. J For 106: 425–430.

182. LANDFIRE-Fire Regime Product Descriptions (n.d.). Available: http://www.landfire.gov/NationalProductDescriptions13.php. Accessed 4 September 2014.

183. Lawler JJ, Safford HD, Girvetz EH (2012) Martens and fishers in a changing climate. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press. pp. 371–397.

184. Fried JS, Torn, Mills E (2004) The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Clim Change 64: 169–191. doi:http://dx.doi.org/10.1023/B:CLIM.0000024667.89579.ed.

185. Westerling AL, Bryant BP, Preisler HK, Holmes TP, Hidalgo HG, et al. (2011) Climate change and growth scenarios for California wildfire. Clim Change 109: 445–463.

186. Mckenzie D, Gedalof Z, Peterson DL, Mote P (2004) Climatic Change, Wildfire, and Conservation. Conserv Biol 18: 890–902.

187. Krawchuk MA, Moritz MA (2012) Fire and Climate Change in California. Calif Energy Comm Publ Number CEC-500-2012-026.

188. Gabriel MW, Wengert GW, Higley JM, Krogan S (2013) Silent forests? Rodenticides on illegal marijuana crops harm wildlife. Wildl Prof Spring.

189. Gabriel MW, Woods LW, Poppenga R, Sweitzer RA, Thompson C, et al. (2012) Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

190. Alterio N (1996) Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. N Z J Zool 23: 331–338.

191. Moriarty JG, Riley PD, Sureiys LE, Sikich JA (2013) Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: from mountain lions to rodents. Proceedings of the 25th Vertebrate Pest Conference. Vol. 25. pp. 144–148.

192. Erickson WA, Urban DJ (2004) Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

193. Fisher P, O'Connor C, Wright G, Easton CT (2003) Persistence of four anticoagulant rodenticides in livers of laboratory rats. New Zealand Department of Conservation.

194. Riley SPD, Bromley C, Poppenga RH, Uzal FA, al et (2007) Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. J Wildl Manag 71: 1874–1884.

195. Cox P, Smith R. (n.d.) Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. 15th Vertebrate Pest Conference. Davis, CA, USA.: University of California.

196. Thompson C, Sweitzer R, Gabriel M, Purcell K, Barrett R, et al. (2013) Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conserv Lett.

197. Laas FJ, Forss DA, Godfreyi MER (1985) Retention of brodifacoum in sheep tissues and excretion in faeces. N Z J Agric Res 28: 357–359.

198. Godfrey MER, Lyman CP (1980) Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). N Z J Exp Agric 8: 1–5.

199. Munday JS, Thompson LJ (2003) Brodifacoum toxicosis in two neonatal puppies. Vet Pathol Online 40: 216–219.

200. Jansman H, van Tulden P (2012) Persecution and poisoning of birds of prey in the Netherlands. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 139–142.

201. Mineau P, Lyon L, McMillin S (2012) Impacts of carbofuran on birds in Canada and the United States. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 219–222.

202. Anderson B, Borges S, Graber K, Hartless C, Housenger J, et al. (2011) Risks of non-compliant rodenticides to nontarget wildlife. Washington D.C., USA: United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division.

203. Berny PJ, Buronfosse T, Buronfosse F, Lamarque F, Lorgue G (1997) Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35: 1817–1829.

204. Ruder MG, Poppenga RH, Bryan JA, Bain M, Pitman J, et al. (2011) Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. J Wildl Dis 47: 212–216.

205. Janeway CA, Travers P, Walport M (2007) Immunobiology. 7th ed. New York, New York, USA: Garland Science.

206. Li Q, Kawada T (2006) The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cell Mol Immunol 3: 171–178.

207. Zabrodskii PF, Lim VG, Strel'tsova EV (2012) Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksp Klin Farmakol 75: 35.

208. Vidal D, Alzaga V, Luque-Larena JJ, Mateo R, Arroyo L, et al. (2009) Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Sci Total Environ 408: 267–271. doi:http://dx.doi.org/10.1016/j.scitotenv.2009.10.001.

209. Gordon CJ (1994) Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicol Teratol 16: 427–453.

210. Grue CE, Hart ADM, Mineau P (1991) Biological consequences of depressed brain cholinesterase activity in wildlife. In: Mineau P, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Amsterdam, Netherlands: Elsevier Science Publishers. pp. 151–209.

211. Ahdaya SM, Shah PV, Guthrie FE (1976) Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicol Appl Pharmacol 35: 575–580.

212. Martin PA, Solomon KR (1991) Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pestic Biochem Physiol 40: 117–127.

213. Hayward MW, Jedrzejewski W, Jedrzewska B (2012) Prey preferences of the tiger Panthera tigris. J Zool 286: 221–231. doi:http://dx.doi.org/10.1111/j.1469-7998.2011.00871.x.

214. Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE (2004) Tigers and their prey: predicting carnivore densities from prey abundance. Proc Natl Acad Sci U S A 101: 4854–4858.

215. Knick ST (1990) Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildl Monogr: 3–42.

216. Knick ST, Hellgren EC, Seal US (1993) Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Can J Zool Can Zool 71: 1448–1453.

217. Colvin, B., Jackson W. (1991) Secondary poisoning hazards associated with rodenticide use. In: Magallona E., editor. 11th International Congress Plant Protection. Manila, Phillipines.

218. Pachauri RK, Reisinger A (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergov Panel Clim Change 1.

219. Solomon S, Qin D, Manning M, ALLEY R, BERNTSEN T, et al. (2007) Technical Summary. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press. pp. 19–91.

220. Bonfils C, Duffy PB, Santer BD, Wigley TML, Lobell DB, et al. (2008) Identification of external influences on temperatures in California. Clim Change 87: 43–55. doi:10.1007/s10584-007-9374-9.

221. Tingley MW, Koo MS, Moritz C, Rush AC, Beissinger SR (2012) The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Glob Change Biol 18: 3279–3290.

222. Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, et al. (2013) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Clim Dyn 40: 839–856. doi:http://dx.doi.org/10.1007/s00382-012-1337-9.

223. Cayan D, Tyree M, Pierce D, Das T (2012) Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

224. Littell JS, Elsner MM, Mauger G, Lutz E, Hamlet AF, et al. (2011) Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. University of Washington, College of the Environment.

225. Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. (2004) Emissions pathways, climate change, and impacts on California. Proc Natl Acad Sci U S A 101: 12422–12427.

226. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, et al. (2007) Regional climate projections. In: Susan S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, Vol. 4.

227. Cayan D, Tyree M, Dettinger M, Hidalgo H, Das T, et al. (2009) Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. Calif Clim Change Cent CEC-500-2009-014-D.

228. Pierce DW, Cayan DR, Das T, Maurer EP, Miller NL, et al. (2013) The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. J Clim. Available: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00766.1. Accessed 14 October 2013.

229. Halofsky JE, Peterson DL, O’Halloran KA, Hawkins-Hoffman C (2011) Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available: http://www.treesearch.fs.fed.us/pubs/38702. Accessed 14 October 2013.

230. Salathe EP, Leung Lr, Qian Y, Zhang Y (2010) Regional climate model projections for the State of Washington. Clim Change 102: 51–75. doi:http://dx.doi.org/10.1007/s10584-010-9849-y.

231. Ralph M (2011) Water supply and flooding. In: Pierce DW, editor. California Climate Extremes Workshop Report. La Jolla, CA: Scripps Institution of Oceanography.

232. Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, et al. (2009) The velocity of climate change. Nature 462: 1052–1055. doi:10.1038/nature08649.

233. Moritz C, Agudo R (2013) The Future of Species Under Climate Change: Resilience or Decline? Science 341: 504–508. doi:10.1126/science.1237190.

234. Lenihan JM, Drapek R, Bachelet D, Neilson RP (2003) Climate change effects on vegetation distribution, carbon, and fire in California. Ecol Appl 13: 1667–1681.

235. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al. (2011) The impact of climate change on California's ecosystem services. Clim Change 109: 465–484. doi:10.1007/s10584-011-0313-4.

236. Koopman ME, Nauman RS, Leonard JL (2010) Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

237. Burns CE, Johnston KM, Schmitz OJ (2003) Global climate change and mammalian species diversity in U.S. national parks. Proc Natl Acad Sci 100: 11474–11477.

238. Littell JS, Oneil EE, McKenzie D, Hicke JA, Lutz JA, et al. (2010) Forest ecosystems, disturbance, and climatic change in Washington State, USA. Clim Change 102: 129–158. doi:http://dx.doi.org/10.1007/s10584-010-9858-x.

239. Spies TA, Giesen TW, Swanson FJ, Franklin JF, Lach D, et al. (2010) Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landsc Ecol 25: 1185–1199. doi:http://dx.doi.org/10.1007/s10980-010-9483-0.

240. Paradis A, Elkinton J, Hayhoe K, Buonaccorsi J (2008) Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitig Adapt Strateg Glob Change 13: 541–554.

241. Safranyik L, Carroll AL, Regniere J, Langor DW, Riel WG, et al. (2010) Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Can Entomol 142: 415–442.

242. Trần JK, Ylioja T, Billings RF, Régnière J, Ayres MP (2007) Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecol Appl 17: 882–899.

243. Vose JM, Peterson DL, Patel-Weynand T (2012) Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

244. USDA Forest Service, USDI Bureau of Land Management (1994) Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team]. 569 p. Available: http://archive.org/details/finalsupplementa03v1unit. Accessed 2 September 2014.

245. USDA Forest Service, USDI Bureau of Land Management (1994) Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

246. The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data (n.d.). Available: http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml. Accessed 5 September 2014.

247. Sulak A, Huntsinger L (2012) Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. J For 110: 312–317.

248. Smith T (2014) What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. Available: http://snamp.cnr.berkeley.edu/teams/fisher. Accessed 1 September 2014.

249. Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics (n.d.). Available: http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/. Accessed 1 September 2014.

250. USDI Bureau of Land Management (2008) Sierra Resource Management Plan and Record of Decision. Folsom, CA: Bureau of Land Management.

251. Hannibal ME (2012) America's Next Best Idea: The National Park System Looks to the Future. George Wright Forum 29: 380–384.

252. FSC Forest Stewardship Council U.S. (FSC-US) · Our History (n.d.). Available: https://us.fsc.org/our-history.180.htm. Accessed 2 September 2014.

253. FSC Forest Stewardship Council U.S. (FSC-US) · Mission and Vision (n.d.). Available: https://us.fsc.org/mission-and-vision.187.htm. Accessed 2 September 2014.

254. preview.fsc-certified-acres-by-state.a-204.pdf (n.d.). Available: https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf. Accessed 2 September 2014.

255. IUCN, SSC (2013) Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

256. Callas RL, Figura P (2008) Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. Sacramento, California: California Department of Fish and Game.

257. Gould GI, Escallier J (1989) Licensed trapper's and dealer's report. Sacramento, California: California Department of Fish and Game.

258. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

Comments from M. Gabriel

STATE OF CALIFORNIA

NATURAL RESOURCES AGENCY

DEPARTMENT OF FISH AND WILDLIFE

CONFIDENTIAL DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [*Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

October 1, 2014

Table of Contents

List of Figures

List of Tables

List of Appendices

(to be completed)

Appendix 1 – Public Notice
Appendix 2 – Peer Review Solicitation Letters
Appendix 3 – Public Comment Letters
Appendix 4 – Peer Review Comments

Acknowledgments

(to be completed)

This report was prepared by: ______________________
Cover photograph © J. Mark Higley, Hoopa Tribal Forestry, used with permission.

Report to the Fish and Game Commission
A Status Review of the Fisher in California

_______, 2014

Executive Summary

This document describes the current status of the fisher (*Pekania pennanti*) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

Formatted: Font: Italic

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act (CESA). On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department of Fish and Game, as it was then named (now called the Department of Fish and Wildlife) (Department), commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Despite being the most valuable furbearer in the state, trappers only reported taking 46 animals from 1920-1924. In addition to trapping, the decline of fishers has also been attributed to logging activities which may render habitats unsuitable for them.

Early researchers believed that the range of fishers in the late 1800s extended from the Oregon border south to Marin County through the Klamath Mountains and the Coast Range as well as through the southern Cascades to the southern Sierra Nevada Mountains. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to European settlement. The location and size of the gap separating these populations is unknown. However, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Comment [Eco1]: Specify in California

Currently fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population). Fishers are also found in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN Fisher ESU) from fishers in northern California (NC Fisher ESU) and the degree of genetic differentiation between them. Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals.

Early work on fishers appeared to indicate that fishers required particular forest types (e.g., old-growth conifers) for survival. However, studies of fishers over the past two decades have demonstrated that they are not dependent on old-growth forests per se, nor are they associated with any particular forest type. Fishers are typically found at low- to mid-elevations characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used for resting (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning and the presence of a suitable cavity appears to be more important than the species of

tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (> 100 years) may be needed for trees to attain sufficient size and for a cavity large enough for a female fisher and her young to develop. Although the number of den and rest structures needed by fisher is not well known, a substantial reduction in these important habitat elements would likely reduce the distribution and abundance of fisher in the state.

Primary threats to fishers within the NC and SSN Fisher ESUs include habitat loss, toxicants, wildfire, and climate change. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests. However, fishers are widespread on public and private lands harvested for timber. A concern for the long-term viability of fishers across their range in California is the presence of suitable den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service or the National Park Service. Private lands within the NC Fisher ESU and the SSN Fisher ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher contracted substantially. This difference is due to the apparent absence of fishers from the central, and portions of the northern, Sierra Nevada. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Comment [Eco2]: Tribal Lands? Yurok, Karuk Hoopa, Tule tribes?

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and to other toxicants. ARs used at illegal marijuana cultivation sites have caused the deaths of some fishers and ARs may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population.

In recent decades the frequency, severity, and extent of wildfires has increased in California. This trend could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due to that population's small size, the linear distribution of the habitat available, and the potential for fires to increase in frequency under scenarios where the climate warms.

Climate research predicts continued climate change through 2100, with rates of change faster than occurred during the previous century. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate related changes that may occur within the range of the fisher in California. The SSN Fisher ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU, due to its comparatively small population size and susceptibility to fragmentation. However, the effects of climate change on fisher populations are unknown, will likely vary throughout the species' range, and the severity of those effects will vary depending on the extent and speed with which warming occurs.

Regulatory Framework

Petition Evaluation Process

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3) The Commission received the petition and, pursuant to Fish & G. Code § 2073, referred the petition to the Department for its evaluation and recommendation. (*Id.*, § 2073) On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*) as Threatened

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[2].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[3].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[4]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[5, 6].

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[7].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (APA) (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA,

---

[2] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[3] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[4] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

[6] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[7] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

subject to various terms and conditions[8]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[9]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[10]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its Status Review and the best science available to the Department that designating fisher as a threatened or endangered species under CESA was not warranted[11]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[12].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[13]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related

---

[8] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[9] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[10] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

[11] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[12] *Id.*, § 670.1, subd. (g).

[13] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[14]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as an endangered or threatened species under CESA was not warranted[15]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[16].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[17] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

---

[14] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

[15] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[16] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[17] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[18]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[19]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its February 2010 status review of the species. This report represents the Department's revised status review, based on the best scientific information available and including independent peer review by scientists with expertise relevant to the status of the fisher (Appendix X).

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail [1]. They typically appear uniformly black from a distance, but in fact are dark brown over most of their bodies with white or cream patches distributed on their undersurfaces [2]. The fur on the head and shoulder may be grizzled with gold or silver, especially in males [1]. The fisher's face is characterized by a sharp muzzle with small rounded ears [3] and forward facing eyes indicating well developed binocular vision [2]. Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0-2.5 kg (4.4-5.5 lbs) and range in length from 70-95 cm (28-34 in) and males weigh between 3.5-5.5 kg (7.7-12.1 lbs) and range from 90-120 cm (35-47 in) long [2].

---

[18] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh about 500-1400 g (1-3 lbs) and range in total length from about 50-68 cm (20-27 in) [4]. Fishers have a single molt in late summer and early fall, and shedding starts in late spring [2]. American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers [5].

Fishers are seldom seen, even where they are abundant. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground [6]. Females, perhaps because of their smaller body size, are more arboreal than males [2,7,8].

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the mustelidae includes wolverine, marten, weasel, mink, skunk, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America; *M. p. pennanti* [9], *M. p. columbiana* [10]; and *M. p. pacifica* [11]. However, the validity of these subspecies has been questioned [3] and [12].

More recently, genetic studies indicate that the fisher is more closely related to wolverine (*Gulo gulo*) and tayra (*Eira barbara*) of Central and South America than to other species of *Martes* [13–19]. Based on those findings, fishers have been reclassified along with wolverine and tayra into the genus *Pekania* [15,19]. In this report, we use *Pekania pennanti* as the taxonomic designation for native fishers in California.

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell [2] thought the most likely possibility was that the name originated with European settlers who noted the similarity between fishers and European polecats, which were also known as fitch ferrets. Many other names have been used for fisher including pekan, pequam, wejack, Pennant's marten, black cat, tha cho (Chippewayan), uskool (Wabanaki), otchoek (Cree), and otschilik (Ojibwa) [2]. In the native language of the Hoopa people, fisher are known as 'ista:ngq'eh-k'itiqowh [20].

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago [21]. Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) [22]. During the late Holocene which began about 4,000 years ago, fishers expanded into western North America [23], presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to European settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 1). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and coniferous forest ecosystems in western North America [24].

By the 1800s and early 1900s the fisher's range was generally greatly reduced due to trapping and large scale anthropogenic influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss [2,24,25]. However, fishers have reoccupied much of the area lost during the early 1900s, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York [25].

Native populations of fisher currently occur in Canada, the western United States (Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada [26].

Historical Range and Distribution in California

Our knowledge of the distribution of fishers in California is primarily informed by Grinnell et al. [3]. They described fishers in California as inhabiting forested mountains

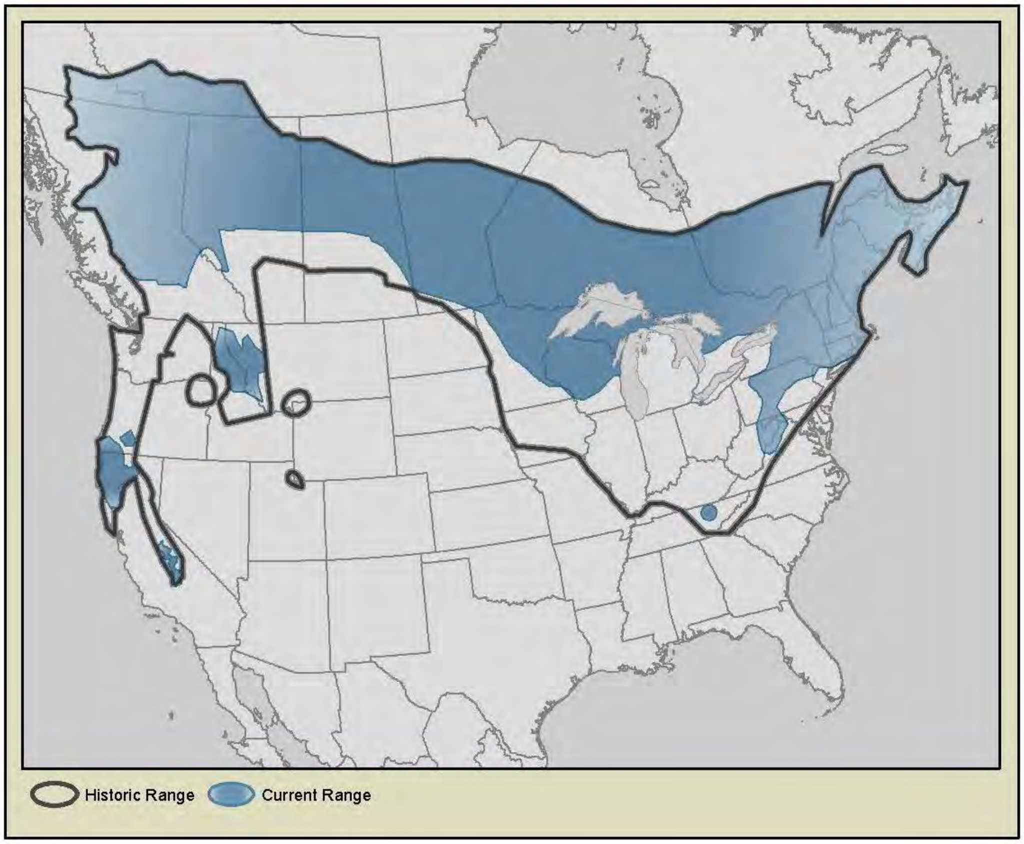


Figure 1. Presumed historical distribution (ca. 1600) and current distribution of fisher in North America. Historical distribution was derived from Giblisco [27]. Refer to Tucker et al. [28] and Knaus et al. [29] for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

.

primarily at elevations between 610 m to 1824 m (2,000 - 5,000 ft) in the northern portions of their range and 1220 m to 2438 m (4,000 ft - 8,000 ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations. Fishers were believed to have ranged from the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County [3].

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919-1924, as well as a line demarcating what they assumed to be general range from approximately 1862-1937 (Figure 2). The point locations on the map were based on reports by trappers and the authors believed that almost all the locations were accurate, although they pointed out that some may have reflected the trapper's residence or post office. The map remains the best approximation of the distribution of fishers in California at that time, although it likely included areas unsuitable for fishers and excluded portions of the state occupied by the species.

Information presented by Grinnell et al. [3] suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. [3] appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included Lake, Marin, and Kern counties.

Evidence of fishers occupying the central and northern Sierra during the mid-1800s through the early 1900s is limited. In the northern Sierra, Grinnell et al. [3] showed two collections from Sierra County from 1919-1924. During that period in the central Sierra, Grinnell et al. reported one collection from Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County. All of these records, as well as one other record from northwestern Tuolumne County in the Tuolumne River watershed, are north of the current northern limit of the southern Sierra fisher population in the Merced River watershed.

In the southern Cascades, Grinnell et al. [3] mentioned that fishers were trapped during the winters of 1920 and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. [30] reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National Park, near the junction of Lassen, Plumas, and Shasta counties. Additional historic records of fishers in the southern Cascades include two collections in 1897, from eastern Shasta County, that are located in the National

Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney.

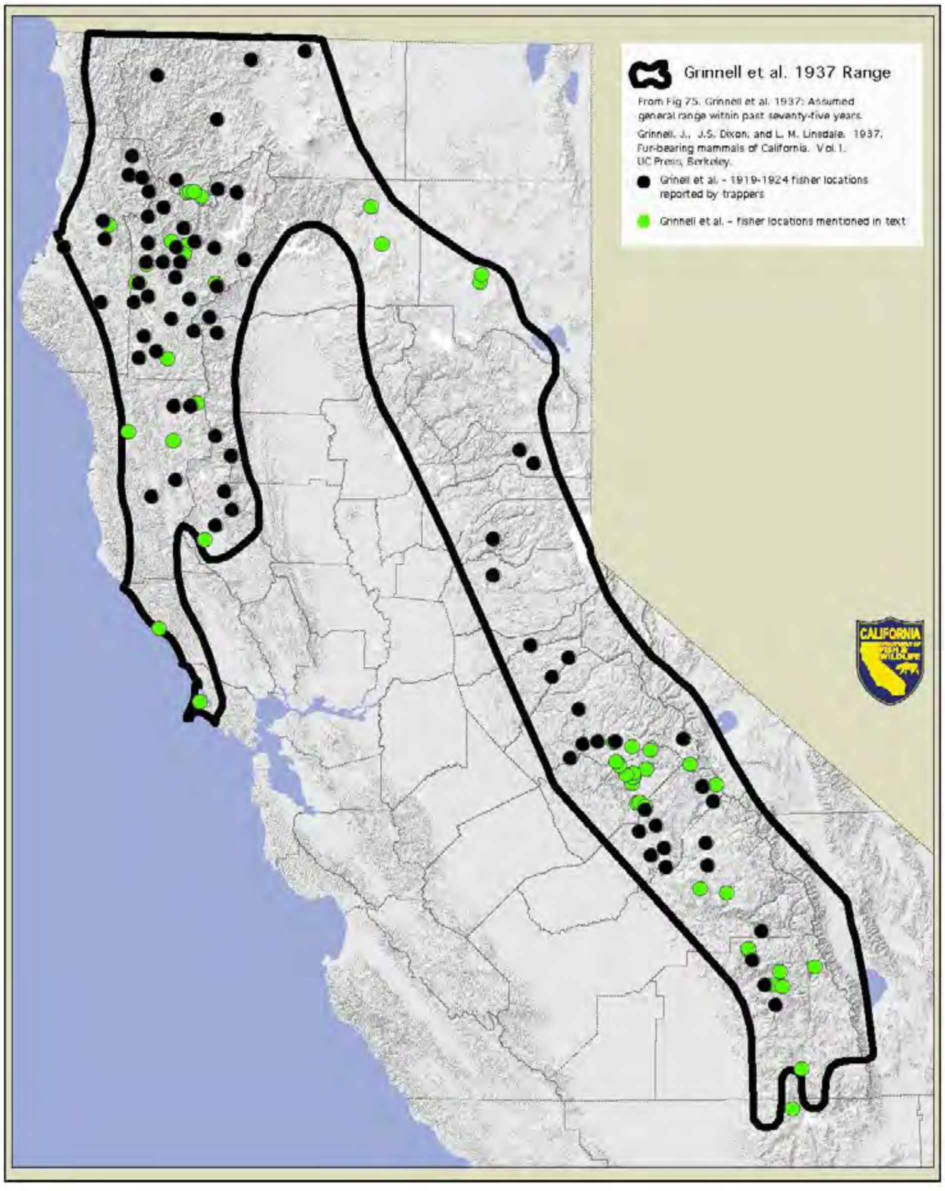


Figure 2. Assumed general range of the fisher in California from ~1850 -1925 from Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Anecdotal evidence of fishers in the northern Sierra is provided in an 1894 publication describing the efforts of William Price to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada [31]. Price included notes on species that he did not collect but were "commonly known to the trappers." His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[20] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Additionally, when relevant, Price discusses more distant geographic localities for some species and their close relatives. If the fishers referenced were trapped at distant locations (e.g., the southern Sierra) it is likely those locations would have been mentioned. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred animals.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fisher in California is based on observations of the species through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

[20] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger [32] noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of species presence (remote cameras and track-plate boxes) [33]. In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* [34] to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be "verified" records (Figure 3). Undoubtedly, reports of

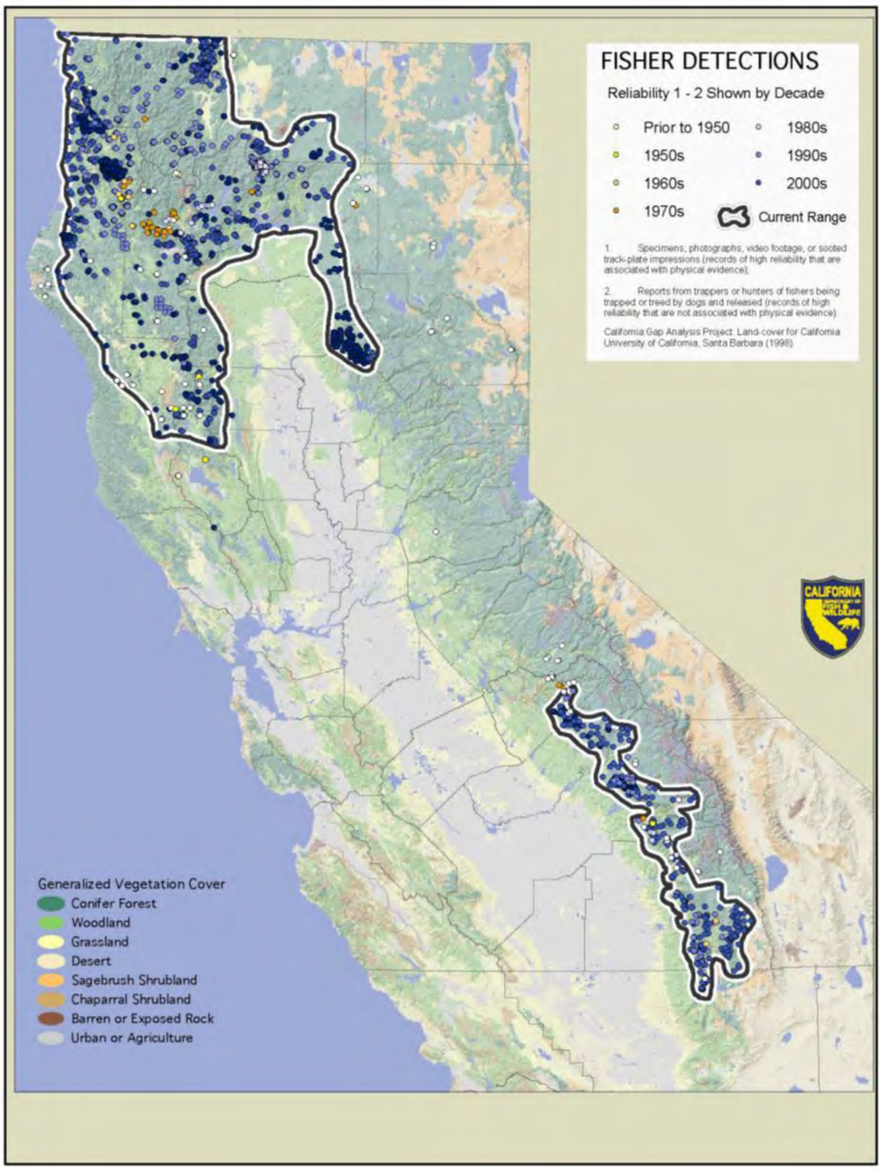


Figure 3. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis [34] were included. California Department of Fish and Wildlife, 2014.

fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state.

A number of broad scale, systematic surveys for fisher and other forest carnivores in the Sierra Nevada Mountains were conducted from 1989-1994 [35], from 1996-2002 [35], and from 2002-2009 (USDA 2006, USDA 2008, Truex et al. 2009). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. [35] expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction due to isolation than if they were connected to other populations. They offered several explanations to account for the lack of fishers in the region including trapping and elimination of habitat through railroad logging.

Zielinski et al. [35] could find no reason to suspect that fisher at one time did not occur where habitat was suitable throughout the Sierra Nevada and thought it likely that the fisher population had already been reduced by the time Grinnell [3] and his colleagues assessed its distribution. Price [31] supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell [3].

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the USDA Forest Service (USFS), private timber companies, and others, since the 1950s no verifiable detections of fishers have occurred in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River [35,36].

To approximate the current range of fishers in California, observations of fishers with high reliability were mapped from 1993 to the present. Those locations were overlaid using GIS on layers of forest cover and layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model) and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 3). This estimate of

current range is approximately 48% of the assumed historical range estimated by Grinnell et al. [3].

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (<5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice sheets [23]. By the late Holocene, records of fishers on the Pacific coast were common [37]. Wisely et al. [37] hypothesized that fishers then expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Currently, fishers in California occur in the northwestern portions of the state, the northern Sierra Nevada, and in the southern Sierra Nevada. Mitochondrial DNA (mtDNA) has been used in several studies to describe the genetic structure of fishers in the state [29,37,38]. Mitochondria are small maternally inherited structures in most cells that produce energy. Portions of the DNA contained within mitochondria known as D-loop regions contain nonfunctional genes and have been widely used in studies of ancestry because they are rich in mutations which are inherited. Early genetic studies of fishers by Drew et al. [38] identified three haplotypes[21] in California (haplotypes 1, 2, and 4) by sequencing mtDNA. Haplotype 1 was found in northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in extant fisher populations in British Columbia. Based on these findings, Drew et al. [38] suggested that gene flow between fishers in British Columbia and California must have occurred historically, but that these populations were now isolated.

Subsequent genetic investigations using nuclear microsatellite DNA and based on sequencing the entire mtDNA genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada [29,37]. Knaus et al. [29] identified three distinct haplotypes unique to fishers in California; one geographically

[21] A haplotype is a set of DNA variations (allele), or polymorphisms, that tend to be inherited together [39].

restricted to the southern Sierra Nevada Mountains and two restricted to the Siskiyou and Klamath mountain ranges. The magnitude of the differentiation between haplotypes of fishers in northern and southern California populations was substantial and considered comparable to differences exhibited among subspecies [29].

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. [29] concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error. Despite this uncertainty, Knaus et al. [29] concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Tucker et al. [40] used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fisher in northwestern California and the southern Sierra Nevada became isolated long before European settlement and estimated that the population declined substantially over a thousand years ago. This generally supports the conclusion of Knaus et al. [29] that fishers in northern and southern portions of the state became isolated prior to European settlement.

Tucker et al. [40] also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fisher from disturbance beginning with the Gold Rush through the first half of the twentieth century. That portion of the range appeared to have maintained a stable population while the remainder of the southern Sierra Nevada occupied by fisher was in decline.

Reproduction and Development

Powell [2] suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April [2,6,41,42]. Females can breed at one year of age, but do not give birth until their second year [2,43,44]. They produce, at most, one litter annually and may not breed every year [8,45]. Reproductive frequency and success depend on a variety of factors including prey availability, male presence or abundance, and age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old [2,8,45,46].

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation [8,47,48]. Implantation is delayed approximately 10 months [41] and occurs shortly before giving birth (parturition) [48]. Arthur and Krohn [46] considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for an average period of 30 to 36 days [2,48]. Females give birth from about mid-March to early April [49–53] and breed approximately 6-10 days after giving birth [2,47,54]. Ovulation is presumed to be induced by copulation [2], with estrus lasting 2-8 days [54]. Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition [2]. Lofroth et al. [24] developed an excellent diagram that illustrates the reproductive cycle of fishers in western North America (Figure 4).

Studies of wild fishers have reported litter sizes to range from 1-4 kits and average 1.8-2.8 [49,55–57]. Based on laboratory examination of corpora lutea[22] observed in harvested fishers, average litter size ranged from 2.3-3.7 kits [8,41–43,59–61]. These averages may be high and counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea [2]. Crowley et al. [60] found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

[22] The corpus luteum is a transient endocrine gland that produces essentially progesterone required for the establishment and maintenance of early pregnancy [58].

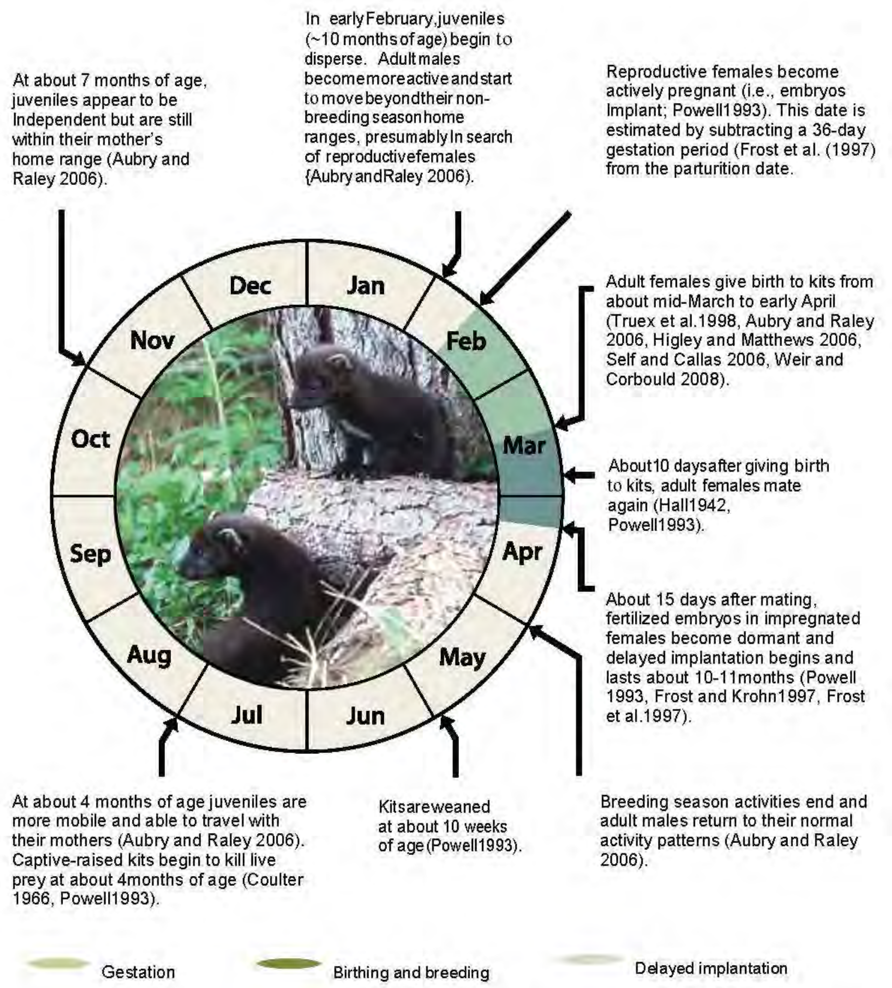


Figure 4. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. [22].

Raised in dens entirely by the female, young are born with their with eyes and ears closed, only partially covered with sparse growth of fine gray hair, and weigh about 40 g [6,25,54]. The kits' eyes open at 7-8 weeks old. They remain dependent on milk until 8-10 weeks of age, and are capable of killing their own prey at around 4 months [2,25]. Juvenile females and males become sexually mature and establish their own home

ranges at one year of age [41,62]. Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum [25]. Fishers have a relatively low annual reproductive capacity [5]. Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually reported from several studies in western North America was 64% (range = 39 – 89%) [24]. However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable.

A recent study in the Hoopa Valley of California reported that 62% (29 of 47) of denning opportunities were successful in weaning at least one kit from 2005-2008 [63]. Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, most ($\overline{x}$ = 78%, range = 63-90%) produced young annually from 2010-2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers [24].

Many kits die immediately following birth. Frost and Krohn [48] found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth [44]. In wild populations, kits have been found dead near den sites and reproductive females have been documented abandoning their dens indicating their young had died [49,50,56]. The number of fishers an individual female is able to raise until they are independent depends primarily upon food resources available to them [64]. Paragi [65] reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.

Survival

There are few studies of longevity of fishers in the wild. Powell [2] believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir [61] captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age [66]). Of

14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age [67].

In the wild, most fishers likely live far less than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years, although one of those animals lived to at least 10 years of age [66,68]. From 2009-2011, a total of 67 fishers were live-trapped in northern California as part of an effort to translocate the species to the southern Cascades and northern Sierra. The median age of those individuals was 2 years (range = 0.6 – 6). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Estimated survival rates of fishers vary throughout their range [24]. Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, and road density. Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation). Lofroth et al. [24] summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America documented by 8 studies, and averaged 68% for 3 studies in eastern Northern America. This difference was presumably due, in part, to the take of fisher by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts). In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range = 0.61-0.84) for adult females and 0.82 (range = 0.73-0.86) for adult males [24].

Food Habits

Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi [2]. Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided [2]. Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey

species that may be otherwise impossible to determine by more traditional techniques [24].

In a review of 13 studies of fisher diets in North America by Martin [69], five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed [24]. The proportion of different food items in the diets of fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey [2].

In California, studies indicate fishers appear to consume a greater diversity of prey than elsewhere in western North America [24,70,71]. This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey [70]. In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats [71,72]. Diets reported in these studies differed somewhat in the frequency of occurrence of specific prey items, but included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California [71], where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material [72,73].

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council [74], Golightly et al. [71] found mammals, particularly gray squirrels (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), and ground squirrels (*Spermophilus* sp.), to be the most frequently consumed prey by fishers. Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet [70–72]. This is likely due to the comparatively low densities of these species in ranges occupied by fishers in California compared to other parts of their range [72].

In the southern Sierra Nevada, Zielinski et al. [72] reported that small mammals comprised the majority of the diet of fishers. However, insects and lizards were also

frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. [72] also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn.

Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available [71,72,75,76]. Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers their ability to capture and handle larger versus smaller prey [24]. The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill. This has been hypothesized as a mechanism that reduces competition between the sexes for food [2]. Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey [24].

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. [72] found that during summer, the diet of female fishers compared to the diet of male fishers contained a greater proportion of small mammals. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. [77] reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley [49] found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). However, since most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits [49]. In some areas, male fishers have been found with significantly ($P<0.1$) more porcupine quills in their heads, chests, shoulders, and legs than female fishers [59,78]. It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers [2].

Movements

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities [79]. These areas have been described for fisher and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young [2]. The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not [2]. Although the home range of a female generally only overlaps the home range of a single male, a male's home range may overlap those of multiple females with the potential benefit of increased reproductive success [2].

Lofroth et al. [24] summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. This difference in home range size, with male fishers using substantially larger areas than females, has been consistently reported [49,52,56,59,80–87]. In 9 studies in western North America the home range sizes of male fishers were 3 times larger than the home range sizes of female fishers [24]. Lofroth et al. [24] noted that home range sizes of fishers generally increase from southern to northern latitudes. Some factors that may influence the suitability of home ranges include landscape scale fragmentation, heterogeneity, and edge ecotones, but these attributes have not been well studied [88].

Dispersal: Dispersal describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. [89] as increasingly recognized to occur in three phases: 1) departing from the natal[23] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to

[23] Natal refers to the place of birth.

move through the landscape, prey resources, turnover rates of adults [52,56,62] and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities [49,52,56]. During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat [2,8,52,90]. Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females [89]. This pattern appears to hold true for fishers [49,57,91]. It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories [91]. Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient [92,93].

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age [24]. In some studies, juvenile male fishers departed from their home ranges earlier than females [57]. Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home ranges. This behavior is characterized by higher mortality risk [52].

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. [62], reported mean maximum dispersal distances for male fishers [$\bar{x}$ =17.3 km (10.7 mi), range=10.9-23.0 km (6.8-14.3 mi), n=8] and for females [$\bar{x}$ =14.9 km (9.3 mi), range=7.5-22.6 km (4.7-14.0 mi), n=5]. York [56] reported mean maximum dispersal distances for males [$\bar{x}$ =25 km (15.5 mi), range=10-60 km (6.2-37.3 mi), n=10]) and for females [$\bar{x}$ =37 km (23 mi), range=12-107 km (7.5-66.5 mi), n=19]. The greater dispersal distance for

juvenile females compared to males reported by York is unusual as, in other studies, males dispersed farther than females.

In the interior of British Columbia, Weir and Corbould [52], reported a mean dispersal distance from the centers of natal and established home ranges of 24.9 km (9.6 mi) for two females and 41.3 km (15.9 mi) for one male. In the southern Oregon Cascade Range, Aubry and Raley [49] reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male fishers [$\bar{x}$ = 29 km (18 mi), range 7-55 km (4.4-34.2 mi), n = 3] and female fishers [$\bar{x}$ = 6 km (3.7 mi), range 0-17 km (0-10.6 mi, n = 4]. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. [57], reported that the mean maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [$\bar{x}$ = 8.1 km (5.0 mi), range = 5.9–10.3 km (3.7-6.4 mi), n = 2) than females [$\bar{x}$ = 6.7 km (4.2 mi), range = 2.1–20.I km (1.3-12.5 mi), n = 12]. They also reported the distance between natal dens and the centroids (geometric center) of home ranges established by a single male [1.3 km (0.82 mi)] and 7 females [$\bar{x}$ = 4.0 km (2.5 mi), range 0.8-18 km (0.5-11.2 mi)].

Habitat Use

Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers [3,94–96] have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

In their comprehensive synthesis of the habitat ecology of fishers in North America, Raley et al. [88] used a hierarchical ordering process proposed by Johnson [97] to assess habitat associations of fishers at multiple scales (Table 1). They described the fisher's geographical distribution (first-order selection) as the ecological niche occupied by the species, which is further refined at the home range scale (second-order selection). Ultimately, the selection of different environments (third-order) and of resources (fourth-order) is constrained by landscape scale processes and conditions

Table 1. Summary of habitats used by fishers categorized by hierarchical order (Johnson 1980) and a synthesis of fisher habitat studies by Raley et al. [88].

.

First-order	Geographic distribution	Fisher distribution has consistently been associated with expanses of low- to mid-elevation mixed conifer or conifer-hardwood forests with relative dense canopies.
Second-order	Selection or composition of home ranges with the geographic distribution	Characterized by a mosaic of forest types and seral stages, with relatively high proportions of mid- to late-seral conditions, but low proportions of open or non-forested habitats.
Third-order	Selection or use of different environments within home ranges	Rest Sites: Fisher consistently selected sites for resting that have larger diameter conifer and hardwood trees, larger diameter snags, more abundant large trees and snags, and more abundant logs than at random sites. Sites used for foraging, traveling, seeking mates: Although results indicate complex vertical and horizontal structure is important to fishers, strong patterns of use or habitat selection were not found.
Fourth-order	Selection or use of specific resources within home ranges	Rest Structures: Fishers primarily used deformed or deteriorating live trees and snags for resting. The species of tree used appeared less important than the presence of a suitable microstructure (e.g., mistletoe brooms, cavities, nests of other species) for resting. Dens: Female fishers use cavities in trees to give birth and shelter their young. Den trees used for reproduction were old and were always among the largest diameter trees in the vicinity.

[88]. We have adopted this hierarchical approach to describe habitats selected by fishers.

Some researchers have hypothesized that fishers require old-growth conifer forests for survival [98]. However, habitat studies during the past 20 years demonstrate that fishers are not dependent on old-growth forests *per se*, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. Raley et al. [88] suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include high proportions of mid- to late-seral forests.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments [24]. The Department calculated the mean elevation of each Public Land Survey [99] section in which fishers were detected in California from 1993-2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 5). Habitats at higher elevations may be less favorable for fishers due to the

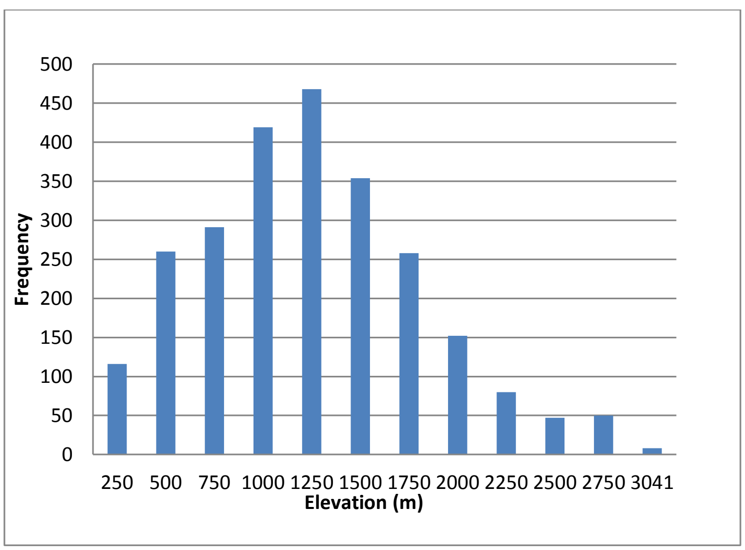


Figure 5. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993-2013. California Department of Fish and Wildlife, 2014.

depth of the winter snowpack that may constrain their movements [100], because the abundance of den, structure, rest structures, and prey may be limited [88], or for other unknown reasons.

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa pine [53,85,101]. Tree species' composition may be less important to fishers than components of forest structure that affect foraging success and provide resting and denning sites [98]. Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale ([53,85,102,103].

Hardwoods were more common in fisher home ranges in California compared elsewhere in western North America, [24]. This may be related to the use of hardwoods for resting and their importance as habitat for prey. In general, based on a number of studies in eastern North America and in California, high canopy closure is an important component of fisher habitat, especially at the rest site and den site level [25,53,85,102]. At the stand and site scale, forest structural attributes considered beneficial to fishers include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground [25].

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare and most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have occurred, active fishers were associated with complex forest structures [88]. Raley et al. ([88]) reviewed several studies ([102,104–106]) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated [88]. The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers to distinguish among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions [88].

During periods when fishers are not actively hunting or traveling, they use structures for resting which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey [24,107]. Fishers typically rest in large deformed or deteriorating live trees, snags, and logs and the forest conditions surrounding these sites frequently include structural elements of mid to late-seral forests [88].
The characteristics of rest structures used by fishers are extremely consistent in western North America, based on an extensive review by Raley et al. [88]. They summarized the results of studies from 12 different geographic regions of more than 2,260 rest structures in western North America and reported that secondarily, fishers rested in snags and logs. The species of tree or log used for resting appeared to be less important than the presence of a suitable microstructure in which to rest (e.g., cavity, platform) [88]. Microstructures used by fishers for resting include: platforms formed as a result of fungal infections, nests, or woody debris; cavities in trees or snags; and logs or debris piles created during timber harvest operations [49,52,86,108,109][49]. Rest structures appear to be reused infrequently by the same fisher. In southern Oregon, Aubry and Raley [49] located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion.

A meta-analysis conducted by Aubry et al. [107] of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. [88]). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (> 100 years) for suitable microstructures to develop [88].

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits [88]. However, hollow logs are used for reproduction (i.e., maternal dens) occasionally [49] and Grinnell et al. [3] reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree [88]. Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose dens with openings small enough to exclude potential predators and aggressive male fishers [88].

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times larger in diameter on average than other trees in the vicinity of the den [52,65,104] as cited by Raley et al. [88]. Depending on the growing conditions, considerable time may be needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits. Information collected from more than 330 dens used by fishers for reproduction indicates that most cavities used were created by decay caused by heart-rot fungi [52,66,110]. Infection by heart-rot fungi is only initiated in living trees [111,112] and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens [88]. Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age [110].

Comment [Eco3]: Would be noteworthy to mention that the age of trees maybe less in CA due to the increased growth season and increased fire scaring etc…

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fisher in California [102,103,113,114]. The newest model was developed by the Conservation Biology Institute and the USFWS (FWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the FWS-CBI model consists of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

The FWS-CBI models predict the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) [109], 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities utilized was from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

For the southern Sierra Nevada and where it blended into the northern Sierra Nevada, the variables used in the FWS-CBI model were basal-area-weighted canopy height,

minimum temperature of the coldest month, tassel-cap greenness[24], and dense forest (percent in forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The FWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables. Other recent models [96, 106] have primarily been focused on predicting habitat in the northwestern part of California or have been derived from far fewer fisher detections [97].

The final FWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as “high quality”, model values associated with habitats avoided by fishers were designated as “low quality”, and habitats that were neither avoided nor selected were considered “intermediate”. The “low quality” habitat category may include non-habitat (not used) as well as areas used infrequently by fishers relative to its availability. This FWS-CBI model was considered to be the best information available depicting the amount and distribution of habitats potentially suitable for fisher within the historical range depicted by Grinnell et al. [3] and the species’ current range in California (Figures 6 and 7).

[24] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

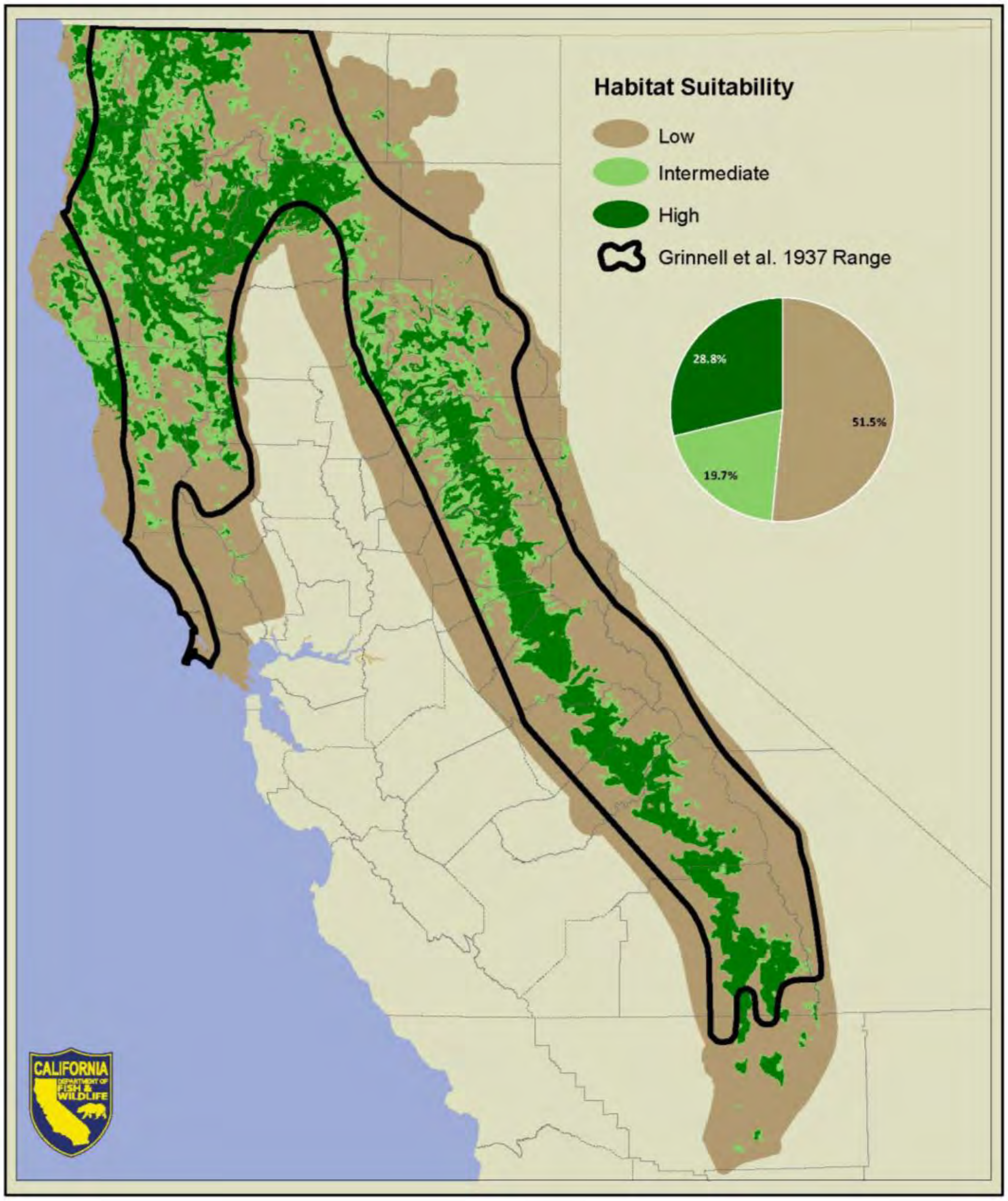


Figure 6. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

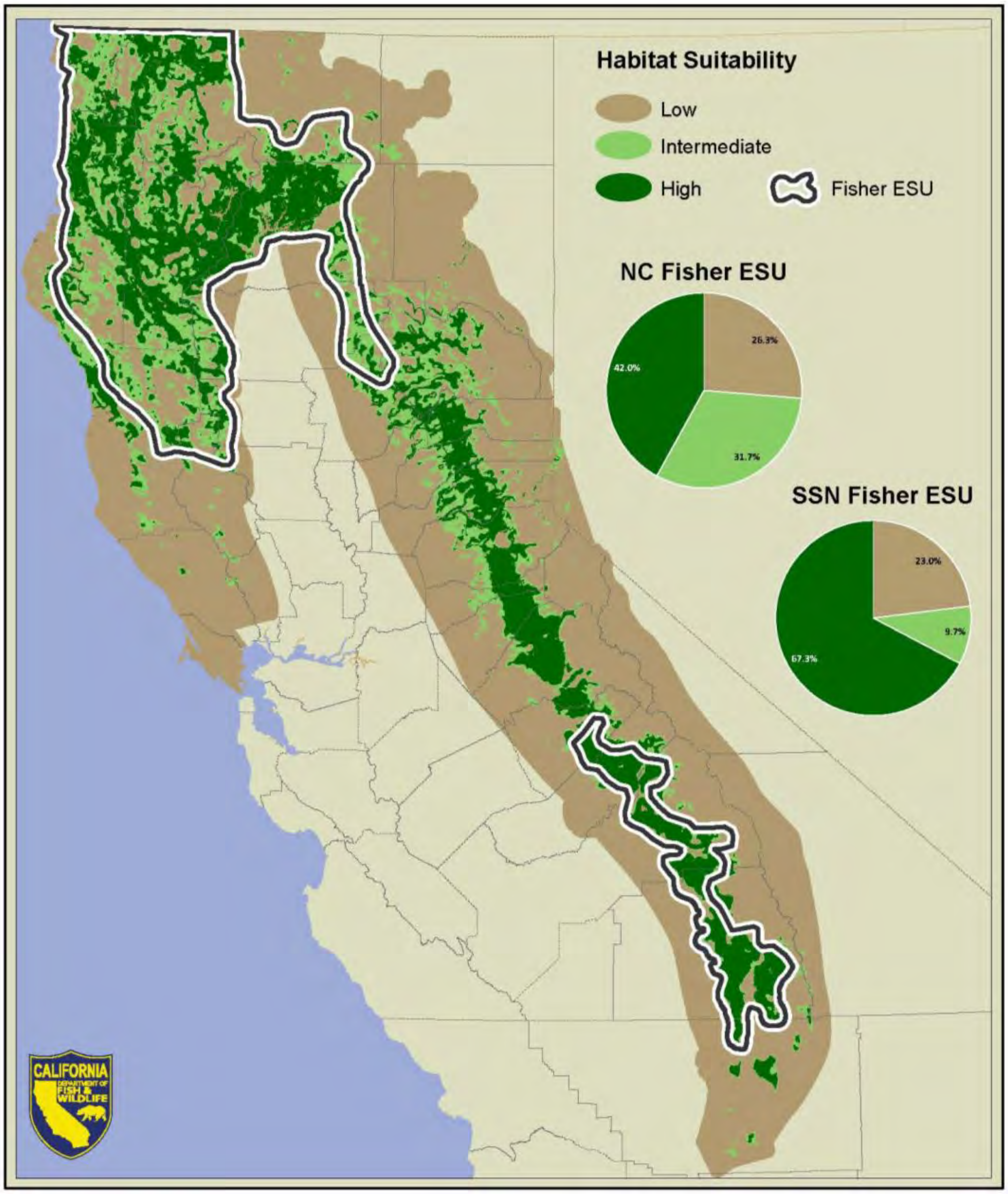


Figure 7. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Conservation Status

Regulatory Status

The fisher is currently designated by the Department as a Species of Special Concern[25] and as a candidate species at both the state[26] and federal[27] levels. Fishers are considered a sensitive species by the USFS and the Bureau of Land Management.

Habitat Essential for the Continued Existence of the Species

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists [3,31] and researchers in modern times [2,25,115–118]. However, the size, age, structure, and scale of forests essential for fisher are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular

---

[25] Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, "Species of Special Concern" is an administrative designation and carries no formal legal status.

[26] A species becomes a state candidate upon the Fish and Game Commission's determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted [California Code of Regulations (Cal. Code Regs), tit. 14, § 670.1(e)(2)]. During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

[27] Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

forest types (e.g., old-growth conifers) habitat for survival [98]. However, studies of fisher habitat use over the past two decades demonstrate that they are not dependent on old-growth forests *per se*, nor are they associated with any particular forest type [88]. Fishers are found in a variety of low- to mid-elevation forest types [105,119–122] that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. These landscapes are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Most studies of habitat use and selection by fishers have focused on structures used for denning and resting, in part because those aspects of fisher ecology are more easily studied than habitat selection for foraging. Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young [52]. Aubry and Raley [49], reported that the sizes of den entrances used by female fishers were typically just large enough to for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir [52], found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110].

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning [88]. These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large and considerable time (>100 years) may be required for suitable cavities to develop [88].

Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. However, forest structure important for fishers

should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers [28] .

Distribution Trend

Comparing the historical range of fishers in California estimated by Grinnell et al. [3] to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Lake and Marin counties. However, recent genetic analyses indicate some of the area considered to be a modern gap [35,36] in the historical distribution of fishers in the northern and central Sierra Nevada may have been long standing and pre-dated European settlement [29,40]. Yet, Grinnell et al. [3] and Price [31] suggest that fishers were present in this region post European settlement. This indicates that the gap was narrower historically than during contemporary times.

Despite extensive surveys from 1989-1995 [36] and 1996-2002 [35] for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled.

Since the 1990s, detections of fishers have increased along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County (Figure 3). It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier surveys. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

Comment [Eco4]: Or that a pulse of new research i.e. golightly students and Hoopa tribe and Simpson initiating research on the species.

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number

of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [3]. In that year, only 14 fishers were reported taken by trappers in the state, with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau of Labor Statistics). Grinnell et al. [3] concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers [123]. Most animals were taken in a single trapping season (1920) when 120 fishers were harvested [124]. Despite concerns about the scarcity of fishers in the state, trapping of fisher was not prohibited until 1946 [125].

Grinnell et al. [3] noted that "Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township." They roughly estimated the fisher population in California at fewer than 300 animals statewide with a density of 1 or 2 animals per township [93 km^2 (36 mi^2)] in good fisher range. For perspective, substantially higher numbers of fisher are captured for radio-collaring/study purposes in various studies in the present day: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were captured as part of an effort to translocate the species to the Southern Cascades and northern Sierra Nevada from 2009-2012 from widely distributed locations in northern California. Over a period of 28 days in 2012, 19 fishers were captured in vicinity of the translocation release site in the northern Sierra Nevada that were likely the offspring of animals translocated to the area [126]. Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers during this effort was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*).

Comment [Eco5]: Is this the case for trapping at other projects where other sympatric carnivores may constitute equal or higher numbers of trap success? Not camera data but trapping #'s?

Despite the paucity of empirical data, there are several estimates of fisher population size in northern California. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of

adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. However, he believed the estimate to be useful for general planning and risk assessment.

Self et al. (2008 SPI comment information) derived two separate "preliminary" estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a "deterministic expert method" and an "analytic model based approach" to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 (95% confidence interval [CI]: 1,848 - 4,550) fishers. Estimates for the southern Sierra Nevada population were 598 using the deterministic expert method and 548 (95% CI: 247 – 849) fishers based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates.

Estimates of the number of fishers in the southern Sierra Nevada indicate that despite using different approaches, the population is quite small. Lamberson et al. [127], using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Spencer et al. [128] estimated the size of the fisher population in the southern Sierra Nevada by extrapolating previous density estimates of Jordan [129], using data from the USFS regional population monitoring program (USDA Forest Service 2006), and linking a regional habitat suitability model to life history attributes. Using these data, they estimated 160-350 fishers in the southern Sierra Nevada population, of which 55-120 were estimated to be adult females. More recent work by Spencer et al. [119] estimated the southern Sierra Nevada fisher population at 300 individuals. Estimates of the number of fishers in California vary depending on the source, but range from 1,000 to approximately 4,500 fishers statewide.

Population Trend in California

No data are available that document long-term trends in fisher populations statewide in California. Despite genetic evidence indicating a long-standing historical separation of fishers in northern California from those in the southern Sierra Nevada [28], fishers reportedly occurred in the central and northern Sierra Nevada post-European settlement

[3,31], but were likely not abundant based on the scarcity of records from this region. By the late 1800s, habitat changes and harvest by trappers may have reduced the abundance of fishers in this region to low levels. The apparent scarcity of fishers in the central and northern Sierra Nevada by the early 1900s is supported by the work of Grinnell et al. [3] and the lack of specimens from that region.

In northern California, Matthews et al. [130] reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. However, continued monitoring of this population indicates that overall the population density has increased by 2012-2013, but only to about half of that estimated in 1998.

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 [131]. Detection rates at segments increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995, lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection ratios (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed.

Swiers et al. [132], collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers et. al. found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of abundance and population growth indicated that the population size was stable, although estimates of survival and recruitment suggested high population turnover [132].

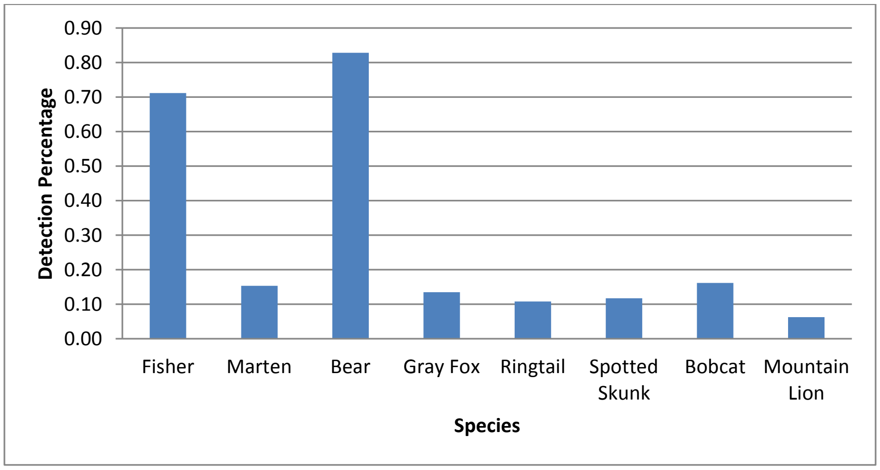


Figure 8. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

Tucker et al. [28] concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated European settlement. Tucker et al. [28] also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-European settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries. The southern extent of fisher habitat in the southern Sierra may have contained sufficient high quality habitat to serve as a refugium supporting enough fishers to constitute a founding population (J. Tucker, pers. comm.). Tucker et al. [28] using genetic techniques estimated that the total current population size of fishers in northwestern California could range from 258-2850 and the southern Sierra Nevada population could range from 334-3380.

Monitoring of fisher populations in northern California has been limited, but several studies are providing insight into the distribution and trends in occupancy rates of fishers in the state. Estimates of trends in occupancy have been used as surrogates for trends in abundance for some species of wildlife [133], in part, because it is more cost

effective and feasible than monitoring direct measures of abundance. Zielinski et al. [134] implemented a monitoring program for fishers in the southern Sierra Nevada over an 8 year period (2002-2009) and modeled trends in occupancy by combining the effects of detection probability and occupancy. They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest in the southeastern portion of their study area (0.261) and highest in the western portions of their study area (southwestern zone = 0.583) [134]. They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra did not appear to be declining.

The Department has conducted a large-scale monitoring project for forest carnivores, including fishers, as part of its Ecoregion Biodiversity Monitoring (EBM) program in the Klamath and East Franciscan ecoregions of northern California since 2011. EBM surveys for carnivores were conducted using camera traps within hexagons established by the Forest and Inventory Assessment system [135]. All the sites selected for survey occurred in forested habitats and were selected randomly (although land ownership, road access, and safety issues occasionally precluded completely random placement of plots). A Bayesian hierarchical model was used to estimate occupancy and detection probabilities for fisher across stations nested within plots within ecoregions (Furnas et al. unpublished manuscript). A total of 85 plots containing 169 stations were surveyed across the entire 2.8 million-ha study area during 2011 and 2012. The overall occupancy estimate for fisher was 0.438 [90% CI: 0.390-0.493] for stations, and 0.622 [90% CI: 0.569-0.685] for station pairs. The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.

Threats (Factors Affecting the Ability of Fishers to Survive and Reproduce)

Evolutionarily Significant Units

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing

separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) Fisher ESU and SSN (southern Sierra Nevada) Fisher ESU. The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by the Third District Court of Appeal that the term "species or subspecies" as used in sections 2062 and 2067 of the CESA includes Evolutionarily Significant Units[28]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species [136].

ESU boundaries for fisher represent the Department's assessment of the current range of the species in the state, considering the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between them (Figure 9). Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events.

Habitat Loss and Degradation

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic [24,52,98,108–110,117]. Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers particularly vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires [5,25]. Buskirk and Powell [98] found that at the landscape scale, the abundance and distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.

[28] 156 Cal.App.4th 1535, 68 Cal.Rptr.3d 391

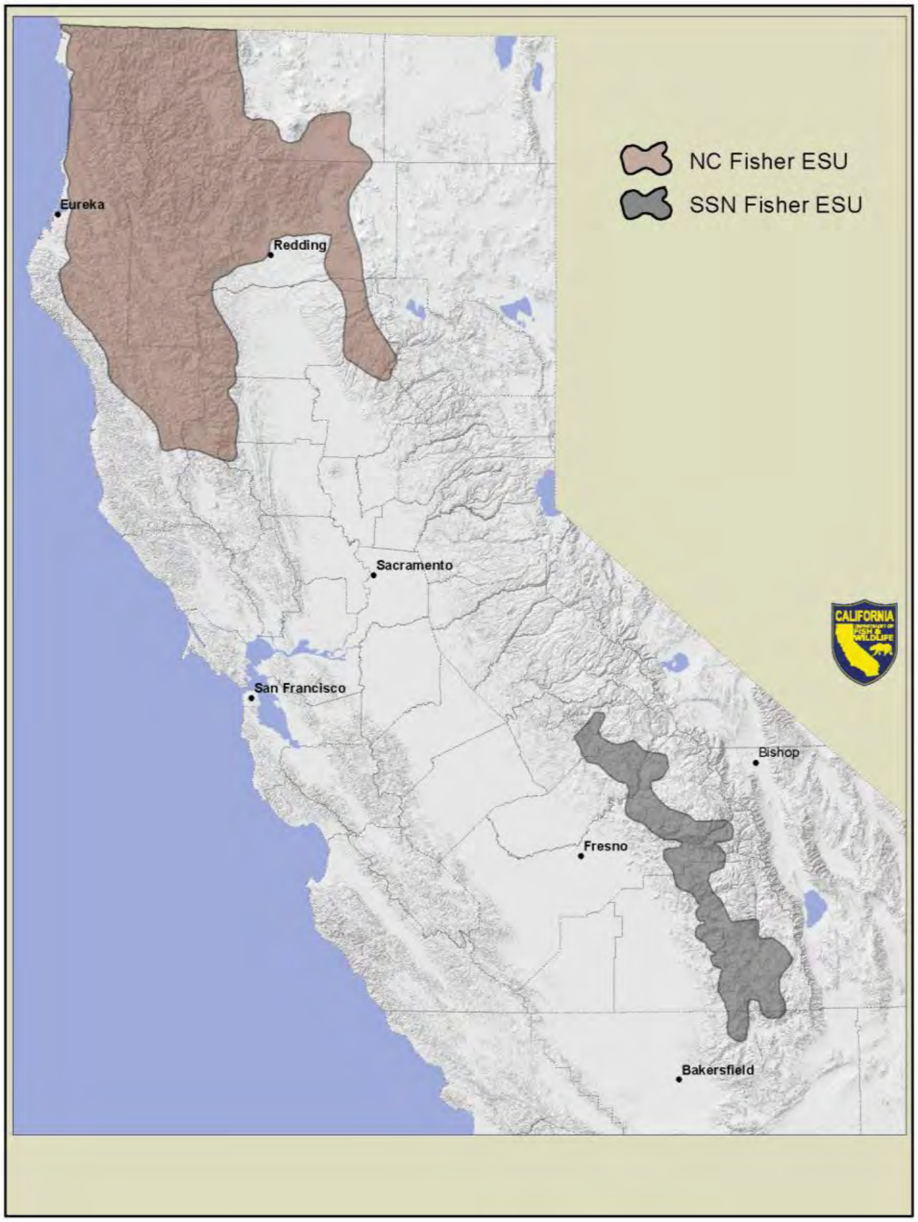


Figure 9. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and Wildlife, 2014.

Fishers have frequently been associated with old-growth forests and some researchers have hypothesized that they require those forests for survival. Habitat studies in recent decades demonstrate that fishers are not dependent on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. However, the home ranges of fishers often include high proportions of mid- to late-seral forests [88].

Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age and structural features of many forests in California. Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. Besides the direct removal of trees through timber harvest, management practices and policies have had many indirect effects on forested landscapes [24]. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Generally, timber harvest has substantially simplified the species composition and structure of forests [137,138]. Habitat elements used by fishers such as microstructures for denning can take decades to develop and a substantial reduction in the density of these elements from landscapes supporting fisher would likely reduce the distribution and abundance of fisher in the state.

Of the historical range of the fisher in California estimated by Grinnell et al. [3], nearly 61% is in public ownership and about 37% is privately owned (Figure 10). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (NPS) (Figure 11). Private lands within the NC Fisher ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 12). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades [139]. Sawtimber volume (net volume in board feet of sawlogs harvested from commercial tree species containing at least one 12-foot sawlog or two noncontiguous 8 foot sawlogs) harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 13 and 14).

Comment [Eco6]: End note font difference

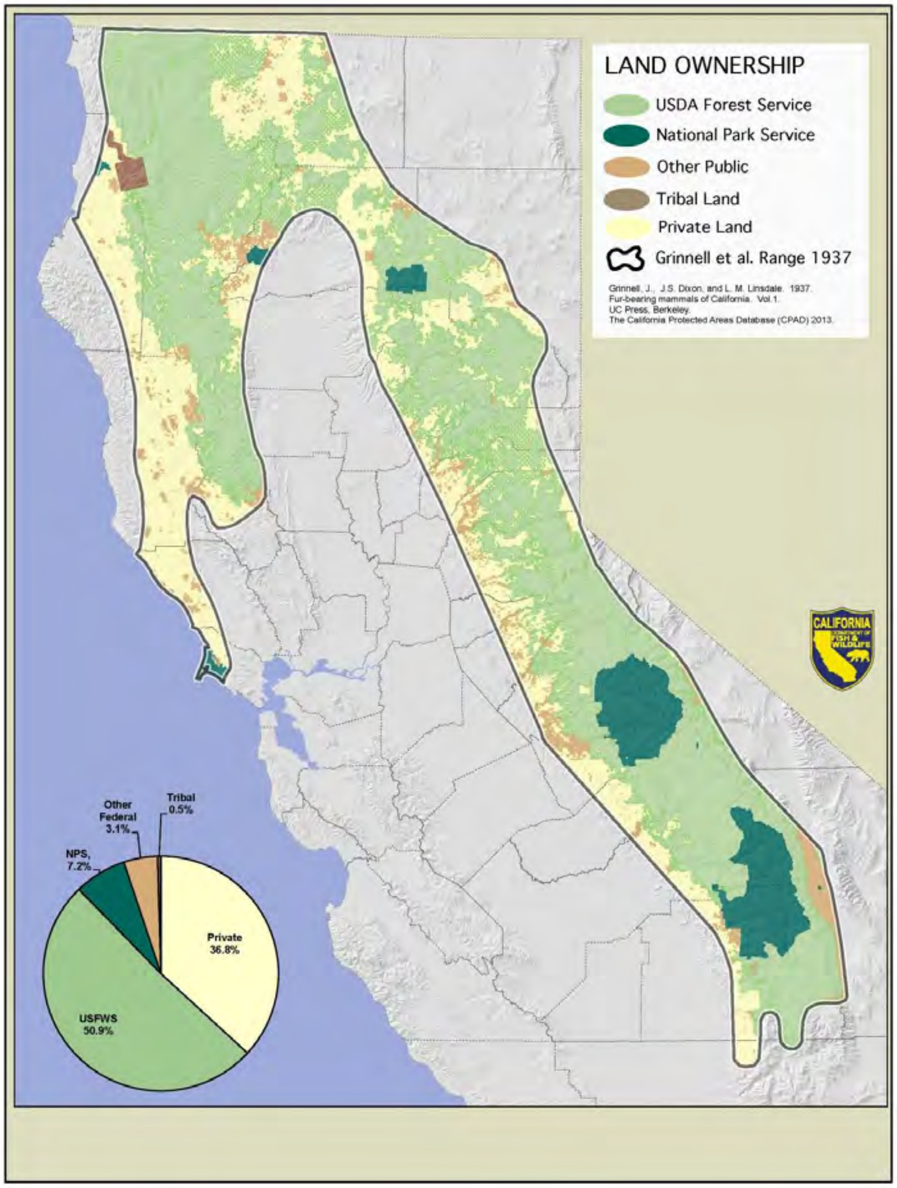


Figure 10. Landownership within the historical range of fisher depicted by Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

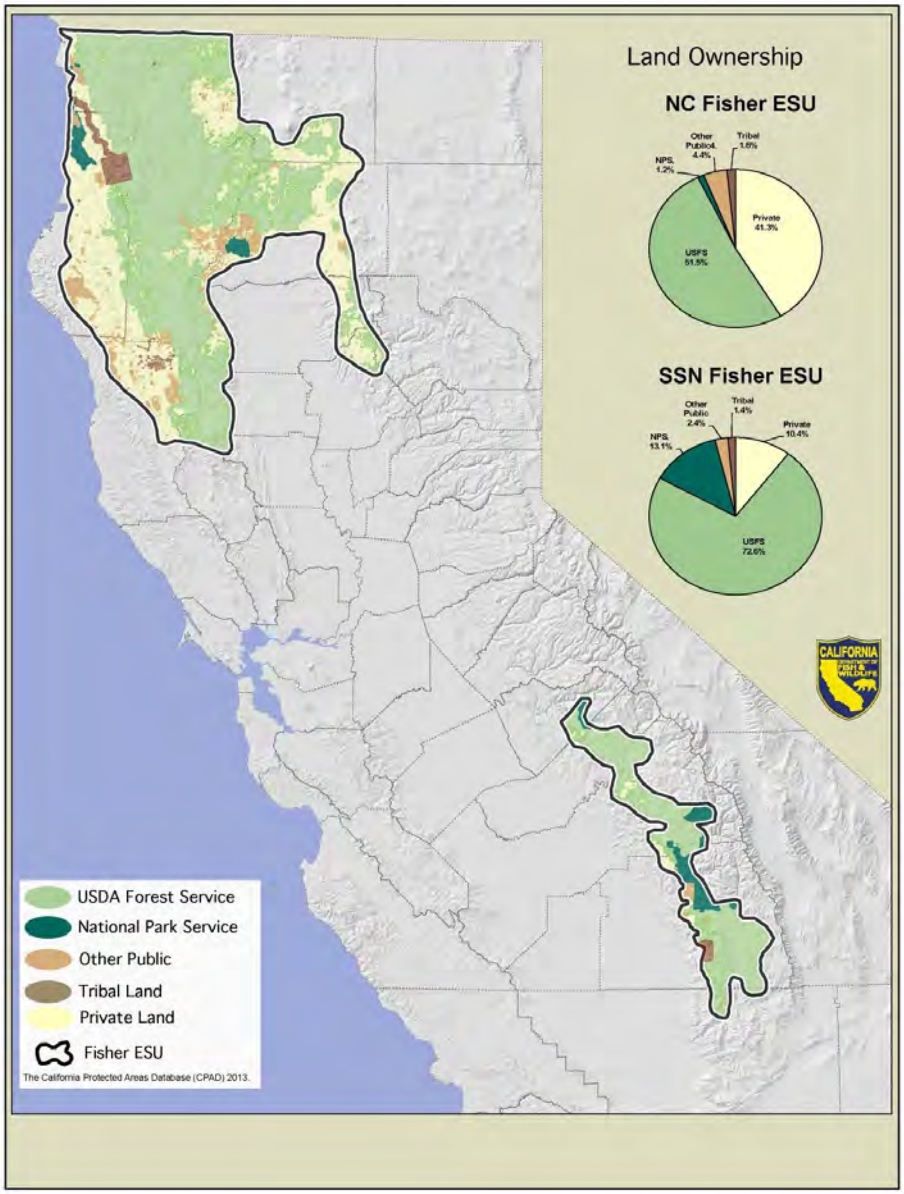


Figure 11. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

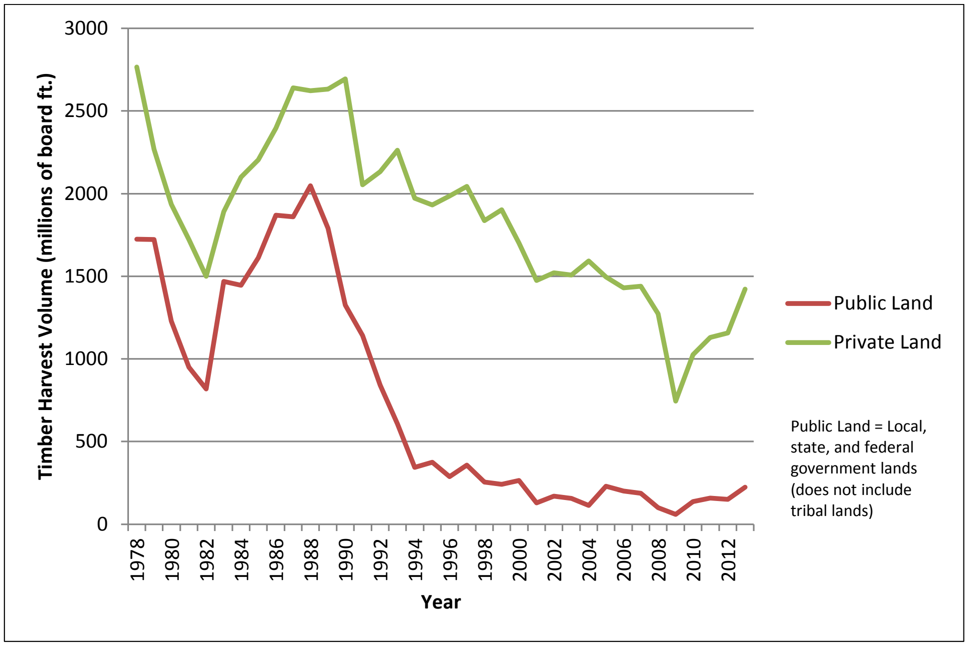


Figure 12. Volume of timber harvested on public and private lands in California (1978-2013) [140].

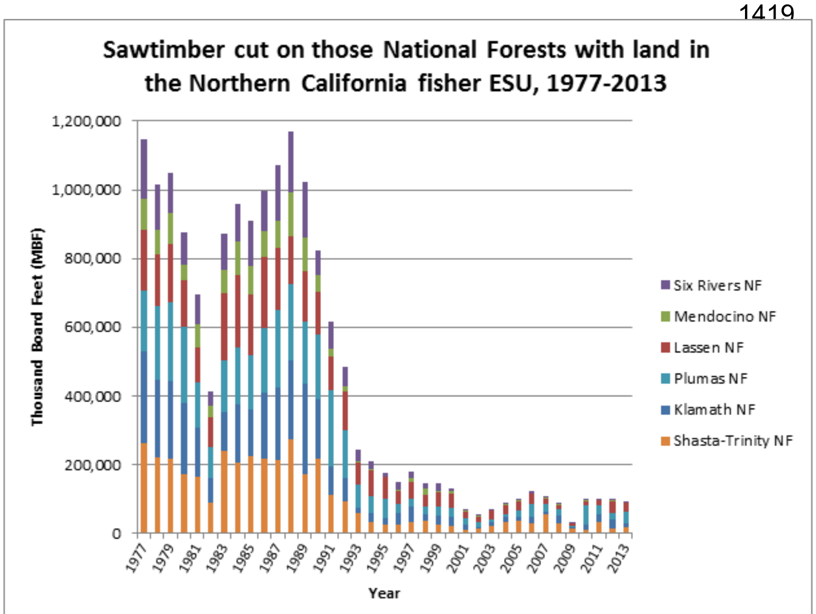


Figure 13. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 [139].

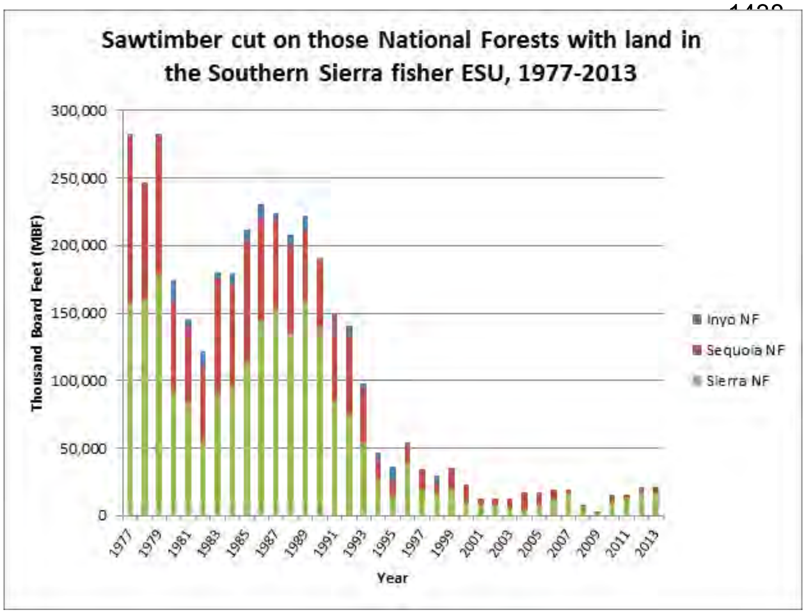


Figure 14. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 [139].

Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. This could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected. However, fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been intensively managed for timber production (Figure 15).

A more proximal concern for the long-term viability of fishers across their range in California is the presence of suitable denning and resting sites and habitats capable of supporting foraging activities. However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California.

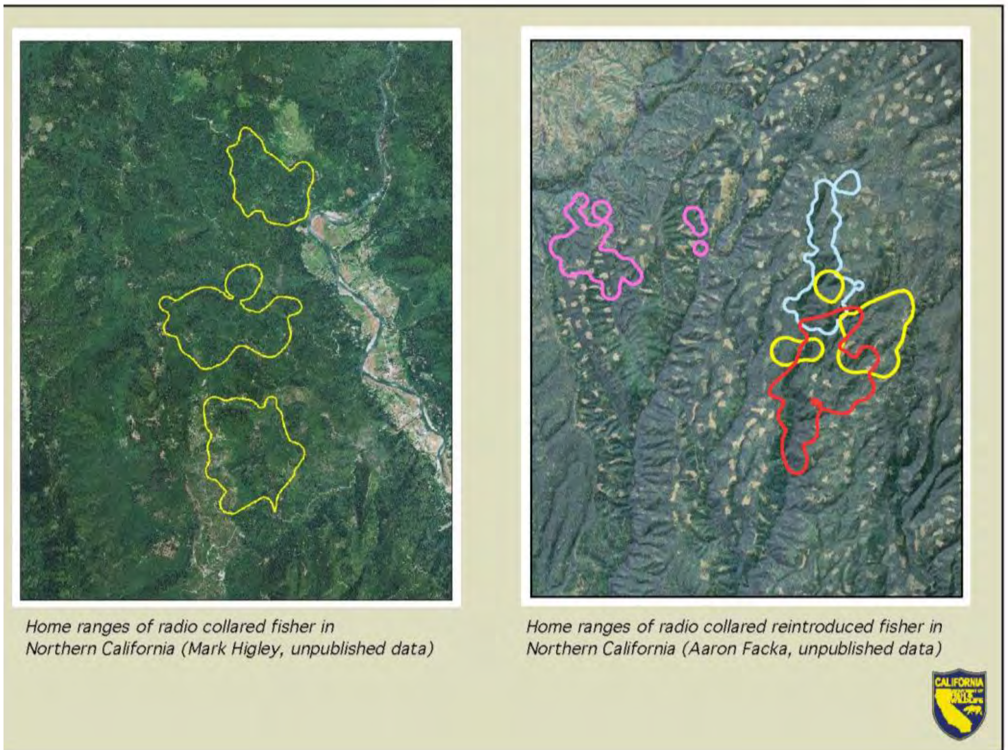


Figure 15. Home ranges of female fishers on managed landscapes in northern California and the northern Sierra Nevada, 2014.

Population Size and Isolation

Grinnell et al. [3], considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. However, few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century [36,38]. However, recent genetic work by Knaus et al. [29] and Tucker et al. [28] indicates fishers in the southern Sierra Nevada became isolated from northern California populations long before European settlement.

Based on Tucker et al. [28], the fisher population in California experienced a significant decline of approximately 90% long before European Settlement, resulting in the isolation of fisher populations in northern California from fishers in the Sierra Nevada. Tucker et al. [28] pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene [141] and would be consistent with the divergence dates of fisher populations in California reported by Knaus et al. [29]. However, in California there were two “mega-droughts” during the Medieval Warm Period (MWP) that lasted over 200 and 140 years each from 832-1074 and 1122-1299 AD, respectively. These droughts may have caused fisher populations to contract isolating the population in the Sierra Nevada from fishers elsewhere in the state [28].

In addition to this early population contraction, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19th century and early 20th century [28]. Tucker et al. [40] suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20th century while fisher in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable based on estimates of occupancy from 2002-2009 [134].

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. Fishers in the southern Sierra Nevada are geographically isolated from breeding populations of fishers elsewhere in the state and do not appear to be expanding their range northward. Should fishers in the southern Sierra Nevada expand their range northward, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, fishers in either location do not appear to be dispersing towards each other and natural contact in the near-term (50 years) is unlikely.

Although fishers in northern California are effectively isolated from fishers in the southern Sierra Nevada, they are part of a regional population that extends into southern Oregon. A fisher that was marked by researchers in Oregon was

subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California [38,91,142,143].

Although fishers do not fully occupy their assumed historical distribution, their population is likely higher than when densities of fishers were estimated by Grinnell et al. [3] at 1-2 per township in good habitat.

Predation and Disease

Predation and disease (including toxins) appear to be the most significant causes of mortality for California fishers. Since 2007, the causes of mortality for radio-collared and opportunistically found fishers from one area in northern California (Hoopa) and the southern Sierra Nevada have been analyzed through gross necropsies, histology, toxicology, and molecular methods. In a sample of 128 fishers from these two populations that died between 2007-2012, predation was the most common cause of mortality (52%), followed by disease/~~toxins~~ toxicants (24%), and vehicular strikes (8%) (M. Gabriel, unpublished data). The proportion of fishers dying from each cause did not differ among these monitored populations, or by sex, which suggests that the relative impact of each source of mortality is similar for both male and female fishers and throughout fisher range in California (M. Gabriel, unpublished data). However, a more recent assessment of predation frequency in southern Sierra Nevada populations suggests predation is by far the greatest source of mortality, reaching nearly 90% of mortality in one Sierra Nevada fisher population (cite 2014 Section 6 report and M. Gabriel, unpublished data). Preliminary assessment of mortality data from 2010-2013 for the northern Sierra Nevada population recently established through translocation is also consistent with these findings (D. Clifford, M. Gabriel and C. Wengert, unpublished data).

Predation: DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project (SNAMP) and King's River projects identified bobcats (*Lynx rufus*) as the predator of 25 sampled fishers (50%), mountain lions (*Puma concolor*) as the predator of 20 sampled fishers (40%) and coyotes (*Canis latrans*) as the predator of 4 fishers (8%). The single remaining carcass had both bobcat and mountain lion DNA present [144].

Comment [Eco7]: Toxins are insults of chemicals produced by a biological organism, it is not the chemicals compounded by humans. These are called toxicants.

Comment [Eco8]: Cite Wengert et al 2014 in The Journal of Wildlife Management 78(4):603–611; 2014; DOI: 10.1002

Comment [Eco9]: The wengert et al 2014 paper should be mentioned too since it highlights predation as a significant contributor, up to 61% of all fisher mortalities.

The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes killed an equal number of male and female fishers [144], though the frequency of coyote predation on fishers was relatively low. These~~is~~ findings suggest~~s~~ that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19/25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival [144].

The proportion of fisher mortalities caused by predation found by Wengert [144] is higher than previously reported in California [145] and British Columbia [52]. Powell and Zielinski [25] suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert [144] indicate that predation is a significant mortality factor for native fisher populations in California. Whether or not some forest management practices favor the existence of more generalist predators (like bobcats) over specialist predators like fishers is not known. However, Wengert [146] found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Disease: A number of viral, bacterial, and parasitic diseases have been documented in fisher. Canine distemper virus (CDV) infection, a cause of significant morbidity and mortality in other carnivore populations [147], was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 [148]. Three of these animals died within a 2-week period from April 22-May 5 and were found within 20 km (12.4 mi) of each other, while the fourth fisher died during an immobilization event 4 months later approximately 70 km (43.5 mi) away from the initial cases. Infection with CDV decreases immune function, thus vital capacity co-infections with other pathogens are common [147].

Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal's ability to survive a capture and immobilization event. The source of the infections in these fishers, as well as pertinent transmission routes remain unclear, but the temporal and spatial distribution of the fisher CDV mortalities, as well as the similarity of the virus isolates, suggest two spillover events from one or multiple other sympatric carnivore species.

In California, CDV mortalities in gray foxes and raccoons are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, CDV has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) [149] and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) [150]. Furthermore, highly virulent biotypes of CDV can be transmitted and cause high mortalities in multiple carnivore species [151] . This scenario was evident by a 2009 CDV outbreak in Switzerland that killed red foxes (*Vulpes vulpes*), Eurasian badgers (*Meles meles*), stone (*Martes foina*) and pine (*Martes martes*) martens, a Eurasian lynx (*Lynx lynx*) and a domestic dog [151].

Although CDV can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 3). Of 98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to CDV [152]. From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the SNAMP area were exposed to CDV [152]. Evidence to date and experiences with other species underscore the fact that CDV has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus (CPV), both potentially significant pathogens for *Martes* species [153], have not been documented in fishers in California. However, virus shedding[29] of CPV has been documented in fisher [152], and clinically significant illness due to CPV was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern

[29] Viral release following reproduction in a host-cell.

California are commonly exposed to and infected with CPV: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 2).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) [154], American minks (*Mustela vision*) [155], and free-ranging southern sea otters (*Enhydra lutris*) [156]. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania [157].

Table 2~~3~~. Prevalence of exposure to canine distemper, canine parvo virus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 [140].

Comment [Eco10]: Correct citation?

	Canine Distemper Percent (No. sampled)	Canine Parvo Virus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) [158], but mortalities of fishers from these diseases have not been reported. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers [153]. Plague is known to cause mortality in other mustelids, is a serious zoonotic[30] risk [159] and is endemic in many parts of California.

Other documented disease-caused fisher mortalities included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown

[30]Zoonotic diseases are contagious diseases that can spread between animals and humans.

helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers and other *Pekania* and *Martes* species harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases, infections and infestations are usually associated with minimal morbidity and mortality [153]. Banci [121] noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell [2].

Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye damage, there were no vision deficits or eye damage noted in affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions [160]. In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination [161]. Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fisher and may have been responsible for local declines in fishers, the Department is not aware of studies indicating that disease is a sole significantly limiting fisher populations in California.

Human Population Growth and Development

The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance from 1970 to 2010 [162,163], the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state [164] and those numbers are expected to reach approximately 53 million by 2060 [165], an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average [166].

The California Department of Forestry and Fire Protection (CAL FIRE) estimated that statewide, between 2000 and 2040, about 2.6 million acres of private forests and rangelands will be impacted by new development [167]. New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 890,000 ha (2.2 million acres). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fisher was comparatively low (6%).

Within the NC and SSN Fisher ESUs, future human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 16, Table 4). This represents an increase of about 1% in the acres developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because parcels of that size likely provide some fisher habitat post-development. In the NC Fisher ESU, slightly more than half of development as of 2010 occurred in habitats predicted to be of intermediate or high value to fishers (Table 5). That percentage is not expected to change substantially by 2030. Within the SSN Fisher ESU, about 60% of past development occurred in habitats predicted to be of intermediate or high value to fishers and that proportion is also not predicted to change substantially by 2030.

Duane [168] identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 17, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). However, the effects of future development on fishers are uncertain. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

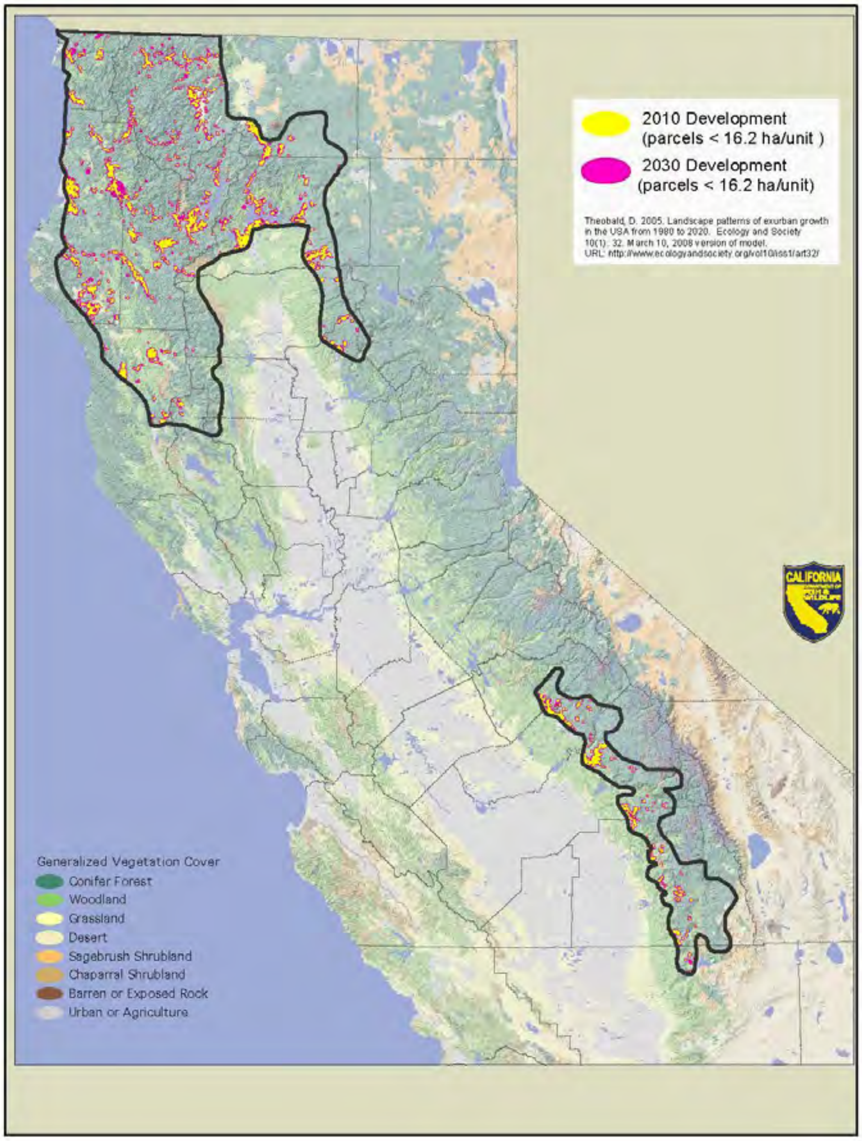


Figure 16. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169]. California Department of Fish and Wildlife, 2014.

Table 3~~4~~. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of Total	Projected Development (2030)	Percent of Total
NC Fisher	4,103,639 (10,140,312)	129,764 (320,654)	3%	160,757 (397,240)	4%
SSN Fisher	778,273 (1,923,155)	32,361 (79,966)	4%	35,845 (88,576)	5%

Table 4~~5~~. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)					
Evolutionarily Significant Unit	Low	Percent of Total	Intermediate	Percent of Total	High	Percent of Total
NC Fisher (2010)	55,954 (138,264)	43%	33,065 (81,706)	26%	39,831 (98,425)	31%
NC Fisher (2030)	69,856 (172,617)	44%	41,952 (103,666)	26%	48,030 (118,684)	30%
SSN Fisher (2010)	11,942 (29,510)	37%	4,213 (10,411)	13%	16,205 (40,044)	50%
SSN Fisher (2030)	14,158 (34,986)	39%	4,758 (11,758)	13%	16,929 (41,832	47%

Figure 17. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Disturbance

Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats the species typically occupies. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off ~~road~~ highway vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be comparatively high. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied, however, monitoring radio-collared females with young provides some insight into their sensitivity

to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. However, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. Most watersheds on private timberlands are harvested at a rate of 1-3% annually (J. Croteau, pers. comm.). Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data).

Recreational use of habitats occupied by fisher in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Roads

Comment [Eco11]: It may be noteworthy to mention that the majority of vehicular struck fishers are unmarked/unmonitored fishers. Very few marked fishers have been killed highlighting that this factor is not a significant additive mortality to CA fishers at the present time.

Fishers occupying habitats containing roads occasionally are struck by vehicles and killed [53,56,100,126]. Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data).

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fisher in California and have been hypothesized to be a potential barrier to dispersal [24,91,170], they have not been demonstrated to limit fisher populations. Roads have not shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County [126].

Fire

Wildfires are a natural part of California's forest ecology and most frequently start as a result of lightning strikes. Wildfires affect habitats used by fisher and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, and the extent of individual fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. [171], believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey.

Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s [172]. In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression [172]. In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok [173] who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act

that established fire exclusion as a national policy and formed the basis for USFS and NPS policies of absolute suppression of fires until those policies were reconsidered in the 1960s [174].

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 102,000 ha/year (252,047 ac/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 [174]. This was based on an estimate of the high fire return interval and was assumed to be similar to the fire rotation [174]. Prior to European settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting [175] and to reduce catastrophic fires [176]. Fires set by indigenous people and fires started by lightning have been estimated to have burned from 2.3 to greater than 5.3 million ha (5.6 to > 13 million acres) annually in California [177].

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more frequent [178]. Westerling et al. [179] found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fisher in California.

In the Sierra Nevada, the severity and the area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy [178]. Miller et al. [180] examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased.

In 1992, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the

largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged post-fire and replanted trees rapidly after the burn [181]. In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, SPI unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fisher using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly comprised of areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm).

The Rim Fire burned approximately 104,000 ha (257,000 ac) in Tuolumne County in August 2013. This fire was situated just north of the SSN ESU. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra population until the vegetation recovers sufficiently to facilitate its use by fishers.

While the frequency and extent of wildfires in the California have increased in recent years, the area burned annually is substantially smaller than in pre-historic (pre-1800) times when 1.8 – 4.8 million ha (4.4 – 11.9 million ac) of the state burned annually [174]. Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity [182] (Figures 18 and 19).

Lawler et al. [183] predicted that fires will be more frequent but less intense by the end of the 21st century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods [184]. Westerling et al. [185], modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California, and potential increases in burned area in the Sierra Nevada

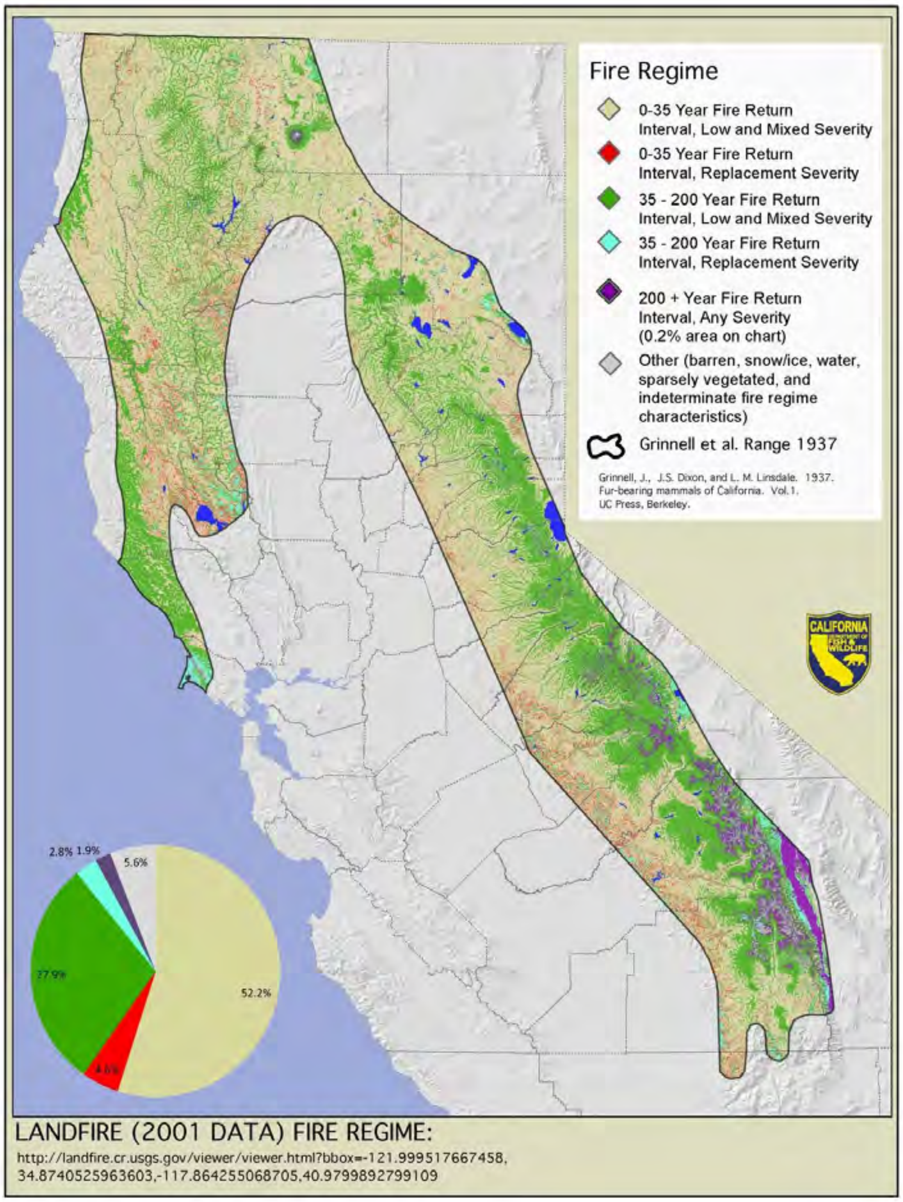
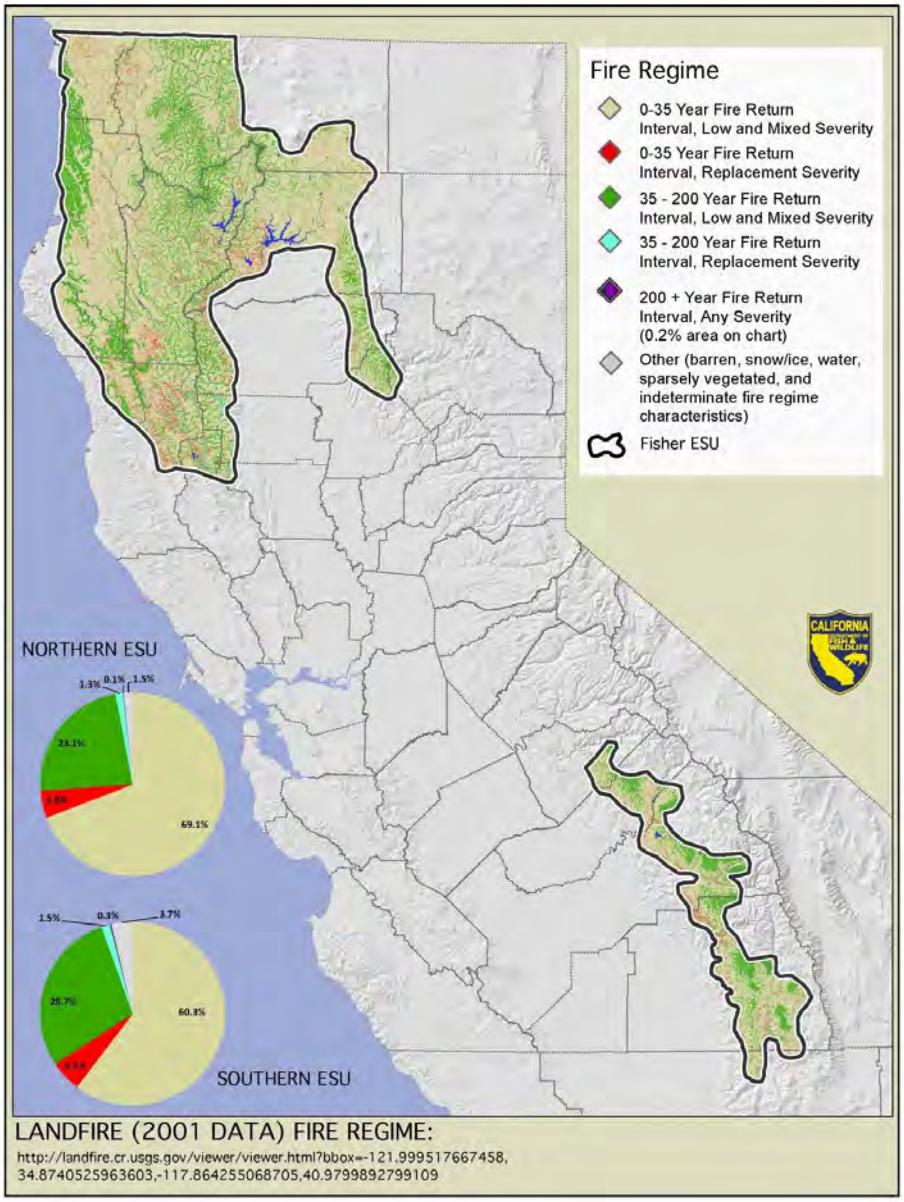


Figure 18. Presumed historical fire regimes within the historical range of fisher in California described by Grinnell et al. [3]. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.



1935 Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant
1936 Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals
1937 and severity were produced using Landscape Fire and Resource Management Tools [182]. California
1938 Department of Fish and Wildlife, 2014.

appeared greatest in mid-elevation sites on the west side of the range [185]. However, the authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predications for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover [171,186,187].

Toxicants

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs) in California fisher populations has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range [153]. Although the source of toxicants to fishers has not been conclusively determined, numerous reports from remediation operations of illegal marijuana cultivation sites (MJCSs) on public, private, and tribal forest lands indicate the presence of a large amount of pesticides, including ARs, at these sites.[31] The presence of a large number of MJCSs within habitat occupied by fisher populations and the lack of other probable sources of ARs suggest that the AR exposure is largely occurring on the cultivation sites.

Fishers are opportunistic generalist predators and can be exposed to toxicants through several routes. They can be exposed directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such tastes as sucrose, bacon, cheese, peanut butter and apple) would also likely appeal to fishers [189]. Furthermore, there have been reports of intentional wildlife poisoning by adding

[31] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As growth sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reports remediating more than 600 large-scale MJCSs on just two of California's 17 national forests [188].

Comment [Eco12]: In addition to remediation, scientist visiting sites at Day 0 (day of raid) have documented toxicants at sites, in addition to finding remaining toxicants at abandoned sites that Law Enforcement were not aware of.

Comment [Eco13]: There is both correlative and first-hand accounts that fisher territories encompass these sites and that these sites have significant quantities of toxicants present. No other sources of exposure are present in these territories, thus leaving the conclusion that these are most likely the source of exposure.

Comment [Eco14]: Citation?

pesticides to food items such as canned tuna or sardines [188]. Many of the pesticides found at MJCSs are liquid formulations that can easily be mixed into food.

As carnivores, fishers could also be exposed to toxicants secondarily through prey. This is likely the primary means of AR exposure because of the ~~toxin's~~ toxicant's persistence in the body tissue of poisoned prey items; secondary exposure of mustelids to ARs has occurred in rodent control operations [190]. Tertiary AR exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed [191] and may be possible in fishers that eat smaller carnivores. Lastly, AR exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer has occurred [189,191].

Anticoagulant Rodenticides: ARs cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impair an animal's ability to produce several key clotting factors. ARs fall into two categories (generations) based on toxicological characteristics and use patterns: first and second generation anticoagulant rodenticides (FGARs and SGARs, respectively). FGARs, developed in the 1940s, are less toxic than SGARs, and require consecutive days of intake by a rodent to achieve a lethal dose. FGARs have a lower ability to accumulate in biological tissue and are metabolized more rapidly [192,193]. There are 60 FGAR products registered in California. Labeled uses of FGARs are commensal rodent (house mice, Norway rats, and roof rats) control and agricultural field rodent control.

Development of SGARs began in the 1970s as resistance to FGARs began to appear in some rodent populations. SGARs have the same mechanism of action as FGARs but have a higher affinity for the target enzymes, leading to greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days) [192,193]. A lethal dose may be consumed at a single feeding. The several days' lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are 79 SGAR products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum. Labeled uses are for the control of commensal rodents in and around residences, agricultural buildings, and industrial facilities, such as food processing facilities and commercial facilities. SGAR products must be placed within 100 feet of man-made structures and may not be used for control of field rodents.

The unexpected discovery of AR residues in a fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project research team prompted monitoring of AR exposure in carcasses of fishers submitted for necropsy from research projects located throughout the fisher's range in California. The livers of 58 fishers that died from 2006-2011 were tested; 79% were positive for AR exposure. Four of these fishers died from AR poisoning. The number of different AR compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers [189]. Of the fishers tested, 96% were exposed to SGARs and the exposure of fishers to ARs was geographically widespread [189].

Gabriel et al. [189] documented the amount of toxicants found at one illegal MJCS in Humboldt County. Among other toxicants, 0.68 kg (1.5 lbs) of brodifacoum, as well as 2.9 kg (6.5 lbs) worth of empty AR bait containers were found. Based on the LD50 value for a domestic dog (5 kg), it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption.

Comment [Eco15]: It would also be worthy to note the #of rodents impacted by this amount, since it was mentioned that secondary exposure is the most likely source. It also highlights the impact to fishers via prey availability.

Comment [Eco16]: It should be mentioned that this report stated the site was within occupied territories by several fishers and they were abandoned sites, posing risks to fishers several years since their activity.

The sublethal impacts of AR exposure to fishers are not fully known. Sublethal effects may include increased susceptibility to disease [194], behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes [195], and reduced reproductive success. The contribution of AR (and other pesticides found on MJCSs) exposure to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer MJCSs located within their home ranges [196]. Studies have suggested that embryos are more sensitive to anticoagulants than are adults [197–199]. AR-related fisher mortalities were concentrated temporally in mid-April and mid-May which is the denning period for fisher females [189]. This raises concerns that mothers could expose their kits to ARs through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Higher AR-related mortalities in spring may be a consequence of more ARs being used at this time to protect young marijuana plants from rodent damage than at other times of the year.

On July 1, 2014, SGARs products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials and their legal use was limited to certified private applicators, certified commercial applicators, or those under their direct supervision. The placement of SGAR bait will generally be prohibited more than

15 m (50 ft) from man-made structures. These new regulations may limit the availability of SGARs, but how effective they will be at reducing the use of SGARs at MJCSs is unknown.

Other Potential Toxicants: Other pesticides deployed at MGCSs have likely caused fisher mortalities: 3 fishers in northern California were suspected to have died as a result of exposure to the carbamate toxicant~~n~~-methomyl, cholecalciferol and bromethalin (Gabriel, unpublished data). Pests at MJCS include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at MJCSs that were presumably used to combat them (Table 6). Some of the organophosphates and carbamates used on MJCSs are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use [200,201]. Volunteer reclamation crews reported that AR and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 [196]. Sixty-eight kilograms of AR and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort in public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km [189].

ARs are persistent in liver tissue, thus the compounds can be detected in liver tissue of sublethally exposed animals for several months following the exposure. Other pesticides such as carbofuran and methamidophos, which are present at the same sites, are more likely to cause immediate mortality, but are much less likely to be detected in fishers because carcasses would need to be recovered quickly from ~~at~~ MJCSs to confirm exposure.

Population-level Impacts: Although it is well documented that anticoagulant rodenticides (ARs) used both legally and illegally have caused mortalities of non-target wildlife species, including fishers [189,192,202–204], the question of whether or not lethal and sublethal exposure to ARs or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed.

To estimate the extent of the current fisher range potentially impacted by MJCSs, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi) and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 20) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.

Table 56. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (MJCSs) (CDFW, IERC, HSVTC unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Comment [Eco17]: Would it worth to mention organic pesticides, which are infrequently discovered . Highlighting that currently, toxic substances tend to be the norm for MJCS.

Class	**Mammalian Toxicity Range**	**Relative Frequency of Occurrence at MJCSs[1]**	**Evidence of Exposure or Toxicity (Gabriel et al. unpublished)**
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Not Detected
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as "occasional" or "common" based on the highest occurrence for any product in each class.

Although AR poisoning resulting in mortality has been documented in four fishers from two geographically separated populations and AR exposure is highly prevalent and geographically widespread [189], the cumulative impact of individual toxicity and exposure is hard to quantify at the population level. Determination of poisoning and exposure usually requires collection of carcasses, and therefore data are only available

Comment [Eco18]: Since the Plos paper exposure rates for CA fishers has climbed to 86% and mortality from AR alone has climbed to 9 fishers (cite as Gabriel unpublished Data)

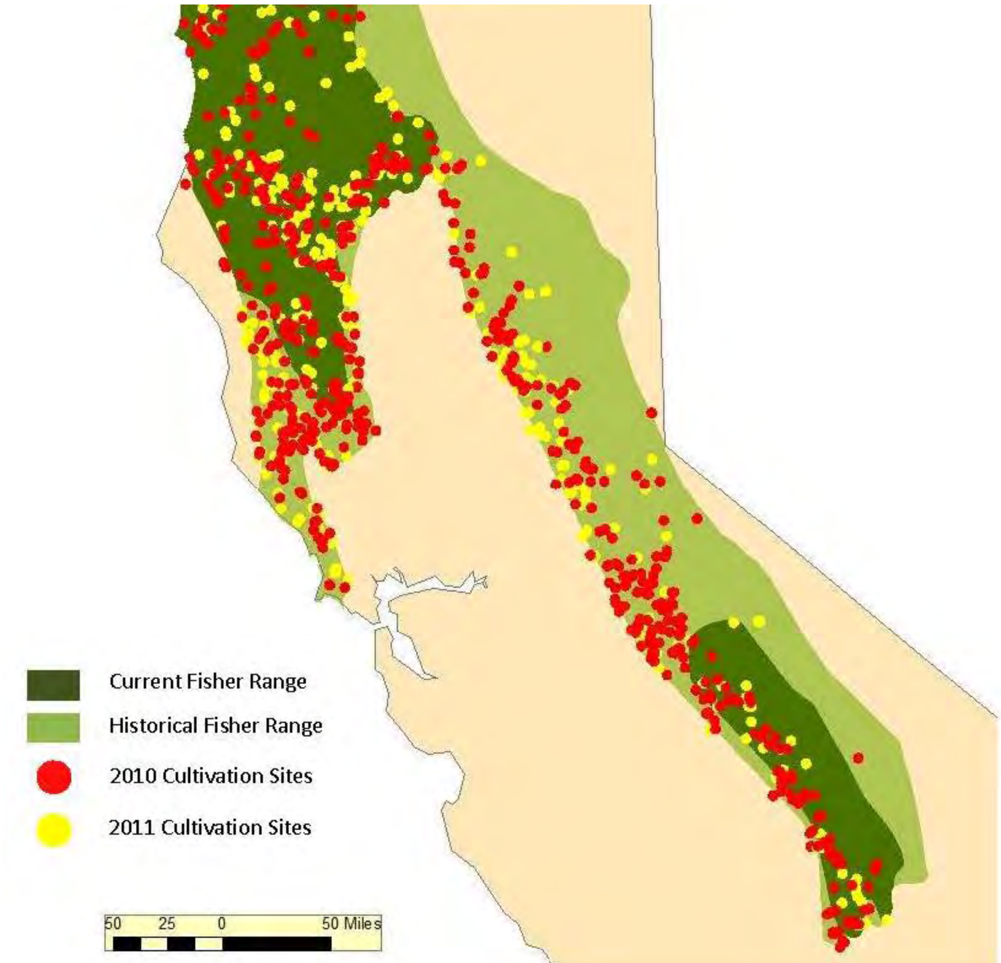


Figure 20. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

for fisher populations where ongoing intensive research (often involving a substantial number of radio collared animals) is conducted. Accordingly, pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected.

Despite these limitations, recent research from the well-monitored southern Sierra Nevada fisher population in California has revealed that female fishers with more MJCSs in their home ranges had higher rates of mortality and a higher likelihood of being exposed to one or more AR compounds [196]. Despite this association, further study is needed to demonstrate that chronic or sublethal AR or other pesticide exposure could predispose a fisher to death from another cause (aka indirect effect). These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival [194,205–212].

Exposure to AR through either milk or placental routes was identified in a dependent fisher kit that died after its mother was killed [189]. Additionally, Gabriel and colleagues observed that AR mortalities occurred in the spring (April-May), a time when adult females are rearing dependent young. Low birth weight, stillbirth, abortion, and bleeding, inappetance and lethargy of neonates have all been documented in other species as a result of exposure to ARs, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of MJCSs located within an individual's home range may start to address this question.

Reductions in prey availability due to pesticide use at MJCSs could potentially impact fisher population vital rates through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant [192], there is potential that MJCSs could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species [213–216]. However, the level of small mammal mortality at MJCSs remains largely unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey remain speculative.

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. A sublethal dose of AR can produce significant clotting abnormalities and some hemorrhaging (Eason and Murphy 2001). Predators with liver concentrations of ARs as low as 0.03ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey [192]. Accordingly, fishers exposed to ARs may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Challenges to investigating toxicant threats from MJCSs within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors [217].

Comment [Eco19]: Safety should be clearly mentioned. That researchers need to collect data at or near MJCS under the protection of law enforcement.

The high prevalence of AR exposure in fishers and other species throughout California indicates the potential for additive and synergistic associations with pesticide exposure at MJCSs and consequently increased mortality from other causes. Small, isolated fisher populations, such as occurs in the SSN Fisher ESU, are of concern because they are more vulnerable to stochastic events than larger populations and a reduction in survivorship may cause a decline or inhibit growth.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s [218,219]. Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years [183]. Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe [218].

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago [220,221]. Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase in California by approximately 2.4 C in California by the 2060s (Pierce et al. [222]) and by 2 to 5 C by 2100 (Cayan et al. [223]). Projections of

precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation [224–226]. However, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation [227]. Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase [222,228]. Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack [229]. These patterns are expected to continue [223–225,230] and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 [231]. Forests throughout the state will likely become more dry [223,224,229].

The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra, rest sites are often located near water [108]. Zielinski et al. [108] suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Warming is predicted throughout the range of the fisher in California [183]. Pierce et al. [222] projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN Fisher ESU may experience greater warming than those occupying portions of the NC Fisher ESU.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their “climatically suitable” range within California by the year 2100 [183]. However, the distribution and climate data for those models was assessed at a 50 x 50 km grid; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California’s montane environments, temperature and other climatic variables

can change considerably over relatively small distances [232]. Thus, the diversity of the physical environment within areas occupied by fisher may buffer some of the projected effects of a changing climate [233].

Climate change is likely to indirectly affect fishers by altering the species composition and structural components of habitats used by fishers in California [183,234]. Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change [179,183,184]. To evaluate potential future climate-driven changes to habitats used by fisher in the state, Lawler et al. [183] combined model projections of fire regimes and vegetation response in California by Lenihan et al. [234] with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs by 2071-2100, as compared to mean cover from 1961-1990 (Table 7).

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands [183]. If woodlands and grasslands within the fisher ESUs expand considerably in the future as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others unsuitable. However, Lawler et al. [183] also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the “floristic conditions” for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. [183] cautioned that their habitat modeling was based on a 10 x 10 km grid, which was a “high resolution for this type of model” and that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales. They further noted that the modeled changes are broad, landscape-scale patterns that will be “filtered” by variability in topography, vegetation and other factors.

Table 6~~7~~. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. [183].

Klamath Mountains - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

Hayoe et al. [225] modeled California vegetation over the same period as Lawler et al. [183] and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. [235] predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100. In the southern Sierra, Koopman et al. [236] modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. [236] also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas.

Burns et al. [237] assessed potential changes in mammal species within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to Yosemite

Comment [Eco20]: And fishers were lost from two NP lands. they are expected to persist in YOSE but it was unclear in the paper if they were in decline or stable.

National Park. Burns et al. [237] suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such "reshuffling" of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health [229,238,239]. Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward [240–242]. Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes [243]. Changes in forest vegetation due to invasive plant species may impact fisher prey species composition and abundance. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state.

Existing Management, Monitoring, and Research Activities

U.S. Forest Service

The majority of land within the current range of the fisher in California is public (approximately 55%) and the majority of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. [3], encompassed all or portions of 13 National Forests including the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia as well as the Tahoe Basin Management Unit.

USFS sensitive species, such as fisher, are plant and animal species identified by the Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within the USFS Pacific Southwest Region are treated as though they were federally listed as threatened or endangered (USDA 1990).

Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA), USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11 National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

U.S. Forest Service – Specially Designated Lands, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan (NWFP) was adopted to guide the management of over 24 million acres of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (NSO) [244]. Adoption of the NWFP resulted in amendment of USFS and the Bureau of Land Management (BLM) management plans to include measures to conserve the NSO and other species, including the fisher, on federal lands.

The NWFP created an extensive and large network of late-successional and old-growth forest (Figure 21). These lands are designated as Congressionally Reserved Areas and Late Successional Reserves and are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan; however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, NSOs, and sites occupied by other species. Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody ([245]).

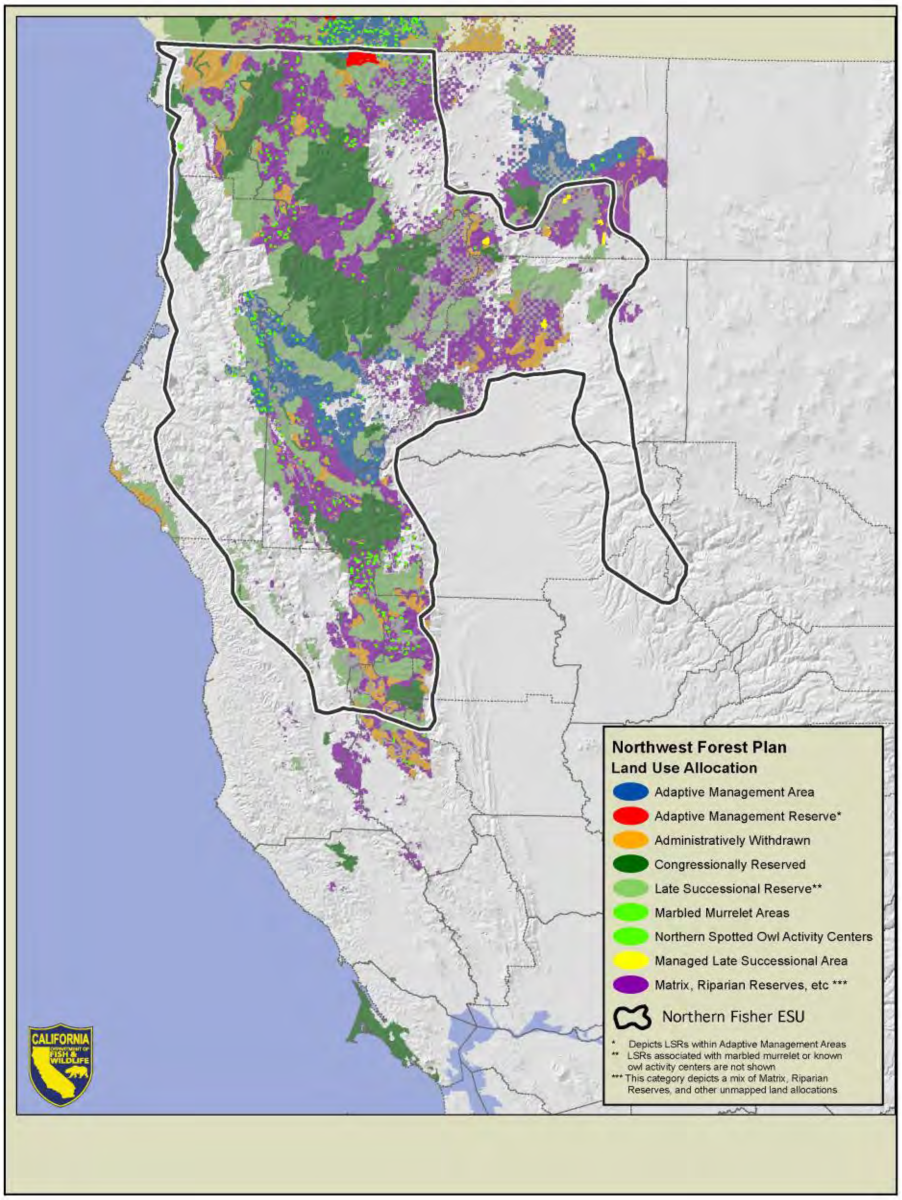


Figure 21. Northwest Forest Plan land use allocations [246]. California Department of Fish and Wildlife, 2014.

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the NSO, the US Fish and Wildlife Service recognized the importance of implementation of the NWFP to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the NSO did not alter land use allocations or change the Standards and Guidelines for management under the NWFP, nor did the rule establish any management plan or prescriptions for the management of critical habitat. However, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the NSO. Those include conservation of older forest, high-value habitat, areas occupied by NSOs, and active management of forests to restore ecosystem health in many parts of the NSO's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality NSO habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised NSO Recovery Plan. NSO critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 22).

Sierra Nevada Forest Plan Amendment (SNFPA): The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the SNFPA by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (USDA 2004). It also amended Land Management Plans for National Forests within the Sierra Nevada.

The Record of Decision for the SNFPA contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the SNFPA conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;

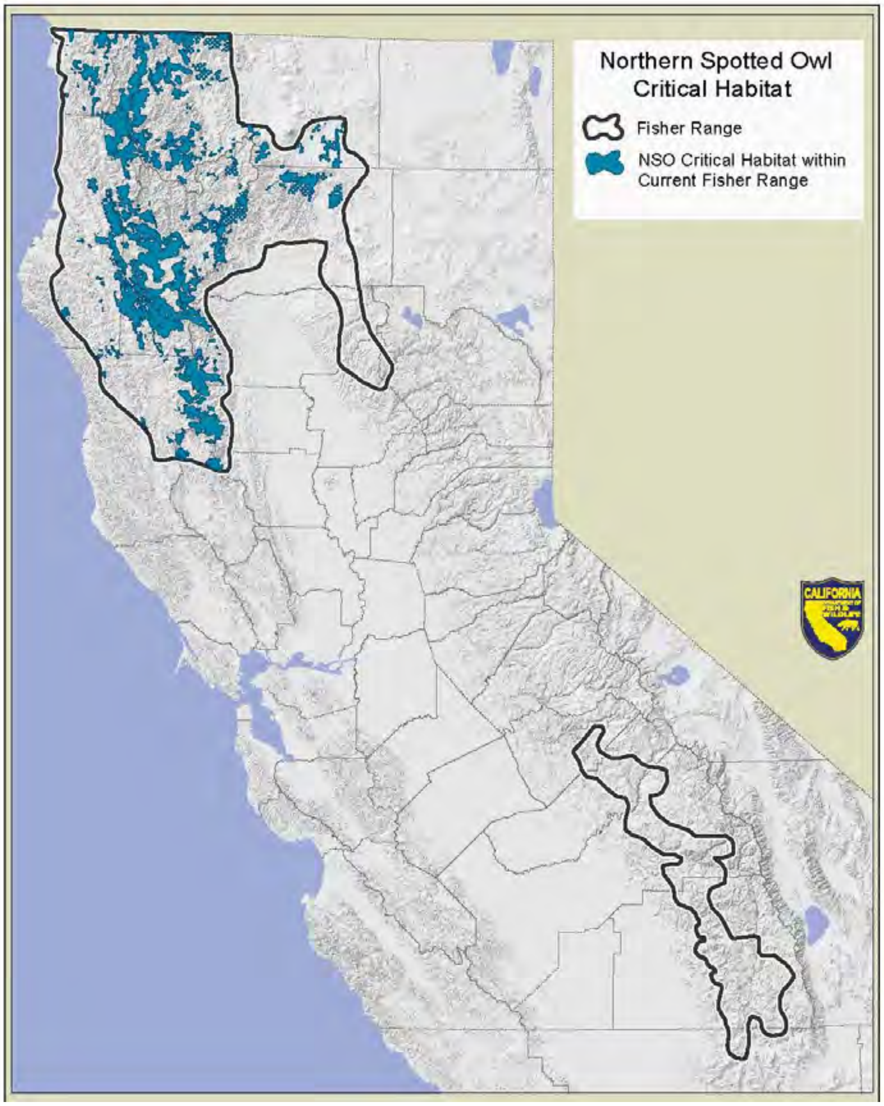


Figure 22. Distribution of northern spotted owl critical habitat within the current estimated range of the fisher in California.

- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and

- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The SNFPA established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit them by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra fisher conservation area
- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 4.9 million acres within the historical range of the fisher described by Grinnell et al. [3]. Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 3.5 million acres and 10 wilderness areas encompassing the southern Sierra population totaling about 416,000 acres. Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 328,315 acre Giant Sequoia National Monument (Monument) is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within the Monument are intended to be managed to support viable populations of these species. Three categories of land allocations within the Monument have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (311,150 acres). The current Management Plan for the Monument lists specific objectives to study and adaptively manage fisher and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project (SNAMP): The SNAMP was initiated in 2005 to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health [247]. A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) and focused on four response variables, including fishers. Researchers are studying factors that may limit the fisher population within SNAMP's study site in the southern Sierra Nevada. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation [248].

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007, in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada [249]. The project area encompasses about 53,200 ha (131,460 ac) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting structures have been identified [249]. Predation has been the primary cause of death of the fishers studied.

Bureau of Land Management

Management of Bureau of Land Management (BLM) lands are authorized under approved Resource Management Plans (RMPs) prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra RMP) include conservation strategies for fishers and other special status species. The Sierra RMP contains objectives to sustain and manage mixed evergreen forest ecosystems in to support viable populations of fisher by conserving denning, resting, and foraging habitats [250]. This plan contains provisions to manage lands within the RMP to support large trees and snags, to provide habitat connectivity among federal lands, and making acquisition of fisher habitat a priority when evaluating private lands for purchase [250].

Management of BLM lands within NSO range are also subject to provisions of the NWFP. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fisher associated with late-successional and old-growth forests [245].

National Park Service

Compared to other public lands which are primarily administered for multiple uses, national parks are among the most protected lands in the nation [251]. The National Park Service (NPS) does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

State Lands

State lands comprise only about one percent of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA). During CEQA review for proposed projects on state lands within fisher range and where suitable habitat is present, potential impacts to fishers are specifically evaluated because the

species is a Department of Fish and Wildlife Species of Special Concern. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (CCR, Title 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the FPRs) that require the preparation and approval of Timber Harvesting Plans (THPs) prior to harvesting trees on California timberlands.

Private Timberlands

The Department estimates that approximately 39% of current fisher range in California is comprised of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act and associated FPRs promulgated by the State Board of Forestry and Fire Protection (BOF). The FPRs are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans (THPs) prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to BOF's rules; and (2) information and direction to timber operators so they comply with BOF's rules (CCR, Title 14, § 1034). The preparation and approval of THPs is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

Under the FPRs (CCR, Title 14, § 897(b)(1)(B)), forest management shall "maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed." Although the FPRs do not require measures specifically designed to protect fishers, elements of these rules provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fisher may be voluntarily retained to achieve post-harvest stocking requirements under the FPR subsection relating to "decadent or deformed trees of value to wildlife" (FPR 912.7(b)(3), 932.7(b)(3), 952.7(b)(3)). Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (WLPZs).

WLPZs are defined areas along streams where the FPRs restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but WLPZs may encompass 15 – 45 m (50-150 ft) on each side of a watercourse 30-91m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. In some locations, WLPZs may constitute 15% or more of a watershed (J. Croteau, pers. comm.). Drier regions of the state with lower stream densities have a much lower proportion of the landscape in WLPZs. Where WLPZs allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes.

Timberland owners with relatively small acreages [<1,012 ha (2,500 acres)] may prepare Non-Industrial Timber Management Plans (NTMPs) designed to provide long-term forest cover on enrolled ownerships which may provide habitat suitable for use by fishers.

For ownerships encompassing at least 50,000 acres, the FPRs require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (CCR, Title 14, § 1091.1, § 913.11, § 933.11, and § 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option is likely to provide forested habitat that is suitable for fishers. However, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare THPs and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The FPRs impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees [trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Portions of the FPRs (CCR, Title 14, §§ 919.16, 939.16, and 959.16) relate to late succession forest stands[32] on private lands. Proposals to harvest late successional stands where the stands' amount, distribution, or functional wildlife habitat value will be reduced and result in a significant adverse impact on the environment must include a discussion of how the species primarily associated with late successional stands will be affected. When long-term significant adverse effects on fish, wildlife, and listed species associated primarily with late successional forests are identified, feasible mitigation measures to mitigate or avoid adverse effects must be incorporated into THPs, Sustained Yield Plans, or NTMPs. Where these impacts cannot be avoided or mitigated, measures taken to reduce them and justification for overriding concerns must be provided.

Some private companies, including large industrial timberland owners and non-industrial timber owners, have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These may include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Private Timberlands – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1992, the Forest Stewardship Council (FSC) was formed to create a voluntary, market-based approach to improve forest practices worldwide [252]. FSC's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity [253]. In California, approximately 1.6 million acres of forest lands are FSC certified [254].

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to "take," as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq.*)(ESA), threatened and endangered species. Applicants for incidental take

[32] Late Succession Forest Stands refers to stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

permits under Section 10 of the ESA must submit an HCP that specifies, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. An HCP may include conservation measures for candidate species, proposed species, and other species not listed under the ESA at the time an HCP is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six HCPs in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods HCP specifically addresses fisher, although other HCPs contain provisions intended to benefit species such as NSO (e.g., Green Diamond Resources Company and Fruit Growers Supply Company) that may also benefit fishers.

Fisher Translocation: From 2009-2012, the Department translocated[33] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra-Pacific Industries (SPI). This effort, the first of its kind in California, was undertaken in cooperation with SPI, USFWS, and North Carolina State University. A primary conservation concern for fisher has been the apparent reduction in overall distribution in the state. Fishers have been successfully translocated many times to reestablish the species in North America [26], and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California [256].

Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites [256]. Those lands represented most of the large, relatively contiguous tracts of SPI land within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto SPI's property, including habitat suitability of candidate release sites, prey availability, genetics, potential impacts to other species with special status, disease, predation, and the effects of removing animals on donor populations.

[33] Translocation refers to the human-mediated movement of living organisms from one area for release in another area [255].

Table 7~~8~~. Approved Habitat Conservation Plans within the range of the fisher in California.

HCP Name	Location	Area (acres)	Permit Period	Covered Species
Green Diamond Resources Company	Del Norte & Humboldt counties	407,000	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	211,000	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Fruit Growers Supply Company	Siskiyou County	152,000	2012-2062 (50 years)	• coho salmon (Southern Oregon/Northern California Coasts ESU) • steelhead (Klamath Mountains Province ESU) • Chinook salmon (Upper Klamath and Trinity Rivers ESU) • northern spotted owl • Yreka phlox
Green Diamond Resources Company	Humboldt and Del Norte counties	417,000	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander
Fisher Family	Mendocino County	24	2007-2057 50 years	• Behren's silverspot butterfly • Point Arena mountain beaver
AT&T	Mendocino County	11	2002-2012 10 years	• Point Arena mountain beaver

From late 2009 through late 2011, 40 fishers (24F, 16M) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release [126]. A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young [126].

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 were born on Stirling [126]. On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California [126]. Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group comprised 47% of the population, suggesting relatively high levels of reproduction and recruitment [126].

Candidate Conservation Agreement with Assurances: A "Candidate Conservation Agreement with Assurances for Fisher" (CCAA) between the USFWS and SPI regarding translocation of fisher to a portion of SPI's lands in the northern Sierra Nevada was approved on May 15, 2008. CCAAs are intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to SPI should USFWS eventually list fisher under the federal ESA. This 20-year permit covers timber management activities on SPI's Stirling Management Area, an approximately 160,000-acre tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge

of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fisher. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society to study the ecology of fishers. Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California.

Management and Monitoring Recommendations

Comment [Eco21]: There is nothing specifically tailored to address the predation topic. Fishers are being predated on at a rate of 60-70% in some projects and within this range for the entire state of CA. Until Wengert et al, initiated a project in 2011-12 to study bobcats in forested areas, this main predator of fishers is lacking relevant studies. It should be noted that predation, the #1 cause of mortality for fishers needs to be addressed and studied to determine if landscape changes, diseases or other factors may be the root of this higher than normal rate of mortality for this species.

The Department has implemented a number of actions designed to better understand fisher in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the BOF, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, and university researchers, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

1. Support independent research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term, multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.

5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations, potential effects of toxicants and their potential effects on fisher and fisher prey. It may be possible to partner with existing studies and surveys to collect some of the data needed.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends. Fishers translocated elsewhere in North America have rarely been monitored and this translocation is the first effort of its kind in the state. Continued monitoring is critical to answer questions about how fishers use managed landscapes and to determine if the project is successful in the long-term and, if not, why it failed.

7. In the southern Sierra Nevada, collaborate with land management agencies and researchers to expand connectivity between core habitats and to facilitate population expansion.

8. Assess the potential for assisted dispersal of juvenile fishers or translocation of adults from the southern Sierra population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region.

Summary of Listing Factors

CESA directs the Department to prepare this report regarding the status of the fisher in California based upon the best scientific information. Key to the Department's analyses are six relevant factors highlighted in regulation. Under the California Code of Regulations, Title 14, § 670.1, subd. (i)(1)(A), a "species shall be listed as endangered or threatened...if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:"

(1) present or threatened modification or destruction of its habitat;
(2) overexploitation;

(3) predation;
(4) competition;
(5) disease; or
(6) other natural occurrences or human-related activities

Also key are the definitions of endangered and threatened species, respectively, in the Fish and Game Code. CESA defines endangered species as one “which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease.” (Fish & G. Code, § 2062.) A threatened species under CESA is one “that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067.)

Fishers in California occur in two separate and isolated populations that differ genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units where appropriate in its analysis of listing factors.

Present or Threatened Modification or Destruction of its Habitat

Considerable research has been conducted to understand the habitat associations of fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types [105,119–122]. Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. Forested landscapes with these characteristics are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Thresholds for these attributes for fishers are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

Management of Federal Lands: Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The

majority of federal actions must comply with NEPA. This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

The status of fisher as a sensitive species on USFS and BLM lands in California provides consideration for the species as guided by land management plans adopted by these agencies. As a result, substantial federal lands currently occupied by fishers in the state are managed to provide habitat for fishers, although specific guidelines are frequently lacking. Federal lands designated as wilderness areas or as National Parks are likely to provide long-term protection of fisher habitat. However, some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur.

Management of Private Lands: Timber harvest activities on private lands are regulated by various provisions of the Z'Berg Nejedly Forest Practice Act of 1973 and additional rules promulgated by the State Board of Forestry and Fire Protection. These rules are enforced by CAL FIRE and, although some timber harvest activities are exempt from these rules, they apply to all commercial harvesting activities on private lands.

The FPRs promulgated under the act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. However, information about what constitutes the "existing wildlife community" is frequently lacking in THPs, and specific guidelines to retain habitat for fishers and other terrestrial mammals are not incorporated into the FPRs.

Timber management activities subject to the FPRs can reduce the suitability of habitats used by fishers or render some areas unsuitable. These changes may be short-term or long-term, depending on a number of factors including the type of silviculture used, intermediate treatments conducted while forests regrow, timber site growing potential, and the time between timber rotations.

Fishers are able to utilize a diversity of forest types and seral stages. An aspect of forest management important to the suitability and long-term viability of fishers is the retention and recruitment of habitat elements for denning, resting, and to support prey

populations in sufficient number and in locations where they can be successfully captured by fisher. The FPRs require the retention of unmerchantable snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However, live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites. No provision is provided in the rules to specifically recruit snags.

The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. The time interval between harvests may also affect the distribution and abundance of habitat structures used by fishers. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity [88]. Frequent harvest entries to salvage dead, dying, and diseased trees likely reduce the availability of these habitat elements. Retention of forest cover and large trees is a requirement of the FPRs along streams (i.e., WLPZs), with the width of these areas determined by stream class, slope, and the presence of anadromous salmonids.

The FPRs do not specifically require the retention or recruitment of hardwoods and, in some cases, their harvest may be required to meet stocking standards. Hardwoods may also be intentionally killed ("hack-and-squirt" herbicide application or felled) individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of habitats used by the species. Various hardwood species provide potential den and rest trees and habitat used by fisher prey. Although the FPRs do not require retention of hardwoods, the Department is not aware of data indicating that their removal on commercial timberlands has substantially affected the distribution or abundance of fishers in California.

Depending on their location, WLPZs may comprise up to 15 percent of private ownerships managed for timber production. Drier regions of the state with lower stream densities have a much lower proportion of the landscape designated as WLPZs. Where they are managed to retain or recruit trees suitable for denning and resting, WLPZs may provide a network of older forest structure within managed forest landscapes beneficial to fishers and provide denning, resting, and foraging habitat for fishers. Outside of WLPZs, trees suitable for denning or resting by fishers are not required to be retained;

however they may be intentionally left by landowners to meet post-harvest stocking requirements.

The effects of future timber harvest activities on habitats used by fishers cannot be accurately predicted as changes in regulations, policies, and market conditions influence management intensity. Independent of the FPRs, trees of value to fishers may remain on landscapes through timber rotations because they are unmerchantable, are located in areas where access is infeasible, or because of company policies. Some private companies have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Fire: In recent decades the frequency, severity, and extent of fires has increased in California. This has varied statewide, with the greatest increases in fires severe enough to eliminate forest stands occurring in the Sierra Nevada, southern Cascades, and Klamath Mountains. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. However, the contemporary extent of wildfires burning annually in California is considerably less than the estimated 1.8 million ha (4.5 million ac) that burned annually in the state prehistorically (pre 1800) [174].

The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due its small size, the comparatively linear distribution of the habitat available, and predicted future climate changes. Timber harvest activities in portions of the southern Sierra Nevada occupied by fisher are largely under federal management. These National Forests in the SSN ESU have adopted specific guidelines to protect habitats used by fishers.

Within the NC Fisher ESU, fishers are comparatively widespread across a matrix of public and private forest lands. With the exceptions of Lake, Sonoma, and Marin counties, fishers currently occur throughout much of the historical range assumed by Grinnell et al. [3].

Overexploitation

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable ([123]. The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917-1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers [3] and were also likely harvested by trappers seeking other furbearers [123].

Since the mid-1800s, the distribution of fisher in North America contracted substantially, in part, due to over-trapping and mortality from predator control programs [26]. Over-trapping of fisher has been considered a significant cause of its decline in California [3]. By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season [3]. Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fisher a prize catch.

Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period from 1920-1924 was only 46 animals [3]. Fishers were considered to be rare in California by the early 1920s [124]. Grinnell et al. [3] considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of fisher in California [3]. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue.

The high value trappers obtained for the pelts of fisher in the early 1900s, the species' vulnerability to trapping [8], and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations [26]. Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [124]. However, despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fisher was not prohibited until 1946 [125]. Although commercial

trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (see Lewis et al. [123]). Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers [8], or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations [8] and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (Fish & G. Code, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designee are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 23), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly

over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to

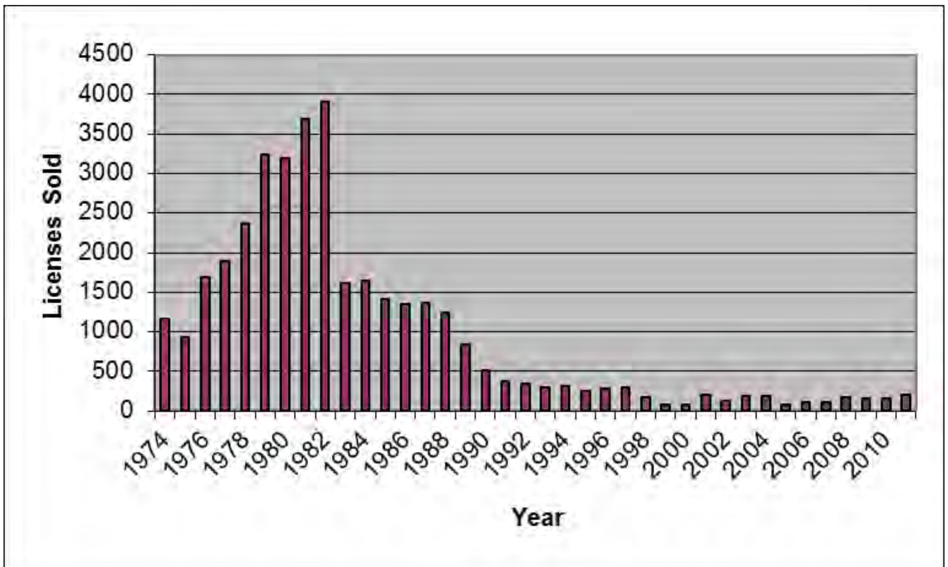


Figure 23. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

increase [257]. From the early 1980s through the present, license sales have continued to decrease with average sales from 2000-2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. However, throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators typically work in close proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by certain species of wildlife. However, fishers are not permitted to be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).

Currently and in the foreseeable future, the likelihood of fishers being overexploited in California is low, based on the prohibition against commercial or recreational take of fishers, low level of commercial and recreational trapping and prohibition of body-gripping traps. The Department is not aware of any data indicating that the potential risk to fisher populations from incidental take due to trapping differs significantly for populations in NC or SSN Fisher ESUs.

Predation

Recent research indicates predation is a substantial cause of mortality for fishers in California [144]. This research, using DNA amplified from fisher carcasses, identified bobcat, mountain lion, and coyote as predators of fishers, with predation attributed to bobcat being the most frequent (50%).

The risk of predation is likely heightened when fishers occupy habitats in close proximity to open and brushy habitats (G. Wengert, pers. comm.), both habitats used extensively by bobcats. Female fishers are more likely to be predated by bobcats and this occurs most frequently during the breeding season when young fishers are dependent on their mothers for survival. Fragmentation of forested landscapes may increase the abundance of some small mammal species used by fishers as prey, but it may also favor potential predators adapted to early successional habitats. However, fishers have co-evolved with the suite of predators naturally occurring within their range and adverse population level effects on fishers due to predation have not been documented.

Comment [MG22]: Can cite Wengert 2013, dissertation

Currently, there is no information indicating differential risk of predation to fisher in the NC or SSN Fisher ESUs. Based on a sample of 50 fisher carcasses from these regions, no difference in the relative frequencies of predation by bobcat or mountain lion was found. Fishers in the SSN Fisher ESU are likely at greater risk of population level effects of predation due to the small size of their population compared to northern California. However, fishers in the southern Sierra Nevada have apparently been isolated in that region for decades or longer and, at times, their numbers may have been smaller than they are today. The abundance of potential predators of fishers during those periods is unknown, but they likely co-occurred with fisher populations in the region.

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood [24]. Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines [24,25,106]. Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Also, the relative similarities in body size, body shape, and prey between fisher and martens suggest the potential for competition between these species [24]. However, in California, martens typically occur at higher elevations than fisher and thus may have evolved strategies to minimize competition by separation and by exploiting somewhat different habitats. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have evolved with other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California. There is no evidence that fisher populations in either NC or SSN Fisher ESUs are adversely affected by competition with other species. However, landscape level habitat changes that favor population increases in competitors may intensify interspecific competition.

Comment [MG23]: May want to look at J. Gilbert's dissertation that documented likely competition between bobcat and fisher in Wisconsin, bobcat kitten survival decreased with reintroduction of fisher, suggesting some form of competition, with bobcat recruitment suffering.

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years [152,158,161,258]. Fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or spill over from other species of carnivores.

Canine distemper virus (CDV) is common in gray fox and raccoon populations in California and both species occur in habitats occupied by fishers. Although studies have shown that fisher may survive CDV infections, outbreaks of highly virulent biotypes have been responsible for the near extirpation of other carnivore species including other mustelids. Deaths caused by other pathogens potentially significant for *Martes* (i.e., rabies, canine parvo virus), have not been documented for fisher in California. Although

canine parvo virus has been documented to cause clinical disease in fishers, testing to date indicates that the disease is circulating in California fishers without causing population level impacts.

Exposure of fishers to *Toxoplasma gondii* in both northern California and the southern Sierra Nevada has been documented. Although this parasite has caused mortality in other mustelids, it has not been documented as a source of mortality in fisher. This is also the case for known vector borne pathogens. Fisher harbor numerous ecto- and endoparasites and, although some can serve as vectors for other diseases, they are usually associated with minimal morbidity and mortality.

There is no evidence indicating that the prevalence of pathogens potentially affecting fishers in the state differs significantly between populations within the NC and SSN Fisher ESUs. The fisher population in the southern Sierra Nevada is likely at a higher risk of diseases that cause significant morbidity or mortality due to the population's isolation and comparatively small size. Although there is no evidence that CDV has caused substantial population declines in fisher, it is a pathogen of conservation concern for fisher and health surveillance of populations is prudent to detect and intervene to the extent possible, if needed.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution of fisher in California appears to have changed substantially before and after European Settlement. Although its precise distribution prior to the 1800s is unknown, based on recent genetic evidence, the fisher population in the state declined dramatically and contracted into two separate populations long before that time. Further reductions in range and abundance were likely post-European Settlement due to over trapping, predator control programs, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. Since trapping of fishers was prohibited in 1946 and the use of body-gripping traps was banned in 1998, the number of fishers in California has increased to levels likely higher than existed during the period of unregulated trapping in the mid-1800s to early 1900s.

The fisher population within the SSN Fisher ESU is likely at greater risk of extirpation due to its small size (recently estimated at <250 individuals [134]), limited geographic range, and isolation compared to fishers in northern California. Small, isolated

populations are subject to an increased risk of extinction from stochastic (random) environmental or demographic events. Small populations are also at greater risk of adverse impacts resulting from the loss of genetic diversity, including inbreeding depression. The probability of this occurring in fisher occupying either the NC Fisher ESU or the SSN Fisher ESU is unknown. Events such as drought, high intensity fires, and disease, should they occur, have a higher probability of adversely affecting the fisher population in the southern Sierra Nevada. Currently, fishers nearest to the southern Sierra Nevada population are those translocated to the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). Fishers within the SSN Fisher ESU are likely to remain isolated in the foreseeable future due to that distance and potential barriers to movement.

Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population [40]. Fishers within the NC Fisher ESU are also largely isolated from other populations of fishers, although their population is contiguous with a small population in southern Oregon. Despite its isolation, the fisher population in northern California is comparatively large, distributed over a large geographic area, and its distribution has apparently not contracted, and may have slightly expanded, in recent decades. Over the last 8 years, occupancy rates of fishers in the southern Sierra have been stable [134]. Although long-term monitoring of population abundance and trends is lacking for fishers within the NC Fisher ESU, surveys from this region and recent estimates of relatively high rates of occupancy indicate that the population has not declined substantially in recent decades.

Toxicants

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and potentially to other toxicants. ARs have caused the deaths of some fishers, and within the SSN Fisher ESU there is a correlation between the presence of MJCSs within a fisher's home range and reduced survival. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data have been collected to quantify usage. In addition, use practices are largely unknown. Food containers that appear to have been spiked with pesticides and piles of bait have been found on MJCSs indicating intended poisoning of wildlife. However, containers are often found onsite without signs of where the material was

applied. In addition, it is important that MJCSs be searched for fisher and other wildlife carcasses, that these be quantified, and that the appropriate body tissues be analyzed for residues of contaminants.

There is incomplete understanding of effects of contaminants on fishers. Also unknown is the effect of multiple exposures of the same contaminant, similar contaminants, and contaminants with different modes of action. It is also unknown if there are potentially additive effects of contaminants with other stressors on individual fishers. ARs may also have indirect effects by predisposing fishers to other sources of mortality such as predation or accidents. AR toxicants were found at MJCSs in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented.

Although limited population level monitoring of fishers has occurred, the species' distribution in California does not appear to have changed appreciably in decades. If toxicant use has been widespread, long-term, and caused substantial mortality, it is likely that new gaps in the range of fishers or declines in capture rates would have been observed due to the extensive efforts conducted since the early 1990s to detect and study the species. However, evidence of exposure in fishers and the documented deaths of a number of animals indicate this is a potentially significant threat that should be closely monitored and evaluated. Exposure to toxicants at MJCSs has been documented in both the NC and SSN Fisher ESU, but there is insufficient information to determine the relative risk to either population. However, the potential risk to fishers within the SSN Fisher ESU may be greater due to its comparatively small population size.

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant communities. The effect of warming

temperatures on mountain ecosystems will most likely be complex and predicting how ecosystems will be affected in particular areas is difficult. Some bioclimatic modeling (Lawler et al. [183]) broadly predicts that the climate in much of California may be unsuitable for fishers by 2100. Several papers that have modeled vegetation change suggest that within those portions of California currently occupied by fishers, conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation) [183,225,235]. These predictions notwithstanding, they are based on long-term models that utilize broad climate and vegetation parameters that largely do not reflect the fine-scale variation (in both climate and vegetation diversity) typically found in the topographically and ecologically diverse montane habitats of California.

Fishers within the SSN Fisher ESU are likely more vulnerable to the potentially adverse effects of warming climate than fishers in northern California. The comparatively small size of the population in the southern Sierra, its linear distribution, and potential barriers to dispersal (the 2013 Rim Fire area, river canyons, etc.) increase the likelihood that it will become fragmented and decline in size during this century. The fisher population within the NC Fisher ESU is comparatively large and well distributed geographically, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain.

While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state, and its severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century. As the 21st century progresses and population data continue to be compiled, scientists will become better informed as to effects of a warming environment on California's fisher population. Continued monitoring of fisher distribution and survival over the ensuing decades will provide information about the immediacy of this threat.

Listing Recommendation

“Endangered species” means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (FGC §2062). "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter” (FGC §2067).

The Department recommends that designation of the fisher in California as threatened/endangered is _______.

Protection Afforded by Listing

CESA defines “take” to mean “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful absent take authorization from the Department (FGC §§ 2080 et seq. and 2835). Take can be authorized by the Department pursuant to FGC §§ 2081.1, 2081, 2086, 2087 and 2835 (NCCP).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and

ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fisher would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fisher because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Economic Considerations

The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).

Literature Cited

1. Douglas CW, Strickland MA (1999) Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

2. Powell RA (1993) The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

3. Grinnell J, Dixon JS, Linsdale JM, University of California B, Museum of Vertebrate Zoology (1937) Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. Berkeley, Calif.: University of California press.

4. Buskirk SW, Ruggiero LF (1994) American Marten. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 186.

5. Lewis JC, Stinson DW (1998) Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

6. Coulter M. (1966) The ecology and management of fishers in Maine Syracuse, New York, USA: University, Syracuse.

7. Pittaway RJ (1978) Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Nat Can 105: 487–489.

8. Douglas CW, Strickland MA (1987) Fisher. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. Ontario, Canada: Ontario Ministry of Natural Resources.

9. Erxleben JCP (1777) Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

10. Goldman FA (1935) New American mustelids of the genera Martes, Gulo, and Lutra. Proc Biol Soc Wash 48: 175–186.

11. Rhoads SN (1898) Contributions to a revision of the North American beavers, otters and fishers. Trans Am Philos Soc 19: 417–439.

12. Hagmeier EM (1959) A reevaluation of the subspecies of fisher. Can Field Nat 73: 185–197.

13. Hosoda T, Suzuki H, Harada M, Tsuchiya K, Han S-H, et al. (2000) Evolutionary trends of the mitochondrial lineage differentiation in species of genera Martes and Mustela. Genes Genet Syst 75: 259–267.

14. Stone KD, Cook JA (2002) Molecular evolution of Holarctic martens (genus Martes, Mammalia: Carnivora: Mustelidae). Mol Phylogenet Evol 24: 169–179.

15. Koepfli K-P, Deere K, Slater G, Begg C, Begg K, et al. (2008) Multigene phylogeny of the Mustelidae: resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biol 6: 10.

16. Sato JJ, Wolsan M, Minami S, Hosoda T, Sinaga MH, et al. (2009) Deciphering and dating the red panda's ancestry and early adaptive radiation of Musteloidea. Mol Phylogenet Evol 53: 907–922.

17. Wolsan M, Sato JJ (2010) Effects of data incompleteness on the relative performance of parsimony and Bayesian approaches in a supermatrix phylogenetic reconstruction of Mustelidae and Procyonidae (Carnivora). Cladistics 26: 168–194.

18. Nyakatura K, Bininda-Emonds OR (2012) Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. BMC Biol 10: 12.

19. Sato JJ, Wolsan M, Prevosti FJ, D'Elía G, Begg C, et al. (2012) Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Mol Phylogenet Evol 63: 745–757.

20. Baldy R, Beck R, Carpenter C, Carpenter W, Golla V, et al. (1996) Hupa language dictionary. Second. Hoopa, CA: Hoopa Valley Tribal Council. 131 p.

21. Samuels JX, Cavin J (2013) The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. J Vertebr Paleontol 33: 448–454. doi:10.1080/02724634.2013.722155.

22. Eshelman R, Grady F (1984) Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. In: McDonald JN, Bird SO, editors. The Quaternary of Virginia - A symposium volume. Charlottsville, Virginia: VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Vol. 75. pp. 43–70.

23. Graham RW, Graham MA (1994) The late Quaternary distribution of Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

24. Lofroth EC, Raley CM, Finley LL, Naney RH (2010) Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

25. Powell RA, Zielinski WJ (1994) Fisher. General Technical Report. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Available: http://treesearch.fs.fed.us/pubs/27328. Accessed 11 October 2013.

26. Lewis JC, Powell RA, Zielinski WJ (2012) Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7: n/a. doi:http://dx.doi.org/10.1371/journal.pone.0032726.

27. Gibilisco CJ (1994) Distributional dynamics of modern Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables,

and fishers: biology and conservation. , Ithaca, New York, USA: Cornell University Press.

28. Tucker JM, Schwartz MK, Truex RL, Pilgrim KL, Allendorf FW (2012) Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS One 7.

29. Knaus BJ, Cronn R, Liston A, Pilgrim K, Schwartz MK (2011) Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC Ecol 11: 10.

30. Grinnell, J, Dixon J, Linsdale M (1930) Vertebrate natural history of a section of northern California through the Lassen Peak region. University of California Publications in Zoology. 594 p.

31. Price WW (1894) Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE Biol J 4: 315–332.

32. Aubry KB, Jagger LA (2006) The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. In: Santos-Reis M, Birks JDS, O'Doherty EC, Proulx G, editors. Martes in Carnivore Communities. Alberta, Canada: Alpha Wildl. Publ.

33. McKelvey KS, Aubry KB, Schwartz MK (2008) Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58: 549–555.

34. Aubry KB, Lewis JC (2003) Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biol Conserv 114: 79–90. doi:http://dx.doi.org/10.1016/S0006-3207(03)00003-X.

35. Zielinski WJ, Truex RL, Schlexer FV, Campbell LA, Carroll C (2005) Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. J Biogeogr 32: 1385–1407.

36. Zielinski WJ, Kucera TE, Barrett RH (1995) Current distribution of the fisher, Martes pennanti, in California. Calif Fish Game 81: 104–112.

37. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

38. Drew RE, Hallett JG, Aubry KB, Cullings KW, Koepf SM, et al. (2003) Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Mol Ecol 12: 51–62.

39. Talking Glossary: "Haplotype" (n.d.). Available: http://www.genome.gov/glossary/index.cfm?id=99. Accessed 4 September 2014.

40. Tucker JM (2013) Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada The University of Montana.

41. Wright PL, Coulter MW (1967) Reproduction and growth in Maine fishers. J Wildl Manag: 70–87.

42. Leonard RD (1986) Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Can Field-Nat Ott ON 100: 32–44.

43. Eadie WR, Hamilton WJ (1958) Reproduction in the fisher in New York. N Y Fish Game J 5: 77–83.

44. Frost HC, Krohn WB (1997) Factors affecting the reproductive success of captive female fishers. In: Proulx G, Bryant HN, Woodward PM, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB. pp. 100–109.

45. Paragi TF, Arthur SM, Krohn WB (1994) Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Can Field-Nat Ott ON 108: 52–57.

46. Arthur SM, Krohn WB (1991) Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J Mammal: 72–2.

47. Mead RA (1994) Reproduction in Martes. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 404–422.

48. Frost HC, Krohn WB, Wallace CR (1997) Age-specific reproductive characteristics in fishers. J Mammal 78: 598–612.

49. Aubry KB, Raley CM (2006) Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report. Olympia, WA: USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory.

50. Higley JM, Matthews S (2006) Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report. Hoopa Valley Tribe and Wildlife Conservation Society.

51. Self S, Callas R (2006) Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pac Ind Calif Dep Fish Game.

52. Weir RD, Corbould FB (2008) Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Prince George, British Columbia, Canada: Peace/Williston Fish & Wildlife Compensation Program.

53. Truex RL, Zielinski WJ, Golightly RT, Barrett RH, Wisely SM (1998) A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft Rep Submitt Calif Dep Fish Game U S For Serv Pac Southwest Res Stn Arcata Calif.

54. Hall ER (1942) Gestation period in the fisher with recommendations for the animal$\backslash$’s protection in California. Calif Fish Game 28: 143–147.

55. Paragi TF, Krohn WB, Arthur SM (1994) Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildl 51: 1–11.

56. York EC (1996) Fisher population dynamics in north-central Massachusetts University of Massachusetts at Amherst.

57. Matthews SM, Higley JM, Rennie KM, Green RE, Goddard CA, et al. (2013) Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. J Mammal 94: 100–108.

58. Bachelot A, Binart N (2005) Corpus luteum development: lessons from genetic models in mice. Curr Top Dev Biol 68: 49–84. doi:10.1016/S0070-2153(05)68003-9.

59. Kelly GM (1977) Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas University of Massachusetts. Available: http://agris.fao.org/agris-search/search/display.do?f=2013/US/US2013054260005426.xml;US201300542658. Accessed 11 October 2013.

60. Crowley SK, Krohn WB, Paragi TF (n.d.) A comparison of fisher reproductive estimates. Trans Northeast Sect Wildl Soc 47: 36–42.

61. Weir RD (2003) Status of the fisher in British Columbia. BC Minist Sustain Resour Manage Conserv Data Cent BC Minist Water Land Air Prot Biodivers Branch Vic BC Wildl Bull No B-105 38pp: 3.

62. Arthur SM, Paragi TF, Krohn WB (1993) Dispersal of juvenile fishers in Maine. J Wildl Manag 57: 868.

63. Higley JM, Matthews S (2009) Fisher habitat use and population monitoring on the Hoopa Valley Reservation, California Final Report USFWS TWG U-12-NA-1. Hoopa Val Tribe Hoopa Calif USA.

64. King CM, Powell RA, Powell C (2007) The natural history of weasels and stoats: ecology, behavior, and management. Oxford University Press New York.

65. Paragi TF (1990) Reproductive biology of female fishers in southcentral Maine University of Maine at Orono. Available: http://www.library.umaine.edu/theses/theses.asp?Cmd=abstract&ID=MARC1647. Accessed 11 October 2013.

66. Reno MA, Rulon K, James C (2008) Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

67. Aging Experience, Accuracy and Precision (n.d.). Available: http://www.matsonslab.com/aging-experience-accuracy-and-precision.html. Accessed 6 September 2014.

68. Brown RN, Gabriel MW, Wengert G, Matthews S, Higley JM, et al. (2006) Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Trans West Sect Wildl Soc 42: 40–46.

69. Sandra Martin (1994) Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael RA, Powell RA, editors. Martens, sables and

fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 297–315.

70. Zielinski WJ, Duncan NP (2004) Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. J Mammal 85: 470–477.

71. Golightly RT, Penland TF, Zielinski WJ, Higley JM (2006) Fisher diet in the Klamath/north coast bioregion. Final Rep US Fish Wildl Serv Scotia Pac Humboldt State Spons Programs Found Arcata Calif.

72. Zielinski WJ, Duncan NP, Farmer EC, Truex RL, Clevenger, et al. (1999) Diet of fishers (Martes pennanti) at the southernmost extent of their range. J Mammal 80: 961–971.

73. Grenfell WE, Fasenfest M (1979) Winter food habits of fisher (Martes pennanti) in northwestern California. Calif Fish Game 65: 186–189.

74. Bioregions of California (n.d.). Available: http://biodiversity.ca.gov/bioregions.html. Accessed 5 September 2014.

75. Powell RA, Brander RB (1977) Adaptations of fishers and porcupines to their predator prey system. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula. pp. 45–53.

76. Powell SM, York EC, Fuller TK (1997) Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta, Edmonton. pp. 279–305.

77. Weir RD, Harestad AS, Wright RC (2005) Winter Diet Of Fishers In British Columbia. Northwest Nat 86: 12–19. doi:http://dx.doi.org/10.1898/1051-1733(2005)086[0012:WDOFIB]2.0.CO;2.

78. Kuehn DW (1989) Winter foods of fishers during a snowshoe hare decline. J Wildl Manag: 688–692.

79. Burt WH (1943) Territoriality and home range concepts as applied to mammals. J Mammal 24: 346–352.

80. Buck S, Mullis C, Mossman AS (1983) Corral Bottom-Hayfork Bally Fisher Study: final report. Arcata, CA: Humboldt State University and USDA Forest Service.

81. Johnson SA (1984) Home range, movements, and habitat use of fishers in Wisconsin University of Wisconsin–Stevens Point.

82. Arthur SM, Krohn WB, Gilbert JR (1989) Home range characteristics of adult fishers. J Wildl Manag 53: 674–679.

83. Jones JL (1991) Habitat use of fisher in northcentral Idaho University of Idaho.

84. Garant Y, Crete M (1997) Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Can Field-Nat Ott ON 111: 359–364.

85. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Home Range Characteristics Of Fishers in California. J Mammal 85: 649–657.

86. Yaeger JS (2005) Habitat at fisher resting sites in the Klamath Province of northern California [Master's Thesis]. Arcata, CA: Humboldt State University. Available: http://www.fws.gov/yreka/fisher/Literature/Yaeger%202005.pdf. Accessed 11 October 2013.

87. Koen EL, Bowman J, Findlay CS, Zheng L (2007) Home Range and Population Density of Fishers in Eastern Ontario. J Wildl Manag 71: 1484–1493. doi:http://dx.doi.org/10.2193/2006-133.

88. Raley CM, Lofroth EC, Truex RL, Yaeger JS, Higley JM (2012) Habitat ecology of fishers in western North America. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press.

89. Mabry KE, Shelley EL, Davis KE, Blumstein DT, Vuren DHv (2013) Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

90. Strickland MA (1994) Harvest management of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 149–164.

91. Aubry K, Wisely S, Raley C, Buskirk S (2004) Zoogeography, Spacing Patterns, and Dispersal in Fishers. In: Harrison DJ, Fuller AK, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. New York, NY: Springer. pp. 201–220.

92. Greenwood PJ (1980) Mating systems, philopatry and dispersal in birds and mammals. Anim Behav 28: 1140–1162.

93. Stephen Dobson F (1982) Competition for mates and predominant juvenile male dispersal in mammals. Anim Behav 30: 1183–1192.

94. De Vos A (1951) Overflow and dispersal of marten and fisher from wildlife refuges. J Wildl Manag 15: 164–175.

95. Hamilton WJ, Cook AH, Hamilton WF (1955) The biology and management of the fisher in New York. N Y Fish Game J 2: 13–35.

96. Powell RA (1979) Ecological energetics and foraging strategies of the fisher (Martes pennanti). J Anim Ecol: 195–212.

97. Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

98. Buskirk SW, Powell RA (1994) Habitat Ecology of Fishers and American Martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 283–296. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

99. The Public Land Survey System (PLSS) (n.d.). Available: http://nationalatlas.gov/articles/boundaries/a_plss.html. Accessed 4 September 2014.

100. Krohn WB, Arthur SM, Paragi TF (1994) Mortality and vulnerability of a heavily trapped fisher population. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

101. Klug Jr RR (1997) Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections Humboldt State University.

102. Carroll C, Zielinski WJ, Noss RF (1999) Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conserv Biol 13: 1344–1359.

103. Davis FW, Seo C, Zielinski WJ (2007) Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecol Appl 17: 2195–2213.

104. Slauson KM, Zielinski WJ, Holm GW (2003) Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final Rep USDA For Serv Pac Southwest Res Stn Arcata Calif USA.

105. Weir RD, Harestad AS (2003) Scale-dependent habitat selectivity by fishers in south-central British Columbia. J Wildl Manag 67: 73–82.

106. Campbell LA (2004) Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada University of California. Available: http://www.fs.fed.us/psw/programs/snrc/staff/campbell/campbell_dissertation.pdf. Accessed 11 October 2013.

107. Aubry KB, Raley CM, Buskirk SW, Zielinski WJ, Schwartz MK, et al. (2013) Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. J Wildl Manag 77: 965–974.

108. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Resting habitat selection by fishers in California. J Wildl Manag 68: 475–492.

109. Purcell KL, Mazzoni AK, Mori SR, Boroski BB (2009) Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. For Ecol Manag 258: 2696–2706.

110. Davis LR (2009) Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau Dept. of Biological Sciences-Simon Fraser University. Available: http://summit.sfu.ca/item/9870. Accessed 10 October 2013.

111. Bull EL, Parks CG, Torgersen TR (1997) Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

112. Manion PD (n.d.) Tree disease concepts. Second. New Jersey, USA: Prentice Hall Career and Technology.

113. Zielinski WJ, Dunk JR, Yaeger JS, LaPlante DW (2010) Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. For Ecol Manag 260: 1579–1591.

114. California Wildlife Habitat Relationships System (2008). Sacramento, California: California Department of Fish and Wildlife: California Interagency Wildlife Task Group.

115. Weir RD, Corbould FB (2010) Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. J Wildl Manag 74: 405–410.

116. Buck SG, Mullis C, Mossman AS, Coolahan C (1994) Habitat use by fishers in adjoining heavily and lightly harvested forest. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 368–376.

117. Jones JL, Garton EO (1994) Selection of successional stages by fishers in north-central Idaho. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 377–387.

118. De Vos A (1952) The ecology and management of fisher and marten in Ontario. Available: http://www.citeulike.org/group/15497/article/9675279. Accessed 21 August 2014.

119. Spencer W, Rustigian-Romsos H, Strittholt J, Scheller R, Zielinski W, et al. (2011) Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biol Conserv 144: 788–803.

120. Hagmeier EM (1956) Distribution of marten and fisher in North America. Can Field Nat 70: 149–168.

121. Banci V (1989) A fisher management strategy for British Columbia. Victoria, British Columbia, Canada: Ministry of Environment.

122. Powell RA (1994) Structure and spacing of Martes populations. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA. pp. 101–121.

123. Lewis JC, Zielinski WJ (1996) Historical harvest and incidental capture of fishers in California. Northwest Sci 70: 291–297.

124. Dixon JS (1925) A closed season needed for fisher, marten, and wolverine. Calif Fish Game 11: 23–25.

125. Gould GI Jr (1987) Forest Mammal Survey and Inventory. Calif. Dept. of Fish and Game.

126. Powell RA, Facka AN, Clifford DL, Beach C, Smith K (2013) Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

127. Lamberson RH, Truex RL, Zielinski WJ, Macfarlane D (2000) Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata CA Humboldt State Univ.

128. Spencer WD, Rustigian H, Strittholt JR, Scheller R, Syphard A (2008) Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

129. Jordan MJ (2007) Fisher ecology in the Sierra National Forest, California Berkeley, Calif.: University of California, Berkeley. Available: http://www.carnivoreconservation.org/files/thesis/jordan_2007_phd.pdf. Accessed 11 October 2013.

130. Matthews SM, Mark Higley J, Scott Yaeger J, Fuller TK (2011) Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildl Soc Bull 35: 69–75.

131. Diller L, Hamm K, Lamphear D, Thompson J (2008) Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Korbel, CA: Green Diamond Resource Company.

132. Swiers RC (2013) Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. [Raleigh, North Carolina]: North Carolina State University,.

133. Noon BR, Bailey LL, Sisk TD, McKelvey KS (2012) Efficient Species-Level Monitoring at the Landscape Scale. Conserv Biol 26: 432–441.

134. Zielinski WJ, Baldwin JA, Truex RL, Tucker JM, Flebbe PA (2013) Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. J Fish Wildl Manag 4: 3–19.

135. Bechtold WA, Patterson PL (2005) The enhanced forest inventory and analysis program: national sampling design and estimation procedures. General Technical Report. Asheville, North Carolina: US Department of Agriculture Forest Service, Southern Research Station.

136. Waples R (1991) Definition of a “species” under teh Endangered Species Act: Application to Pacific salmon. Technical menorandum. NOAA.

137. Franklin JF, Spies TA, Pelt RV, Carey AB, Thornburgh DA, et al. (2002) Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. For Ecol Manag 155: 399–423.

138. Thompson ID, Baker JA, Ter-Mikaelian M (2003) A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. For Ecol Manag 177: 441–469.

139. USDA Forest Service (2014) Forest Management: Cut and sold reports. Available: http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml. Accessed 22 August 2014.

140. California Timber Harvest Statistics - harvyr2.pdf (n.d.). Available: http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf. Accessed 6 September 2014.

141. Barnosky AD, Koch PL, Feranec RS, Wing SL, Shabel AB (2004) Assessing the causes of Late Pleistocene extinctions on the continents. Science 306: 70–75.

142. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

143. Farber S, Callas RL, Yaeger JS, Schwartz MK, Pilgrim K, et al. (2010) Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report. Yreka Fish and Wildlife Office, Yreka, California: USDI Fish and Wildlife Service.

144. Wengert GW, Gabriel MW, Matthews SM, Higley JM, Sweitzer R, et al. (2013) Intraguild Predation on Fishers in California: Patterns of Predation by Three Larger Carnivores. Rev J Wildl Manag.

145. Buck SG (1982) Habitat utilization by fisher (Martes pennanti) near Big Bar, California [Master’s Thesis]. Arcata, CA: Humboldt State University.

146. Wengert GM (2013) Ecology of intraguild predation on fishers (Martes pennanti) in California UNIVERSITY OF CALIFORNIA, DAVIS. Available: http://gradworks.umi.com/36/14/3614292.html. Accessed 4 September 2014.

147. Williams ES (2001) Canine distemper. In: Williams ES, Barker RICK, editors. Infectious diseases of wild mammals. Ames, Iowa: Iowa State University Press. p. 50.

148. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

149. Williams ES, Thorne ET, Appel MJ, Belitsky DW (1988) Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. J Wildl Dis 24: 385–398.

150. Timm SF, Munson L, Summers BA, Terio KA, Dubovi EJ, et al. (2009) A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). J Wildl Dis 45: 333–343.

151. Origgi FC, Plattet P, Sattler U, Robert N, Casaubon J, et al. (2012) Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Vet Pathol Online 49: 913–929.

152. Gabriel MW, Wengert GM, Matthews SM, Higley JM, Foley JE, et al. (2010) Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). J Wildl Dis 46: 966–970.

153. Gabriel MW, Wengert GW, Brown RN (2012) Pathogens and parasites of Martes species: Management and conservation implications. In: Aubry KB, Zielinski WJ,

Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press. pp. 138–185.

154. Burns R, O'Toole ESWD, 2003 JPD (n.d.) Toxoplasma gondii infections in captive black-footed ferrets (Mustela nigripes), 1992–1998: clinical signs, serology, pathology, and prevention. J Wildl Dis 39: 787–797.

155. Pridham TJ, Belcher J (1958) Toxoplasmosis in mink. Can J Comp Med Vet Sci 22: 99–106.

156. Cole RA, Lindsay DS, Howe DK, Roderick CL, Dubey JP, et al. (2000) Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). J Parasitol 86: 526–530.

157. Larkin JL, Gabriel M, Gerhold RW, Yabsley MJ, Wester JC, et al. (2011) Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. J Parasitol 97: 425–429. doi:http://dx.doi.org/10.1645/GE-2623.1.

158. Brown RN, Gabriel MW, Wengert GW, Matthews S, Higley JM, et al. (2008) Pathogens associated with fishers. Final Report USFWS-813335G021. Yreka, CA.

159. Williams ES, Mills K, Kwiatkowski DR, Thorne ET, Boerger-Fields A (1994) Plague in a black-footed ferret (Mustela nigripes). J Wildl Dis 30: 581–585.

160. Weinmann R, Raskas HJ, Roeder RG (1974) Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proc Natl Acad Sci 71: 3426–3430.

161. Clifford DL, Woods L, Gabriel MW, Tkach V, Hoberg E, et al. (2012) Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

162. CDOF (2011) E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. Sacramento, California: State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-6/2000-10/.

163. CDOF (1991) E-6 County Population Estimates and Components of Change— July 1, 1970–1990. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/view.php#objCollapsiblePanelEstimatesAnchor.

164. CDOF (2013) E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php.

165. CDOF (2013) Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

166. Bunn D, Mummert A, Hoshovsky M, Gilardi K, Shanks S (2007) California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

167. FRAP (2003) The changing California: Forest and range 2003 assessment. CalFire. Available: http://frap.fire.ca.gov/data/assessment2003/index.html.

168. Duane TP (1996) Human Settlement 1850-2040. In: Center WR, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. Davis, CA, USA.: University of California.

169. Theobald D (2005) Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecol Soc 10.

170. Garroway CJ, Bowman J, Wilson PJ (2011) Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Mol Ecol 20: 3978–3988.

171. Safford HD (2006) Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report. Vallejo, California: USDA Forest Service, Pacific Southwest Region.

172. Stephens SL, Sugihara NG (2006) Fire management and policy since European settlement. Fire in California's Ecosystems. Berkeley, California: University of California Press. pp. 431–443.

173. Show SB, Kotok EI (1923) Forest fires in California, 1911-1920: an analytical study. Washington D.C., USA: US Department of Agriculture. Available: http://scholarsarchive.library.oregonstate.edu/jspui/handle/1957/11024. Accessed 11 October 2013.

174. Stephens SL, Martin RE, Clinton NE (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. For Ecol Manag 251: 205–216. doi:http://dx.doi.org/10.1016/j.foreco.2007.06.005.

175. Taylor AH, Skinner CN (1998) Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. For Ecol Manag 111: 285–301.

176. Anderson MK (2006) The use of fire by Native Americans in California. In: Sugihara NG, Van Wagtendonk JW, Shaffer KE, Fites-Kaufman J, Thode AE, editors. Fire in California's Ecosystems. University of California Press. p. 596.

177. Martin RE, Sapsis DB (1992) Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

178. Miller JD, Safford HD, Crimmins M, Thode AE (2009) Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12: 16–32.

179. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW (2006) Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

180. Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecol Appl 22: 184–203.

181. Zhang J, Webster J, Powers RF, Mills J (2008) Reforestation after the Fountain Fire in Northern California: An Untold Success Story. J For 106: 425–430.

182. LANDFIRE-Fire Regime Product Descriptions (n.d.). Available: http://www.landfire.gov/NationalProductDescriptions13.php. Accessed 4 September 2014.

183. Lawler JJ, Safford HD, Girvetz EH (2012) Martens and fishers in a changing climate. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press. pp. 371–397.

184. Fried JS, Torn, Mills E (2004) The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Clim Change 64: 169–191. doi:http://dx.doi.org/10.1023/B:CLIM.0000024667.89579.ed.

185. Westerling AL, Bryant BP, Preisler HK, Holmes TP, Hidalgo HG, et al. (2011) Climate change and growth scenarios for California wildfire. Clim Change 109: 445–463.

186. Mckenzie D, Gedalof Z, Peterson DL, Mote P (2004) Climatic Change, Wildfire, and Conservation. Conserv Biol 18: 890–902.

187. Krawchuk MA, Moritz MA (2012) Fire and Climate Change in California. Calif Energy Comm Publ Number CEC-500-2012-026.

188. Gabriel MW, Wengert GW, Higley JM, Krogan S (2013) Silent forests? Rodenticides on illegal marijuana crops harm wildlife. Wildl Prof Spring.

189. Gabriel MW, Woods LW, Poppenga R, Sweitzer RA, Thompson C, et al. (2012) Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

190. Alterio N (1996) Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. N Z J Zool 23: 331–338.

191. Moriarty JG, Riley PD, Sureiys LE, Sikich JA (2013) Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: from mountain lions to rodents. Proceedings of the 25th Vertebrate Pest Conference. Vol. 25. pp. 144–148.

192. Erickson WA, Urban DJ (2004) Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

193. Fisher P, O'Connor C, Wright G, Easton CT (2003) Persistence of four anticoagulant rodenticides in livers of laboratory rats. New Zealand Department of Conservation.

194. Riley SPD, Bromley C, Poppenga RH, Uzal FA, al et (2007) Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. J Wildl Manag 71: 1874–1884.

195. Cox P, Smith R. (n.d.) Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. 15th Vertebrate Pest Conference. Davis, CA, USA.: University of California.

196. Thompson C, Sweitzer R, Gabriel M, Purcell K, Barrett R, et al. (2013) Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conserv Lett.

197. Laas FJ, Forss DA, Godfreyi MER (1985) Retention of brodifacoum in sheep tissues and excretion in faeces. N Z J Agric Res 28: 357–359.

198. Godfrey MER, Lyman CP (1980) Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). N Z J Exp Agric 8: 1–5.

199. Munday JS, Thompson LJ (2003) Brodifacoum toxicosis in two neonatal puppies. Vet Pathol Online 40: 216–219.

200. Jansman H, van Tulden P (2012) Persecution and poisoning of birds of prey in the Netherlands. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 139–142.

201. Mineau P, Lyon L, McMillin S (2012) Impacts of carbofuran on birds in Canada and the United States. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 219–222.

202. Anderson B, Borges S, Graber K, Hartless C, Housenger J, et al. (2011) Risks of non-compliant rodenticides to nontarget wildlife. Washington D.C., USA: United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division.

203. Berny PJ, Buronfosse T, Buronfosse F, Lamarque F, Lorgue G (1997) Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35: 1817–1829.

204. Ruder MG, Poppenga RH, Bryan JA, Bain M, Pitman J, et al. (2011) Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. J Wildl Dis 47: 212–216.

205. Janeway CA, Travers P, Walport M (2007) Immunobiology. 7th ed. New York, New York, USA: Garland Science.

206. Li Q, Kawada T (2006) The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cell Mol Immunol 3: 171–178.

207. Zabrodskii PF, Lim VG, Strel'tsova EV (2012) Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksp Klin Farmakol 75: 35.

208. Vidal D, Alzaga V, Luque-Larena JJ, Mateo R, Arroyo L, et al. (2009) Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Sci Total Environ 408: 267–271. doi:http://dx.doi.org/10.1016/j.scitotenv.2009.10.001.

209. Gordon CJ (1994) Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicol Teratol 16: 427–453.

210. Grue CE, Hart ADM, Mineau P (1991) Biological consequences of depressed brain cholinesterase activity in wildlife. In: Mineau P, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Amsterdam, Netherlands: Elsevier Science Publishers. pp. 151–209.

211. Ahdaya SM, Shah PV, Guthrie FE (1976) Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicol Appl Pharmacol 35: 575–580.

212. Martin PA, Solomon KR (1991) Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pestic Biochem Physiol 40: 117–127.

213. Hayward MW, Jedrzejewski W, Jedrzewska B (2012) Prey preferences of the tiger Panthera tigris. J Zool 286: 221–231. doi:http://dx.doi.org/10.1111/j.1469-7998.2011.00871.x.

214. Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE (2004) Tigers and their prey: predicting carnivore densities from prey abundance. Proc Natl Acad Sci U S A 101: 4854–4858.

215. Knick ST (1990) Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildl Monogr: 3–42.

216. Knick ST, Hellgren EC, Seal US (1993) Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Can J Zool Can Zool 71: 1448–1453.

217. Colvin, B., Jackson W. (1991) Secondary poisoning hazards associated with rodenticide use. In: Magallona E., editor. 11th International Congress Plant Protection. Manila, Phillipines.

218. Pachauri RK, Reisinger A (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergov Panel Clim Change 1.

219. Solomon S, Qin D, Manning M, ALLEY R, BERNTSEN T, et al. (2007) Technical Summary. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press. pp. 19–91.

220. Bonfils C, Duffy PB, Santer BD, Wigley TML, Lobell DB, et al. (2008) Identification of external influences on temperatures in California. Clim Change 87: 43–55. doi:10.1007/s10584-007-9374-9.

221. Tingley MW, Koo MS, Moritz C, Rush AC, Beissinger SR (2012) The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Glob Change Biol 18: 3279–3290.

222. Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, et al. (2013) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Clim Dyn 40: 839–856. doi:http://dx.doi.org/10.1007/s00382-012-1337-9.

223. Cayan D, Tyree M, Pierce D, Das T (2012) Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

224. Littell JS, Elsner MM, Mauger G, Lutz E, Hamlet AF, et al. (2011) Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. University of Washington, College of the Environment.

225. Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. (2004) Emissions pathways, climate change, and impacts on California. Proc Natl Acad Sci U S A 101: 12422–12427.

226. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, et al. (2007) Regional climate projections. In: Susan S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, Vol. 4.

227. Cayan D, Tyree M, Dettinger M, Hidalgo H, Das T, et al. (2009) Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. Calif Clim Change Cent CEC-500-2009-014-D.

228. Pierce DW, Cayan DR, Das T, Maurer EP, Miller NL, et al. (2013) The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. J Clim. Available: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00766.1. Accessed 14 October 2013.

229. Halofsky JE, Peterson DL, O'Halloran KA, Hawkins-Hoffman C (2011) Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available: http://www.treesearch.fs.fed.us/pubs/38702. Accessed 14 October 2013.

230. Salathe EP, Leung Lr, Qian Y, Zhang Y (2010) Regional climate model projections for the State of Washington. Clim Change 102: 51–75. doi:http://dx.doi.org/10.1007/s10584-010-9849-y.

231. Ralph M (2011) Water supply and flooding. In: Pierce DW, editor. California Climate Extremes Workshop Report. La Jolla, CA: Scripps Institution of Oceanography.

232. Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, et al. (2009) The velocity of climate change. Nature 462: 1052–1055. doi:10.1038/nature08649.

233. Moritz C, Agudo R (2013) The Future of Species Under Climate Change: Resilience or Decline? Science 341: 504–508. doi:10.1126/science.1237190.

234. Lenihan JM, Drapek R, Bachelet D, Neilson RP (2003) Climate change effects on vegetation distribution, carbon, and fire in California. Ecol Appl 13: 1667–1681.

235. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al. (2011) The impact of climate change on California's ecosystem services. Clim Change 109: 465–484. doi:10.1007/s10584-011-0313-4.

236. Koopman ME, Nauman RS, Leonard JL (2010) Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

237. Burns CE, Johnston KM, Schmitz OJ (2003) Global climate change and mammalian species diversity in U.S. national parks. Proc Natl Acad Sci 100: 11474–11477.

238. Littell JS, Oneil EE, McKenzie D, Hicke JA, Lutz JA, et al. (2010) Forest ecosystems, disturbance, and climatic change in Washington State, USA. Clim Change 102: 129–158. doi:http://dx.doi.org/10.1007/s10584-010-9858-x.

239. Spies TA, Giesen TW, Swanson FJ, Franklin JF, Lach D, et al. (2010) Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landsc Ecol 25: 1185–1199. doi:http://dx.doi.org/10.1007/s10980-010-9483-0.

240. Paradis A, Elkinton J, Hayhoe K, Buonaccorsi J (2008) Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitig Adapt Strateg Glob Change 13: 541–554.

241. Safranyik L, Carroll AL, Regniere J, Langor DW, Riel WG, et al. (2010) Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Can Entomol 142: 415–442.

242. Trần JK, Ylioja T, Billings RF, Régnière J, Ayres MP (2007) Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecol Appl 17: 882–899.

243. Vose JM, Peterson DL, Patel-Weynand T (2012) Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

244. USDA Forest Service, USDI Bureau of Land Management (1994) Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team]. 569 p. Available: http://archive.org/details/finalsupplementa03v1unit. Accessed 2 September 2014.

245. USDA Forest Service, USDI Bureau of Land Management (1994) Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

246. The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data (n.d.). Available: http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml. Accessed 5 September 2014.

247. Sulak A, Huntsinger L (2012) Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. J For 110: 312–317.

248. Smith T (2014) What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. Available: http://snamp.cnr.berkeley.edu/teams/fisher. Accessed 1 September 2014.

249. Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics (n.d.). Available: http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/. Accessed 1 September 2014.

250. USDI Bureau of Land Management (2008) Sierra Resource Management Plan and Record of Decision. Folsom, CA: Bureau of Land Management.

251. Hannibal ME (2012) America's Next Best Idea: The National Park System Looks to the Future. George Wright Forum 29: 380–384.

252. FSC Forest Stewardship Council U.S. (FSC-US) · Our History (n.d.). Available: https://us.fsc.org/our-history.180.htm. Accessed 2 September 2014.

253. FSC Forest Stewardship Council U.S. (FSC-US) · Mission and Vision (n.d.). Available: https://us.fsc.org/mission-and-vision.187.htm. Accessed 2 September 2014.

254. preview.fsc-certified-acres-by-state.a-204.pdf (n.d.). Available: https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf. Accessed 2 September 2014.

255. IUCN, SSC (2013) Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

256. Callas RL, Figura P (2008) Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. Sacramento, California: California Department of Fish and Game.

257. Gould GI, Escallier J (1989) Licensed trapper's and dealer's report. Sacramento, California: California Department of Fish and Game.

258. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

Comments from J.M. Higley

STATE OF CALIFORNIA

NATURAL RESOURCES AGENCY

DEPARTMENT OF FISH AND WILDLIFE

CONFIDENTIAL DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [*Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

October 1, 2014

Table of Contents

List of Figures

List of Tables

List of Appendices

(to be completed)

Acknowledgments

(to be completed)

This report was prepared by: ______________________

Cover photograph © J. Mark Higley, Hoopa Tribal Forestry, used with permission.

Report to the Fish and Game Commission
A Status Review of the Fisher in California

_______, 2014

Executive Summary

This document describes the current status of the fisher (Pekania pennanti) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act. On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department of Fish and Game, as it was then named (now called the Department of Fish and Wildlife) (Department), commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Despite being the most valuable furbearer in the state, trappers only reported taking 46 animals from 1920-1924. In addition to trapping, the decline of fishers has also been attributed to logging activities which may render habitats unsuitable for them.

Early researchers believed that the range of fishers in the late 1800s extended from the Oregon border south to Marin County through the Klamath Mountains and the Coast Range as well as through the southern Cascades to the southern Sierra Nevada Mountains. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to European settlement. The location and size of the gap separating these populations is unknown. However, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Currently fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population). Fishers are also found in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN Fisher ESU) from fishers in northern California (NC Fisher ESU) and the degree of genetic differentiation between them. Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals.

Early work on fishers appeared to indicate that fishers required particular forest types (e.g., old-growth conifers) for survival. However, studies of fishers over the past two decades have demonstrated that they are not dependent on old-growth forests per se, nor are they associated with any particular forest type. Fishers are typically found at low- to mid-elevations characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used for resting (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning and the presence of a suitable cavity appears to be more important than the species of

tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (> 100 years) may be needed for trees to attain sufficient size and for a cavity large enough for a female fisher and her young to develop. Although the number of den and rest structures needed by fisher is not well known, a substantial reduction in these important habitat elements would likely reduce the distribution and abundance of fisher in the state.

Primary threats to fishers within the NC and SSN Fisher ESUs include habitat loss, toxicants, wildfire, and climate change. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests. However, fishers are widespread on public and private lands harvested for timber. A concern for the long-term viability of fishers across their range in California is the presence of suitable den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service or the National Park Service. Private lands within the NC Fisher ESU and the SSN Fisher ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher contracted substantially. This difference is due to the apparent absence of fishers from the central, and portions of the northern, Sierra Nevada. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and to other toxicants. ARs used at illegal marijuana cultivation sites have caused the deaths of some fishers and ARs may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population.

In recent decades the frequency, severity, and extent of wildfires has increased in California. This trend could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due to that population's small size, the linear distribution of the habitat available, and the potential for fires to increase in frequency under scenarios where the climate warms.

Climate research predicts continued climate change through 2100, with rates of change faster than occurred during the previous century. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate related changes that may occur within the range of the fisher in California. The SSN Fisher ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU, due to its comparatively small population size and susceptibility to fragmentation. However, the effects of climate change on fisher populations are unknown, will likely vary throughout the species' range, and the severity of those effects will vary depending on the extent and speed with which warming occurs.

Regulatory Framework

Petition Evaluation Process

Comment [f1]: I would recommend that there be a clear section break between the Executive summary and the rest of the document. Start a new page?

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3) The Commission received the petition and, pursuant to Fish & G. Code § 2073, referred the petition to the Department for its evaluation and recommendation. (*Id.*, § 2073) On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*) as Threatened

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[2].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[3].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[4]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[5, 6].

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[7].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (APA) (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA,

---

[2] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[3] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[4] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

[6] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[7] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

subject to various terms and conditions[8]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[9]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[10]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its Status Review and the best science available to the Department that designating fisher as a threatened or endangered species under CESA was not warranted[11]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[12].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[13]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related

---

[8] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[9] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[10] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

[11] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[12] *Id.*, § 670.1, subd. (g).

[13] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[14]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as an endangered or threatened species under CESA was not warranted[15]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[16].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[17] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

---

[14] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

[15] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[16] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[17] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[18]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[19]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its February 2010 status review of the species. This report represents the Department's revised status review, based on the best scientific information available and including independent peer review by scientists with expertise relevant to the status of the fisher (Appendix X).

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail [1]. They typically appear uniformly black from a distance, but in fact are dark brown over most of their bodies with white or cream patches distributed on their undersurfaces [2]. The fur on the head and shoulder may be grizzled with gold or silver, especially in males [1]. The fisher's face is characterized by a sharp muzzle with small rounded ears [3] and forward facing eyes indicating well developed binocular vision [2]. Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0-2.5 kg (4.4-5.5 lbs) and range in length from 70-95 cm (28-34 in) and males weigh between 3.5-5.5 kg (7.7-12.1 lbs) and range from 90-120 cm (35-47 in) long [2].

[18] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh about 500-1400 g (1-3 lbs) and range in total length from about 50-68 cm (20-27 in) [4]. Fishers have a single molt in late summer and early fall, and shedding starts in late spring [2]. American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers [5].

Comment [f2]: Might consider staying with kg instead of grams 0.5-1.4 kg

Fishers are seldom seen, even where they are abundant. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground [6]. Females, perhaps because of their smaller body size, are more arboreal than males [2,7,8].

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the mustelidae includes wolverine, marten, weasel, mink, skunk, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America; *M. p. pennanti* [9], *M. p. columbiana* [10]; and *M. p. pacifica* [11]. However, the validity of these subspecies has been questioned [3] and [12].

More recently, genetic studies indicate that the fisher is more closely related to wolverine (*Gulo gulo*) and tayra (*Eira barbara*) of Central and South America than to other species of *Martes* [13–19]. Based on those findings, fishers have been reclassified along with wolverine and tayra into the genus *Pekania* [15,19]. In this report, we use *Pekania pennanti* as the taxonomic designation for native fishers in California.

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell [2] thought the most likely possibility was that the name originated with European settlers who noted the similarity between fishers and European polecats, which were also known as fitch ferrets. Many other names have been used for fisher including pekan, pequam, wejack, Pennant's marten, black cat, tha cho (Chippewayan), uskool (Wabanaki), otchoek (Cree), and otschilik (Ojibwa) [2]. In the native language of the ~~Hoopa~~ Hupa people, fisher are known as 'ista:ngq'eh-k'itiqowh [20].

Comment [f3]: Hoopa is the place while Hupa is the people and language

Comment [f4]: Could include translation here "log-along-it scampers"

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago [21]. Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) [22]. During the late Holocene which began about 4,000 years ago, fishers expanded into western North America [23], presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to European settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 1). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and coniferous forest ecosystems in western North America [24].

By the 1800s and early 1900s the fisher's range was generally greatly reduced due to trapping and large scale anthropogenic influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss [2,24,25]. However, fishers have reoccupied much of the area lost during the early 1900s, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York [25].

Native populations of fisher currently occur in Canada, the western United States (Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada [26].

Historical Range and Distribution in California

Our knowledge of the distribution of fishers in California is primarily informed by Grinnell et al. [3]. They described fishers in California as inhabiting forested mountains

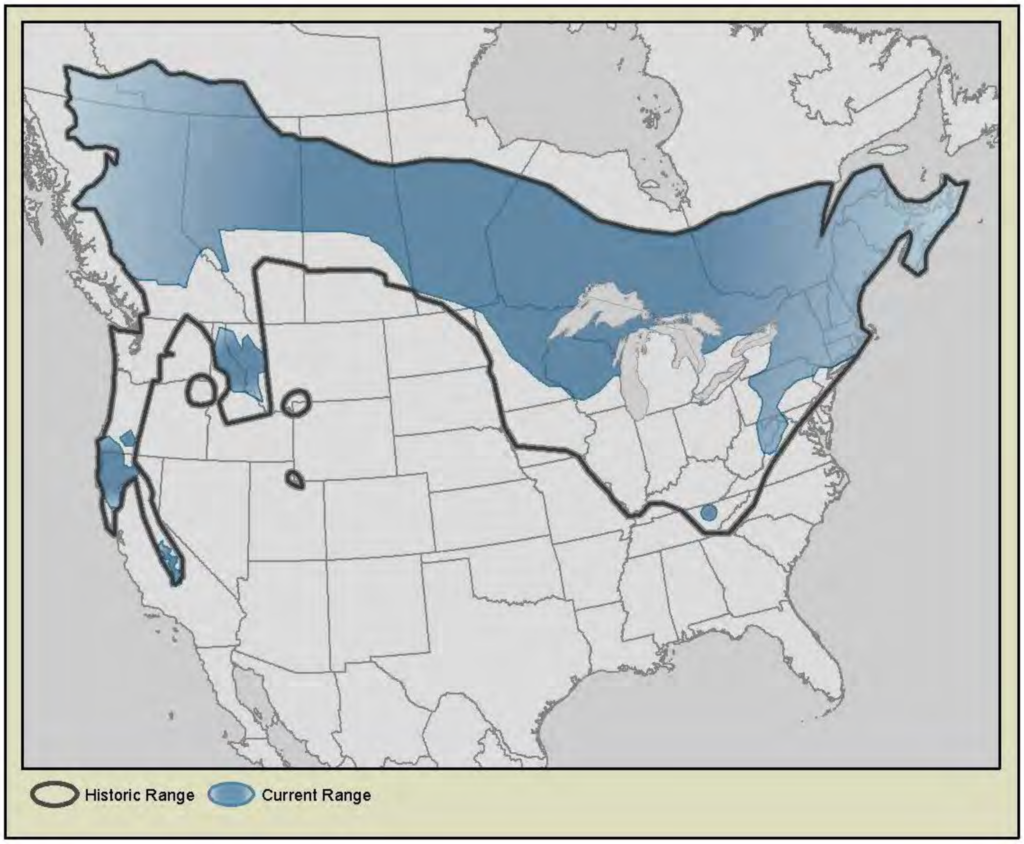


Figure 1. Presumed historical distribution (ca. 1600) and current distribution of fisher in North America. Historical distribution was derived from Giblisco [27]. Refer to Tucker et al. [28] and Knaus et al. [29] for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

primarily at elevations between 610 m to 1824 m (2,000 - 5,000 ft) in the northern portions of their range and 1220 m to 2438 m (4,000 ft - 8,000 ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations. Fishers were believed to have ranged from the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County [3].

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919-1924, as well as a line demarcating what they assumed to be general range from approximately 1862-1937 (Figure 2). The point locations on the map were based on reports by trappers and the authors believed that almost all the locations were accurate, although they pointed out that some may have reflected the trapper's residence or post office. The map remains the best approximation of the distribution of fishers in California at that time, although it likely included areas unsuitable for fishers and excluded portions of the state occupied by the species.

Information presented by Grinnell et al. [3] suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. [3] appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included Lake, Marin, and Kern counties.

Evidence of fishers occupying the central and northern Sierra during the mid-1800s through the early 1900s is limited. In the northern Sierra, Grinnell et al. [3] showed two collections from Sierra County from 1919-1924. During that period in the central Sierra, Grinnell et al. reported one collection from Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County. All of these records, as well as one other record from northwestern Tuolumne County in the Tuolumne River watershed, are north of the current northern limit of the southern Sierra fisher population in the Merced River watershed.

In the southern Cascades, Grinnell et al. [3] mentioned that fishers were trapped during the winters of 1920 and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. [30] reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National Park, near the junction of Lassen, Plumas, and Shasta counties. Additional historic records of fishers in the southern Cascades include two collections in 1897, from eastern Shasta County, that are located in the National

Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney.

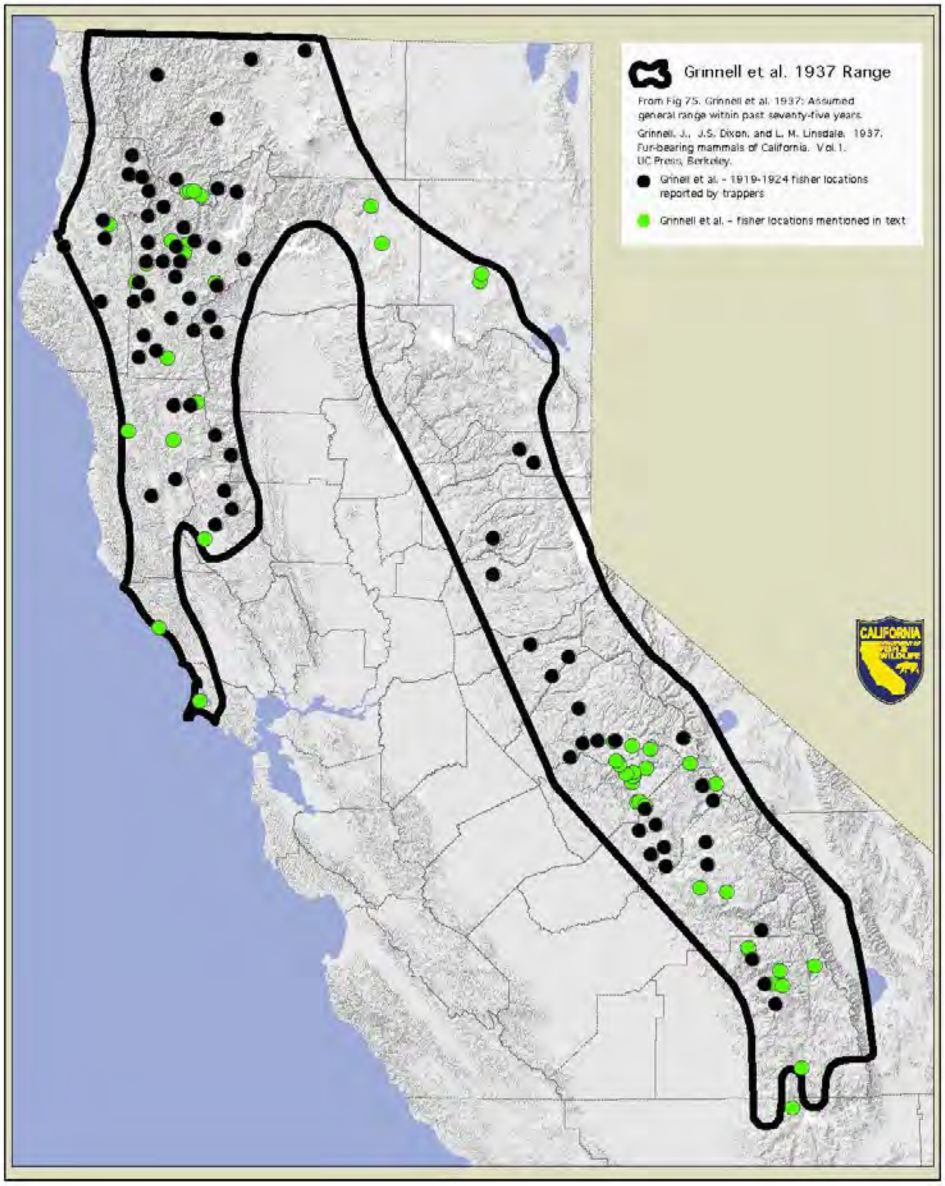


Figure 2. Assumed general range of the fisher in California from ~1850 -1925 from Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Anecdotal evidence of fishers in the northern Sierra is provided in an 1894 publication describing the efforts of William Price to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada [31]. Price included notes on species that he did not collect but were "commonly known to the trappers." His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[20] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Additionally, when relevant, Price discusses more distant geographic localities for some species and their close relatives. If the fishers referenced were trapped at distant locations (e.g., the southern Sierra) it is likely those locations would have been mentioned. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred animals.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fisher in California is based on observations of the species through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

[20] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger [32] noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of species presence (remote cameras and track-plate boxes) [33]. In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* [34] to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be "verified" records (Figure 3). Undoubtedly, reports of

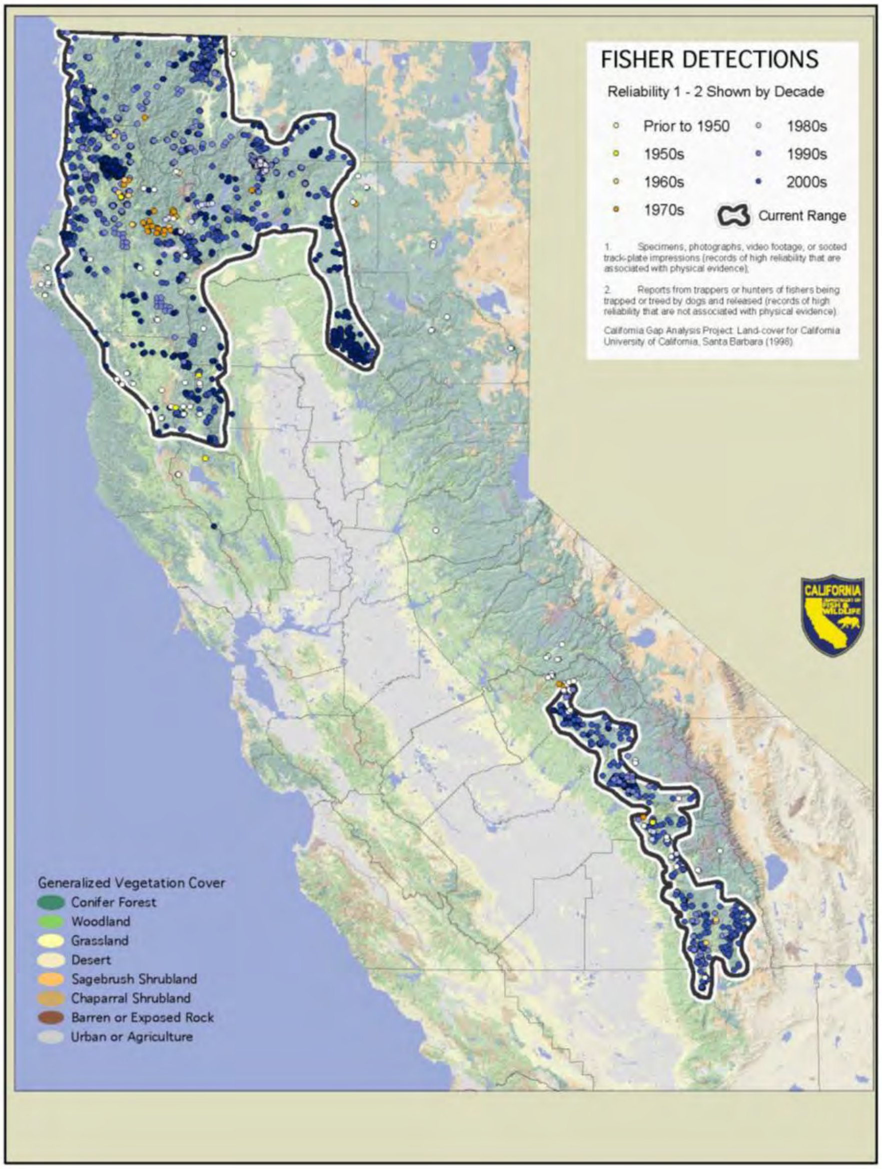


Figure 3. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis [34] were included. California Department of Fish and Wildlife, 2014.

fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state.

A number of broad scale, systematic surveys for fisher and other forest carnivores in the Sierra Nevada Mountains were conducted from 1989-1994 [35], from 1996-2002 [35], and from 2002-2009 (USDA 2006, USDA 2008, Truex et al. 2009). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. [35] expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction due to isolation than if they were connected to other populations. They offered several explanations to account for the lack of fishers in the region including trapping and elimination of habitat through railroad logging.

Zielinski et al. [35] could find no reason to suspect that fisher at one time did not occur where habitat was suitable throughout the Sierra Nevada and thought it likely that the fisher population had already been reduced by the time Grinnell [3] and his colleagues assessed its distribution. Price [31] supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell [3].

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the USDA Forest Service (USFS), private timber companies, and others, since the 1950s no verifiable detections of fishers have occurred in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River [35,36].

To approximate the current range of fishers in California, observations of fishers with high reliability were mapped from 1993 to the present. Those locations were overlaid using GIS on layers of forest cover and layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model) and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 3). This estimate of

current range is approximately 48% of the assumed historical range estimated by Grinnell et al. [3].

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (<5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice sheets [23]. By the late Holocene, records of fishers on the Pacific coast were common [37]. Wisely et al. [37] hypothesized that fishers then expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Currently, fishers in California occur in the northwestern portions of the state, the northern Sierra Nevada, and in the southern Sierra Nevada. Mitochondrial DNA (mtDNA) has been used in several studies to describe the genetic structure of fishers in the state [29,37,38]. Mitochondria are small maternally inherited structures in most cells that produce energy. Portions of the DNA contained within mitochondria known as D-loop regions contain nonfunctional genes and have been widely used in studies of ancestry because they are rich in mutations which are inherited. Early genetic studies of fishers by Drew et al. [38] identified three haplotypes[21] in California (haplotypes 1, 2, and 4) by sequencing mtDNA. Haplotype 1 was found in northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in extant fisher populations in British Columbia. Based on these findings, Drew et al. [38] suggested that gene flow between fishers in British Columbia and California must have occurred historically, but that these populations were now isolated.

Subsequent genetic investigations using nuclear microsatellite DNA and based on sequencing the entire mtDNA genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada [29,37]. Knaus et al. [29] identified three distinct haplotypes unique to fishers in California; one geographically

[21] A haplotype is a set of DNA variations (allele), or polymorphisms, that tend to be inherited together [39].

restricted to the southern Sierra Nevada Mountains and two restricted to the Siskiyou and Klamath mountain ranges. The magnitude of the differentiation between haplotypes of fishers in northern and southern California populations was substantial and considered comparable to differences exhibited among subspecies [29].

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. [29] concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error. Despite this uncertainty, Knaus et al. [29] concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Comment [f5]: Interesting that fishers were thought to have arrived <5000 yrs ago and yet began divergence 16700 yrs ago.

Tucker et al. [40] used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fisher in northwestern California and the southern Sierra Nevada became isolated long before European settlement and estimated that the population declined substantially over a thousand years ago. This generally supports the conclusion of Knaus et al. [29] that fishers in northern and southern portions of the state became isolated prior to European settlement.

Tucker et al. [40] also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fisher from disturbance beginning with the Gold Rush through the first half of the twentieth century. That portion of the range appeared to have maintained a stable population while the remainder of the southern Sierra Nevada occupied by fisher was in decline.

Reproduction and Development

Powell [2] suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April [2,6,41,42]. Females can breed at one year of age, but do not give birth until their second year [2,43,44]. They produce, at most, one litter annually and may not breed every year [8,45]. Reproductive frequency and success depend on a variety of factors including prey availability, male presence or abundance, and age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old [2,8,45,46].

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation [8,47,48]. Implantation is delayed approximately 10 months [41] and occurs shortly before giving birth (parturition) [48]. Arthur and Krohn [46] considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for an average period of 30 to 36 days [2,48]. Females give birth from about mid-March to early April [49–53] and breed approximately 6-10 days after giving birth [2,47,54]. Ovulation is presumed to be induced by copulation [2], with estrus lasting 2-8 days [54]. Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition [2]. Lofroth et al. [24] developed an excellent diagram that illustrates the reproductive cycle of fishers in western North America (Figure 4).

Studies of wild fishers have reported litter sizes to range from 1-4 kits and average 1.8-2.8 [49,55–57]. Based on laboratory examination of corpora lutea[22] observed in harvested fishers, average litter size ranged from 2.3-3.7 kits [8,41–43,59–61]. These averages may be high and counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea [2]. Crowley et al. [60] found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

[22] The corpus luteum is a transient endocrine gland that produces essentially progesterone required for the establishment and maintenance of early pregnancy [58].

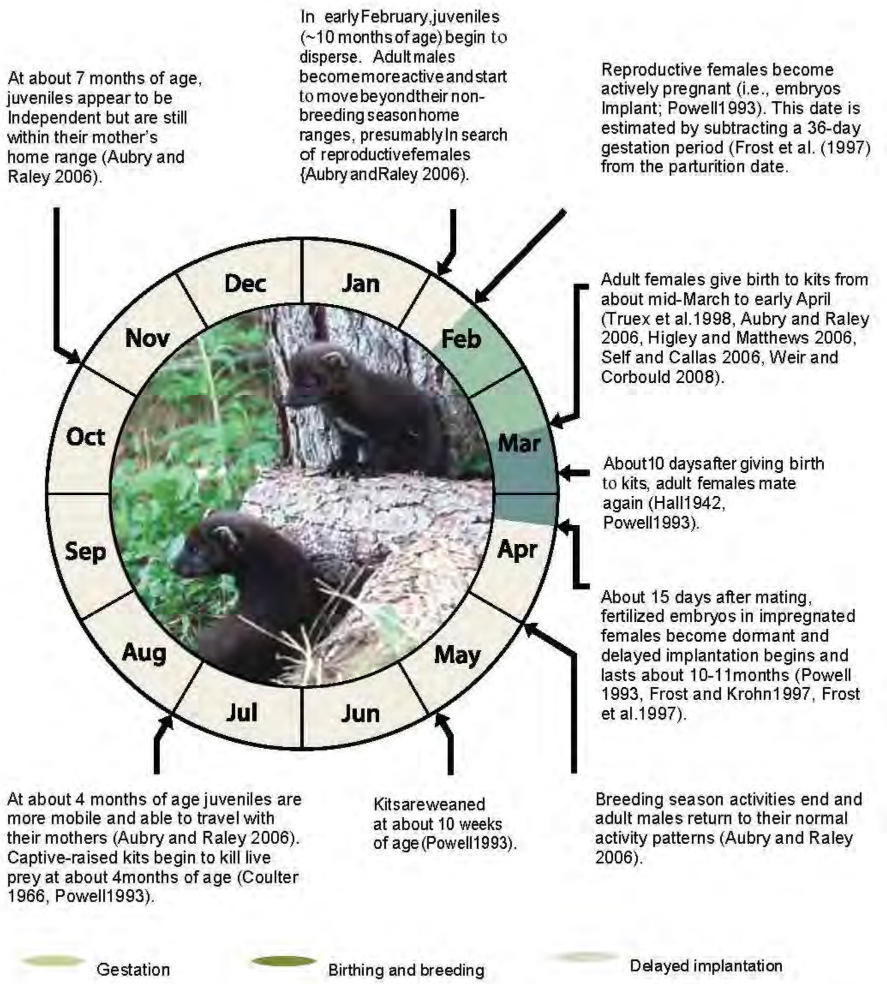


Figure 4. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. [22].

Raised in dens entirely by the female, young are born with their with eyes and ears closed, only partially covered with sparse growth of fine gray hair, and weigh about 40 g [6,25,54]. The kits' eyes open at 7-8 weeks old. They remain dependent on milk until 8-10 weeks of age, and are capable of killing their own prey at around 4 months [2,25]. Juvenile females and males become sexually mature and establish their own home

ranges at one year of age [41,62]. Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum [25]. Fishers have a relatively low annual reproductive capacity [5]. Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually reported from several studies in western North America was 64% (range = 39 – 89%) [24]. However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable.

A recent study in the Hoopa Valley of California reported that 62% (29 of 47) of denning opportunities were successful in weaning at least one kit from 2005-2008 [63]. Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, most ($\overline{x}$ = 78%, range = 63-90%) produced young annually from 2010-2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers [24].

Comment [f6]: You could add citation 57 to this (Matthews et al.). that paper found that 2 year old females were less likely to den and wean kits than older females. An important point when discussing reproductive potential.

Many kits die immediately following birth. Frost and Krohn [48] found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth [44]. In wild populations, kits have been found dead near den sites and reproductive females have been documented abandoning their dens indicating their young had died [49,50,56]. The number of fishers an individual female is able to raise until they are independent depends primarily upon food resources available to them [64]. Paragi [65] reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.

Survival

There are few studies of longevity of fishers in the wild. Powell [2] believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir [61] captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age [66]). Of

14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age [67].

In the wild, most fishers likely live far less than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years, although one of those animals lived to at least 10 years of age [66,68]. From 2009-2011, a total of 67 fishers were live-trapped in northern California as part of an effort to translocate the species to the southern Cascades and northern Sierra. The median age of those individuals was 2 years (range = 0.6 – 6). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Estimated survival rates of fishers vary throughout their range [24]. Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, and road density. Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation). Lofroth et al. [24] summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America documented by 8 studies, and averaged 68% for 3 studies in eastern Northern America. This difference was presumably due, in part, to the take of fisher by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts). In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range = 0.61-0.84) for adult females and 0.82 (range = 0.73-0.86) for adult males [24].

Comment [f7]: Our final report (**Bobcat Ecology and Relationship with and influence on Fisher survival on the Hoopa Valley Indian Reservation, California Final Report USFWS TWG CA U-29-NA-1) Includes quite a bit of population age structure information for the Hoopa Study area, including a shift in mean age of females (increasing during the study). Not sure if you would have noticed that part of our report given that the thing is very long. The most important thing was that during our study, females died at a younger age during the first half of the study and over all female survival has trended upwards so reproductive potential has improved.**

Comment [f8]: Unfortunately our causes of mortality data has not been published yet other than in reports. Within the report mentioned above we indicated that over 29% of all male mortality at Hoopa was a direct result (not indirect) of toxicosis. Currently that number stands at over 35%

Comment [f9]: Our report mentioned above clearly shows males with lower and declining survival rates when compared to females with the top known fate models showing lower average monthly survival for both males and females in May and June compared to all the other months. Presumably due to the rat poisons being placed at grow sites in the spring.

Food Habits

Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi [2]. Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided [2]. Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey

species that may be otherwise impossible to determine by more traditional techniques [24].

In a review of 13 studies of fisher diets in North America by Martin [69], five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed [24]. The proportion of different food items in the diets of fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey [2].

In California, studies indicate fishers appear to consume a greater diversity of prey than elsewhere in western North America [24,70,71]. This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey [70]. In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats [71,72]. Diets reported in these studies differed somewhat in the frequency of occurrence of specific prey items, but included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California [71], where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material [72,73].

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council [74], Golightly et al. [71] found mammals, particularly gray squirrels (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), and ground squirrels (*Spermophilus* sp.), to be the most frequently consumed prey by fishers. Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet [70–72]. This is likely due to the comparatively low densities of these species in ranges occupied by fishers in California compared to other parts of their range [72].

In the southern Sierra Nevada, Zielinski et al. [72] reported that small mammals comprised the majority of the diet of fishers. However, insects and lizards were also

Comment [f10]: Golightly (71) mentions woodrats being more common than squirrels in the coastal zone, should at least include them here. We have a more recent un-published report from Hoopa where woodrats were the number one prey item. I can send a copy of that report if you would like.

frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. [72] also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn.

Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available [71,72,75,76]. Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers their ability to capture and handle larger versus smaller prey [24]. The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill. This has been hypothesized as a mechanism that reduces competition between the sexes for food [2]. Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey [24].

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. [72] found that during summer, the diet of female fishers compared to the diet of male fishers contained a greater proportion of small mammals. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. [77] reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley [49] found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). However, since most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits [49]. In some areas, male fishers have been found with significantly ($P<0.1$) more porcupine quills in their heads, chests, shoulders, and legs than female fishers [59,78]. It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers [2].

Movements

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities [79]. These areas have been described for fisher and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young [2]. The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not [2]. Although the home range of a female generally only overlaps the home range of a single male, a male's home range may overlap those of multiple females with the potential benefit of increased reproductive success [2].

Lofroth et al. [24] summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. This difference in home range size, with male fishers using substantially larger areas than females, has been consistently reported [49,52,56,59,80–87]. In 9 studies in western North America the home range sizes of male fishers were 3 times larger than the home range sizes of female fishers [24]. Lofroth et al. [24] noted that home range sizes of fishers generally increase from southern to northern latitudes. Some factors that may influence the suitability of home ranges include landscape scale fragmentation, heterogeneity, and edge ecotones, but these attributes have not been well studied [88].

Dispersal: Dispersal describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. [89] as increasingly recognized to occur in three phases: 1) departing from the natal[23] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to

[23] Natal refers to the place of birth.

move through the landscape, prey resources, turnover rates of adults [52,56,62] and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities [49,52,56]. During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat [2,8,52,90]. Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females [89]. This pattern appears to hold true for fishers [49,57,91]. It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories [91]. Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient [92,93].

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age [24]. In some studies, juvenile male fishers departed from their ~~home~~ natal ranges earlier than females [57]. Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home ranges. This behavior is characterized by higher mortality risk [52].

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. [62], reported mean maximum dispersal distances for male fishers [$\bar{x}$ =17.3 km (10.7 mi), range=10.9-23.0 km (6.8-14.3 mi), n=8] and for females [$\bar{x}$ =14.9 km (9.3 mi), range=7.5-22.6 km (4.7-14.0 mi), n=5]. York [56] reported mean maximum dispersal distances for males [$\bar{x}$ =25 km (15.5 mi), range=10-60 km (6.2-37.3 mi), n=10]) and for females [$\bar{x}$ =37 km (23 mi), range=12-107 km (7.5-66.5 mi), n=19]. The greater dispersal distance for

juvenile females compared to males reported by York is unusual as, in other studies, males dispersed farther than females.

In the interior of British Columbia, Weir and Corbould [52], reported a mean dispersal distance from the centers of natal and established home ranges of 24.9 km (9.6 mi) for two females and 41.3 km (15.9 mi) for one male. In the southern Oregon Cascade Range, Aubry and Raley [49] reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male fishers [$\bar{x}$ = 29 km (18 mi), range 7-55 km (4.4-34.2 mi), n = 3] and female fishers [$\bar{x}$ = 6 km (3.7 mi), range 0-17 km (0-10.6 mi, n = 4]. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. [57], reported that the mean maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [$\bar{x}$ = 8.1 km (5.0 mi), range = 5.9–10.3 km (3.7-6.4 mi), n = 2) than females [$\bar{x}$ = 6.7 km (4.2 mi), range = 2.1–20.I km (1.3-12.5 mi), n = 12]. They also reported the distance between natal dens and the centroids (geometric center) of home ranges established by a single male [1.3 km (0.82 mi)] and 7 females [$\bar{x}$ = 4.0 km (2.5 mi), range 0.8-18 km (0.5-11.2 mi)].

Habitat Use

Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers [3,94–96] have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

In their comprehensive synthesis of the habitat ecology of fishers in North America, Raley et al. [88] used a hierarchical ordering process proposed by Johnson [97] to assess habitat associations of fishers at multiple scales (Table 1). They described the fisher's geographical distribution (first-order selection) as the ecological niche occupied by the species, which is further refined at the home range scale (second-order selection). Ultimately, the selection of different environments (third-order) and of resources (fourth-order) is constrained by landscape scale processes and conditions

Table 1. Summary of habitats used by fishers categorized by hierarchical order (Johnson 1980) and a synthesis of fisher habitat studies by Raley et al. [88].

.

First-order	Geographic distribution	Fisher distribution has consistently been associated with expanses of low- to mid-elevation mixed conifer or conifer-hardwood forests with relative dense canopies.
Second-order	Selection or composition of home ranges with the geographic distribution	Characterized by a mosaic of forest types and seral stages, with relatively high proportions of mid- to late-seral conditions, but low proportions of open or non-forested habitats.
Third-order	Selection or use of different environments within home ranges	Rest Sites: Fisher consistently selected sites for resting that have larger diameter conifer and hardwood trees, larger diameter snags, more abundant large trees and snags, and more abundant logs than at random sites. Sites used for foraging, traveling, seeking mates: Although results indicate complex vertical and horizontal structure is important to fishers, strong patterns of use or habitat selection were not found.
Fourth-order	Selection or use of specific resources within home ranges	Rest Structures: Fishers primarily used deformed or deteriorating live trees and snags for resting. The species of tree used appeared less important than the presence of a suitable microstructure (e.g., mistletoe brooms, cavities, nests of other species) for resting. Dens: Female fishers use cavities in trees to give birth and shelter their young. Den trees used for reproduction were old and were always among the largest diameter trees in the vicinity.

[88]. We have adopted this hierarchical approach to describe habitats selected by fishers.

Some researchers have hypothesized that fishers require old-growth conifer forests for survival [98]. However, habitat studies during the past 20 years demonstrate that fishers are not dependent on old-growth forests *per se*, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. Raley et al. [88] suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include high proportions of mid- to late-seral forests.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments [24]. The Department calculated the mean elevation of each Public Land Survey [99] section in which fishers were detected in California from 1993-2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 5). Habitats at higher elevations may be less favorable for fishers due to the

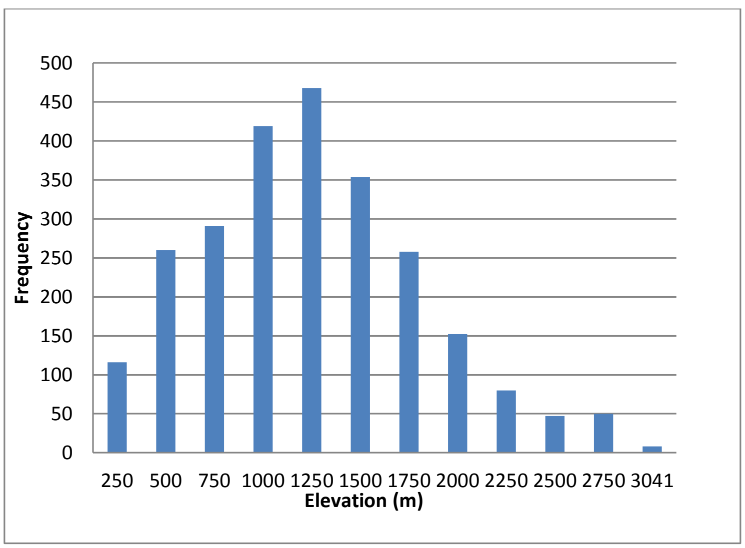


Figure 5. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993-2013. California Department of Fish and Wildlife, 2014.

depth of the winter snowpack that may constrain their movements [100], because the abundance of den, structure, rest structures, and prey may be limited [88], or for other unknown reasons.

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa pine [53,85,101]. Tree species' composition may be less important to fishers than components of forest structure that affect foraging success and provide resting and denning sites [98]. Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale ([53,85,102,103].

Hardwoods were more common in fisher home ranges in California compared elsewhere in western North America, [24]. This may be related to the use of hardwoods for resting and their importance as habitat for prey. In general, based on a number of studies in eastern North America and in California, high canopy closure is an important component of fisher habitat, especially at the rest site and den site level [25,53,85,102]. At the stand and site scale, forest structural attributes considered beneficial to fishers include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground [25].

Comment [f11]: Also the availability of hardwoods within landscapes would be important. Many regions in the western US where fishers are found do not have many hardwoods.

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare and most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have occurred, active fishers were associated with complex forest structures [88]. Raley et al. ([88]) reviewed several studies ([102,104–106]) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated [88]. The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers to distinguish among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions [88].

During periods when fishers are not actively hunting or traveling, they use structures for resting which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey [24,107]. Fishers typically rest in large deformed or deteriorating live trees, snags, and logs and the forest conditions surrounding these sites frequently include structural elements of late-seral forests [88]. The characteristics of rest structures used by fishers are extremely consistent in western North America, based on an extensive review by Raley et al. [88]. They summarized the results of studies from 12 different geographic regions of more than 2,260 rest structures in western North America and reported that secondarily, fishers rested in snags and logs. The species of tree or log used for resting appeared to be less important than the presence of a suitable microstructure in which to rest (e.g., cavity, platform) [88]. Microstructures used by fishers for resting include: platforms formed as a result of fungal infections, nests, or woody debris; cavities in trees or snags; and logs or debris piles created during timber harvest operations [49,52,86,108,109][49]. Rest structures appear to be reused infrequently by the same fisher. In southern Oregon, Aubry and Raley [49] located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion.

A meta-analysis conducted by Aubry et al. [107] of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. [88]). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (> 100 years) for suitable microstructures to develop [88].

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits [88]. However, hollow logs are used for reproduction (i.e., maternal dens) occasionally [49] and Grinnell et al. [3] reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree [88]. Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose

dens with openings small enough to exclude potential predators and aggressive male fishers [88].

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times larger in diameter on average than other trees in the vicinity of the den [52,65,104] as cited by Raley et al. [88]. Depending on the growing conditions, considerable time may be needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits. Information collected from more than 330 dens used by fishers for reproduction indicates that most cavities used were created by decay caused by heart-rot fungi [52,66,110]. Infection by heart-rot fungi is only initiated in living trees [111,112] and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens [88]. Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age [110].

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fisher in California [102,103,113,114]. The newest model was developed by the Conservation Biology Institute and the USFWS (FWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the FWS-CBI model consists of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

The FWS-CBI models predict the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) [109], 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities utilized was from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

For the southern Sierra Nevada and where it blended into the northern Sierra Nevada, the variables used in the FWS-CBI model were basal-area-weighted canopy height,

minimum temperature of the coldest month, tassel-cap greenness[24], and dense forest (percent in forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The FWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables. Other recent models [96, 106] have primarily been focused on predicting habitat in the northwestern part of California or have been derived from far fewer fisher detections [97].

The final FWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as “high quality”, model values associated with habitats avoided by fishers were designated as “low quality”, and habitats that were neither avoided nor selected were considered “intermediate”. The “low quality” habitat category may include non-habitat (not used) as well as areas used infrequently by fishers relative to its availability. This FWS-CBI model was considered to be the best information available depicting the amount and distribution of habitats potentially suitable for fisher within the historical range depicted by Grinnell et al. [3] and the species’ current range in California (Figures 6 and 7).

[24] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

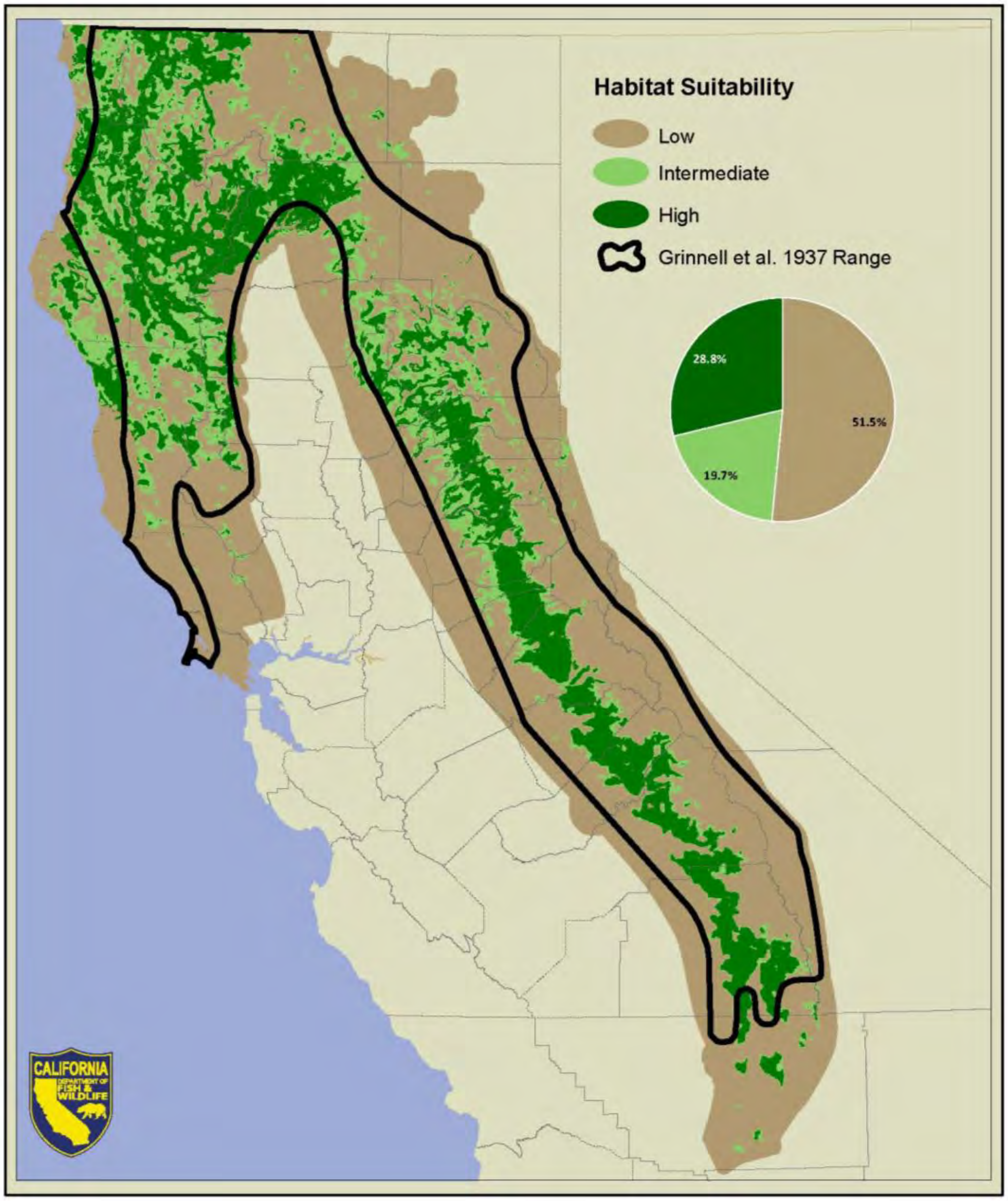


Figure 6. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

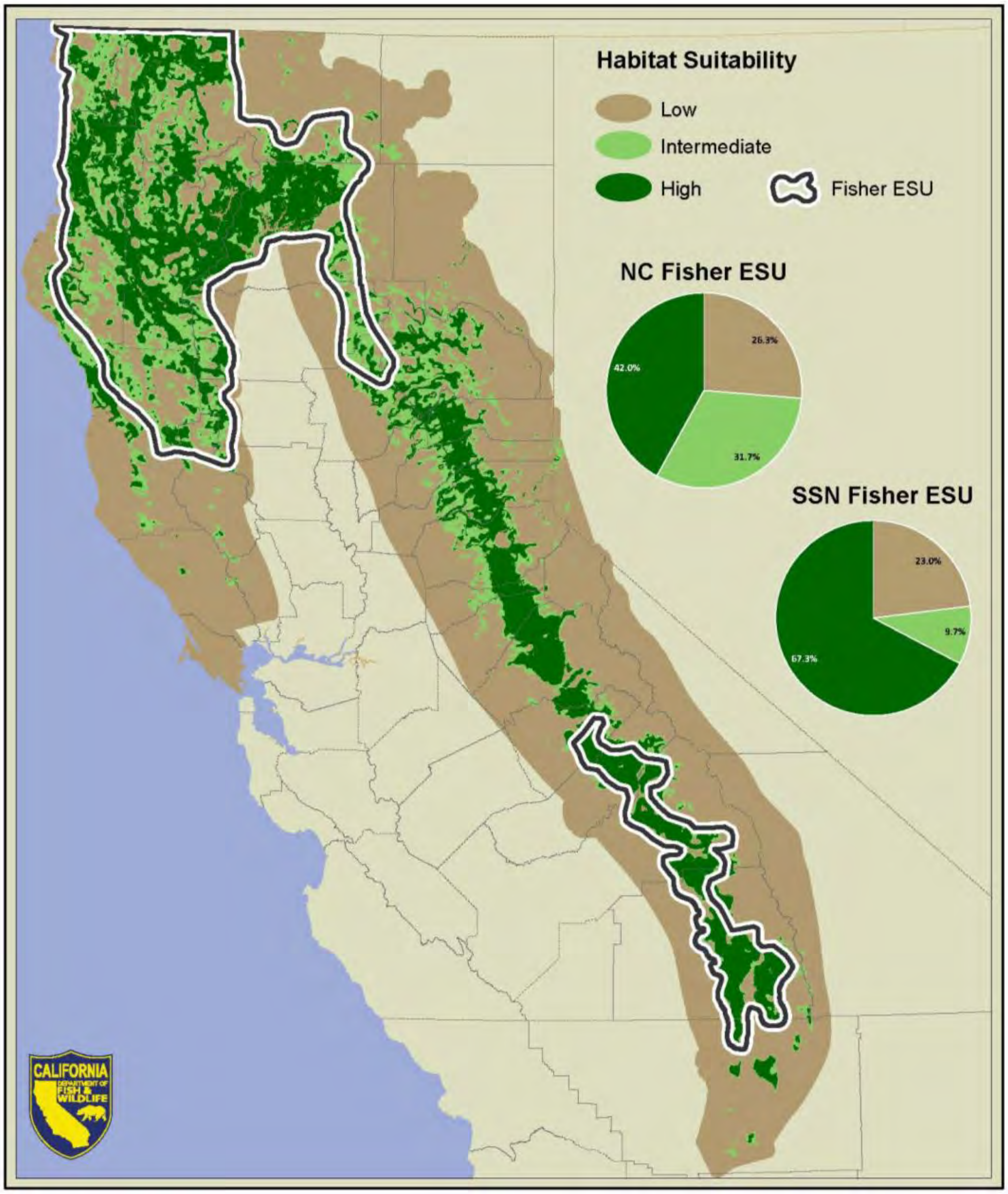


Figure 7. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Conservation Status

Regulatory Status

The fisher is currently designated by the Department as a Species of Special Concern[25] and as a candidate species at both the state[26] and federal[27] levels. Fishers are considered a sensitive species by the USFS and the Bureau of Land Management.

Habitat Essential for the Continued Existence of the Species

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists [3,31] and researchers in modern times [2,25,115–118]. However, the size, age, structure, and scale of forests essential for fisher are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular

[25] Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, "Species of Special Concern" is an administrative designation and carries no formal legal status.

[26] A species becomes a state candidate upon the Fish and Game Commission's determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted [California Code of Regulations (Cal. Code Regs), tit. 14, § 670.1(e)(2)]. During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

[27] Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

forest types (e.g., old-growth conifers) habitat for survival [98]. However, studies of fisher habitat use over the past two decades demonstrate that they are not dependent on old-growth forests *per se*, nor are they associated with any particular forest type [88]. Fishers are found in a variety of low- to mid-elevation forest types [105,119–122] that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. These landscapes are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Most studies of habitat use and selection by fishers have focused on structures used for denning and resting, in part because those aspects of fisher ecology are more easily studied than habitat selection for foraging. Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young [52]. Aubry and Raley [49], reported that the sizes of den entrances used by female fishers were typically just large enough to for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir [52], found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110].

Comment [f12]: It is true that it may be easier to study den and rest site selection, but I believe most of the research focused on that because earlier papers recommended that research be done and that resting and denning habitat would likely be most critical to fishers. The attitude seemed to be that they could forage just about anywhere but were limited in rest site selection and even more limited for dens. I do wish we could do better at teasing apart foraging from other active behaviors. That is definitely a difficult task.

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning [88]. These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large and considerable time (>100 years) may be required for suitable cavities to develop [88].

Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. However, forest structure important for fishers

should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers [28] .

Distribution Trend

Comparing the historical range of fishers in California estimated by Grinnell et al. [3] to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Lake and Marin counties. However, recent genetic analyses indicate some of the area considered to be a modern gap [35,36] in the historical distribution of fishers in the northern and central Sierra Nevada may have been long standing and pre-dated European settlement [29,40]. Yet, Grinnell et al. [3] and Price [31] suggest that fishers were present in this region post European settlement. This indicates that the gap was narrower historically than during contemporary times.

Despite extensive surveys from 1989-1995 [36] and 1996-2002 [35] for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled.

Since the 1990s, detections of fishers have increased along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County (Figure 3). It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier surveys. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number

of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [3]. In that year, only 14 fishers were reported taken by trappers in the state, with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau of Labor Statistics). Grinnell et al. [3] concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers [123]. ~~Most~~ Many of the animals were taken in a single trapping season (1920) when 120 fishers were harvested [124]. Despite concerns about the scarcity of fishers in the state, trapping of fisher was not prohibited until 1946 [125].

Grinnell et al. [3] noted that "Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township." They roughly estimated the fisher population in California at fewer than 300 animals statewide with a density of 1 or 2 animals per township [93 km^2 (36 mi^2)] in good fisher range. For perspective, substantially higher numbers of fisher are captured for radio-collaring/study purposes in various studies in the present day: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were captured as part of an effort to translocate the species to the Southern Cascades and northern Sierra Nevada from 2009-2012 from widely distributed locations in northern California. Over a period of 28 days in 2012, 19 fishers were captured in vicinity of the translocation release site in the northern Sierra Nevada that were likely the offspring of animals translocated to the area [126]. Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers during this effort was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*).

Comment [f13]: Clearly comparing apples and oranges due to techniques and technology compared to today, but still interesting. Fishers most likely really were far fewer back then.

Despite the paucity of empirical data, there are several estimates of fisher population size in northern California. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of

adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. However, he believed the estimate to be useful for general planning and risk assessment.

Self et al. (2008 SPI comment information) derived two separate "preliminary" estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a "deterministic expert method" and an "analytic model based approach" to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 (95% confidence interval [CI]: 1,848 - 4,550) fishers. Estimates for the southern Sierra Nevada population were 598 using the deterministic expert method and 548 (95% CI: 247 – 849) fishers based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates.

Estimates of the number of fishers in the southern Sierra Nevada indicate that despite using different approaches, the population is quite small. Lamberson et al. [127], using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Spencer et al. [128] estimated the size of the fisher population in the southern Sierra Nevada by extrapolating previous density estimates of Jordan [129], using data from the USFS regional population monitoring program (USDA Forest Service 2006), and linking a regional habitat suitability model to life history attributes. Using these data, they estimated 160-350 fishers in the southern Sierra Nevada population, of which 55-120 were estimated to be adult females. More recent work by Spencer et al. [119] estimated the southern Sierra Nevada fisher population at 300 individuals. Estimates of the number of fishers in California vary depending on the source, but range from 1,000 to approximately 4,500 fishers statewide.

Population Trend in California

No data are available that document long-term trends in fisher populations statewide in California. Despite genetic evidence indicating a long-standing historical separation of fishers in northern California from those in the southern Sierra Nevada [28], fishers reportedly occurred in the central and northern Sierra Nevada post-European settlement

[3,31], but were likely not abundant based on the scarcity of records from this region. By the late 1800s, habitat changes and harvest by trappers may have reduced the abundance of fishers in this region to low levels. The apparent scarcity of fishers in the central and northern Sierra Nevada by the early 1900s is supported by the work of Grinnell et al. [3] and the lack of specimens from that region.

In northern California, Matthews et al. [130] reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. However, continued monitoring of this population indicates that overall the population density has increased by 2012-2013, but only to about half of that estimated in 1998.

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 [131]. Detection rates at segments increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995, lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection ratios (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed.

Swiers et al. [132], collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers et. al. found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of abundance and population growth indicated that the population size was stable, although estimates of survival and recruitment suggested high population turnover [132].

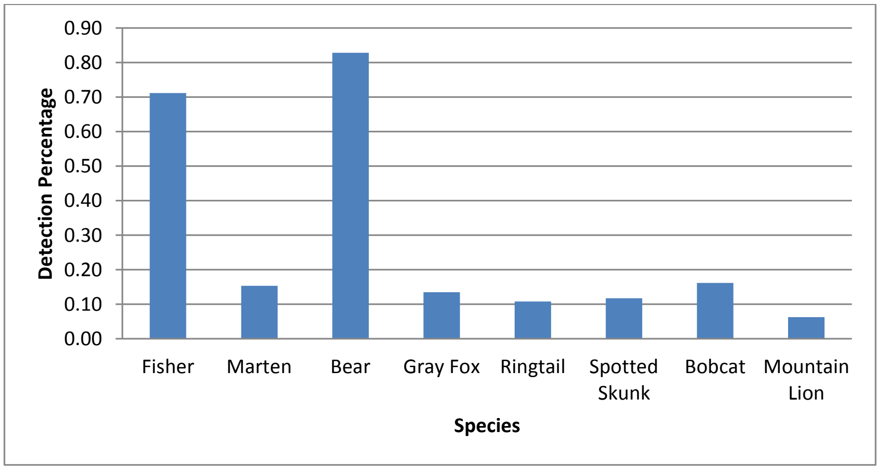


Figure 8. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

Tucker et al. [28] concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated European settlement. Tucker et al. [28] also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-European settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries. The southern extent of fisher habitat in the southern Sierra may have contained sufficient high quality habitat to serve as a refugium supporting enough fishers to constitute a founding population (J. Tucker, pers. comm.). Tucker et al. [28] using genetic techniques estimated that the total current population size of fishers in northwestern California could range from 258-2850 and the southern Sierra Nevada population could range from 334-3380.

Monitoring of fisher populations in northern California has been limited, but several studies are providing insight into the distribution and trends in occupancy rates of fishers in the state. Estimates of trends in occupancy have been used as surrogates for trends in abundance for some species of wildlife [133], in part, because it is more cost

Comment [f14]: I am in no way a genetics expert. This work is extremely interesting to me and I did re-read the paper yesterday to try and ge a better grasp oon their conclusions. I have no problem believing that the 2 current populations have been isolated for a 1000 years. The gap is quite large and it does sound like the SSN population likely retreated to the extreme south. At the north end of the Sierras there is a noticable gap in the suitable habitat model on your figures above. Jody did not have any historical samples from the central/northern Sierras where Grinnell showed historical records. I could totally picture a now missing, third, genetically isolated population that disappeared post European settlement. It seems that we either have to believe that none of the Grinnell records were real or that there were indeed fisher in the central-northern Sierras. If they were there, it seems plausible that they could have been genetically isolated from both the SSN and NC populations or at least isolated from 1 or the other.

Comment [f15]: This should say "current effective population size" rather than an estimate of the actual current population.

effective and feasible than monitoring direct measures of abundance. Zielinski et al. [134] implemented a monitoring program for fishers in the southern Sierra Nevada over an 8 year period (2002-2009) and modeled trends in occupancy by combining the effects of detection probability and occupancy. They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest in the southeastern portion of their study area (0.261) and highest in the western portions of their study area (southwestern zone = 0.583) [134]. They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra did not appear to be declining.

The Department has conducted a large-scale monitoring project for forest carnivores, including fishers, as part of its Ecoregion Biodiversity Monitoring (EBM) program in the Klamath and East Franciscan ecoregions of northern California since 2011. EBM surveys for carnivores were conducted using camera traps within hexagons established by the Forest and Inventory Assessment system [135]. All the sites selected for survey occurred in forested habitats and were selected randomly (although land ownership, road access, and safety issues occasionally precluded completely random placement of plots). A Bayesian hierarchical model was used to estimate occupancy and detection probabilities for fisher across stations nested within plots within ecoregions (Furnas et al. unpublished manuscript). A total of 85 plots containing 169 stations were surveyed across the entire 2.8 million-ha study area during 2011 and 2012. The overall occupancy estimate for fisher was 0.438 [90% CI: 0.390-0.493] for stations, and 0.622 [90% CI: 0.569-0.685] for station pairs. The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.

Threats (Factors Affecting the Ability of Fishers to Survive and Reproduce)

Evolutionarily Significant Units

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing

separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) Fisher ESU and SSN (southern Sierra Nevada) Fisher ESU. The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by the Third District Court of Appeal that the term "species or subspecies" as used in sections 2062 and 2067 of the CESA includes Evolutionarily Significant Units[28]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species [136].

ESU boundaries for fisher represent the Department's assessment of the current range of the species in the state, considering the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between them (Figure 9). Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events.

Habitat Loss and Degradation

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic [24,52,98,108–110,117]. Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers particularly vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires [5,25]. Buskirk and Powell [98] found that at the landscape scale, the abundance and distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.

[28] 156 Cal.App.4th 1535, 68 Cal.Rptr.3d 391

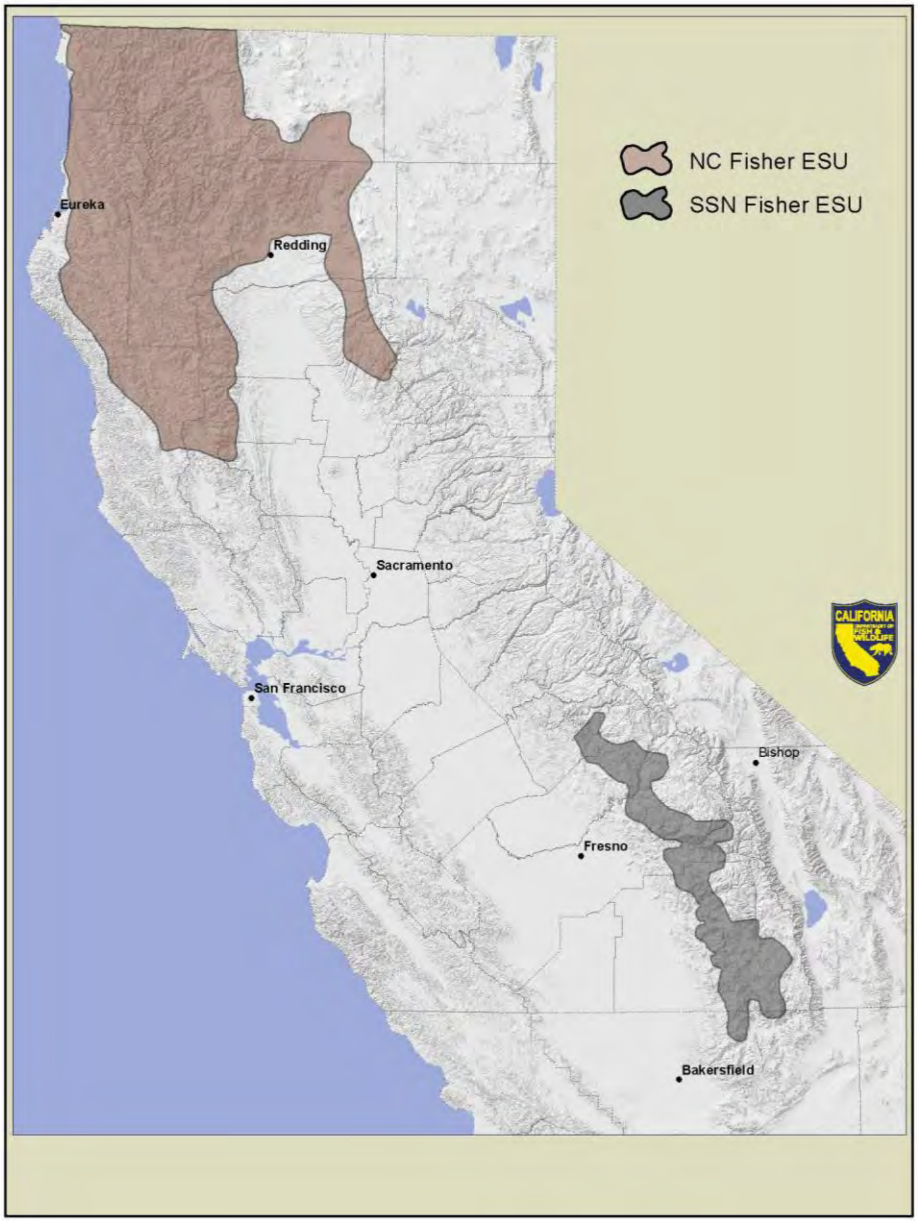


Figure 9. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and Wildlife, 2014.

Fishers have frequently been associated with old-growth forests and some researchers have hypothesized that they require those forests for survival. Habitat studies in recent decades demonstrate that fishers are not dependent on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. However, the home ranges of fishers often include high proportions of mid- to late-seral forests [88].

Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age and structural features of many forests in California. Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. Besides the direct removal of trees through timber harvest, management practices and policies have had many indirect effects on forested landscapes [24]. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Generally, timber harvest has substantially simplified the species composition and structure of forests [137,138]. Habitat elements used by fishers such as microstructures for denning can take decades to develop and a substantial reduction in the density of these elements from landscapes supporting fisher would likely reduce the distribution and abundance of fisher in the state.

Of the historical range of the fisher in California estimated by Grinnell et al. [3], nearly 61% is in public ownership and about 37% is privately owned (Figure 10). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (NPS) (Figure 11). Private lands within the NC Fisher ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 12). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades [139]. Sawtimber volume (net volume in board feet of sawlogs harvested from commercial tree species containing at least one 12-foot sawlog or two noncontiguous 8 foot sawlogs) harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 13 and 14).

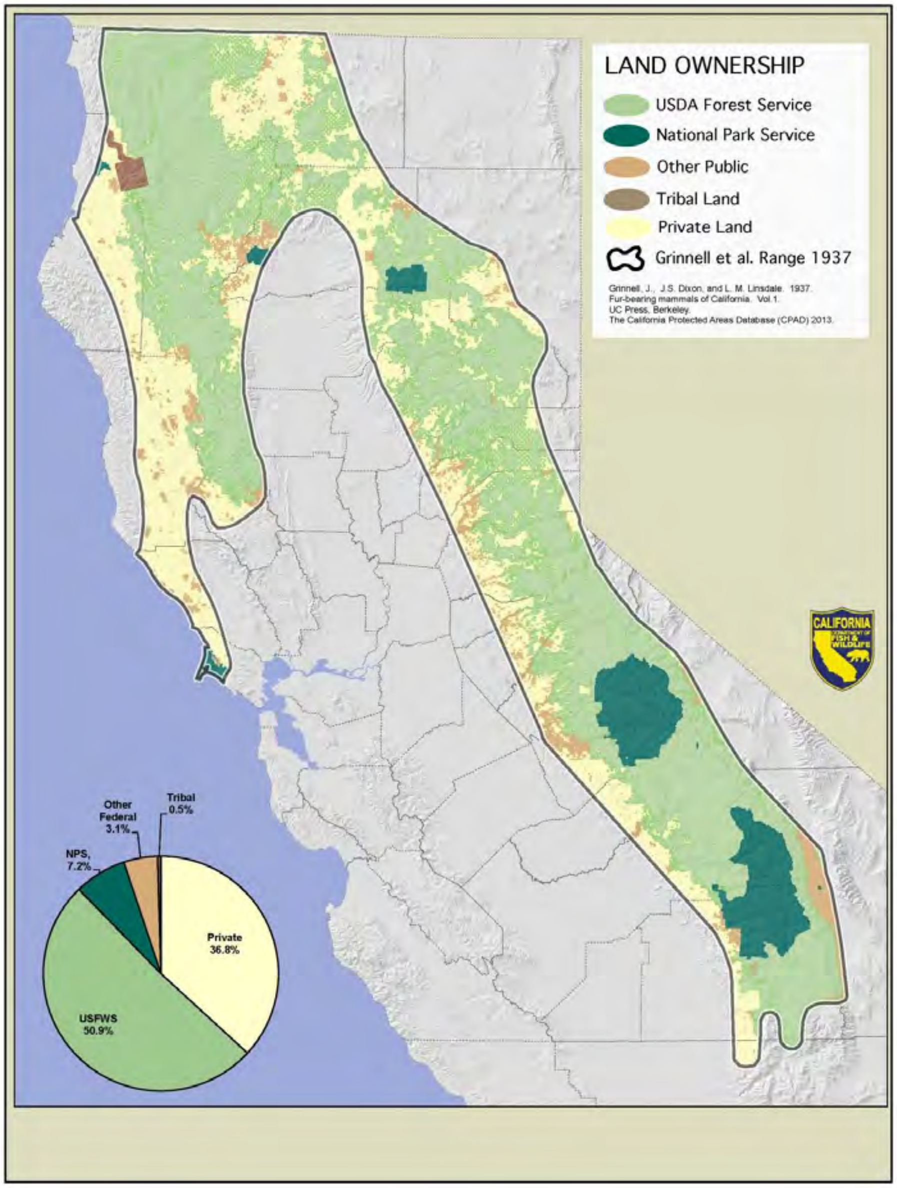


Figure 10. Landownership within the historical range of fisher depicted by Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Comment [f16]: Looks like Round Valley and Tule River Reservations are lumped in with public land on this figure but not on the next 1

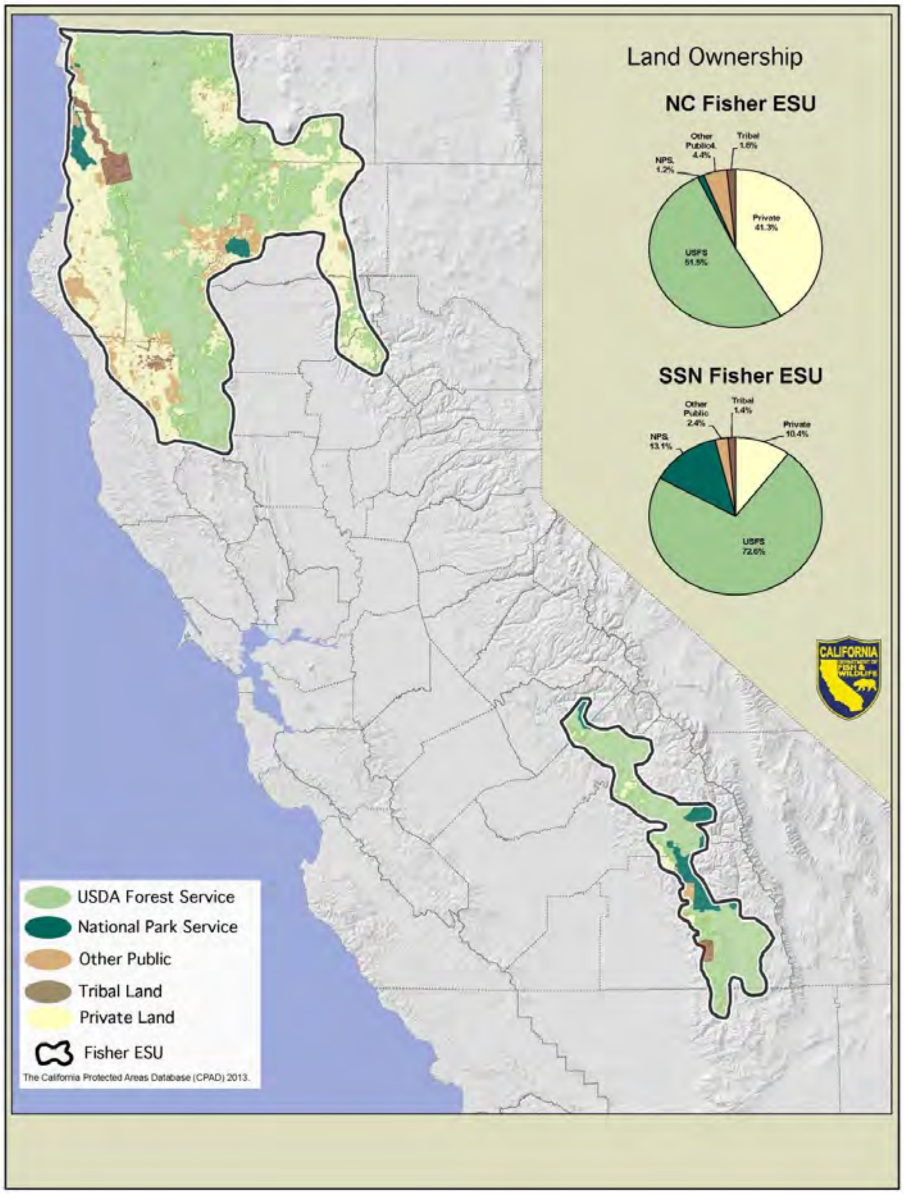


Figure 11. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

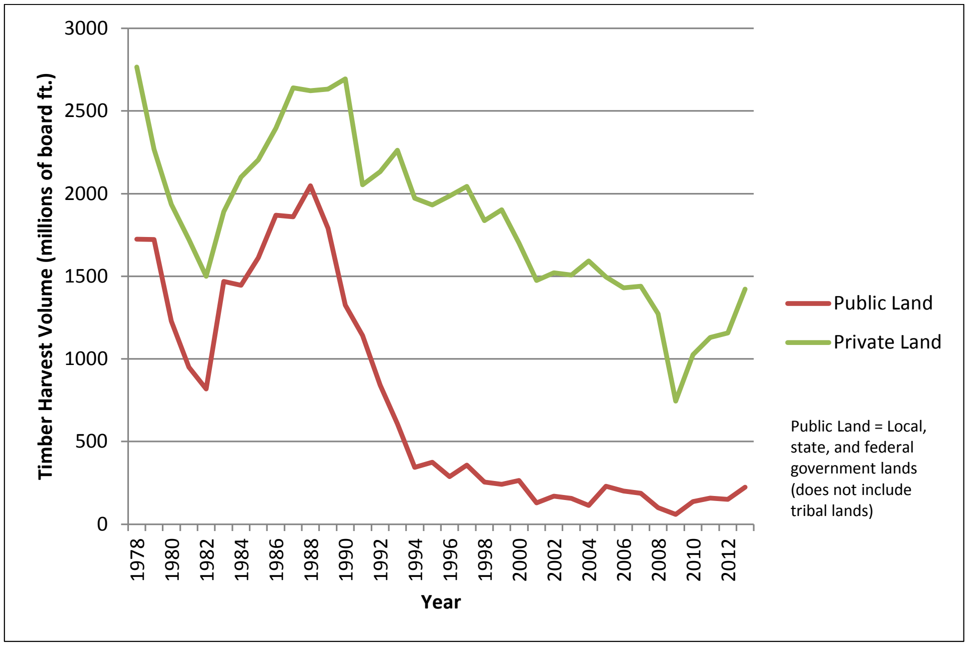


Figure 12. Volume of timber harvested on public and private lands in California (1978-2013) [140].

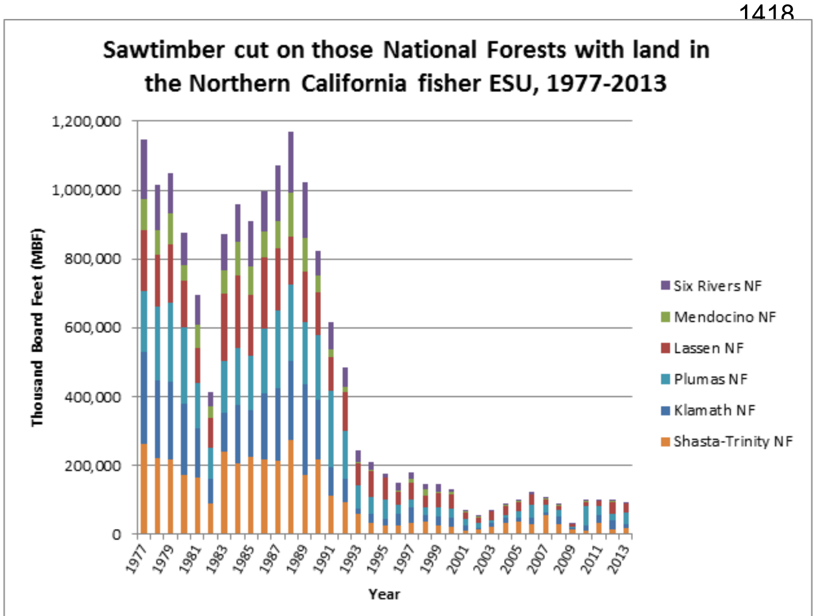


Figure 13. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 [139].

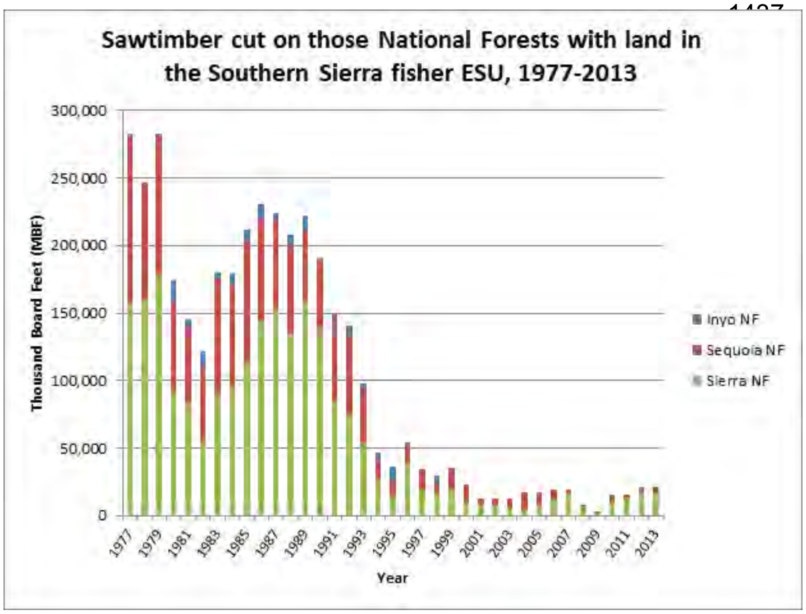


Figure 14. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 [139].

Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. This could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected. However, fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been intensively managed for timber production (Figure 15).

A more proximal concern for the long-term viability of fishers across their range in California is the presence of suitable denning and resting sites and habitats capable of supporting foraging activities. However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California.

Comment [f17]: Although fishers do occupy heavily managed areas throughout the NC ESU, occupancy even with reproduction, does not always mean good quality habitat. I make this case cautiously and with caveats each time. Yes, they occupy managed landscapes and sometimes reproduce, however, it doesn't necessarily equate to high fitness habitat. The landscape, even in higher quality habitat likely has a mix of source, sink and neutral territories. Figure 15 really shows a number of fisher home ranges with relatively few open clear cuts within them. I have scanned the northern and central Sierras using Google Earth and I can see large areas that are heavily impacted by clear cuts. Much of that area I would think would be capable of supporting fisher habitat but, due to management activities it may remain of low to un-suitable quality. I am hoping that the monitoring of the Stirling reintroduction can continue long term and we will get a better picture of how fisher populations respond to landscapes subjected to intensive regeneration timber management. I have often thought that fishers would do quite well in the northern and central Sierra's if they could make their way to the public lands there. If they can survive and expand on the Stirling tract then I would imagine they will do well on the adjacent public lands as well.

Comment [f18]: I agree that this is probably true but again, tend to point out that we simply do not have the data to make this conclusion. There are probably large chunks of potentially capable habitat that have few if any denning structures due to past management or intense stand replacing fire. Does this hinder population expansion? We don't really know.

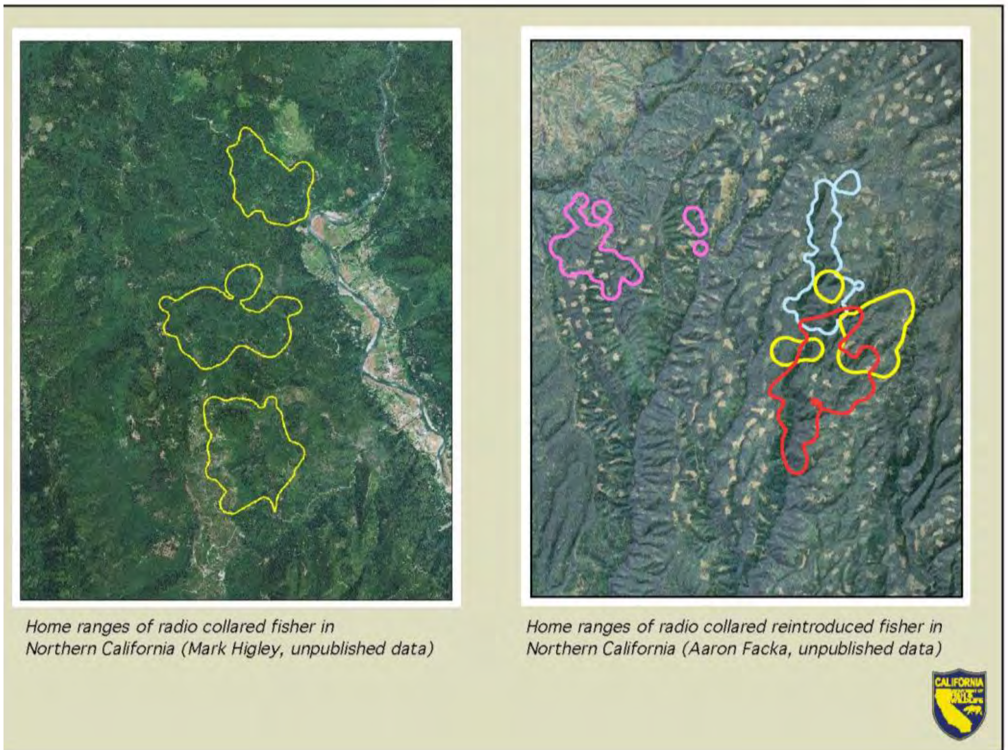


Figure 15. Home ranges of female fishers on managed landscapes in northern California and the northern Sierra Nevada, 2014.

Population Size and Isolation

Grinnell et al. [3], considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. However, few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century [36,38]. However, recent genetic work by Knaus et al. [29] and Tucker et al. [28] indicates fishers in the southern Sierra Nevada became isolated from northern California populations long before European settlement.

Comment [f19]: I would repeat my comment from page 43 here.

Based on Tucker et al. [28], the fisher population in California experienced a significant decline of approximately 90% long before European Settlement, resulting in the isolation of fisher populations in northern California from fishers in the Sierra Nevada. Tucker et al. [28] pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene [141] and would be consistent with the divergence dates of fisher populations in California reported by Knaus et al. [29]. However, in California there were two “mega-droughts” during the Medieval Warm Period (MWP) that lasted over 200 and 140 years each from 832-1074 and 1122-1299 AD, respectively. These droughts may have caused fisher populations to contract isolating the population in the Sierra Nevada from fishers elsewhere in the state [28].

In addition to this early population contraction, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19th century and early 20th century [28]. Tucker et al. [40] suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20th century while fisher in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable based on estimates of occupancy from 2002-2009 [134].

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. Fishers in the southern Sierra Nevada are geographically isolated from breeding populations of fishers elsewhere in the state and do not appear to be expanding their range northward. Should fishers in the southern Sierra Nevada expand their range northward, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, fishers in either location do not appear to be dispersing towards each other and natural contact in the near-term (50 years) is unlikely.

Although fishers in northern California are effectively isolated from fishers in the southern Sierra Nevada, they are part of a regional population that extends into southern Oregon. A fisher that was marked by researchers in Oregon was

Comment [f20]: If there had been a third isolated population as I suggested in previous comment, then during this period when the second bottle neck occurred that population might have been lost completely. I wish that there had been historic samples for Tucker et al from the central-northern Sierras. I feel that unless we are willing to discount Grinnell’s records , we need to assume that fishers had been present in the central to northern Sierras and they are now gone. I think that if they had been there, Turcker et al’s work would indicate that there was not any gene flow to either current population for at least 1000 years or so.

Comment [f21]: Although it is very promising that the occupancy surveys are not indicating a downward trend, I am only cautiously optimistic for several reasons. First, the occupancy surveys are only expected to detect fairly significant declines of populations (20% or so). Second, it is quite possible that fisher home range size might be at least partially density dependent, thus as the population decreases, home ranges increase in size and as we all know fishers are fairly easily trapped/detected when they are present. Therefore, a declining population could still occupy essentially the same area as a previously high density population. I say this because that certainly appeared to be the case at Hoopa. I think that there is some evidence that the SSN population might actually be expanding northward a bit as you mention. I think that I would emphasis that aspect more.

subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California [38,91,142,143].

Although fishers do not fully occupy their assumed historical distribution, their population is likely higher than when densities of fishers were estimated by Grinnell et al. [3] at 1-2 per township in good habitat.

Predation and Disease

Predation and disease (including toxins) appear to be the most significant causes of mortality for California fishers. Since 2007, the causes of mortality for radio-collared and opportunistically found fishers from one area in northern California (Hoopa) and the southern Sierra Nevada have been analyzed through gross necropsies, histology, toxicology, and molecular methods. In a sample of 128 fishers from these two populations that died between 2007-2012, predation was the most common cause of mortality (52%), followed by disease/toxins (24%), and vehicular strikes (8%) (M. Gabriel, unpublished data). The proportion of fishers dying from each cause did not differ among these monitored populations, or by sex, which suggests that the relative impact of each source of mortality is similar for both male and female fishers and throughout fisher range in California (M. Gabriel, unpublished data). Preliminary assessment of mortality data from 2010-2013 for the northern Sierra Nevada population recently established through translocation is also consistent with these findings (D. Clifford, M. Gabriel and C. Wengert, unpublished data).

Predation: DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project (SNAMP) and King's River projects identified bobcats (*Lynx rufus*) as the predator of 25 sampled fishers (50%), mountain lions (*Puma concolor*) as the predator of 20 sampled fishers (40%) and coyotes (*Canis latrans*) as the predator of 4 fishers (8%). The single remaining carcass had both bobcat and mountain lion DNA present [144].

The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes

Comment [f22]: Or even mixed with native southern OR population?

Comment [f23]: I was really struck by this when you mentioned it above. Not sure how strong a case can be made given the changes in access, technology, population estimation techniques etc. If you can give a bit more detail as to how Grinnell arrived at his estimation it might help make this case stronger. I totally believe that at least in accessible portions of the range that the density at that time would have been far less than today and I have always believed that over exploitation led to local to even wide spread extirpation (OR and WA and possibly central-northern Sierra). Then landscape changes following that period may have kept them from rebounding.

Comment [f24]: I know that Mourad is working on publishing and has increased the sample size and come to some different results (I just got a copy of his paper today). I will leave it up to he and you to figure out whether or not to make any changes here.

killed an equal number of male and female fishers [144]. This finding suggests that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19/25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival [144].

The proportion of fisher mortalities caused by predation found by Wengert et al. [144] is higher than previously reported in California [145] and British Columbia [52]. Powell and Zielinski [25] suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert et al. [144] indicate that predation is a significant mortality factor for native fisher populations in California. Whether or not some forest management practices favor the existence of more generalist predators (like bobcats) over specialist predators like fishers is not known. However, Wengert [146] found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Disease: A number of viral, bacterial, and parasitic diseases have been documented in fisher. Canine distemper virus (CDV) infection, a cause of significant morbidity and mortality in other carnivore populations [147], was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 [148]. Three of these animals died within a 2-week period from April 22-May 5 and were found within 20 km (12.4 mi) of each other, while the fourth fisher died during an immobilization event 4 months later approximately 70 km (43.5 mi) away from the initial cases. Infection with CDV decreases immune function, thus vital capacity co-infections with other pathogens are common [147].

Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal's ability to survive a capture and immobilization event. The source of the infections in these fishers, as well as pertinent transmission routes remain unclear, but the temporal and spatial distribution of the fisher CDV mortalities, as well as the similarity of the virus isolates, suggest two spillover events from one or multiple other sympatric carnivore species.

In California, CDV mortalities in gray foxes and raccoons are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, CDV has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) [149] and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) [150]. Furthermore, highly virulent biotypes of CDV can be transmitted and cause high mortalities in multiple carnivore species [151] . This scenario was evident by a 2009 CDV outbreak in Switzerland that killed red foxes (*Vulpes vulpes*), Eurasian badgers (*Meles meles*), stone (*Martes foina*) and pine (*Martes martes*) martens, a Eurasian lynx (*Lynx lynx*) and a domestic dog [151].

Although CDV can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 3). Of 98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to CDV [152]. From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the SNAMP area were exposed to CDV [152]. Evidence to date and experiences with other species underscore the fact that CDV has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus (CPV), both potentially significant pathogens for *Martes* species [153], have not been documented in fishers in California. However, virus shedding[29] of CPV has been documented in fisher [152], and clinically significant illness due to CPV was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern California are commonly exposed to and infected with CPV: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 2).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) [154], American minks (*Mustela vision*) [155], and free-ranging southern sea

[29] Viral release following reproduction in a host-cell.

otters (*Enhydra lutris*) [156]. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania [157].

Table 22~~3~~. Prevalence of exposure to canine distemper, canine parvo virus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 [140].

	Canine Distemper Percent (No. sampled)	Canine Parvo Virus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) [158], but mortalities of fishers from these diseases have not been reported. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers [153]. Plague is known to cause mortality in other mustelids, is a serious zoonotic[30] risk [159] and is endemic in many parts of California.

Other documented disease-caused fisher mortalities included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers and other *Pekania* and *Martes* species harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases,

[30]Zoonotic diseases are contagious diseases that can spread between animals and humans.

infections and infestations are usually associated with minimal morbidity and mortality [153]. Banci [121] noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell [2].

Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye damage, there were no vision deficits or eye damage noted in affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions [160]. In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination [161]. Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fisher and may have been responsible for local declines in fishers, the Department is not aware of studies indicating that disease is significantly limiting fisher populations in California.

Human Population Growth and Development

The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance from 1970 to 2010 [162,163], the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state [164] and those numbers are expected to reach approximately 53 million by 2060 [165], an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average [166].

The California Department of Forestry and Fire Protection (CAL FIRE) estimated that statewide, between 2000 and 2040, about 2.6 million acres of private forests and

rangelands will be impacted by new development [167]. New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 890,000 ha (2.2 million acres). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fisher was comparatively low (6%).

Within the NC and SSN Fisher ESUs, future human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 16, Table 4). This represents an increase of about 1% in the acres developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because parcels of that size likely provide some fisher habitat post-development. In the NC Fisher ESU, ~~slightly~~ more than half (57%) of development as of 2010 occurred in habitats predicted to be of intermediate or high value to fishers (Table 5). That percentage is not expected to change substantially by 2030. Within the SSN Fisher ESU, about 60% of past development occurred in habitats predicted to be of intermediate or high value to fishers and that proportion is also not predicted to change substantially by 2030.

Duane [168] identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 17, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). However, the effects of future development on fishers are uncertain. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

Comment [f25]: However, increased risk and severity of wildfire could lead to significant loss of habitat, at least temporarily.

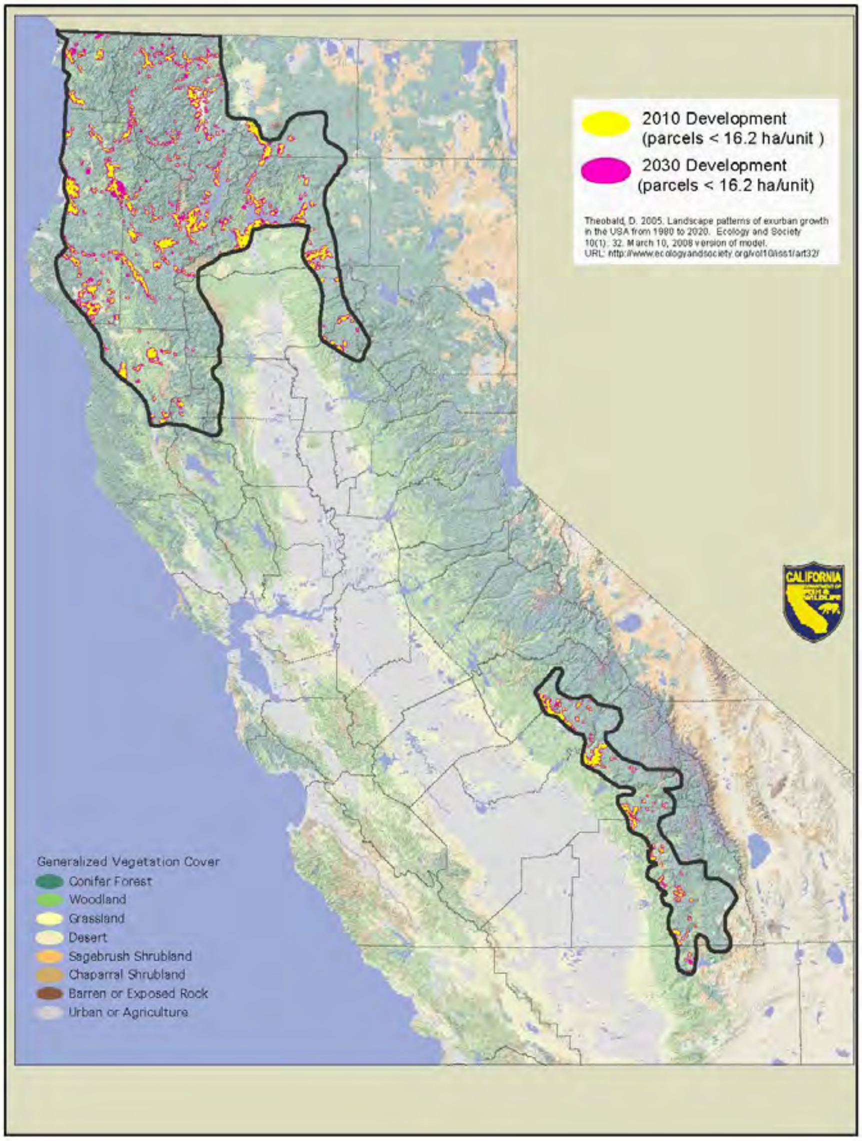


Figure 16. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169]. California Department of Fish and Wildlife, 2014.

Table 3~~34~~. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of Total	Projected Development (2030)	Percent of Total
NC Fisher	4,103,639 (10,140,312)	129,764 (320,654)	3%	160,757 (397,240)	4%
SSN Fisher	778,273 (1,923,155)	32,361 (79,966)	4%	35,845 (88,576)	5%

Table 4~~45~~. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)					
Evolutionarily Significant Unit	Low	Percent of Total	Intermediate	Percent of Total	High	Percent of Total
NC Fisher (2010)	55,954 (138,264)	43%	33,065 (81,706)	26%	39,831 (98,425)	31%
NC Fisher (2030)	69,856 (172,617)	44%	41,952 (103,666)	26%	48,030 (118,684)	30%
SSN Fisher (2010)	11,942 (29,510)	37%	4,213 (10,411)	13%	16,205 (40,044)	50%
SSN Fisher (2030)	14,158 (34,986)	39%	4,758 (11,758)	13%	16,929 (41,832	47%

Figure 17. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Disturbance

Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats the species typically occupies. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off road vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be comparatively high. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied, however, monitoring radio-collared females with young provides some insight into their sensitivity

to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. However, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. Most watersheds on private timberlands are harvested at a rate of 1-3% annually (J. Croteau, pers. comm.). Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data).

Recreational use of habitats occupied by fisher in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Roads

Fishers occupying habitats containing roads occasionally are struck by vehicles and killed [53,56,100,126]. Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data).

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fisher in California and have been hypothesized to be a potential barrier to dispersal [24,91,170], they have not been demonstrated to limit fisher populations. Roads have not shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County [126].

Fire

Wildfires are a natural part of California's forest ecology and most frequently start as a result of lightning strikes. Wildfires affect habitats used by fisher and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, and the extent of individual fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. [171], believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey.

Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s [172]. In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression [172]. In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok [173] who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act

that established fire exclusion as a national policy and formed the basis for USFS and NPS policies of absolute suppression of fires until those policies were reconsidered in the 1960s [174].

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 102,000 ha/year (252,047 ac/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 [174]. This was based on an estimate of the high fire return interval and was assumed to be similar to the fire rotation [174]. Prior to European settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting [175] and to reduce catastrophic fires [176]. Fires set by indigenous people and fires started by lightning have been estimated to have burned from 2.3 to greater than 5.3 million ha (5.6 to > 13 million acres) annually in California [177].

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more frequent [178]. Westerling et al. [179] found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fisher in California.

In the Sierra Nevada, the severity and the area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy [178]. Miller et al. [180] examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased.

In 1992, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the

largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged post-fire and replanted trees rapidly after the burn [181]. In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, SPI unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fisher using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly comprised of areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm).

The Rim Fire burned approximately 104,000 ha (257,000 ac) in Tuolumne County in August 2013. This fire was situated just north of the SSN ESU. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra population until the vegetation recovers sufficiently to facilitate its use by fishers.

While the frequency and extent of wildfires in the California have increased in recent years, the area burned annually is substantially smaller than in pre-historic (pre-1800) times when 1.8 – 4.8 million ha (4.4 – 11.9 million ac) of the state burned annually [174]. Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity [182] (Figures 18 and 19).

Lawler et al. [183] predicted that fires will be more frequent but less intense by the end of the 21st century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods [184]. Westerling et al. [185], modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California, and potential increases in burned area in the Sierra Nevada

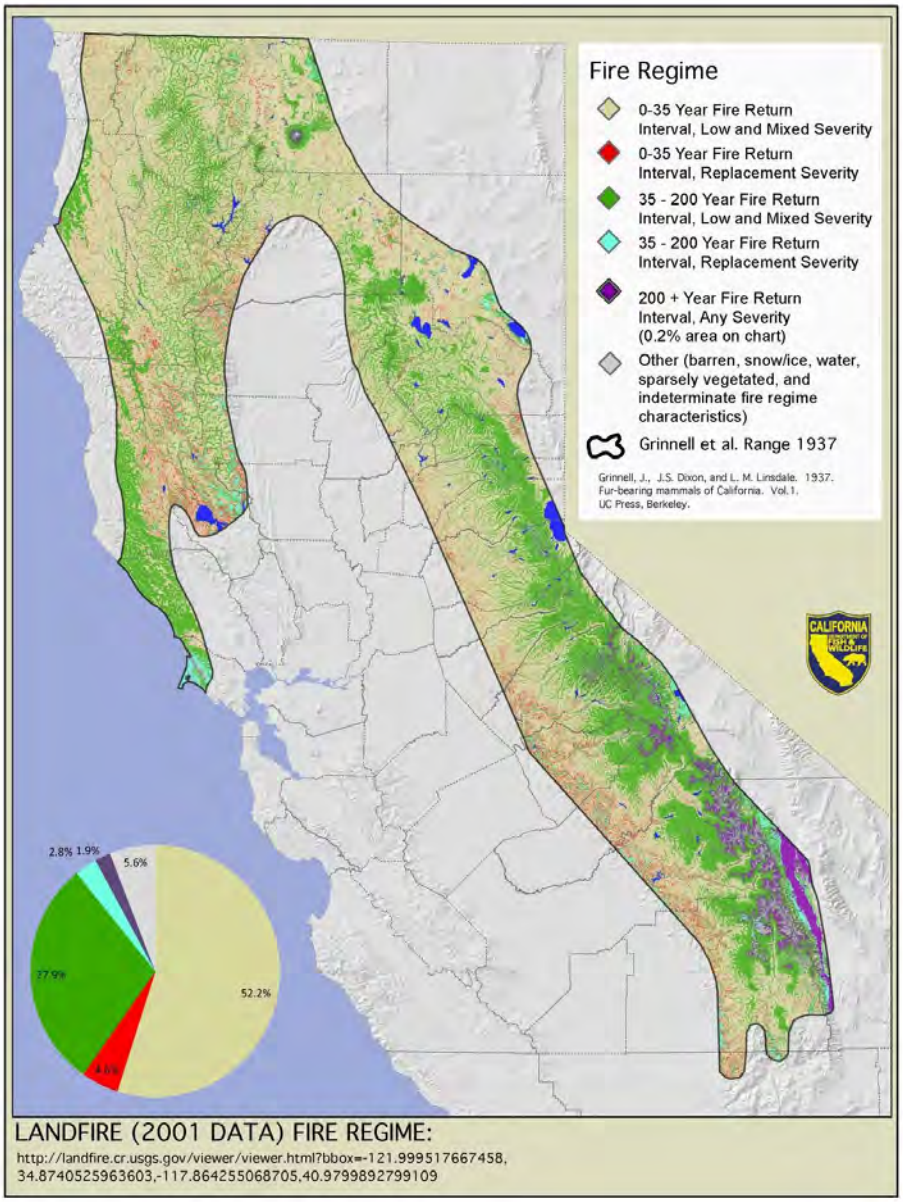


Figure 18. Presumed historical fire regimes within the historical range of fisher in California described by Grinnell et al. [3]. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

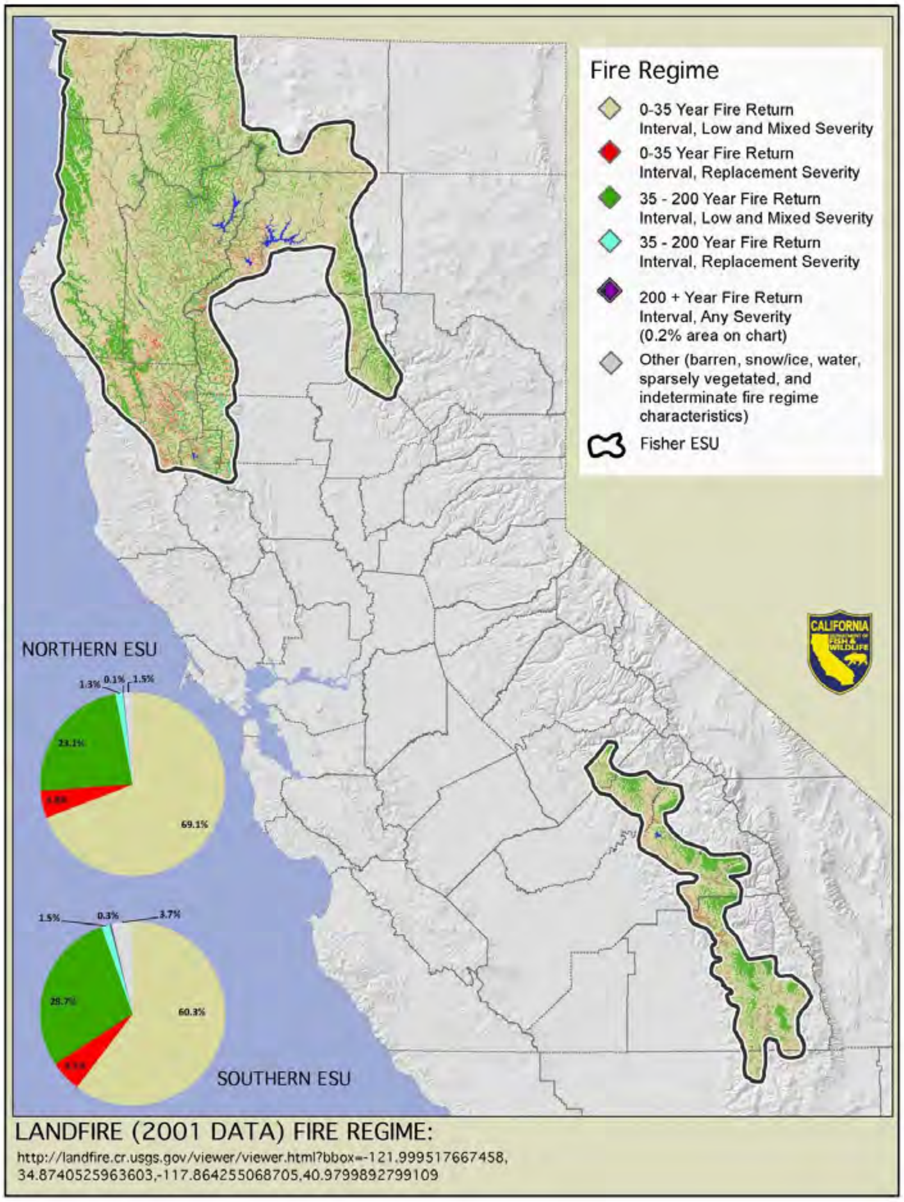


Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

appeared greatest in mid-elevation sites on the west side of the range [185]. However, the authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predications for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover [171,186,187].

Toxicants

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs) in California fisher populations has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range [153]. Although the source of toxicants to fishers has not been conclusively determined, numerous reports from remediation operations of illegal marijuana cultivation sites (MJCSs) on public, private, and tribal forest lands indicate the presence of a large amount of pesticides, including ARs, at these sites.[31] The presence of a large number of MJCSs within habitat occupied by fisher populations and the lack of other probable sources of ARs suggest that the AR exposure is largely occurring on the cultivation sites.

Fishers are opportunistic generalist predators and can be exposed to toxicants through several routes. They can be exposed directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such tastes as sucrose, bacon, cheese, peanut butter, fish, ~~and~~ apple etc.) would also likely appeal to fishers [189]. Furthermore, there have been reports of intentional wildlife poisoning by

[31] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As growth sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reports remediating more than 600 large-scale MJCSs on just two of California's 17 national forests [188].

adding pesticides to food items such as canned tuna or sardines [188]. Many of the pesticides found at MJCSs are liquid formulations that can easily be mixed into food.

As carnivores, fishers could also be exposed to toxicants secondarily through prey. This is likely the primary means of AR exposure because of the ~~toxin's~~ toxicant's persistence in the body tissue of poisoned prey items; secondary exposure of mustelids to ARs has occurred in rodent control operations [190]. Tertiary AR exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed [191] and may be possible in fishers that eat smaller carnivores. Lastly, AR exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer has occurred [189,191].

Comment [f26]: Toxins are natural occurring from plants or animals, while toxicants generally refer to man-made chemicals. (I've been hanging around with Mourad way too much)

Anticoagulant Rodenticides: ARs cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impair an animal's ability to produce several key clotting factors. ARs fall into two categories (generations) based on toxicological characteristics and use patterns: first and second generation anticoagulant rodenticides (FGARs and SGARs, respectively). FGARs, developed in the 1940s, are less toxic than SGARs, and require consecutive days of intake by a rodent to achieve a lethal dose. FGARs have a lower ability to accumulate in biological tissue and are metabolized more rapidly [192,193]. There are 60 FGAR products registered in California. Labeled uses of FGARs are commensal rodent (house mice, Norway rats, and roof rats) control and agricultural field rodent control.

Development of SGARs began in the 1970s as resistance to FGARs began to appear in some rodent populations. SGARs have the same mechanism of action as FGARs but have a higher affinity for the target enzymes, leading to greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days) [192,193]. A lethal dose may be consumed at a single feeding. The several days' lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are 79 SGAR products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum. Labeled uses are for the control of commensal rodents in and around residences, agricultural buildings, and industrial facilities, such as food processing facilities and commercial facilities. SGAR products must be placed within 100 feet of man-made structures and may not be used for control of field rodents.

The unexpected discovery of AR residues in a fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project research team prompted monitoring of AR exposure in carcasses of fishers submitted for necropsy from research projects located throughout the fisher's range in California. The livers of 58 fishers that died from 2006-2011 were tested; 79% were positive for AR exposure. Four of these fishers died from AR poisoning. The number of different AR compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers [189]. Of the fishers tested, 96% were exposed to SGARs and the exposure of fishers to ARs was geographically widespread [189].

Gabriel et al. [189] documented the amount of toxicants found at one illegal MJCS in Humboldt County. Among other toxicants, 0.68 kg (1.5 lbs) of brodifacoum, as well as 2.9 kg (6.5 lbs) worth of empty AR bait containers were found. Based on the LD50 value for a domestic dog, it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption.

The sublethal impacts of AR exposure to fishers are not fully known. Sublethal effects may include increased susceptibility to disease [194], behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes [195], and reduced reproductive success. The contribution of AR (and other pesticides found on MJCSs) exposure to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer MJCSs located within their home ranges [196]. Studies have suggested that embryos are more sensitive to anticoagulants than are adults [197–199]. AR-related fisher mortalities were concentrated temporally in mid-April and mid-May which is the denning period for fisher females [189]. This raises concerns that mothers could expose their kits to ARs through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Higher AR-related mortalities in spring may be a consequence of more ARs being used at this time to protect young marijuana plants from rodent damage than at other times of the year.

Comment [f27]: At Hoopa, they are primarily May and June, using April to June would cover the CA range well

On July 1, 2014, SGARs products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials and their legal use was limited to certified private applicators, certified commercial applicators, or those under their direct supervision. The placement of SGAR bait will generally be prohibited more than

15 m (50 ft) from man-made structures. These new regulations may limit the availability of SGARs, but how effective they will be at reducing the use of SGARs at MJCSs is unknown.

Comment [f28]: I do not disagree that the use at MJCS is unknown, however, they will be using something. We have documented restricted use chemicals at a number of sites as well as banned chemicals. Therefore, if they feel the need for it they will likely continue to use it or a similar product. One thing that we are concerned about is that some of the other rat poisons are much more difficult to detect in animals, such as bromethalin (Tomcat).

Other Potential Toxicants: Other pesticides deployed at MGCSs have likely caused fisher mortalities: 3 fishers in northern California were suspected to have died as a result of exposure to the carbamate toxin-methomyl, cholecalciferol and bromethalin (Gabriel, unpublished data). Pests include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at MJCSs that were presumably used to combat them (Table 6). Some of the organophosphates and carbamates used on MJCSs are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use [200,201]. Volunteer reclamation crews reported that AR and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 [196]. Sixty-eight kilograms of AR and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort in public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km [189].

Comment [f29]: In an effort to remain undetected by law enforcement growers are spreading out their plants much further, planting multiple patches and linear strips. In such cases they are spreading poisons out much further while growing fewer plants. Just because plant counts drop, doesn't mean the problem has gone away.

ARs are persistent in liver tissue, thus the compounds can be detected in liver tissue of sublethally exposed animals for ~~several~~ many months following the exposure. Other pesticides such as carbofuran and methamidophos, which are present at the same sites, are more likely to cause immediate mortality, but are much less likely to be detected in fishers because carcasses would need to be recovered at MJCSs to confirm exposure.

Population-level Impacts: Although it is well documented that anticoagulant rodenticides (ARs) used both legally and illegally have caused mortalities of non-target wildlife species, including fishers [189,192,202–204], the question of whether or not lethal and sublethal exposure to ARs or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed.

To estimate the extent of the current fisher range potentially impacted by MJCSs, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi) and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 20) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.

Table 55~~6~~. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (MJCSs) (CDFW, IERC, HSVTC unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Class	**Mammalian Toxicity Range**	**Relative Frequency of Occurrence at MJCSs[1]**	**Evidence of Exposure or Toxicity (Gabriel et al. unpublished)**
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Not Detected
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as “occasional” or “common” based on the highest occurrence for any product in each class.

Although AR poisoning resulting in mortality has been documented in four fishers from two geographically separated populations and AR exposure is highly prevalent and geographically widespread [189], the cumulative impact of individual toxicity and exposure is hard to quantify at the population level. Determination of poisoning and exposure usually requires collection of carcasses, and therefore data are only available

Comment [f30]: This number is substantially higher now, again I would refer you to Mourad if you would like to update. At Hoopa we have had 7 male and 1 female mortality due to toxicosis. 6 were AR, 2 males were other rat poisons. Toxicosis is the leading cause of death for male fishers at Hoopa.

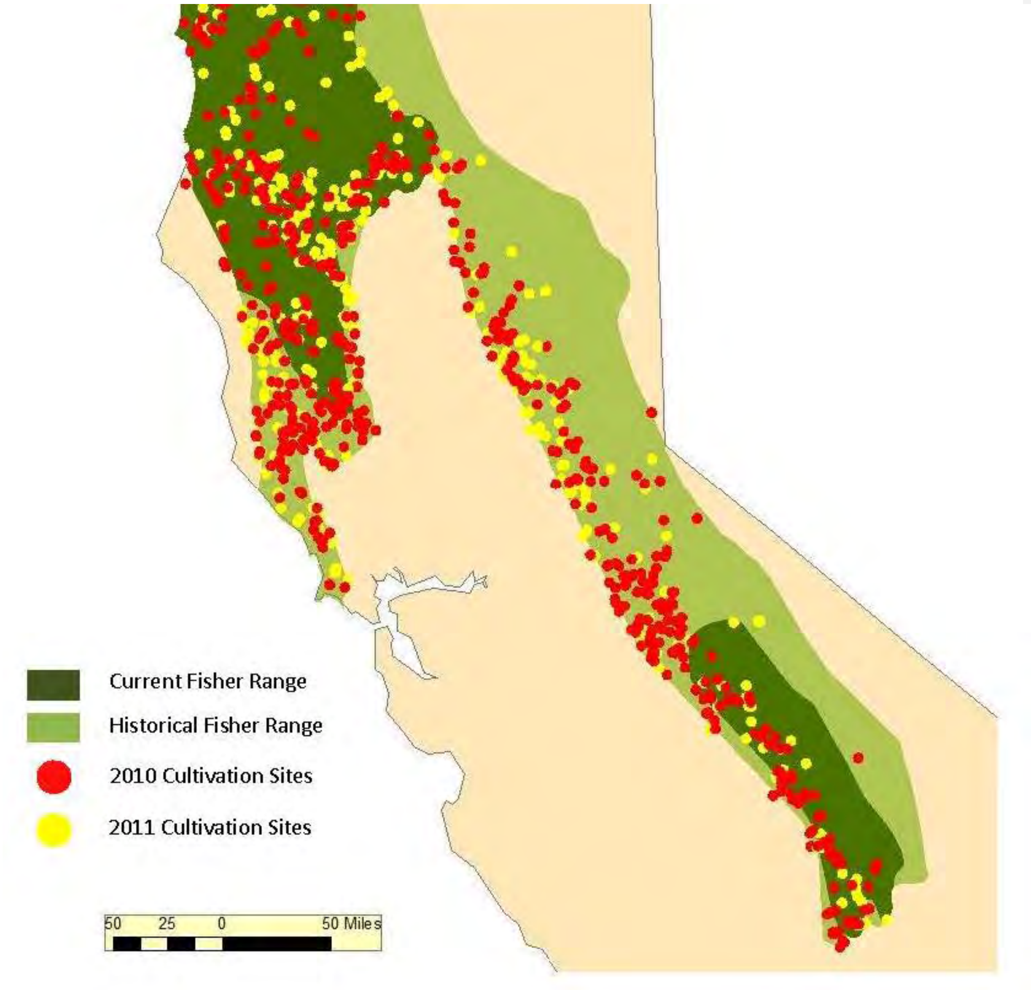


Figure 20. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

Comment [f31]: I know that I created a similar map for you that used the boundaries of the current range that you sent me, so you could use that map (which I will send you to be sure you have it) to be consistent with all of your other maps.

for fisher populations where ongoing intensive research (often involving a substantial number of radio collared animals) is conducted. Accordingly, pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected.

Despite these limitations, recent research from the well-monitored southern Sierra Nevada fisher population in California has revealed that female fishers with more MJCSs in their home ranges had higher rates of mortality and a higher likelihood of being exposed to one or more AR compounds [196]. Despite this association, further study is needed to demonstrate that chronic or sublethal AR or other pesticide exposure could predispose a fisher to death from another cause (aka indirect effect). These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival [194,205–212].

Exposure to AR through either milk or placental routes was identified in a dependent fisher kit that died after its mother was killed [189]. Additionally, Gabriel and colleagues observed that AR mortalities occurred in the spring (April-~~May~~June), a time when adult females are rearing dependent young. Low birth weight, stillbirth, abortion, and bleeding, inappetance and lethargy of neonates have all been documented in other species as a result of exposure to ARs, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of MJCSs located within an individual's home range may start to address this question.

Reductions in prey availability due to pesticide use at MJCSs could potentially impact fisher population vital rates through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant [192], there is potential that MJCSs could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species [213–216]. However, the level of small mammal mortality at MJCSs remains largely unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey remain speculative.

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. A sublethal dose of AR can produce significant clotting abnormalities and some hemorrhaging (Eason and Murphy 2001). Predators with liver concentrations of ARs as low as 0.03ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey [192]. Accordingly, fishers exposed to ARs may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Challenges to investigating toxicant threats from MJCSs within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors [217].

The high prevalence of AR exposure in fishers and other species throughout California indicates the potential for additive and synergistic associations with pesticide exposure at MJCSs and consequently increased mortality from other causes. Small, isolated fisher populations, such as occurs in the SSN Fisher ESU, are of concern because they are more vulnerable to stochastic events than larger populations and a reduction in survivorship may cause a population decline or inhibit growth.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s [218,219]. Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years [183]. Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe [218].

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago [220,221]. Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase in California by approximately 2.4 C in California by the 2060s (Pierce et al. [222]) and by 2 to 5 C by 2100 (Cayan et al. [223]). Projections of

precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation [224–226]. However, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation [227]. Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase [222,228]. Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack [229]. These patterns are expected to continue [223–225,230] and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 [231]. Forests throughout the state will likely become more dry [223,224,229].

The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra, rest sites are often located near water [108]. Zielinski et al. [108] suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Warming is predicted throughout the range of the fisher in California [183]. Pierce et al. [222] projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN Fisher ESU may experience greater warming than those occupying portions of the NC Fisher ESU.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their “climatically suitable” range within California by the year 2100 [183]. However, the distribution and climate data for those models was assessed at a 50 x 50 km grid; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California’s montane environments, temperature and other climatic variables

can change considerably over relatively small distances [232]. Thus, the diversity of the physical environment within areas occupied by fisher may buffer some of the projected effects of a changing climate [233].

Climate change is likely to indirectly affect fishers by altering the species composition and structural components of habitats used by fishers in California [183,234]. Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change [179,183,184]. To evaluate potential future climate-driven changes to habitats used by fisher in the state, Lawler et al. [183] combined model projections of fire regimes and vegetation response in California by Lenihan et al. [234] with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs by 2071-2100, as compared to mean cover from 1961-1990 (Table 7).

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands [183]. If woodlands and grasslands within the fisher ESUs expand considerably in the future as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others unsuitable. However, Lawler et al. [183] also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the “floristic conditions” for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. [183] cautioned that their habitat modeling was based on a 10 x 10 km grid, which was a “high resolution for this type of model” and that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales. They further noted that the modeled changes are broad, landscape-scale patterns that will be “filtered” by variability in topography, vegetation and other factors.

Table 66~~7~~. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. [183].

Klamath Mountains - land cover percentages	**Current**	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages	**Current**	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

Hayoe et al. [225] modeled California vegetation over the same period as Lawler et al. [183] and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. [235] predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100. In the southern Sierra, Koopman et al. [236] modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. [236] also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas.

Burns et al. [237] assessed potential changes in mammal species within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to occupy

Yosemite National Park. Burns et al. [237] suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such "reshuffling" of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health [229,238,239]. Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward [240–242]. Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes [243]. Changes in forest vegetation due to invasive plant species may impact fisher prey species composition and abundance. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state.

Comment [f32]: I think that it is important to also discuss sudden oak death, as it may be exacerbated by climate change (especially if we have warmer, wetter conditions. We could easily end up with an expansion of Klamath mixed evergreen forest that is perpetually in an early seral stage condition as intense wildfire and disease complement each other.

Existing Management, Monitoring, and Research Activities

U.S. Forest Service

The majority of land within the current range of the fisher in California is public (approximately 55%) and the majority of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. [3], encompassed all or portions of 13 National Forests including the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia as well as the Tahoe Basin Management Unit.

USFS sensitive species, such as fisher, are plant and animal species identified by the Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within

the USFS Pacific Southwest Region are treated as though they were federally listed as threatened or endangered (USDA 1990).
Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA), USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11 National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

U.S. Forest Service – Specially Designated Lands, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan (NWFP) was adopted to guide the management of over 24 million acres of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (NSO) [244]. Adoption of the NWFP resulted in amendment of USFS and the Bureau of Land Management (BLM) management plans to include measures to conserve the NSO and other species, including the fisher, on federal lands.

The NWFP created an extensive ~~and large~~ network of large late-successional and old-growth forest reserves (Figure 21). These lands include ~~are designated as~~ Congressionally Reserved Areas, Administratively Withdrawn or ~~and~~ Late Successional Reserves and are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan; however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, NSOs, and sites occupied by other species. Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody ([245]).

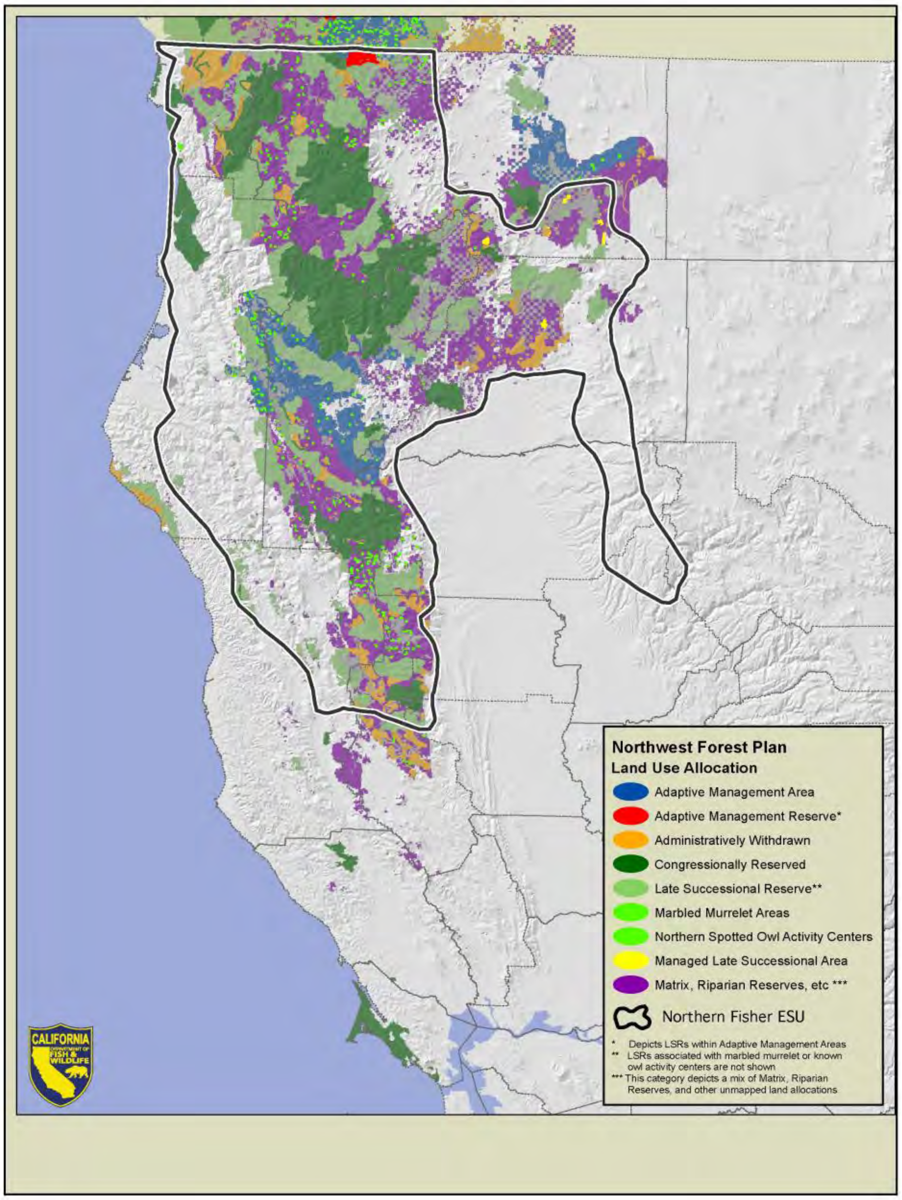


Figure 21. Northwest Forest Plan land use allocations [246]. California Department of Fish and Wildlife, 2014.

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the NSO, the US Fish and Wildlife Service recognized the importance of implementation of the NWFP to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the NSO did not alter land use allocations or change the Standards and Guidelines for management under the NWFP, nor did the rule establish any management plan or prescriptions for the management of critical habitat. However, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the NSO. Those include conservation of older forest, high-value habitat, areas occupied by NSOs, and active management of forests to restore ecosystem health in many parts of the NSO's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality NSO habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised NSO Recovery Plan. NSO critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 22).

Sierra Nevada Forest Plan Amendment (SNFPA): The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the SNFPA by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (USDA 2004). It also amended Land Management Plans for National Forests within the Sierra Nevada.

The Record of Decision for the SNFPA contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the SNFPA conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;

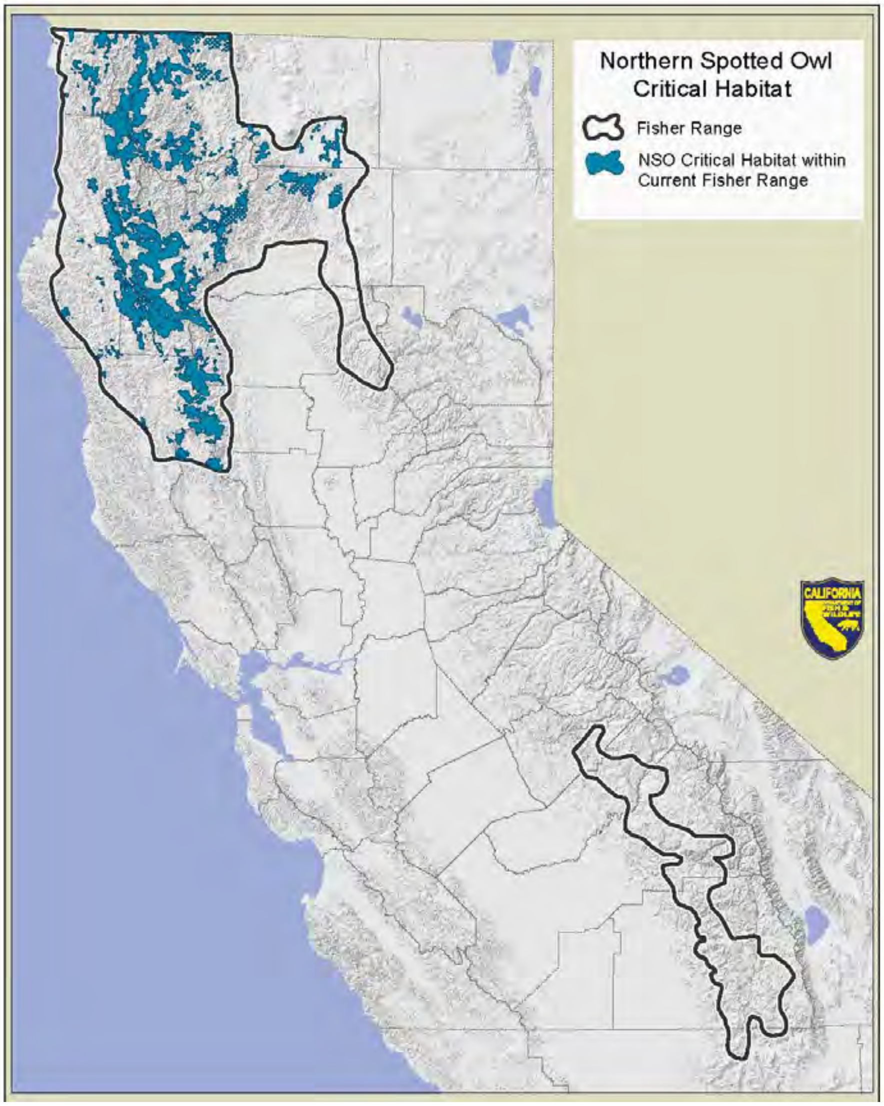


Figure 22. Distribution of northern spotted owl critical habitat within the current estimated range of the fisher in California.

- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and

- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The SNFPA established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit them by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra fisher conservation area
- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 4.9 million acres within the historical range of the fisher described by Grinnell et al. [3]. Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 3.5 million acres and 10 wilderness areas encompassing the southern Sierra population totaling about 416,000 acres. Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 328,315 acre Giant Sequoia National Monument (Monument) is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within the Monument are intended to be managed to support viable populations of these species. Three categories of land allocations within the Monument have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (311,150 acres). The current Management Plan for the Monument lists specific objectives to study and adaptively manage fisher and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project (SNAMP): The SNAMP was initiated in 2005 to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health [247]. A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) and focused on four response variables, including fishers. Researchers are studying factors that may limit the fisher population within SNAMP's study site in the southern Sierra Nevada. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation [248].

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007, in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada [249]. The project area encompasses about 53,200 ha (131,460 ac) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting structures have been identified [249]. Predation has been the primary cause of death of the fishers studied.

Bureau of Land Management

Management of Bureau of Land Management (BLM) lands are authorized under approved Resource Management Plans (RMPs) prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra RMP) include conservation strategies for fishers and other special status species. The Sierra RMP contains objectives to sustain and manage mixed evergreen forest ecosystems in to support viable populations of fisher by conserving denning, resting, and foraging habitats [250]. This plan contains provisions to manage lands within the RMP to support large trees and snags, to provide habitat connectivity among federal lands, and making acquisition of fisher habitat a priority when evaluating private lands for purchase [250].

Management of BLM lands within NSO range are also subject to provisions of the NWFP. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fisher associated with late-successional and old-growth forests [245].

National Park Service

Compared to other public lands which are primarily administered for multiple uses, national parks are among the most protected lands in the nation [251]. The National Park Service (NPS) does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

State Lands

State lands comprise only about one percent of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA). During CEQA review for proposed projects on state lands within fisher range and where suitable habitat is present, potential impacts to fishers are specifically evaluated because the

species is a Department of Fish and Wildlife Species of Special Concern. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (CCR, Title 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the FPRs) that require the preparation and approval of Timber Harvesting Plans (THPs) prior to harvesting trees on California timberlands.

Private Timberlands

The Department estimates that approximately 39% of current fisher range in California is comprised of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act and associated FPRs promulgated by the State Board of Forestry and Fire Protection (BOF). The FPRs are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans (THPs) prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to BOF's rules; and (2) information and direction to timber operators so they comply with BOF's rules (CCR, Title 14, § 1034). The preparation and approval of THPs is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

Under the FPRs (CCR, Title 14, § 897(b)(1)(B)), forest management shall "maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed." Although the FPRs do not require measures specifically designed to protect fishers, elements of these rules provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fisher may be voluntarily retained to achieve post-harvest stocking requirements under the FPR subsection relating to "decadent or deformed trees of value to wildlife" (FPR 912.7(b)(3), 932.7(b)(3), 952.7(b)(3)). Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (WLPZs).

WLPZs are defined areas along streams where the FPRs restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but WLPZs may encompass 15 – 45 m (50-150 ft) on each side of a watercourse 30-91m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. In some locations, WLPZs may constitute 15% or more of a watershed (J. Croteau, pers. comm.). Drier regions of the state with lower stream densities have a much lower proportion of the landscape in WLPZs. Where WLPZs allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes.

Timberland owners with relatively small acreages [<1,012 ha (2,500 acres)] may prepare Non-Industrial Timber Management Plans (NTMPs) designed to provide long-term forest cover on enrolled ownerships which may provide habitat suitable for use by fishers.

For ownerships encompassing at least 50,000 acres, the FPRs require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (CCR, Title 14, § 1091.1, § 913.11, § 933.11, and § 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option is likely to provide forested habitat that is suitable for fishers. However, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare THPs and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The FPRs impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees [trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Portions of the FPRs (CCR, Title 14, §§ 919.16, 939.16, and 959.16) relate to late succession forest stands[32] on private lands. Proposals to harvest late successional stands where the stands' amount, distribution, or functional wildlife habitat value will be reduced and result in a significant adverse impact on the environment must include a discussion of how the species primarily associated with late successional stands will be affected. When long-term significant adverse effects on fish, wildlife, and listed species associated primarily with late successional forests are identified, feasible mitigation measures to mitigate or avoid adverse effects must be incorporated into THPs, Sustained Yield Plans, or NTMPs. Where these impacts cannot be avoided or mitigated, measures taken to reduce them and justification for overriding concerns must be provided.

Some private companies, including large industrial timberland owners and non-industrial timber owners, have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These may include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Private Timberlands – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1992, the Forest Stewardship Council (FSC) was formed to create a voluntary, market-based approach to improve forest practices worldwide [252]. FSC's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity [253]. In California, approximately 1.6 million acres of forest lands are FSC certified [254].

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to "take," as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq.*)(ESA), threatened and endangered species. Applicants for incidental take

[32] Late Succession Forest Stands refers to stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

permits under Section 10 of the ESA must submit an HCP that specifies, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. An HCP may include conservation measures for candidate species, proposed species, and other species not listed under the ESA at the time an HCP is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six HCPs in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods HCP specifically addresses fisher, although other HCPs contain provisions intended to benefit species such as NSO (e.g., Green Diamond Resources Company and Fruit Growers Supply Company) that may also benefit fishers.

Fisher Translocation: From 2009-2012, the Department translocated[33] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra-Pacific Industries (SPI). This effort, the first of its kind in California, was undertaken in cooperation with SPI, USFWS, and North Carolina State University. A primary conservation concern for fisher has been the apparent reduction in overall distribution in the state. Fishers have been successfully translocated many times to reestablish the species in North America [26], and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California [256].

Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites [256]. Those lands represented most of the large, relatively contiguous tracts of SPI land within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto SPI's property, including habitat suitability of candidate release sites, prey availability, genetics, potential impacts to other species with special status, disease, predation, and the effects of removing animals on donor populations.

[33] Translocation refers to the human-mediated movement of living organisms from one area for release in another area [255].

Table 7~~78~~. Approved Habitat Conservation Plans within the range of the fisher in California.

HCP Name	**Location**	**Area (acres)**	**Permit Period**	**Covered Species**
Green Diamond Resources Company	Del Norte & Humboldt counties	407,000	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	211,000	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Fruit Growers Supply Company	Siskiyou County	152,000	2012-2062 (50 years)	• coho salmon (Southern Oregon/Northern California Coasts ESU) • steelhead (Klamath Mountains Province ESU) • Chinook salmon (Upper Klamath and Trinity Rivers ESU) • northern spotted owl • Yreka phlox
Green Diamond Resources Company	Humboldt and Del Norte counties	417,000	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander
Fisher Family	Mendocino County	24	2007-2057 50 years	• Behren's silverspot butterfly • Point Arena mountain beaver
AT&T	Mendocino County	11	2002-2012 10 years	• Point Arena mountain beaver

From late 2009 through late 2011, 40 fishers (24F, 16M) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release [126]. A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young [126].

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 were born on Stirling [126]. On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California [126]. Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group comprised 47% of the population, suggesting relatively high levels of reproduction and recruitment [126].

Candidate Conservation Agreement with Assurances: A "Candidate Conservation Agreement with Assurances for Fisher" (CCAA) between the USFWS and SPI regarding translocation of fisher to a portion of SPI's lands in the northern Sierra Nevada was approved on May 15, 2008. CCAAs are intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to SPI should USFWS eventually list fisher under the federal ESA. This 20-year permit covers timber management activities on SPI's Stirling Management Area, an approximately 160,000-acre tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge

of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fisher. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society and Integral Ecology Research Center to study the ecology of fishers. One hundred and ten fishers (39 male, 71 female) had been monitored with radio telemetry from December 2004 to March 2013 and the demographic monitoring continues. Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California. Predation has been the leading cause of mortality for females however, toxicosis, primarily from SGAR has been the leading cause of mortality for males from January 2005 to March 2013 (Information in our most recent 2013 report).

Management and Monitoring Recommendations

The Department has implemented a number of actions designed to better understand fisher in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the BOF, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, and university researchers, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

Comment [f33]: Could include tribes or BIA.

1. Support independent research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term,

multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.

5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations, potential effects of toxicants and their potential effects on fisher and fisher prey. It may be possible to partner with existing studies and surveys to collect some of the data needed.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends. Fishers translocated elsewhere in North America have rarely been monitored and this translocation is the first effort of its kind in the state. Continued monitoring is critical to answer questions about how fishers use managed landscapes and to determine if the project is successful in the long-term and, if not, why it failed.

7. In the southern Sierra Nevada, collaborate with land management agencies and researchers to expand connectivity between core habitats and to facilitate population expansion.

8. Assess the potential for assisted dispersal of juvenile fishers or translocation of adults from the southern Sierra population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region.

Comment [f34]: I totally agree with your list and particularly these last 3.

Summary of Listing Factors

CESA directs the Department to prepare this report regarding the status of the fisher in California based upon the best scientific information. Key to the Department's analyses are six relevant factors highlighted in regulation. Under the California Code of Regulations, Title 14, § 670.1, subd. (i)(1)(A), a "species shall be listed as endangered or threatened...if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:”

(1) present or threatened modification or destruction of its habitat;
(2) overexploitation;
(3) predation;
(4) competition;
(5) disease; or
(6) other natural occurrences or human-related activities

Also key are the definitions of endangered and threatened species, respectively, in the Fish and Game Code. CESA defines endangered species as one “which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease.” (Fish & G. Code, § 2062.) A threatened species under CESA is one “that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067.)

Fishers in California occur in two separate and isolated populations that differ genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units where appropriate in its analysis of listing factors.

Present or Threatened Modification or Destruction of its Habitat

Considerable research has been conducted to understand the habitat associations of fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types [105,119–122]. Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. Forested landscapes with these characteristics are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Thresholds for these attributes for fishers are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

Management of Federal Lands: Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The majority of federal actions must comply with NEPA. This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

The status of fisher as a sensitive species on USFS and BLM lands in California provides consideration for the species as guided by land management plans adopted by these agencies. As a result, substantial federal lands currently occupied by fishers in the state are managed to provide habitat for fishers, although specific guidelines are frequently lacking. Federal lands designated as wilderness areas or as National Parks are likely to provide long-term protection of fisher habitat. However, some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur.

Management of Private Lands: Timber harvest activities on private lands are regulated by various provisions of the Z'Berg Nejedly Forest Practice Act of 1973 and additional rules promulgated by the State Board of Forestry and Fire Protection. These rules are enforced by CAL FIRE and, although some timber harvest activities are exempt from these rules, they apply to all commercial harvesting activities on private lands.

The FPRs promulgated under the act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. However, information about what constitutes the "existing wildlife community" is frequently lacking in THPs, and specific guidelines to retain habitat for fishers and other terrestrial mammals are not incorporated into the FPRs.

Timber management activities subject to the FPRs can reduce the suitability of habitats used by fishers or render some areas unsuitable. These changes may be short-term or long-term, depending on a number of factors including the type of silviculture used, intermediate treatments conducted while forests regrow, timber site growing potential, and the time between timber rotations.

Fishers are able to utilize a diversity of forest types and seral stages. An aspect of forest management important to the suitability and long-term viability of fishers is the retention and recruitment of habitat elements for denning, resting, and to support prey populations in sufficient number and in locations where they can be successfully captured by fisher. The FPRs require the retention of unmerchantable snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However, live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites. No provision is provided in the rules to specifically recruit snags.

The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. The time interval between harvests may also affect the distribution and abundance of habitat structures used by fishers. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity [88]. Frequent harvest entries to salvage dead, dying, and diseased trees likely reduce the availability of these habitat elements. Retention of forest cover and large trees is a requirement of the FPRs along streams (i.e., WLPZs), with the width of these areas determined by stream class, slope, and the presence of anadromous salmonids.

The FPRs do not specifically require the retention or recruitment of hardwoods and, in some cases, their harvest may be required to meet stocking standards. Hardwoods may also be intentionally killed ("hack-and-squirt" herbicide application or felled) individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of habitats used by the species. Various hardwood species provide potential den and rest trees and habitat used by fisher prey. Although the FPRs do not require retention of hardwoods, the Department is not aware of data indicating that their removal on commercial timberlands has substantially affected the distribution or abundance of fishers in California.

Depending on their location, WLPZs may comprise up to 15 percent of private ownerships managed for timber production. Drier regions of the state with lower stream densities have a much lower proportion of the landscape designated as WLPZs. Where they are managed to retain or recruit trees suitable for denning and resting, WLPZs may provide a network of older forest structure within managed forest landscapes beneficial to fishers and provide denning, resting, and foraging habitat for fishers. Outside of WLPZs, trees suitable for denning or resting by fishers are not required to be retained; however they may be intentionally left by landowners to meet post-harvest stocking requirements.

The effects of future timber harvest activities on habitats used by fishers cannot be accurately predicted as changes in regulations, policies, and market conditions influence management intensity. Independent of the FPRs, trees of value to fishers may remain on landscapes through timber rotations because they are unmerchantable, are located in areas where access is infeasible, or because of company policies. Some private companies have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Fire: In recent decades the frequency, severity, and extent of fires has increased in California. This has varied statewide, with the greatest increases in fires severe enough to eliminate forest stands occurring in the Sierra Nevada, southern Cascades, and Klamath Mountains. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. However, the contemporary extent of wildfires burning annually in California is considerably less than the estimated 1.8 million ha (4.5 million ac) that burned annually in the state prehistorically (pre 1800) [174].

The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due its small size, the comparatively linear distribution of the habitat available, and predicted future climate changes. Timber harvest activities in portions of the southern Sierra Nevada occupied by fisher are largely under federal management. These National Forests in the SSN ESU have adopted specific guidelines to protect habitats used by fishers.

Within the NC Fisher ESU, fishers are comparatively widespread across a matrix of public and private forest lands. With the exceptions of Lake, Sonoma, and Marin counties, fishers currently occur throughout much of the historical range assumed by Grinnell et al. [3].

Overexploitation

Comment [f35]: Seems like you could reduce this section considerably since you have covered the material well above and all you really need to cover here is the incidental capture while trapping other species and animal control efforts since fishers are protected. Just a thought.

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable ([123]. The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917-1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers [3] and were also likely harvested by trappers seeking other furbearers [123].

Since the mid-1800s, the distribution of fisher in North America contracted substantially, in part, due to over-trapping and mortality from predator control programs [26]. Over-trapping of fisher has been considered a significant cause of its decline in California [3]. By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season [3]. Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fisher a prize catch.

Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period from 1920-1924 was only 46 animals [3]. Fishers were considered to be rare in California by the early 1920s [124]. Grinnell et al. [3] considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of fisher in California [3]. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue.

The high value trappers obtained for the pelts of fisher in the early 1900s, the species' vulnerability to trapping [8], and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations [26]. Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [124]. However, despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fisher was not prohibited until 1946 [125]. Although commercial trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (see Lewis et al. [123]). Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers [8], or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations [8] and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (Fish & G. Code, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designee are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 23), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to

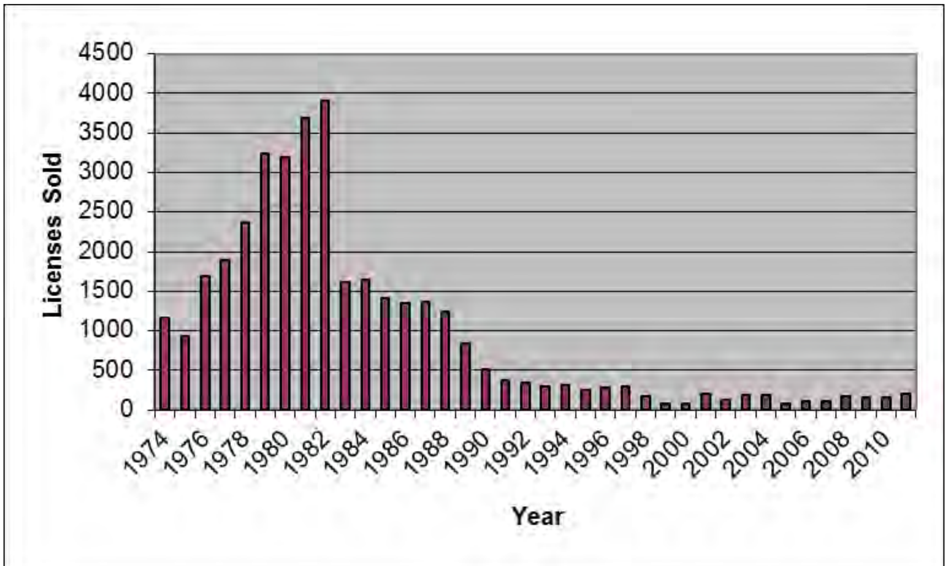


Figure 23. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

increase [257]. From the early 1980s through the present, license sales have continued to decrease with average sales from 2000-2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. However, throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators

typically work in close proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by certain species of wildlife. However, fishers are not permitted to be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).
Currently and in the foreseeable future, the likelihood of fishers being overexploited in California is low, based on the prohibition against commercial or recreational take of fishers, low level of commercial and recreational trapping and prohibition of body-gripping traps. The Department is not aware of any data indicating that the potential risk to fisher populations from incidental take due to trapping differs significantly for populations in NC or SSN Fisher ESUs.

Predation

Recent research indicates predation is a substantial cause of mortality for fishers in California [144]. This research, using DNA amplified from fisher carcasses, identified bobcat, mountain lion, and coyote as predators of fishers, with predation attributed to bobcat being the most frequent (50%).

The risk of predation is likely heightened when fishers occupy habitats in close proximity to open and brushy habitats (G. Wengert, pers. comm.), both habitats used extensively by bobcats. Female fishers are more likely to be predated by bobcats and this occurs most frequently during the breeding season when young fishers are dependent on their mothers for survival. Fragmentation of forested landscapes may increase the abundance of some small mammal species used by fishers as prey, but it may also favor potential predators adapted to early successional habitats. However, fishers have co-evolved with the suite of predators naturally occurring within their range and adverse population level effects on fishers due to predation have not been documented.

Currently, there is no information indicating differential risk of predation to fisher in the NC or SSN Fisher ESUs. Based on a sample of 50 fisher carcasses from these regions, no difference in the relative frequencies of predation by bobcat or mountain lion was found. Fishers in the SSN Fisher ESU are likely at greater risk of population level effects of predation due to the small size of their population compared to northern California. However, fishers in the southern Sierra Nevada have apparently been isolated in that region for decades or longer and, at times, their numbers may have been smaller than they are today. The abundance of potential predators of fishers during those periods is unknown, but they likely co-occurred with fisher populations in the region.

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood [24]. Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines [24,25,106]. Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Also, the relative similarities in body size, body shape, and prey between fisher and martens suggest the potential for competition between these species [24]. However, in California, martens typically occur at higher elevations than fisher and thus may have evolved strategies to minimize competition by separation and by exploiting somewhat different habitats. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have evolved with other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California. There is no evidence that fisher populations in either NC or SSN Fisher ESUs are adversely affected by competition with other species. However, landscape level habitat changes that favor population increases in competitors may intensify interspecific competition.

Comment [f36]: One species you haven't considered here is the barred owl which takes similar prey. In addition, barred owl density can be quite high. Therefore as the barred owl expands and increases in density there may be some level of competition with fishers. Of course, barred owls may also be preyed upon by fishers especially nestlings and juveniles. However, I could totally envision a barred owl taking fisher kits following their mother. I hope that we can continue monitoring fishers through at least the end of the experimental barred owl removal study. We removed 71 barred owls in 2013-14 and we know we didn't get them all. To put that in perspective the highest number of spotted owls we ever had was 71.

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years [152,158,161,258]. Fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or spill over from other species of carnivores.

Canine distemper virus (CDV) is common in gray fox and raccoon populations in California and both species occur in habitats occupied by fishers. Although studies have shown that fisher may survive CDV infections, outbreaks of highly virulent biotypes have been responsible for the near extirpation of other carnivore species including other mustelids. Deaths caused by other pathogens potentially significant for *Martes* (i.e., rabies, canine parvo virus), have not been documented for fisher in California. Although canine parvo virus has been documented to cause clinical disease in fishers, testing to date indicates that the disease is circulating in California fishers without causing population level impacts.

Exposure of fishers to *Toxoplasma gondii* in both northern California and the southern Sierra Nevada has been documented. Although this parasite has caused mortality in other mustelids, it has not been documented as a source of mortality in fisher. This is also the case for known vector borne pathogens. Fisher harbor numerous ecto- and endoparasites and, although some can serve as vectors for other diseases, they are usually associated with minimal morbidity and mortality.

There is no evidence indicating that the prevalence of pathogens potentially affecting fishers in the state differs significantly between populations within the NC and SSN Fisher ESUs. The fisher population in the southern Sierra Nevada is likely at a higher risk of diseases that cause significant morbidity or mortality due to the population's isolation and comparatively small size. Although there is no evidence that CDV has caused substantial population declines in fisher, it is a pathogen of conservation concern for fisher and health surveillance of populations is prudent to detect and intervene to the extent possible, if needed.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution of fisher in California appears to have changed substantially before and after European Settlement. Although its precise distribution prior to the 1800s is unknown, based on recent genetic evidence, the fisher population in the state declined dramatically and contracted into two separate populations long before that time. Further reductions in range and abundance were likely post-European Settlement due to over trapping, predator control programs, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. Since trapping of fishers was prohibited in 1946 and the use of body-gripping traps was banned in 1998, the number of fishers in California has increased to levels likely higher than existed during the period of unregulated trapping in the mid-1800s to early 1900s.

The fisher population within the SSN Fisher ESU is likely at greater risk of extirpation due to its small size (recently estimated at <250 individuals [134]), limited geographic range, and isolation compared to fishers in northern California. Small, isolated populations are subject to an increased risk of extinction from stochastic (random) environmental or demographic events. Small populations are also at greater risk of adverse impacts resulting from the loss of genetic diversity, including inbreeding depression. The probability of this occurring in fisher occupying either the NC Fisher ESU or the SSN Fisher ESU is unknown. Events such as drought, high intensity fires, and disease, should they occur, have a higher probability of adversely affecting the fisher population in the southern Sierra Nevada. Currently, fishers nearest to the southern Sierra Nevada population are those translocated to the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). Fishers within the SSN Fisher ESU are likely to remain isolated in the foreseeable future due to that distance and potential barriers to movement.

Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population [40]. Fishers within the NC Fisher ESU are also largely isolated from other populations of fishers, although their population is contiguous with a small population in southern Oregon. Despite its isolation, the fisher population in northern California is comparatively large, distributed over a large geographic area, and its distribution has apparently not contracted, and may have slightly expanded, in recent decades. Over the last 8 years, occupancy rates of fishers in the southern Sierra have been stable [134]. Although long-term monitoring of population abundance and trends is lacking for fishers within the NC Fisher ESU, surveys from this region and recent estimates of relatively high rates of occupancy indicate that the population has not declined substantially in recent decades.

Toxicants

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and potentially to other toxicants. ARs have caused the deaths of some fishers, and within the SSN Fisher ESU there is a correlation between the presence of MJCSs within a fisher's home range and reduced survival. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data have been collected to quantify usage. In addition, use practices are largely unknown. Food containers that appear to have been spiked with pesticides and piles of bait have been found on MJCSs indicating intended poisoning of wildlife. However, containers are often found onsite without signs of where the material was applied. In addition, it is important that MJCSs be searched for fisher and other wildlife carcasses, that these be quantified, and that the appropriate body tissues be analyzed for residues of contaminants.

There is incomplete understanding of effects of contaminants on fishers. Also unknown is the effect of multiple exposures of the same contaminant, similar contaminants, and contaminants with different modes of action. It is also unknown if there are potentially additive effects of contaminants with other stressors on individual fishers. ARs may also have indirect effects by predisposing fishers to other sources of mortality such as predation or accidents. AR toxicants were found at MJCSs in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented.

Although limited population level monitoring of fishers has occurred, the species' distribution in California does not appear to have changed appreciably in decades. If toxicant use has been widespread, long-term, and caused substantial mortality, it is likely that new gaps in the range of fishers or declines in capture rates would have been observed due to the extensive efforts conducted since the early 1990s to detect and study the species. However, evidence of exposure in fishers and the documented deaths of a number of animals indicate this is a potentially significant threat that should be closely monitored and evaluated. Exposure to toxicants at MJCSs has been documented in both the NC and SSN Fisher ESU, but there is insufficient information to determine the relative risk to either population. However, the potential risk to fishers within the SSN Fisher ESU may be greater due to its comparatively small population size.

Comment [f37]: I agree that information on population level monitoring is quite limited however we have included some information on that topic in the paper cited in your document as (130) and we have included additional information in our 2013 report which I will send you. The most important things our limited analysis can provide is that fisher populations can fluctuate widely (density dropped by 50% between 1998 and 2005) and yet may not be detectable from occupancy monitoring alone (130). Possibly more important, we have documented a decline in male fisher apparent survival from 2005 to 2013 and that the highest cause of mortality of male fishers in our study has been toxicosis. (included in our 2013 report)/

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant communities. The effect of warming temperatures on mountain ecosystems will most likely be complex and predicting how ecosystems will be affected in particular areas is difficult. Some bioclimatic modeling (Lawler et al. [183]) broadly predicts that the climate in much of California may be unsuitable for fishers by 2100. Several papers that have modeled vegetation change suggest that within those portions of California currently occupied by fishers, conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation) [183,225,235]. These predictions notwithstanding, they are based on long-term models that utilize broad climate and vegetation parameters that largely do not reflect the fine-scale variation (in both climate and vegetation diversity) typically found in the topographically and ecologically diverse montane habitats of California.

Fishers within the SSN Fisher ESU are likely more vulnerable to the potentially adverse effects of warming climate than fishers in northern California. The comparatively small size of the population in the southern Sierra, its linear distribution, and potential barriers to dispersal (the 2013 Rim Fire area, river canyons, etc.) increase the likelihood that it will become fragmented and decline in size during this century. The fisher population within the NC Fisher ESU is comparatively large and well distributed geographically, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain.

While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state, and its severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century. As the 21st century progresses and population data continue to be compiled, scientists will become better informed as to effects of a warming environment on California's fisher population. Continued monitoring of fisher distribution and survival over the ensuing decades will provide information about the immediacy of this threat.

Listing Recommendation

“Endangered species” means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (FGC §2062). "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter” (FGC §2067).

The Department recommends that designation of the fisher in California as threatened/endangered is _______.

Protection Afforded by Listing

CESA defines “take” to mean “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful absent take authorization from the Department (FGC §§ 2080 et seq. and 2835). Take can be authorized by the Department pursuant to FGC §§ 2081.1, 2081, 2086, 2087 and 2835 (NCCP).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fisher would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fisher because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Economic Considerations

The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).

Literature Cited

1. Douglas CW, Strickland MA (1999) Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

2. Powell RA (1993) The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

3. Grinnell J, Dixon JS, Linsdale JM, University of California B, Museum of Vertebrate Zoology (1937) Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. Berkeley, Calif.: University of California press.

4. Buskirk SW, Ruggiero LF (1994) American Marten. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 186.

5. Lewis JC, Stinson DW (1998) Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

6. Coulter M. (1966) The ecology and management of fishers in Maine Syracuse, New York, USA: University, Syracuse.

7. Pittaway RJ (1978) Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Nat Can 105: 487–489.

8. Douglas CW, Strickland MA (1987) Fisher. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. Ontario, Canada: Ontario Ministry of Natural Resources.

9. Erxleben JCP (1777) Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

10. Goldman FA (1935) New American mustelids of the genera Martes, Gulo, and Lutra. Proc Biol Soc Wash 48: 175–186.

11. Rhoads SN (1898) Contributions to a revision of the North American beavers, otters and fishers. Trans Am Philos Soc 19: 417–439.

12. Hagmeier EM (1959) A reevaluation of the subspecies of fisher. Can Field Nat 73: 185–197.

13. Hosoda T, Suzuki H, Harada M, Tsuchiya K, Han S-H, et al. (2000) Evolutionary trends of the mitochondrial lineage differentiation in species of genera Martes and Mustela. Genes Genet Syst 75: 259–267.

14. Stone KD, Cook JA (2002) Molecular evolution of Holarctic martens (genus Martes, Mammalia: Carnivora: Mustelidae). Mol Phylogenet Evol 24: 169–179.

15. Koepfli K-P, Deere K, Slater G, Begg C, Begg K, et al. (2008) Multigene phylogeny of the Mustelidae: resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biol 6: 10.

16. Sato JJ, Wolsan M, Minami S, Hosoda T, Sinaga MH, et al. (2009) Deciphering and dating the red panda's ancestry and early adaptive radiation of Musteloidea. Mol Phylogenet Evol 53: 907–922.

17. Wolsan M, Sato JJ (2010) Effects of data incompleteness on the relative performance of parsimony and Bayesian approaches in a supermatrix phylogenetic reconstruction of Mustelidae and Procyonidae (Carnivora). Cladistics 26: 168–194.

18. Nyakatura K, Bininda-Emonds OR (2012) Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. BMC Biol 10: 12.

19. Sato JJ, Wolsan M, Prevosti FJ, D'Elía G, Begg C, et al. (2012) Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Mol Phylogenet Evol 63: 745–757.

20. Baldy R, Beck R, Carpenter C, Carpenter W, Golla V, et al. (1996) Hupa language dictionary. Second. Hoopa, CA: Hoopa Valley Tribal Council. 131 p.

21. Samuels JX, Cavin J (2013) The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. J Vertebr Paleontol 33: 448–454. doi:10.1080/02724634.2013.722155.

22. Eshelman R, Grady F (1984) Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. In: McDonald JN, Bird SO, editors. The Quaternary of Virginia - A symposium volume. Charlottsville, Virginia: VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Vol. 75. pp. 43–70.

23. Graham RW, Graham MA (1994) The late Quaternary distribution of Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

24. Lofroth EC, Raley CM, Finley LL, Naney RH (2010) Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

25. Powell RA, Zielinski WJ (1994) Fisher. General Technical Report. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Available: http://treesearch.fs.fed.us/pubs/27328. Accessed 11 October 2013.

26. Lewis JC, Powell RA, Zielinski WJ (2012) Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7: n/a. doi:http://dx.doi.org/10.1371/journal.pone.0032726.

27. Gibilisco CJ (1994) Distributional dynamics of modern Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables,

and fishers: biology and conservation. , Ithaca, New York, USA: Cornell University Press.

28. Tucker JM, Schwartz MK, Truex RL, Pilgrim KL, Allendorf FW (2012) Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS One 7.

29. Knaus BJ, Cronn R, Liston A, Pilgrim K, Schwartz MK (2011) Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC Ecol 11: 10.

30. Grinnell, J, Dixon J, Linsdale M (1930) Vertebrate natural history of a section of northern California through the Lassen Peak region. University of California Publications in Zoology. 594 p.

31. Price WW (1894) Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE Biol J 4: 315–332.

32. Aubry KB, Jagger LA (2006) The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. In: Santos-Reis M, Birks JDS, O'Doherty EC, Proulx G, editors. Martes in Carnivore Communities. Alberta, Canada: Alpha Wildl. Publ.

33. McKelvey KS, Aubry KB, Schwartz MK (2008) Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58: 549–555.

34. Aubry KB, Lewis JC (2003) Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biol Conserv 114: 79–90. doi:http://dx.doi.org/10.1016/S0006-3207(03)00003-X.

35. Zielinski WJ, Truex RL, Schlexer FV, Campbell LA, Carroll C (2005) Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. J Biogeogr 32: 1385–1407.

36. Zielinski WJ, Kucera TE, Barrett RH (1995) Current distribution of the fisher, Martes pennanti, in California. Calif Fish Game 81: 104–112.

37. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

38. Drew RE, Hallett JG, Aubry KB, Cullings KW, Koepf SM, et al. (2003) Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Mol Ecol 12: 51–62.

39. Talking Glossary: "Haplotype" (n.d.). Available: http://www.genome.gov/glossary/index.cfm?id=99. Accessed 4 September 2014.

40. Tucker JM (2013) Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada The University of Montana.

41. Wright PL, Coulter MW (1967) Reproduction and growth in Maine fishers. J Wildl Manag: 70–87.

42. Leonard RD (1986) Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Can Field-Nat Ott ON 100: 32–44.

43. Eadie WR, Hamilton WJ (1958) Reproduction in the fisher in New York. N Y Fish Game J 5: 77–83.

44. Frost HC, Krohn WB (1997) Factors affecting the reproductive success of captive female fishers. In: Proulx G, Bryant HN, Woodward PM, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB. pp. 100–109.

45. Paragi TF, Arthur SM, Krohn WB (1994) Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Can Field-Nat Ott ON 108: 52–57.

46. Arthur SM, Krohn WB (1991) Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J Mammal: 72–2.

47. Mead RA (1994) Reproduction in Martes. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 404–422.

48. Frost HC, Krohn WB, Wallace CR (1997) Age-specific reproductive characteristics in fishers. J Mammal 78: 598–612.

49. Aubry KB, Raley CM (2006) Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report. Olympia, WA: USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory.

50. Higley JM, Matthews S (2006) Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report. Hoopa Valley Tribe and Wildlife Conservation Society.

51. Self S, Callas R (2006) Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pac Ind Calif Dep Fish Game.

52. Weir RD, Corbould FB (2008) Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Prince George, British Columbia, Canada: Peace/Williston Fish & Wildlife Compensation Program.

53. Truex RL, Zielinski WJ, Golightly RT, Barrett RH, Wisely SM (1998) A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft Rep Submitt Calif Dep Fish Game U S For Serv Pac Southwest Res Stn Arcata Calif.

54. Hall ER (1942) Gestation period in the fisher with recommendations for the animal$\backslash$’s protection in California. Calif Fish Game 28: 143–147.

55. Paragi TF, Krohn WB, Arthur SM (1994) Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildl 51: 1–11.

56. York EC (1996) Fisher population dynamics in north-central Massachusetts University of Massachusetts at Amherst.

57. Matthews SM, Higley JM, Rennie KM, Green RE, Goddard CA, et al. (2013) Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. J Mammal 94: 100–108.

58. Bachelot A, Binart N (2005) Corpus luteum development: lessons from genetic models in mice. Curr Top Dev Biol 68: 49–84. doi:10.1016/S0070-2153(05)68003-9.

59. Kelly GM (1977) Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas University of Massachusetts. Available: http://agris.fao.org/agris-search/search/display.do?f=2013/US/US2013054260005426.xml;US201300542658. Accessed 11 October 2013.

60. Crowley SK, Krohn WB, Paragi TF (n.d.) A comparison of fisher reproductive estimates. Trans Northeast Sect Wildl Soc 47: 36–42.

61. Weir RD (2003) Status of the fisher in British Columbia. BC Minist Sustain Resour Manage Conserv Data Cent BC Minist Water Land Air Prot Biodivers Branch Vic BC Wildl Bull No B-105 38pp: 3.

62. Arthur SM, Paragi TF, Krohn WB (1993) Dispersal of juvenile fishers in Maine. J Wildl Manag 57: 868.

63. Higley JM, Matthews S (2009) Fisher habitat use and population monitoring on the Hoopa Valley Reservation, California Final Report USFWS TWG U-12-NA-1. Hoopa Val Tribe Hoopa Calif USA.

64. King CM, Powell RA, Powell C (2007) The natural history of weasels and stoats: ecology, behavior, and management. Oxford University Press New York.

65. Paragi TF (1990) Reproductive biology of female fishers in southcentral Maine University of Maine at Orono. Available: http://www.library.umaine.edu/theses/theses.asp?Cmd=abstract&ID=MARC1647. Accessed 11 October 2013.

66. Reno MA, Rulon K, James C (2008) Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

67. Aging Experience, Accuracy and Precision (n.d.). Available: http://www.matsonslab.com/aging-experience-accuracy-and-precision.html. Accessed 6 September 2014.

68. Brown RN, Gabriel MW, Wengert G, Matthews S, Higley JM, et al. (2006) Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Trans West Sect Wildl Soc 42: 40–46.

69. Sandra Martin (1994) Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael RA, Powell RA, editors. Martens, sables and

fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 297–315.

70. Zielinski WJ, Duncan NP (2004) Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. J Mammal 85: 470–477.

71. Golightly RT, Penland TF, Zielinski WJ, Higley JM (2006) Fisher diet in the Klamath/north coast bioregion. Final Rep US Fish Wildl Serv Scotia Pac Humboldt State Spons Programs Found Arcata Calif.

72. Zielinski WJ, Duncan NP, Farmer EC, Truex RL, Clevenger, et al. (1999) Diet of fishers (Martes pennanti) at the southernmost extent of their range. J Mammal 80: 961–971.

73. Grenfell WE, Fasenfest M (1979) Winter food habits of fisher (Martes pennanti) in northwestern California. Calif Fish Game 65: 186–189.

74. Bioregions of California (n.d.). Available: http://biodiversity.ca.gov/bioregions.html. Accessed 5 September 2014.

75. Powell RA, Brander RB (1977) Adaptations of fishers and porcupines to their predator prey system. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula. pp. 45–53.

76. Powell SM, York EC, Fuller TK (1997) Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta, Edmonton. pp. 279–305.

77. Weir RD, Harestad AS, Wright RC (2005) Winter Diet Of Fishers In British Columbia. Northwest Nat 86: 12–19. doi:http://dx.doi.org/10.1898/1051-1733(2005)086[0012:WDOFIB]2.0.CO;2.

78. Kuehn DW (1989) Winter foods of fishers during a snowshoe hare decline. J Wildl Manag: 688–692.

79. Burt WH (1943) Territoriality and home range concepts as applied to mammals. J Mammal 24: 346–352.

80. Buck S, Mullis C, Mossman AS (1983) Corral Bottom-Hayfork Bally Fisher Study: final report. Arcata, CA: Humboldt State University and USDA Forest Service.

81. Johnson SA (1984) Home range, movements, and habitat use of fishers in Wisconsin University of Wisconsin–Stevens Point.

82. Arthur SM, Krohn WB, Gilbert JR (1989) Home range characteristics of adult fishers. J Wildl Manag 53: 674–679.

83. Jones JL (1991) Habitat use of fisher in northcentral Idaho University of Idaho.

84. Garant Y, Crete M (1997) Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Can Field-Nat Ott ON 111: 359–364.

85. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Home Range Characteristics Of Fishers in California. J Mammal 85: 649–657.

86. Yaeger JS (2005) Habitat at fisher resting sites in the Klamath Province of northern California [Master's Thesis]. Arcata, CA: Humboldt State University. Available: http://www.fws.gov/yreka/fisher/Literature/Yaeger%202005.pdf. Accessed 11 October 2013.

87. Koen EL, Bowman J, Findlay CS, Zheng L (2007) Home Range and Population Density of Fishers in Eastern Ontario. J Wildl Manag 71: 1484–1493. doi:http://dx.doi.org/10.2193/2006-133.

88. Raley CM, Lofroth EC, Truex RL, Yaeger JS, Higley JM (2012) Habitat ecology of fishers in western North America. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press.

89. Mabry KE, Shelley EL, Davis KE, Blumstein DT, Vuren DHv (2013) Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

90. Strickland MA (1994) Harvest management of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 149–164.

91. Aubry K, Wisely S, Raley C, Buskirk S (2004) Zoogeography, Spacing Patterns, and Dispersal in Fishers. In: Harrison DJ, Fuller AK, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. New York, NY: Springer. pp. 201–220.

92. Greenwood PJ (1980) Mating systems, philopatry and dispersal in birds and mammals. Anim Behav 28: 1140–1162.

93. Stephen Dobson F (1982) Competition for mates and predominant juvenile male dispersal in mammals. Anim Behav 30: 1183–1192.

94. De Vos A (1951) Overflow and dispersal of marten and fisher from wildlife refuges. J Wildl Manag 15: 164–175.

95. Hamilton WJ, Cook AH, Hamilton WF (1955) The biology and management of the fisher in New York. N Y Fish Game J 2: 13–35.

96. Powell RA (1979) Ecological energetics and foraging strategies of the fisher (Martes pennanti). J Anim Ecol: 195–212.

97. Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

98. Buskirk SW, Powell RA (1994) Habitat Ecology of Fishers and American Martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 283–296. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

99. The Public Land Survey System (PLSS) (n.d.). Available: http://nationalatlas.gov/articles/boundaries/a_plss.html. Accessed 4 September 2014.

100. Krohn WB, Arthur SM, Paragi TF (1994) Mortality and vulnerability of a heavily trapped fisher population. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

101. Klug Jr RR (1997) Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections Humboldt State University.

102. Carroll C, Zielinski WJ, Noss RF (1999) Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conserv Biol 13: 1344–1359.

103. Davis FW, Seo C, Zielinski WJ (2007) Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecol Appl 17: 2195–2213.

104. Slauson KM, Zielinski WJ, Holm GW (2003) Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final Rep USDA For Serv Pac Southwest Res Stn Arcata Calif USA.

105. Weir RD, Harestad AS (2003) Scale-dependent habitat selectivity by fishers in south-central British Columbia. J Wildl Manag 67: 73–82.

106. Campbell LA (2004) Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada University of California. Available: http://www.fs.fed.us/psw/programs/snrc/staff/campbell/campbell_dissertation.pdf. Accessed 11 October 2013.

107. Aubry KB, Raley CM, Buskirk SW, Zielinski WJ, Schwartz MK, et al. (2013) Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. J Wildl Manag 77: 965–974.

108. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Resting habitat selection by fishers in California. J Wildl Manag 68: 475–492.

109. Purcell KL, Mazzoni AK, Mori SR, Boroski BB (2009) Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. For Ecol Manag 258: 2696–2706.

110. Davis LR (2009) Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau Dept. of Biological Sciences-Simon Fraser University. Available: http://summit.sfu.ca/item/9870. Accessed 10 October 2013.

111. Bull EL, Parks CG, Torgersen TR (1997) Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

112. Manion PD (n.d.) Tree disease concepts. Second. New Jersey, USA: Prentice Hall Career and Technology.

113. Zielinski WJ, Dunk JR, Yaeger JS, LaPlante DW (2010) Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. For Ecol Manag 260: 1579–1591.

114. California Wildlife Habitat Relationships System (2008). Sacramento, California: California Department of Fish and Wildlife: California Interagency Wildlife Task Group.

115. Weir RD, Corbould FB (2010) Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. J Wildl Manag 74: 405–410.

116. Buck SG, Mullis C, Mossman AS, Coolahan C (1994) Habitat use by fishers in adjoining heavily and lightly harvested forest. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 368–376.

117. Jones JL, Garton EO (1994) Selection of successional stages by fishers in north-central Idaho. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 377–387.

118. De Vos A (1952) The ecology and management of fisher and marten in Ontario. Available: http://www.citeulike.org/group/15497/article/9675279. Accessed 21 August 2014.

119. Spencer W, Rustigian-Romsos H, Strittholt J, Scheller R, Zielinski W, et al. (2011) Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biol Conserv 144: 788–803.

120. Hagmeier EM (1956) Distribution of marten and fisher in North America. Can Field Nat 70: 149–168.

121. Banci V (1989) A fisher management strategy for British Columbia. Victoria, British Columbia, Canada: Ministry of Environment.

122. Powell RA (1994) Structure and spacing of Martes populations. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA. pp. 101–121.

123. Lewis JC, Zielinski WJ (1996) Historical harvest and incidental capture of fishers in California. Northwest Sci 70: 291–297.

124. Dixon JS (1925) A closed season needed for fisher, marten, and wolverine. Calif Fish Game 11: 23–25.

125. Gould GI Jr (1987) Forest Mammal Survey and Inventory. Calif. Dept. of Fish and Game.

126. Powell RA, Facka AN, Clifford DL, Beach C, Smith K (2013) Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

127. Lamberson RH, Truex RL, Zielinski WJ, Macfarlane D (2000) Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata CA Humboldt State Univ.

128. Spencer WD, Rustigian H, Strittholt JR, Scheller R, Syphard A (2008) Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

129. Jordan MJ (2007) Fisher ecology in the Sierra National Forest, California Berkeley, Calif.: University of California, Berkeley. Available: http://www.carnivoreconservation.org/files/thesis/jordan_2007_phd.pdf. Accessed 11 October 2013.

130. Matthews SM, Mark Higley J, Scott Yaeger J, Fuller TK (2011) Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildl Soc Bull 35: 69–75.

131. Diller L, Hamm K, Lamphear D, Thompson J (2008) Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Korbel, CA: Green Diamond Resource Company.

132. Swiers RC (2013) Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. [Raleigh, North Carolina]: North Carolina State University,.

133. Noon BR, Bailey LL, Sisk TD, McKelvey KS (2012) Efficient Species-Level Monitoring at the Landscape Scale. Conserv Biol 26: 432–441.

134. Zielinski WJ, Baldwin JA, Truex RL, Tucker JM, Flebbe PA (2013) Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. J Fish Wildl Manag 4: 3–19.

135. Bechtold WA, Patterson PL (2005) The enhanced forest inventory and analysis program: national sampling design and estimation procedures. General Technical Report. Asheville, North Carolina: US Department of Agriculture Forest Service, Southern Research Station.

136. Waples R (1991) Definition of a “species” under teh Endangered Species Act: Application to Pacific salmon. Technical menorandum. NOAA.

137. Franklin JF, Spies TA, Pelt RV, Carey AB, Thornburgh DA, et al. (2002) Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. For Ecol Manag 155: 399–423.

138. Thompson ID, Baker JA, Ter-Mikaelian M (2003) A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. For Ecol Manag 177: 441–469.

139. USDA Forest Service (2014) Forest Management: Cut and sold reports. Available: http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml. Accessed 22 August 2014.

140. California Timber Harvest Statistics - harvyr2.pdf (n.d.). Available: http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf. Accessed 6 September 2014.

141. Barnosky AD, Koch PL, Feranec RS, Wing SL, Shabel AB (2004) Assessing the causes of Late Pleistocene extinctions on the continents. Science 306: 70–75.

142. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

143. Farber S, Callas RL, Yaeger JS, Schwartz MK, Pilgrim K, et al. (2010) Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report. Yreka Fish and Wildlife Office, Yreka, California: USDI Fish and Wildlife Service.

144. Wengert GW, Gabriel MW, Matthews SM, Higley JM, Sweitzer R, et al. (2013) Intraguild Predation on Fishers in California: Patterns of Predation by Three Larger Carnivores. Rev J Wildl Manag.

145. Buck SG (1982) Habitat utilization by fisher (Martes pennanti) near Big Bar, California [Master’s Thesis]. Arcata, CA: Humboldt State University.

146. Wengert GM (2013) Ecology of intraguild predation on fishers (Martes pennanti) in California UNIVERSITY OF CALIFORNIA, DAVIS. Available: http://gradworks.umi.com/36/14/3614292.html. Accessed 4 September 2014.

147. Williams ES (2001) Canine distemper. In: Williams ES, Barker RICK, editors. Infectious diseases of wild mammals. Ames, Iowa: Iowa State University Press. p. 50.

148. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

149. Williams ES, Thorne ET, Appel MJ, Belitsky DW (1988) Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. J Wildl Dis 24: 385–398.

150. Timm SF, Munson L, Summers BA, Terio KA, Dubovi EJ, et al. (2009) A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). J Wildl Dis 45: 333–343.

151. Origgi FC, Plattet P, Sattler U, Robert N, Casaubon J, et al. (2012) Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Vet Pathol Online 49: 913–929.

152. Gabriel MW, Wengert GM, Matthews SM, Higley JM, Foley JE, et al. (2010) Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). J Wildl Dis 46: 966–970.

153. Gabriel MW, Wengert GW, Brown RN (2012) Pathogens and parasites of Martes species: Management and conservation implications. In: Aubry KB, Zielinski WJ,

Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press. pp. 138–185.

154. Burns R, O'Toole ESWD, 2003 JPD (n.d.) Toxoplasma gondii infections in captive black-footed ferrets (Mustela nigripes), 1992–1998: clinical signs, serology, pathology, and prevention. J Wildl Dis 39: 787–797.

155. Pridham TJ, Belcher J (1958) Toxoplasmosis in mink. Can J Comp Med Vet Sci 22: 99–106.

156. Cole RA, Lindsay DS, Howe DK, Roderick CL, Dubey JP, et al. (2000) Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). J Parasitol 86: 526–530.

157. Larkin JL, Gabriel M, Gerhold RW, Yabsley MJ, Wester JC, et al. (2011) Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. J Parasitol 97: 425–429. doi:http://dx.doi.org/10.1645/GE-2623.1.

158. Brown RN, Gabriel MW, Wengert GW, Matthews S, Higley JM, et al. (2008) Pathogens associated with fishers. Final Report USFWS-813335G021. Yreka, CA.

159. Williams ES, Mills K, Kwiatkowski DR, Thorne ET, Boerger-Fields A (1994) Plague in a black-footed ferret (Mustela nigripes). J Wildl Dis 30: 581–585.

160. Weinmann R, Raskas HJ, Roeder RG (1974) Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proc Natl Acad Sci 71: 3426–3430.

161. Clifford DL, Woods L, Gabriel MW, Tkach V, Hoberg E, et al. (2012) Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

162. CDOF (2011) E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. Sacramento, California: State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-6/2000-10/.

163. CDOF (1991) E-6 County Population Estimates and Components of Change—July 1, 1970–1990. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/view.php#objCollapsiblePanelEstimatesAnchor.

164. CDOF (2013) E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php.

165. CDOF (2013) Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

166. Bunn D, Mummert A, Hoshovsky M, Gilardi K, Shanks S (2007) California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

167. FRAP (2003) The changing California: Forest and range 2003 assessment. CalFire. Available: http://frap.fire.ca.gov/data/assessment2003/index.html.

168. Duane TP (1996) Human Settlement 1850-2040. In: Center WR, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. Davis, CA, USA.: University of California.

169. Theobald D (2005) Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecol Soc 10.

170. Garroway CJ, Bowman J, Wilson PJ (2011) Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Mol Ecol 20: 3978–3988.

171. Safford HD (2006) Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report. Vallejo, California: USDA Forest Service, Pacific Southwest Region.

172. Stephens SL, Sugihara NG (2006) Fire management and policy since European settlement. Fire in California's Ecosystems. Berkeley, California: University of California Press. pp. 431–443.

173. Show SB, Kotok EI (1923) Forest fires in California, 1911-1920: an analytical study. Washington D.C., USA: US Department of Agriculture. Available: http://scholarsarchive.library.oregonstate.edu/jspui/handle/1957/11024. Accessed 11 October 2013.

174. Stephens SL, Martin RE, Clinton NE (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. For Ecol Manag 251: 205–216. doi:http://dx.doi.org/10.1016/j.foreco.2007.06.005.

175. Taylor AH, Skinner CN (1998) Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. For Ecol Manag 111: 285–301.

176. Anderson MK (2006) The use of fire by Native Americans in California. In: Sugihara NG, Van Wagtendonk JW, Shaffer KE, Fites-Kaufman J, Thode AE, editors. Fire in California's Ecosystems. University of California Press. p. 596.

177. Martin RE, Sapsis DB (1992) Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

178. Miller JD, Safford HD, Crimmins M, Thode AE (2009) Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12: 16–32.

179. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW (2006) Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

180. Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecol Appl 22: 184–203.

181. Zhang J, Webster J, Powers RF, Mills J (2008) Reforestation after the Fountain Fire in Northern California: An Untold Success Story. J For 106: 425–430.

182. LANDFIRE-Fire Regime Product Descriptions (n.d.). Available: http://www.landfire.gov/NationalProductDescriptions13.php. Accessed 4 September 2014.

183. Lawler JJ, Safford HD, Girvetz EH (2012) Martens and fishers in a changing climate. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press. pp. 371–397.

184. Fried JS, Torn, Mills E (2004) The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Clim Change 64: 169–191. doi:http://dx.doi.org/10.1023/B:CLIM.0000024667.89579.ed.

185. Westerling AL, Bryant BP, Preisler HK, Holmes TP, Hidalgo HG, et al. (2011) Climate change and growth scenarios for California wildfire. Clim Change 109: 445–463.

186. Mckenzie D, Gedalof Z, Peterson DL, Mote P (2004) Climatic Change, Wildfire, and Conservation. Conserv Biol 18: 890–902.

187. Krawchuk MA, Moritz MA (2012) Fire and Climate Change in California. Calif Energy Comm Publ Number CEC-500-2012-026.

188. Gabriel MW, Wengert GW, Higley JM, Krogan S (2013) Silent forests? Rodenticides on illegal marijuana crops harm wildlife. Wildl Prof Spring.

189. Gabriel MW, Woods LW, Poppenga R, Sweitzer RA, Thompson C, et al. (2012) Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

190. Alterio N (1996) Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. N Z J Zool 23: 331–338.

191. Moriarty JG, Riley PD, Sureiys LE, Sikich JA (2013) Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: from mountain lions to rodents. Proceedings of the 25th Vertebrate Pest Conference. Vol. 25. pp. 144–148.

192. Erickson WA, Urban DJ (2004) Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

193. Fisher P, O'Connor C, Wright G, Easton CT (2003) Persistence of four anticoagulant rodenticides in livers of laboratory rats. New Zealand Department of Conservation.

194. Riley SPD, Bromley C, Poppenga RH, Uzal FA, al et (2007) Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. J Wildl Manag 71: 1874–1884.

195. Cox P, Smith R. (n.d.) Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. 15th Vertebrate Pest Conference. Davis, CA, USA.: University of California.

196. Thompson C, Sweitzer R, Gabriel M, Purcell K, Barrett R, et al. (2013) Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conserv Lett.

197. Laas FJ, Forss DA, Godfreyi MER (1985) Retention of brodifacoum in sheep tissues and excretion in faeces. N Z J Agric Res 28: 357–359.

198. Godfrey MER, Lyman CP (1980) Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). N Z J Exp Agric 8: 1–5.

199. Munday JS, Thompson LJ (2003) Brodifacoum toxicosis in two neonatal puppies. Vet Pathol Online 40: 216–219.

200. Jansman H, van Tulden P (2012) Persecution and poisoning of birds of prey in the Netherlands. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 139–142.

201. Mineau P, Lyon L, McMillin S (2012) Impacts of carbofuran on birds in Canada and the United States. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 219–222.

202. Anderson B, Borges S, Graber K, Hartless C, Housenger J, et al. (2011) Risks of non-compliant rodenticides to nontarget wildlife. Washington D.C., USA: United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division.

203. Berny PJ, Buronfosse T, Buronfosse F, Lamarque F, Lorgue G (1997) Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35: 1817–1829.

204. Ruder MG, Poppenga RH, Bryan JA, Bain M, Pitman J, et al. (2011) Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. J Wildl Dis 47: 212–216.

205. Janeway CA, Travers P, Walport M (2007) Immunobiology. 7th ed. New York, New York, USA: Garland Science.

206. Li Q, Kawada T (2006) The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cell Mol Immunol 3: 171–178.

207. Zabrodskii PF, Lim VG, Strel'tsova EV (2012) Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksp Klin Farmakol 75: 35.

208. Vidal D, Alzaga V, Luque-Larena JJ, Mateo R, Arroyo L, et al. (2009) Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Sci Total Environ 408: 267–271. doi:http://dx.doi.org/10.1016/j.scitotenv.2009.10.001.

209. Gordon CJ (1994) Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicol Teratol 16: 427–453.

210. Grue CE, Hart ADM, Mineau P (1991) Biological consequences of depressed brain cholinesterase activity in wildlife. In: Mineau P, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Amsterdam, Netherlands: Elsevier Science Publishers. pp. 151–209.

211. Ahdaya SM, Shah PV, Guthrie FE (1976) Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicol Appl Pharmacol 35: 575–580.

212. Martin PA, Solomon KR (1991) Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pestic Biochem Physiol 40: 117–127.

213. Hayward MW, Jedrzejewski W, Jedrzewska B (2012) Prey preferences of the tiger Panthera tigris. J Zool 286: 221–231. doi:http://dx.doi.org/10.1111/j.1469-7998.2011.00871.x.

214. Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE (2004) Tigers and their prey: predicting carnivore densities from prey abundance. Proc Natl Acad Sci U S A 101: 4854–4858.

215. Knick ST (1990) Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildl Monogr: 3–42.

216. Knick ST, Hellgren EC, Seal US (1993) Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Can J Zool Can Zool 71: 1448–1453.

217. Colvin, B., Jackson W. (1991) Secondary poisoning hazards associated with rodenticide use. In: Magallona E., editor. 11th International Congress Plant Protection. Manila, Phillipines.

218. Pachauri RK, Reisinger A (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergov Panel Clim Change 1.

219. Solomon S, Qin D, Manning M, ALLEY R, BERNTSEN T, et al. (2007) Technical Summary. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press. pp. 19–91.

220. Bonfils C, Duffy PB, Santer BD, Wigley TML, Lobell DB, et al. (2008) Identification of external influences on temperatures in California. Clim Change 87: 43–55. doi:10.1007/s10584-007-9374-9.

221. Tingley MW, Koo MS, Moritz C, Rush AC, Beissinger SR (2012) The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Glob Change Biol 18: 3279–3290.

222. Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, et al. (2013) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Clim Dyn 40: 839–856. doi:http://dx.doi.org/10.1007/s00382-012-1337-9.

223. Cayan D, Tyree M, Pierce D, Das T (2012) Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

224. Littell JS, Elsner MM, Mauger G, Lutz E, Hamlet AF, et al. (2011) Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. University of Washington, College of the Environment.

225. Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. (2004) Emissions pathways, climate change, and impacts on California. Proc Natl Acad Sci U S A 101: 12422–12427.

226. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, et al. (2007) Regional climate projections. In: Susan S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, Vol. 4.

227. Cayan D, Tyree M, Dettinger M, Hidalgo H, Das T, et al. (2009) Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. Calif Clim Change Cent CEC-500-2009-014-D.

228. Pierce DW, Cayan DR, Das T, Maurer EP, Miller NL, et al. (2013) The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. J Clim. Available: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00766.1. Accessed 14 October 2013.

229. Halofsky JE, Peterson DL, O'Halloran KA, Hawkins-Hoffman C (2011) Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available: http://www.treesearch.fs.fed.us/pubs/38702. Accessed 14 October 2013.

230. Salathe EP, Leung Lr, Qian Y, Zhang Y (2010) Regional climate model projections for the State of Washington. Clim Change 102: 51–75. doi:http://dx.doi.org/10.1007/s10584-010-9849-y.

231. Ralph M (2011) Water supply and flooding. In: Pierce DW, editor. California Climate Extremes Workshop Report. La Jolla, CA: Scripps Institution of Oceanography.

232. Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, et al. (2009) The velocity of climate change. Nature 462: 1052–1055. doi:10.1038/nature08649.

233. Moritz C, Agudo R (2013) The Future of Species Under Climate Change: Resilience or Decline? Science 341: 504–508. doi:10.1126/science.1237190.

234. Lenihan JM, Drapek R, Bachelet D, Neilson RP (2003) Climate change effects on vegetation distribution, carbon, and fire in California. Ecol Appl 13: 1667–1681.

235. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al. (2011) The impact of climate change on California's ecosystem services. Clim Change 109: 465–484. doi:10.1007/s10584-011-0313-4.

236. Koopman ME, Nauman RS, Leonard JL (2010) Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

237. Burns CE, Johnston KM, Schmitz OJ (2003) Global climate change and mammalian species diversity in U.S. national parks. Proc Natl Acad Sci 100: 11474–11477.

238. Littell JS, Oneil EE, McKenzie D, Hicke JA, Lutz JA, et al. (2010) Forest ecosystems, disturbance, and climatic change in Washington State, USA. Clim Change 102: 129–158. doi:http://dx.doi.org/10.1007/s10584-010-9858-x.

239. Spies TA, Giesen TW, Swanson FJ, Franklin JF, Lach D, et al. (2010) Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landsc Ecol 25: 1185–1199. doi:http://dx.doi.org/10.1007/s10980-010-9483-0.

240. Paradis A, Elkinton J, Hayhoe K, Buonaccorsi J (2008) Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitig Adapt Strateg Glob Change 13: 541–554.

241. Safranyik L, Carroll AL, Regniere J, Langor DW, Riel WG, et al. (2010) Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Can Entomol 142: 415–442.

242. Trần JK, Ylioja T, Billings RF, Régnière J, Ayres MP (2007) Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecol Appl 17: 882–899.

243. Vose JM, Peterson DL, Patel-Weynand T (2012) Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

244. USDA Forest Service, USDI Bureau of Land Management (1994) Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team]. 569 p. Available: http://archive.org/details/finalsupplementa03v1unit. Accessed 2 September 2014.

245. USDA Forest Service, USDI Bureau of Land Management (1994) Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

246. The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data (n.d.). Available: http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml. Accessed 5 September 2014.

247. Sulak A, Huntsinger L (2012) Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. J For 110: 312–317.

248. Smith T (2014) What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. Available: http://snamp.cnr.berkeley.edu/teams/fisher. Accessed 1 September 2014.

249. Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics (n.d.). Available: http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/. Accessed 1 September 2014.

250. USDI Bureau of Land Management (2008) Sierra Resource Management Plan and Record of Decision. Folsom, CA: Bureau of Land Management.

251. Hannibal ME (2012) America's Next Best Idea: The National Park System Looks to the Future. George Wright Forum 29: 380–384.

252. FSC Forest Stewardship Council U.S. (FSC-US) · Our History (n.d.). Available: https://us.fsc.org/our-history.180.htm. Accessed 2 September 2014.

253. FSC Forest Stewardship Council U.S. (FSC-US) · Mission and Vision (n.d.). Available: https://us.fsc.org/mission-and-vision.187.htm. Accessed 2 September 2014.

254. preview.fsc-certified-acres-by-state.a-204.pdf (n.d.). Available: https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf. Accessed 2 September 2014.

255. IUCN, SSC (2013) Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

256. Callas RL, Figura P (2008) Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. Sacramento, California: California Department of Fish and Game.

257. Gould GI, Escallier J (1989) Licensed trapper's and dealer's report. Sacramento, California: California Department of Fish and Game.

258. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

Comments from S. Matthews

7 November 2014

Richard Callas
601 Locust Street
Redding, CA 96001
(530) 340-5977

Richard:

The following is my analysis regarding the scientific validity of "A Status Review of the Fisher in California" and its assessment of the status of fisher in California. As requested, I focused my review on the scientific information presented regarding the status of fisher in the state. I will reserve comment on the Department's conclusion that listing the species as threatened or endangered under CESA is not warranted.

Generally, the Status Review summarizes much of the state of knowledge of fisher in California. The Review provides a body of evidence and interpretation to inform each of the State's listing factors. The Review does fall short in several sections, defaulting to subjective terminology (e.g., "widespread", "common") rather than a quantitative assessment of the data available. The Review also presents some data without references or supporting documentation. I also point out omissions of information currently available. The following comments call out specifics in the Report by line number and my associated notes.

Line 54-58: The report states "Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable." The conclusion fishers are "widespread and relatively common" is subjective at best and misleading at worst. I used spatial data provided by Lewis et al. (2012; Jeff Lewis, Washington Department of Fish and Wildlife, personal communication) to estimate the spatial extent of historic and contemporary fisher distributions. As a conservative estimate, I considered the historic and contemporary ranges to occur north of California Highway 299 and for regulatory considerations to occur south of the California/Oregon border. Within these bounds and accepting the caveats of historic distribution data present by Gibilisco (1994), Lofroth et al. (2010), and others, fishers occupied approximately 78,212 km^2. Currently fishers are estimated to occupy 56,844 km^2, representing a 27% decrease in occupied range in northwestern California. Alternatively, considering only the area of overlap between historic and contemporary distributions, fishers currently occupy 52,256

THE WILDLIFE CONSERVATION SOCIETY
2210 NE WEIDLER STREET #1
PORTLAND, OR 97232

PHONE: 530-351-2418
SMATTHEWS@WCS.ORG
WWW.WCS.ORG

km^2, representing a 33% decrease in the historic distribution currently occupied. It's undisputed that fishers in northwestern California are more widely distributed than fishers in the southern Sierra Nevada, however, presented with the fisher range in northwest California having contracted at least 25% over the last century in northwestern California, I question the conclusion fishers are "widespread" in the region.

The conclusion fishers are relatively common appears to be partially based on comparisons of species visitation rates to remote survey stations (e.g., remotely-triggered cameras) presented in the report (Line 1256-1262). These surveys are most often designed based on individual movement patterns of a target species. For example, remotely triggered cameras are placed within a study area based on estimated home range sizes of fishers. Provided the spatial component of the sampling design is species specific, it is not valid to make comparisons of visitation rates of target and non-target species outside of more elaborate spatially nested sampling approach to accommodate the movement patterns of species being compared. I'll address this point further where these comparisons are made in the report.

Regarding fishers in the southern Sierra Nevada, the conclusion of population stability is likely from Zielinski et al. (2013), who concluded fisher occupancy to be stable between 2002-2009. Tucker (2013), however, investigated the link between occupancy and abundance, showing that a 43% decline in abundance over an 8-year period only resulted in a 23% decline in occupancy reported. The U.S. Fish and Wildlife Service (2014) correctly articulates, "This effort demonstrates the complexities in determining population trend and identifies important cautions in extrapolating the conclusion of no trend in occupancy to a conclusion of no trend in abundance over 8-years of monitoring of the Southern Sierra Nevada Population."

More recently Sweitzer et al. (In review) report an estimated λ for a portion of the SSN population on the Bass Lake Ranger District in the Sierra National Forest, near Oakhurst, California between 2007-2013 was 0.91 (95% CI 0.71-1.13). Zielinski et al. (2013) concluded fisher occupancy to be stable between 2002-2009. Taken together, these results indicate fishers are not in spatial recovery and numerically may be in decline.

Line 86-87: The report states, "However, fishers are widespread on public and private lands harvested for timber." I would suggest it be more accurate to say fishers are known to occupy public and private lands harvested for timber. Comparisons of fisher demographic or surrogate state variables and potential source-sink dynamics between areas of alternate timber management intensities in California have yet to be made. Further, Lewis and Aubry (2003) summarized, "In the western USA, fishers generally avoid clearcuts and forested stands with <40% canopy cover (Buck et al. 1994, Jones and Garton 1994), and occur at low densities in second-growth forests (Powell and Zielinski 1994) and landscapes that have been extensively fragmented by timber harvesting (Rosenberg and Raphael 1986, Carroll et al. 1999)." Most recently, Weir and Corbould (2010) concluded that a 5% increase in recent logging decreased the relative probability of occupancy of a potential home range by 50% in north-central British Columbia. Similar occupancy and demographic-based metrics on public and private lands harvested for timber in California are not yet available.

Line 89-91: The report states: "At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California." An opposite interpretation of available data is made by the U.S. Fish and Wildlife Service (2014) in the Draft Species Report, Fisher (*Pekania pennanti*), West Coast Population. The Service identified a variety of stressors for fishers related to habitat. The Service defines a stressor as:

> *…the activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, or impairment of west coast fisher populations or their habitat. Stressors are primarily related to human activities, but can be natural events and act on fishers at various scales and intensities throughout the analysis area. Stressors may be observed, inferred, or projected to occur in the near term.* (USDI Fish and Wildlife Service 2014:46)

The Service summarizes their findings in stating, "Past and ongoing loss and fragmentation of fisher habitat may contribute to the decline of fisher populations (Aubry and Lewis 2003, p.82)" (USDI Fish and Wildlife Service 2014:54).

Line 99-100: The report states: "This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years." There is some mixed empirical evidence for population expansion in the SSN (Tucker et al. 2014), however I did not see the work of Tucker et al. (2014) or other support for this conclusion outlined in the body of the Status Review.

Line 106-108: The report states: "Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population." Thompson et al. (2014) identify a population-level effect, concluding that female fishers more likely to encounter cultivation sites suffered significantly higher rates of mortality.

Line 294: Hoopa should be changed to Hupa. Hoopa refers to geography or tribe, Hupa refers to people or culture.

Line 663-665: Consider citing Facka et al. 2013. A note on standardization of reproductive and survival rates for populations of Martes. Martes Working Group Newsletter 20:10-15.

Line 667-669: require the following changes: A recent study in the Hoopa Valley of California reported that 65% (55 of 85) of denning opportunities were successful in weaning at least one kit from 2005-2011 [57].

Line 672-674: consider also citing Matthews et al. (2013).

Line 679-681: consider also citing Matthews et al. (2013).

Line 683-684: The report states: "Paragi (Paragi 1990) reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female." Lofroth et al. (2010) state that looking at results on recruitment from fisher populations in eastern North America provides limited insights into the dynamics of western populations because legal harvest of fishers in the East directly affects recruitment rates. Weir and Corbould (2008) estimated an average fall recruitment rate of 0.58 juveniles/adult female; Matthews et al. (2013) estimated the recruitment rate of juveniles that successfully established a home range per adult female was 0.19 (0.16 for females and 0.02 for males).

Line 697: see to Higley et al. 2013. Bobcat ecology and relationship with and influence on fisher survival on the Hoopa Valley Indian Reservation, California. Final Report USFWS TWG CA U-29-NA-1. Hoopa Valley Tribe, Hoopa, California. Page 24: Forty-eight fishers were monitored via radio telemetry until they died (17M, 31F) between 2004 and 2013 on the Hoopa Valley Indian Reservation. Average age at death across all years and all ages was 4.1 and 4.8 years for males and females respectively. Comparing the mean age at time of death of females for the years 2005-2008 (n=19) and 2009 to 2012 (n =12) there has been an increase in age from 3.8 to 6.3 years. There were not enough males monitored prior to 2009 do make a similar comparison for males.

Line 710-712: The report states: "Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation)." This statement suggests toxicants are only an indirect source of mortality. Gabriel et al. (2012) diagnosed four fisher deaths, including a lactating female, that were directly attributed to AR toxicosis and documented the first neonatal or milk transfer of an AR to an altricial fisher kit. Other toxicosis deaths have since been diagnosed (likely a Gabriel pers.comm.)

Line 718: additional data on survival rates can be found in Sweitzer et al. (In revision), estimated survival: juvenile, 0.79 (95% C.I. 0.65-0.93), subadult, 0.72 (95% C.I. 0.59-0.86), and adult, 0.72 (95% C.I. 0.62-0.82).

Line 1050-1055: references don't seem to match statements made, please double check

Line 1256-1262: The report states: "More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed." As I stated previously, these comparisons and conclusions are not valid. First and foremost, these conclusions are not supported by a citation or supporting documentation. I am assuming the remote camera stations were deployed using an occupancy or similar sampling design. These designs are most often species specific, based on individual movement data. Because the 8 species in figure 8 represent at least an order of magnitude difference in distances traveled, comparisons of their frequencies of detection are not valid and cannot be used to assess how common or rare a species is, even in a relative sense.

Line 1322-1324: Commenting on the results of the Department's EBM program, the report states: "The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed." The strength of an occupancy-based protocol is to elucidate occupancy trends over time. While the results from 2 years of the program present a snapshot of fisher occupancy in the region, I suggest a comparison to historic distribution is a more appropriate evaluation of "widespread" and the conclusion of "common" steps beyond the data provided an occupancy protocol without an occupancy-abundance link (see Tucker 2013).

Line 1463: I would caution the use of "intensively" to describe Hoopa forest management practices reflected in figure 15. BIA management in the 1970's and 80's may have been classified as such, but structural diversity in managed stands across Hoopa are relatively high compared to other "intensively managed" ownerships. More quantitative measurements of board feet per acre would be useful.

Line 1467-1468: The report suggests: "However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California." The report does not provide nor am I aware of any reference supporting this claim.

Line 1505: The report suggests the SSN population appears to have been stable. Refer to my comments above for lines 54-58.

Line 1555: the reference now has a publication available: The Journal of Wildlife Management 78(4):603–611; 2014

Lines 2266-2276: Consideration of the potential impacts of Sudden Oak Death on the tanoak communities of the NC population should be considered.

Lines 2520-2521: WLPZs may offer protection for trees in bottom 1/3 of drainages, but many early/midseason fisher den sites are in the middle to upper 3rds of drainages/slopes, affording solar/thermal advantages (Matthews, personal communication)

Line 2995-2996: The report states: "However, fishers have co-evolved with the suite of predators naturally occurring within their range…" This conclusion and the preceding paragraph fail to recognize the linkage established by Wengert (2013) and Higley et al. (2013). Fishers have co-evolved with a suite of potential predators, however under a natural forest-disturbance regime. Anthropogenic land use and fragmentation have increased fisher susceptibility to predation (Higley et al. 2013, Wengert 2013).

Line 3131-3135: Counter to the language in the report, toxicant use is suspected by many in the law enforcement community to be on the rise both in extent and abundance of use in recent years and we are only beginning to see its direct and indirect impact on fishers, fisher prey, other wildlife, and possibly human health. Any available data would be available through Mourad Gabriel.

I appreciate the Department's invitation to review the report and I hope my comments are helpful in a revision process and recommendations offered to the Commission.

Sincerely,

Sean M. Matthews, Ph.D.

Literature Cited

Aubry, K. B., and J. C. Lewis. 2003. Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biological Conservation 114:79–90.

Buck, S. G., C. Mullis, A. S. Mossman, I. Show, and C. Coolahan. 1994. Habitat Use by fishers in Adjoining Heavily and Lightly Harvested Forest. Pages 368–376 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Carroll, C., W. J. Zielinski, and R. F. Noss. 1999. Using presence-absence data to build and test spatial habitat models for the fisher in the Klamath Region, U.S.A. Conservation Biology 13:1344–1359.

Gibilisco, C. J. 1994. Distirbutional dynamics of modern martens in North America. Pages 59–71 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Higley, J. M., G. M. Wengert, S. M. Matthews, and K. Rennie. 2013. Bobcat ecology and relationship with and influence on fisher survival on the Hoopa Valley Indian Reservation, California. Final Report USFWS TWG CA U-29-NA-1. Hoopa Valley Tribe, Hoopa, California, USA.

Jones, J. L., and E. O. Garton. 1994. Selection of Successional Stages by Fishers in North-Central Idaho. Pages 377–387 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Lewis, J. C., R. A. Powell, and W. J. Zielinski. 2012. Carnivore translocations and conservation: insights from population models and field data for fishers (Martes pennanti). PloS one 7:e32726.

Lofroth, E. C., C. M. Raley, J. M. Higley, R. L. Truex, J. S. Yaeger, J. C. Lewis, P. J. Happe, L. L. Finley, R. H. Naney, L. J. Hale, A. L. Krause, S. A. Livingston, A. M. Myers, and R. N. Brown. 2010. Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California–volume I: conservation assessment. USDI Bureau of Land Management, Denver, Colorado, USA.

Matthews, S. M., J. M. Higley, K. M. Rennie, R. E. Green, C. a. Goddard, G. M. Wengert, M. W. Gabriel, and T. K. Fuller. 2013. Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. Journal of Mammalogy 94:100–108.

Paragi, T. F. 1990. Reproductive biology of female fishers in southcentral Maine. University of Maine.

Powell, R. A., and W. J. Zielinski. 1994. Fisher. Pages 38–73 *in* L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, editors. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. General Technical Report RM-254. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, USA.

Rosenberg, K. V, and M. G. Raphael. 1986. Effects of forest fragmentation on vertebrates in Douglas-fir forests. Pages 263–272 *in* J. Verner, M. L. Morrison, and C. J. Ralph, editors. Wildlife 2000--modeling habitat relationships of terrestrial vertebrates. University of Wisconsin Press, Madison, Wisconsin, USA.

Thompson, C., R. Sweitzer, M. Gabriel, K. Purcell, R. Barrett, and R. Poppenga. 2014. Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conservation Letters 7:91–102.

Tucker, J. M., M. K. Schwartz, R. L. Truex, S. M. Wisely, and F. W. Allendorf. 2014. Sampling affects the detection of genetic subdivision and conservation implications for fisher in the Sierra Nevada. Conservation Genetics 15:123–136.

Tucker, J. M. 2013. Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada. Dissertation. University of Montana, Missoula, Montana, USA.

USDI Fish and Wildlife Service. 2014. Draft species report, fisher (*Pekania pennanti*), west coast population. USDI Fish and Wildlife Service, Yreka, California, USA.

Weir, R. D., and F. B. Corbould. 2008. Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Journal of Mammalogy. Prince George, British Columbia, Canada.

Weir, R. D., and F. B. Corbould. 2010. Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. Journal of Wildlife Management 74:405–410.

Wengert, G. M. 2013. Ecology of intraguild predation on fishers (Martes pennanti) in California. Dissertation. University of California Davis, Davis, California, USA.

Zielinski, W. J., J. a. Baldwin, R. L. Truex, J. M. Tucker, and P. a. Flebbe. 2013. Estimating trend in occupancy for the southern Sierra fisher Martes pennanti population. Journal of Fish and Wildlife Management 4:3–19.

Dear Richard,

Here are my comments on the draft Report to the Fish & Game Commission on the status review of the fisher.

My general comments, on both grammar and content, separated, are below.

Attached, please find a Word file of the review. I have entered suggested revisions and comments using TrackChanges.

Get back to me if you have any questions or need more information.

Good luck with revisions.

peace , , , , ,

rog . . . . .

Comments on Content

1) Lines 281-284 – These statements are wrong. The best molecular and DNA phylogenies that include samples from the most species and that use the most molecular material do not put fishers, tayras and wolverines into a clade of their own. Koepfli gave a good talk at the Musteloid Conference at Oxford last year, reviewing the phylogenetic research that has been done. His review showed that the result for fishers and martens reported in his 2008 paper is still the best understanding for the relationships among these species (reference 15 in the review). I have attached a pdf figure with a summary of the pertinent material. Note that the tayra, the fisher, the wolverine, and the house marten all fall in clades including no other species. Thus, according to rules of zoological nomenclature, if all the "true" martens are included within Martes, then the house marten might or might not be included in Martes as well. This inclusion has been accepted. Next, the wolverine might be included within Martes. If so, fine, but this inclusion has not generally been accepted. Consequently, the wolverine has its own genus, Gulo. And, therefore, the fisher and the tayra must each have its own genus as well. In addition, the fisher is no more closely related to the wolverine than it is to any other species in the clade that includes the wolverine and the martens. But, because the fisher is in a clade with the wolverine and the martens, it is more closely related to those species than to the tayra (but not more closely related to wolverines than martens). A legitimate systematic decision (legal according to the rules of zoological nomenclature) would be to include the fisher, the wolverine and all the martens within Martes but to exclude tayras from that genus. Such a decision would include in 1 genus species that are more distantly related than usual for being member of the same genus.
I hope I have been clear. Get back to me if you are confused.

2) Line 291 – Wild European polecats are not and have never been known as "fitch ferrets". I actually made a misstatement in my book about this point. The fitch ferret is a domesticated polecat whose ancestor is probably the European polecat but may be the Siberian polecat, or a hybrid of the 2. The point here is that fitchet, fitche, and fitchew are names used for the pelts of European polecats, are names for polecats in other languages, and are names the led to the name "fitch" ferret. This point is minor and possibly not worth revising but I felt obliged to make it.

3) Line 384 – The legend for this figure and for several other figures are so small that I can not read them even when I blow them up on my computer monitor. You need to attend to your figures.

4) Lines 525 and 565 – The content of these 2 lines contradict each other. If fishers did not reach California until <5000 years ago, the north and south populations in California could not have diverged 16,700 years ago. The 2 populations did not exist 16700 years ago.

5) Lines 971-996 – Telemetry studies of rest sites of fishers have a seldom mentioned bias that could be important. Fishers resting in trees transmit strong signals, biasing studies of rest sites. Fishers down on or in the ground do not transmit strong signals and, therefore, researchers seldom walk in on fishers resting in logs or in piles of brush or down holes.

6) Lines 740-742 – The diversity of prey eaten by fishers in California, especially southern California, actually suggests that fishers'
preferred prey is not present or is found at such low abundances that low ranked prey must be eaten. Across their range, fishers prey predominantly on mammals that are the largest they can catch consistently: porcupines, snowshoe hares, grey squirrels (and of course carrion). When those prey are abundant, fishers prey on nothing else.
This pattern is consistent with the predictions of Charnov's (1976) model of optimal foraging. That model predicts that a predator should prey exclusively on its top ranked prey if such prey are abundant enough. If such prey are not abundant enough to support the predator population, then the predators should include the next ranked prey, and so on down. When fishers eat diverse prey, especially small prey, the best explanation is that their preferred prey are rare (or absent).

7) Lines 776-780 – You can not cite my book as a source of this hypothesis. I state pretty clearly that differences in diet between the sexes probably seldom exist and are probably not related to sexual dimorphism in body size. I cite, in my book, several other publications that have espoused that hypothesis. I did, in my book, document that females might prey on smaller porcupines than males. Thor Holmes did nice morphometric work showing that trophic structures (teeth, jaws) are more alike than body sizes, meaning that selection has acted on the tools used for predation to make them more similar between the sexes than body size. Holmes's work suggests that diets do not differ between the sexes (Holmes & Powell in the 1994 Martes book).

8) Lines 815-824 – One can not compare home range sizes estimated with kernel estimators unless they were calculated using the same software package, the same band width and the same kernel. Different software packages produce different utilization distributions for a single set of data. Using different band widths and different kernels will yield different utilization distributions for a single data set. Thus, comparisons of home ranges sizes can not be made legitimately. If you insist on making such comparisons, you MUST make a strong disclaimer that the results of such comparisons might yield false results.

9) Line 2277 and onward – Existing actions and regulations aimed to protect fishers and their habitat exist because of the fisher's status.
If protection for fishers is removed, then many (or at least some) of those protections will disappear. Thus, what is important is not what regulations and policies exist to protect fishers but, rather, what regulations and policies not having anything to do with fishers specifically will continue to protect fishers if fishers lose protection. Consequently, I recommend huge changes in this section to emphasize the protections that exist for fishers not because they are candidate species but because fishers simply get

covered. If the Commission chooses not to list fishers, this section needs to show how background protections are adequate. If the Commission chooses to list fishers, then this section needs to show how background protections are not adequate. Protections created by the fisher's present, candidate status are irrelevant.

10) Lines 2507, 2510, 2560-1574, 2828-2829 – These lines mention optional actions that, if taken, benefit fishers. Unless these optional actions have been shown to have been taken and, when taken, benefitted fishers, they are irrelevant. So, do not mention optional actions that are not taken or that do not benefit fishers.

11) Lines 1669-1671 – The Department blatantly ignored this recommendation by not considering our Section 6 proposal earlier this year. By not considering our proposal, the Department also contradicted recommendation 6 on page 95. I find these recommendations disingenuous and recommend that they be deleted unless the Department is willing to make a public commitment. Alternately, we could use these public recommendations in our proposals and make public the Department's contradictory behavior and lack of commitment if our proposals are not funded.

12) Lines 2994-2996 – This statement lacks context and is actually false in its true context. Fishers may have co-evolved with the present suite of other predators but it did not do so within a fragmented landscape.
Consequently, its co-evolution with these predators is irrelevant because the conditions of the co-evolution no longer exist. Fishers did not co-evolve interacting in close relationships with these other predators. Fishers lived in other habitats and on other parts of the landscape and, therefore, did not interact with these other predators as they do now.

13) Lines 3067-3076 – Actually, the genetic evidence does not show that the fisher population in present day California had contracted to 2 independent populations. The genetic evidence shows that no gene flow existed between fishers in what are presently the northern and southern populations. Jodi Tucker has shown that rivers and canyons presently limit gene flow within the southern population itself. Many rivers and canyons cross the Sierra Nevada between Yosemite and Mt Shasta. Those rivers and canyons create gene bottlenecks that could easily have allowed a continuous population throughout Grinnell's distribution while preventing gene flow across that whole range. This possibility is real and must be considered.

14) Lines 3093-3097 – Local adaptation has never been documented, a point that is extremely important. Small populations are far more likely to experience genetic drift than local adaptations. Consequently, the genetic differences between the northern and southern populations of fishers are most likely due to genetic drift within the southern population. Until local adaptations can be demonstrated, the most logical position to take is that genetic drift has caused the genetic changes.

15) Lines 3129-3140 – Before you can make this statement, you MUST show that marijuana fields have a long-term existence within the forests where fishers live. If marijuana fields are a recent occurrence away from the coast, then you can not make this argument.

Grammatical Comments

1) I strongly urge you not to use acronyms and abbreviations. Asking readers to remember abbreviations is not a big request, I know, but for

4 reasons I recommend that you use no acronyms. i) The Commissioners may have just read another publications or papers that required them to remember abbreviations for other things, perhaps some with the same abbreviations, can easily forget what your abbreviations mean. Recently I reviewed a manuscript that asked readers to remember abbreviations for
3 types of forest, one of which was mixed deciduous forest, abbreviated as MDF. Before reading that manuscript, I had been reading a woodworking magazine and all I could think when I read “MDF” was “medium-density fiberboard”. You do not want the Commissioners to be confused like that.
ii) I could not read the entire draft review in 1 sitting. When I picked up the tome after a spell, sometimes after days, I simply could not remember what all the damn acronyms meant. That left me to search back through tens of pages, trying to find the definitions. All that exercise did was irritate me, making me less open to and more critical of the review. You do not want the commissioners to be irritated, or even tired, of the report. iii) The result of items i and ii is that comprehension is decreased. Remember, use abbreviations and acronyms only when they serve to improve your ability to communicate with your readers. Do not use abbreviations and acronyms to save space, to save you from having to write out long names many times, or to make you think that your manuscript is important because it has a bunch of capital letters strewn through it. Do not use abbreviations simply out of habit when they are not needed. By and large, acronyms are a sign of authors who have not been thinking. Given that your goal is to help the commissioners understand and remember the points you make in your review, avoiding acronyms is your best approach. This leads me to iv) You have no space limits. You have absolutely no reason to use acronyms at all, especially since all they ever do is decrease comprehension.
Spelling out whole names is worth the space used to be clear. If you can think of ways to shorten names, that would be good. For example, “mixed forest” worked for “mixed deciduous forest”. If you insist on not writing out names in full all the time, I know you can think of short names that the commissioners can remember easily.
If you must use acronyms, then you must have a table of acronyms at the beginning of the review. This option is a far, far inferior, however, to avoiding acronyms.

2) Names of most mammals have 2 plurals: the formal plural, ending in “s”, and the sportsman’s plural, which is the singular used as the plural. For a few species, the sportsman’s plural has become the formal plural (deer, moose). The sportsman’s plural is used uniformly in hunting and fishing magazines (such as Field and Stream) and consistently but not universally in wildlife journals (such as the Journal of Wildlife Management). The formal plural is used in most other places, including most professional journals. Most journals do not have a formal policy towards plurals but leave the decision regarding use of plural to authors. I prefer formal plurals.
You, of course, may choose the plurals you wish to use. Once you make your decision, however, you must be consistent, both within and among species. Using the sportsman’s plural forces readers to determine number from context. Switching back and forth can confuse readers because they never know whether they need to determine number from context or not.
You are mostly consistent in using the sportsman’s plural but do switch back and forth. That is a no-no.

3) Strunk & White, in “Elements of Style”, recommended against starting sentences and independent clauses with “however” when it means “nevertheless” or “nonetheless”. Starting sentence with “However” has become common in biology (though not in other disciplines) but, nonetheless, Strunk & White’s rule still has merit for 2 reasons. i) At the beginning of a sentence (or independent clause) and without a comma, “However” means “No matter how”. “However often I get caught in the rain, I still don’t learn to bring my rain gear.” A reader can mis-anticipate the sentence to come when the sentence starts with “However” meaning “Nevertheless”. ii) “However,” (with the comma) can be a harsh jolt for

a reader and, far too often, the sentence following "however" does not make clear exactly what from the previous sentence is to be compared to something in the following sentence. You start many, many sentences with "However" when the comparison is not obvious at all.
You have some paragraphs with "However" starting sentences, which is boring besides being confusing. When I find "However" at the beginning of a sentence in my own writing, I use it as a red flag for a sentence that can be improved. Try replacing "However" with "Nevertheless", "Nonetheless", "In contrast" or some other wording. Try putting "however" into the interior of the sentence. Try leaving "however" out of the sentence entirely. I bet you will find that you can improve the sentence. Try it. Use the Search & Destroy capabilities of Word (TrackChangees) to find every "However" and revise the sentences. I wager that you will find that "However" is not even needed in most places where you use it.

4) The method used to cite references is the worst for comprehension.
Citing author and year is the best because it facilitates remembering specific publications. Using numbers for references arranged alphabetically is also better than arranging references in the order cited. Because you have no space limits, using author and year is what I recommend, strongly.

5) line 414 – No one has observed the species but lots of people have observed members of the species. Let me explain. Do not confuse a species with an animal or animals. Animals have flesh and fur. They hunt prey or escape from predators. They eat. They interact with each other.
They have offspring. A species, in contrast, is a human concept used to put organisms into categories. A species is not an animal in the flesh and fur, it does not hunt, it does not escape from predators, and any offspring it might have are, or will be, new species categories. A species can not do anything because it exists only as a concept in our brains. A species can not be seen in the wild, since it exists only in our brains. You can refer to the species when presenting characteristics of the species (its distribution, weight range, color, mean litter size,
etc.) but not when presenting characteristics that may not be universal for all individuals. You can refer to individual animals as members of a species.
A further confusion can exist. A single fisher (a critter in the flesh and fur) is certainly addressed in the singular. Once you have addressed one such otter, you need to use the definite article "the" to distinguish him (or her) from other individuals. The potential exists to confuse "the fisher" the species with "the fisher" a single, identified individual. The reader must be able to distinguish these 2 meanings using context. Thus, you must write clearly. I do not think, however, that you ever single out an individual fisher in this status review, so this point is not a problem for you.

6) Line 613 and elsewhere – The expression "1-4" is a range. Although we read the expression as "one to four", the "to" does not exist in the sentence formally. We could just as well rename the range "1-4" to be "Range A". Then, replacing "1-4" in the sentence with "Range A" would not change the meaning of the sentence. If, however, you write "from 1-4", what you have written makes no sense. Writing "from" implies that some "to" must exist. Think of it as "from Range A to Range B", but you have written only "from Range A" and the other half of the expression is missing. Either write "from 1 to 4" or revise the sentence to eliminate the "from".

7) An average is a single number, not a range. Averages from several studies can cover a range of numbers, however, which is what I think you mean here.

8) Line 2210 – Splitting infinitives is accepted by most writers of English ("to boldly go"). Nonetheless, splitting infinitives can have unanticipated effects that a good writer must consider. When an infinitive is split (for example, "to indirectly affect fishers"), the reader understands (usually unconsciously) that the

adverb is more important than the verb because the adverb comes first. If a writer really means to put heavy emphasis on the adverb, then splitting the infinitive is the right thing to do. If the adverb is not very important (if the fact that a fishers are affected is way more important than whether the effect was direct or indirect) then splitting the infinitive misinforms the reader. You split several infinitives that I think you should not split.

Some adverbs are verbs in their own right – "to better", for example.

Splitting an infinitive with an adverb that is also a good verb can confuse readers. If one writes "to better understand", the reader is faced with several challenges. Did the writer mean to use the verb "to better" or to use the verb "to understand"? Because the reader reads "to better" first, his or her first thought will be that "to better" is the verb. When "understand" comes along, the reader must re-evaluate, which slows the reading, reduces comprehension, and can introduce confusion.

Once the reader has figured out the true verb, and if it is "to understand", then the reader must figure out whether the adverb is really more important than the verb – is improvement in understanding more important, or is understanding more important.

The same logic applies to splitting compound verbs (for example, "I was aimlessly walking" vs "I was walking aimlessly").

9) Line 2435 – Giving this area in hectares makes no sense. Do you give your height in millimeters or you weight in grams (or ounces)? Giving large areas in hectare (or acres) makes no sense. Here, 532 km^2 works fine (and the appropriate mi^2).

--

Roger A Powell

Department of Applied Ecology
North Carolina State University
PO Box 918, Ely, Minnesota 55731

tel. 218-235-8808
e-mail: newf@ncsu.edu
http://www4.ncsu.edu/unity/users/r/rpowell/WebPage/

Husk at leve
Mens du gør det.
Husk at elske
Mens du tør det.

Peit Hein

Comments from R. Powell

STATE OF CALIFORNIA

NATURAL RESOURCES AGENCY

DEPARTMENT OF FISH AND WILDLIFE

CONFIDENTIAL DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [formerly *Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

October 1, 2014

Table of Contents

List of Figures

List of Tables

List of Appendices

(to be completed)

Acknowledgments

(to be completed)

This report was prepared by: ______________________
Cover photograph © J. Mark Higley, Hoopa Tribal Forestry, used with permission.

Report to the Fish and Game Commission
A Status Review of the Fisher in California
_______, 2014

Executive Summary

This document describes the current status of the fisher (*Pekania pennanti*) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

Formatted: Font: Italic

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act. On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department of Fish and Game, as it was then named (now called the Department of Fish and Wildlife) (Department), commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Despite being the most valuable furbearer in the state, trappers only reported taking 46 animals from 1920-1924. In addition to trapping, the decline of fishers has also been attributed to logging activities which may render habitats unsuitable for them.

Early researchers believed that the range of fishers in the late 1800s extended from the Oregon border south to Marin County through the Klamath Mountains and the Coast Range as well as through the southern Cascades to the southern Sierra Nevada Mountains. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to European settlement. The location and size of the gap separating these populations is unknown. However, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Currently fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population). Fishers are also found in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN Fisher ESU) from fishers in northern California (NC Fisher ESU) and the degree of genetic differentiation between them. Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals.

Early work on fishers appeared to indicate that fishers required particular forest types in western US (e.g., old-growth conifers) for survival. However, studies of fishers over the past two decades have demonstrated that they are not dependent on old-growth forests per se, nor are they associated with any particular forest type. Fishers are typically found at low- to mid-elevations characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used for resting (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning and the presence of a suitable cavity appears to be more important than the species of

tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (> 100 years) may be needed for trees to attain sufficient size and for a cavity large enough for a female fisher and her young to develop. Although the number of den and rest structures needed by fisher is not well known, a substantial reduction in these important habitat elements would likely reduce the distribution and abundance of fisher in the state.

Primary threats to fishers within the NC and SSN Fisher ESUs include habitat loss, toxicants, wildfire, and climate change. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests. However, fishers are widespread on public and private lands harvested for timber. A concern for the long-term viability of fishers across their range in California is the presence of suitable den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service or the National Park Service. Private lands within the NC Fisher ESU and the SSN Fisher ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher contracted substantially. This difference is due to the apparent absence of fishers from the central, and portions of the northern, Sierra Nevada. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and to other toxicants. ARs used at illegal marijuana cultivation sites have caused the deaths of some fishers and ARs may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population.

In recent decades the frequency, severity, and extent of wildfires has increased in California. This trend could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due to that population's small size, the linear distribution of the habitat available, and the potential for fires to increase in frequency under scenarios where the climate warms.

Climate research predicts continued climate change through 2100, with rates of change faster than occurred during the previous century. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate related changes that may occur within the range of the fisher in California. The SSN Fisher ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU, due to its comparatively small population size and susceptibility to fragmentation. However, the effects of climate change on fisher populations are unknown, will likely vary throughout the species' range, and the severity of those effects will vary depending on the extent and speed with which warming occurs.

Regulatory Framework

Petition Evaluation Process

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3) The Commission received the petition and, pursuant to Fish & G. Code § 2073, referred the petition to the Department for its evaluation and recommendation. (*Id.*, § 2073) On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*) as Threatened

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[2].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[3].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[4]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[5, 6].

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[7].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (APA) (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA,

---

[2] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[3] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[4] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

[6] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[7] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

subject to various terms and conditions[8]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[9]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[10]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its Status Review and the best science available to the Department that designating fisher as a threatened or endangered species under CESA was not warranted[11]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[12].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[13]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related

[8] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[9] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[10] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

[11] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[12] *Id.*, § 670.1, subd. (g).

[13] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[14]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as an endangered or threatened species under CESA was not warranted[15]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[16].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[17] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

---

[14] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

[15] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[16] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[17] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[18]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[19]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its February 2010 status review of the species. This report represents the Department's revised status review, based on the best scientific information available and including independent peer review by scientists with expertise relevant to the status of the fisher (Appendix X).

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail [1]. They typically appear uniformly black from a distance, but in fact are dark brown over most of their bodies with white or cream patches distributed on their undersurfaces [2]. The fur on the head and shoulder may be grizzled with gold or silver, especially in males [1]. The fisher's face is characterized by a sharp muzzle with small rounded ears [3] and forward facing eyes indicating well developed binocular vision [2]. Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0-2.5 kg (4.4-5.5 lbs) and range in length from 70-95 cm (28-34 in) and males weigh between 3.5-5.5 kg (7.7-12.1 lbs) and range from 90-120 cm (35-47 in) long [2].

---

[18] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh about 500-1400 g (1-3 lbs) and range in total length from about 50-68 cm (20-27 in) [4]. Fishers have a single molt in late summer and early fall, and shedding starts in late spring [2]. American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers [5].

Fishers are seldom seen, even where they are abundant. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground [6]. Females, perhaps because of their smaller body size, are more arboreal than males [2,7,8].

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the ~~m~~Mustelidae includes wolverine, marten, weasel, mink, skunk, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America; *M. p. pennanti* [9], *M. p. columbiana* [10]; and *M. p. pacifica* [11]. However, the validity of these subspecies has been questioned [3] and [12].

More recently, genetic studies indicate that the fisher is more closely related to wolverine (*Gulo gulo*) and tayra (*Eira barbara*) of Central and South America than to other species of *Martes* [13–19]. Based on those findings, fishers have been reclassified along with wolverine and tayra into the genus *Pekania* [15,19]. In this report, we use *Pekania pennanti* as the taxonomic designation for native fishers in California.

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell [2] thought the most likely possibility was that the name originated with European settlers who noted the similarity between fishers and European polecats, which were also known as fitch ferrets. Many other names have been used for fisher including pekan, pequam, wejack, Pennant's marten, black cat, *tha cho* (Chippewayan), *uskool* (Wabanaki), *otchoek* (Cree), and *otschilik* (Ojibwa) [2]. In the native language of the Hoopa people, fisher are known as *'ista:ngq'eh-k'itiqowh* [20].

Comment [RAP1]: Skunks are no longer included within the Mustelidae but are in their own family, Mephitidae.

Comment [RAP2]: See grammatical comment in letter

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Formatted: Font: Italic

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago [21]. Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) [22]. During the late Holocene which began about 4,000 years ago, fishers expanded into western North America [23], presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to European settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 1). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and mixed coniferous forest ecosystems in western North America [24].

By the 1800s and early 1900s the fisher's range was generally greatly reduced due to trapping and large scale anthropogenic influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss [2,24,25]. However, fishers have reoccupied much of the area lost during the early 1900s, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York [25].

Native populations of fisher currently occur in Canada, the western United States (Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada [26].

Historical Range and Distribution in California

Our knowledge of the distribution of fishers in California is primarily informed by Grinnell et al. [3]. They described fishers in California as inhabiting forested mountains

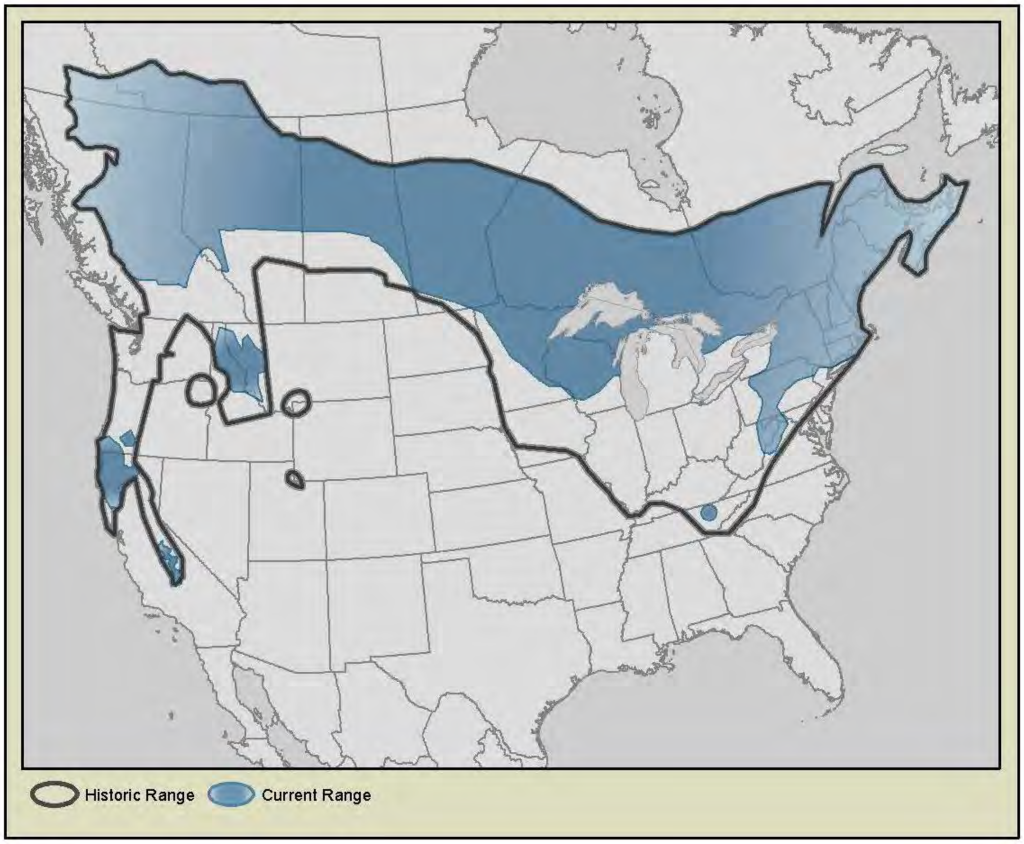


Figure 1. Presumed historical distribution (ca. 1600) and current distribution of fisher in North America. Historical distribution was derived from Giblisco [27]. Refer to Tucker et al. [28] and Knaus et al. [29] for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

primarily at elevations between 610 m to 1824 m (2,000 - 5,000 ft) in the northern portions of their range and 1220 m to 2438 m (4,000 ft - 8,000 ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations. Fishers were believed to have ranged from the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County [3].

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919-1924, as well as a line demarcating what they assumed to be general range from approximately 1862-1937 (Figure 2). The point locations on the map were based on reports by trappers and the authors believed that almost all the locations were accurate, although they pointed out that some may have reflected the trapper's residence or post office. The map remains the best approximation of the distribution of fishers in California at that time, although it likely included areas unsuitable for fishers and excluded portions of the state occupied by the species.

Information presented by Grinnell et al. [3] suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. [3] appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included Lake, Marin, and Kern counties.

Evidence of fishers occupying the central and northern Sierra during the mid-1800s through the early 1900s is limited. In the northern Sierra, Grinnell et al. [3] showed two collections from Sierra County from 1919-1924. During that period in the central Sierra, Grinnell et al. reported one collection from Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County. All of these records, as well as one other record from northwestern Tuolumne County in the Tuolumne River watershed, are north of the current northern limit of the southern Sierra fisher population in the Merced River watershed.

In the southern Cascades, Grinnell et al. [3] mentioned that fishers were trapped during the winters of 1920 and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. [30] reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National Park, near the junction of Lassen, Plumas, and Shasta counties. Additional historic records of fishers in the southern Cascades include two collections in 1897, from eastern Shasta County, that are located in the National

Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney.

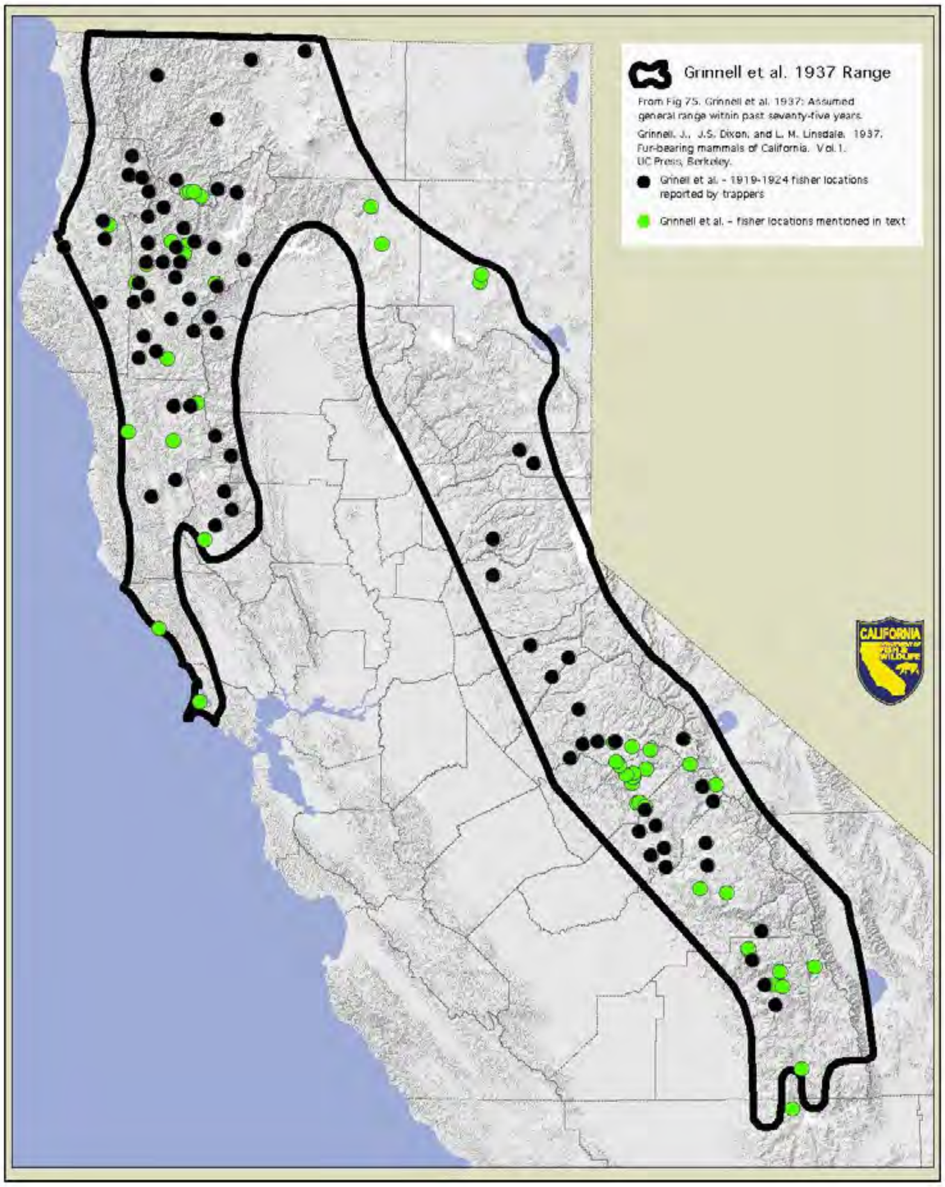


Figure 2. Assumed general range of the fisher in California from ~1850 -1925 from Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Anecdotal evidence of fishers in the northern Sierra is provided in an 1894 publication describing the efforts of William Price to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada [31]. Price included notes on species that he did not collect but were "commonly known to the trappers." His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[20] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Additionally, when relevant, Price discusses more distant geographic localities for some species and their close relatives. If the fishers referenced were trapped at distant locations (e.g., the southern Sierra) it is likely those locations would have been mentioned. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred animals.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fisher in California is based on observations of the species through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

[20] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger [32] noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of species presence (remote cameras and track-plate boxes) [33]. In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* [34] to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be "verified" records (Figure 3). Undoubtedly, reports of

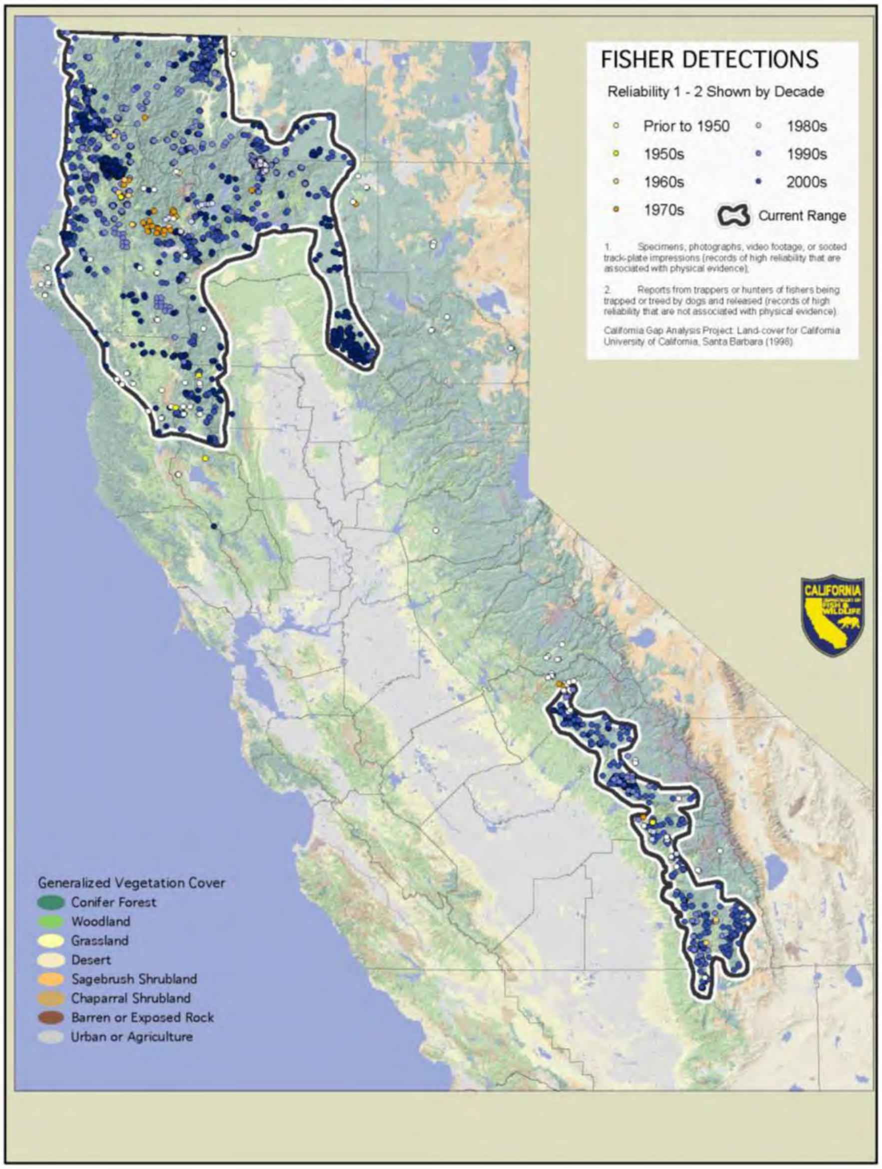


Figure 3. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis [34] were included. California Department of Fish and Wildlife, 2014.

fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state.

A number of broad scale, systematic surveys for fisher and other forest carnivores in the Sierra Nevada Mountains were conducted from 1989-1994 [35], from 1996-2002 [35], and from 2002-2009 (USDA 2006, USDA 2008, Truex et al. 2009). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. [35] expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction due to isolation than if they were connected to other populations. They offered several explanations to account for the lack of fishers in the region including trapping and elimination of habitat through railroad logging.

Zielinski et al. [35] could find no reason to suspect that fisher at one time did not occur where habitat was suitable throughout the Sierra Nevada and thought it likely that the fisher population had already been reduced by the time Grinnell [3] and his colleagues assessed its distribution. Price [31] supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell [3].

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the USDA Forest Service (USFS), private timber companies, and others, since the 1950s no verifiable detections of fishers have occurred in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River [35,36].

To approximate the current range of fishers in California, observations of fishers with high reliability were mapped from 1993 to the present. Those locations were overlaid using GIS on layers of forest cover and layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model) and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 3). This estimate of

current range is approximately 48% of the assumed historical range estimated by Grinnell et al. [3].

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (<5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice sheets [23]. By the late Holocene, records of fishers on the Pacific coast were common [37]. Wisely et al. [37] hypothesized that fishers then expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Currently, fishers in California occur in the northwestern portions of the state, the northern Sierra Nevada, and in the southern Sierra Nevada. Mitochondrial DNA (mtDNA) has been used in several studies to describe the genetic structure of fishers in the state [29,37,38]. Mitochondria are small maternally inherited structures in most cells that produce energy. Portions of the DNA contained within mitochondria known as D-loop regions contain nonfunctional genes and have been widely used in studies of ancestry because they are rich in mutations which are inherited. Early genetic studies of fishers by Drew et al. [38] identified three haplotypes[21] in California (haplotypes 1, 2, and 4) by sequencing mtDNA. Haplotype 1 was found in northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in extant fisher populations in British Columbia. Based on these findings, Drew et al. [38] suggested that gene flow between fishers in British Columbia and California must have occurred historically, but that these populations were now isolated.

Subsequent genetic investigations using nuclear microsatellite DNA and based on sequencing the entire mtDNA genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada [29,37]. Knaus et al. [29] identified three distinct haplotypes unique to fishers in California; one geographically

[21] A haplotype is a set of DNA variations (allele), or polymorphisms, that tend to be inherited together [39].

restricted to the southern Sierra Nevada Mountains and two restricted to the Siskiyou and Klamath mountain ranges. The magnitude of the differentiation between haplotypes of fishers in northern and southern California populations was substantial and considered comparable to differences exhibited among subspecies [29].

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. [29] concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error. Despite this uncertainty, Knaus et al. [29] concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Tucker et al. [40] used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fisher in northwestern California and the southern Sierra Nevada became isolated long before European settlement and estimated that the population declined substantially over a thousand years ago. This generally supports the conclusion of Knaus et al. [29] that fishers in northern and southern portions of the state became isolated prior to European settlement.

Tucker et al. [40] also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fisher from disturbance beginning with the Gold Rush through the first half of the twentieth century. That portion of the range appeared to have maintained a stable population while the remainder of the southern Sierra Nevada occupied by fisher was in decline.

Reproduction and Development

Powell [2] suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April [2,6,41,42]. Females can breed at one year of age, but do not give birth until their second year [2,43,44]. They produce, at most, one litter annually and may not breed every year [8,45]. Reproductive frequency and success depend on a variety of factors including prey availability, male presence or abundance, and age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old [2,8,45,46].

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation [8,47,48]. Implantation is delayed approximately 10 months [41] and occurs shortly before giving birth (parturition) [48]. Arthur and Krohn [46] considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for an average period of 30 to 36 days [2,48]. Females give birth from about mid-March to early April [49–53] and breed approximately 6-10 days after giving birth [2,47,54]. Ovulation is presumed to be induced by copulation [2], with estrus lasting 2-8 days [54]. Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition [2]. Lofroth et al. [24] ~~developed an excellent~~presented a diagram that illustrates the reproductive cycle of fishers in western North America (Figure 4).

Studies of wild fishers have reported litter sizes to range from 1-4 kits and average 1.8-2.8 [49,55–57]. Based on laboratory examination of corpora lutea[22] observed in harvested fishers, average litter size ranged from 2.3-3.7 kits [8,41–43,59–61]. These averages may be high and counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea [2]. Crowley et al. [60] found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

[22] The corpus luteum is a transient endocrine gland that produces essentially progesterone required for the establishment and maintenance of early pregnancy [58].

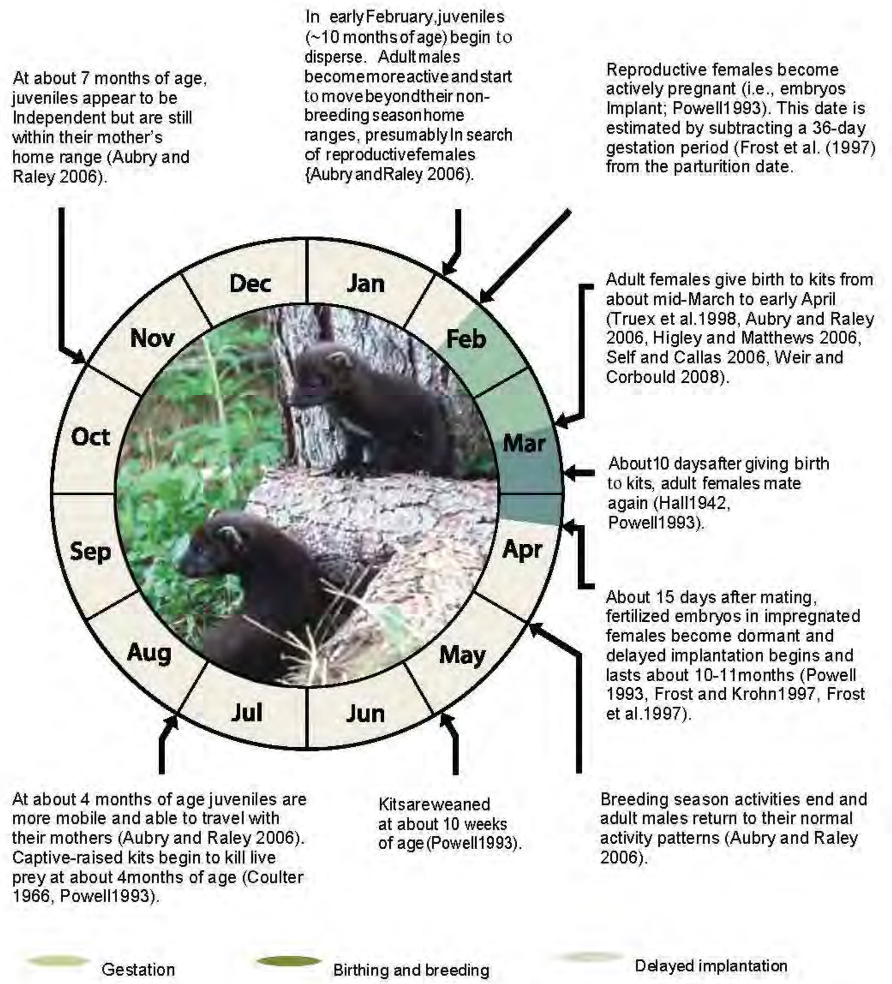


Figure 4. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. [22].

Raised in dens entirely by the female, young are born with their with eyes and ears closed, only partially covered with sparse growth of fine gray hair, and weigh about 40 g [6,25,54]. The kits' eyes open at 7-8 weeks old. They remain dependent on milk until 8-10 weeks of age, and are capable of killing their own prey at around 4 months [2,25]. Juvenile females and males become sexually mature and establish their own home

ranges at one year of age [41,62]. Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum [25]. Fishers have a relatively low annual reproductive capacity [5]. Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually reported from several studies in western North America was 64% (range = 39 – 89%) [24]. However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable.

A recent study in the Hoopa Valley of California reported that 62% (29 of 47) of denning opportunities were successful in weaning at least one kit from 2005-2008 [63]. Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, most ($\overline{x}$ = 78%, range = 63-90%) produced young annually from 2010-2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers [24].

Many kits die immediately following birth. Frost and Krohn [48] found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth [44]. In wild populations, kits have been found dead near den sites and reproductive females have been documented abandoning their dens indicating their young had died [49,50,56]. The number of fishers an individual female is able to raise until they are independent depends primarily upon food resources available to them [64]. Paragi [65] reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.

Survival

There are few studies of longevity of fishers in the wild. Powell [2] believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir [61] captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age [66]). Of

14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age [67].

In the wild, most fishers likely live far less than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years, although one of those animals lived to at least 10 years of age [66,68]. From 2009-2011, a total of 67 fishers were live-trapped in northern California as part of an effort to translocate the species to the southern Cascades and northern Sierra. The median age of those individuals was 2 years (range = 0.6 – 6). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Estimated survival rates of fishers vary throughout their range [24]. Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, and road density. Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation). Lofroth et al. [24] summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America documented by 8 studies, and averaged 68% for 3 studies in eastern Northern America. This difference was presumably due, in part, to the take of fisher by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts). In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range = 0.61-0.84) for adult females and 0.82 (range = 0.73-0.86) for adult males [24].

Food Habits

Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi [2]. Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided [2]. Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey

species that may be otherwise impossible to determine by more traditional techniques [24].

In a review of 13 studies of fisher diets in North America by Martin [69], five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed [24]. The proportion of different food items in the diets of fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey [2].

In California, studies indicate fishers appear to consume a greater diversity of prey than elsewhere in western North America [24,70,71]. This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey [70]. In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats [71,72]. Diets reported in these studies differed somewhat in the frequency of occurrence of specific prey items, but included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California [71], where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material [72,73].

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council [74], Golightly et al. [71] found mammals, particularly gray squirrels (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), and ground squirrels (*Spermophilus* sp.), to be the most frequently consumed prey by fishers. Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet [70–72]. This is likely due to the comparatively low densities of these species in ranges occupied by fishers in California compared to other parts of their range [72].

In the southern Sierra Nevada, Zielinski et al. [72] reported that small mammals comprised the majority of the diet of fishers. However, insects and lizards were also

frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. [72] also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn.

Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available [71,72,75,76]. Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers their ability to capture and handle larger versus smaller prey [24]. The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill. This has been hypothesized as a mechanism that reduces competition between the sexes for food [2]. Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey [24].

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. [72] found that during summer, the diet of female fishers compared to the diet of male fishers contained a greater proportion of small mammals. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. [77] reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley [49] found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). However, since most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits [49]. In some areas, male fishers have been found with significantly ($P<0.1$) more porcupine quills in their heads, chests, shoulders, and legs than female fishers [59,78]. It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers [2].

Movements

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities [79]. These areas have been described for fisher and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young [2]. The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not [2]. Although the home range of a female generally only overlaps the home range of a single male, a male's home range may overlap those of multiple females with the potential benefit of increased reproductive success [2].

Lofroth et al. [24] summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. This difference in home range size, with male fishers using substantially larger areas than females, has been consistently reported [49,52,56,59,80–87]. In 9 studies in western North America the home range sizes of male fishers were 3 times larger than the home range sizes of female fishers [24]. Lofroth et al. [24] noted that home range sizes of fishers generally increase from southern to northern latitudes. Some factors that may influence the suitability of home ranges include landscape scale fragmentation, heterogeneity, and edge ecotones, but these attributes have not been well studied [88].

Dispersal: Dispersal describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. [89] as increasingly recognized to occur in three phases: 1) departing from the natal[23] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to

[23] Natal refers to the place of birth.

move through the landscape, prey resources, turnover rates of adults [52,56,62] and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities [49,52,56]. During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat [2,8,52,90]. Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females [89]. This pattern appears to hold true for fishers [49,57,91]. It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories [91]. Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient [92,93].

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age [24]. In some studies, juvenile male fishers departed from their home ranges earlier than females [57]. Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home ranges. This behavior is characterized by higher mortality risk [52].

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. [62], reported mean maximum dispersal distances for male fishers [$\bar{x}$ =17.3 km (10.7 mi), range=10.9-23.0 km (6.8-14.3 mi), n=8] and for females [$\bar{x}$ =14.9 km (9.3 mi), range=7.5-22.6 km (4.7-14.0 mi), n=5]. York [56] reported mean maximum dispersal distances for males [$\bar{x}$ =25 km (15.5 mi), range=10-60 km (6.2-37.3 mi), n=10]) and for females [$\bar{x}$ =37 km (23 mi), range=12-107 km (7.5-66.5 mi), n=19]. The greater dispersal distance for

juvenile females compared to males reported by York is unusual as, in other studies, males dispersed farther than females.

In the interior of British Columbia, Weir and Corbould [52], reported a mean dispersal distance from the centers of natal and established home ranges of 24.9 km (9.6 mi) for two females and 41.3 km (15.9 mi) for one male. In the southern Oregon Cascade Range, Aubry and Raley [49] reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male fishers [$\bar{x}$ = 29 km (18 mi), range 7-55 km (4.4-34.2 mi), n = 3] and female fishers [$\bar{x}$ = 6 km (3.7 mi), range 0-17 km (0-10.6 mi, n = 4]. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. [57], reported that the mean maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [$\bar{x}$ = 8.1 km (5.0 mi), range = 5.9–10.3 km (3.7-6.4 mi), n = 2) than females [$\bar{x}$ = 6.7 km (4.2 mi), range = 2.1–20.l km (1.3-12.5 mi), n = 12]. They also reported the distance between natal dens and the centroids (geometric center) of home ranges established by a single male [1.3 km (0.82 mi)] and 7 females [$\bar{x}$ = 4.0 km (2.5 mi), range 0.8-18 km (0.5-11.2 mi)].

Habitat Use

Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers [3,94–96] have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

In their comprehensive ~~synthesis~~ overview of the habitat ecology of fishers in North America, Raley et al. [88] used a hierarchical ordering process proposed by Johnson [97] to assess habitat associations of fishers at multiple scales (Table 1). They described the fisher's geographical distribution (first-order selection) as the ecological niche occupied by the species, which is further refined at the home range scale (second-order selection). Ultimately, the selection of different environments (third-order) and of resources (fourth-order) is constrained by landscape scale processes and conditions

Comment [RAP3]: Raley et al. do not really synthesize the literature but do give a good overview.

Table 1. Summary of habitats used by fishers categorized by hierarchical order (Johnson 1980) and a synthesis of fisher habitat studies by Raley et al. [88].

.

First-order	Geographic distribution	Fisher distribution has consistently been associated with expanses of low- to mid-elevation mixed conifer or conifer-hardwood forests with relative dense canopies.
Second-order	Selection or composition of home ranges with the geographic distribution	Characterized by a mosaic of forest types and seral stages, with relatively high proportions of mid- to late-seral conditions, but low proportions of open or non-forested habitats.
Third-order	Selection or use of different environments within home ranges	Rest Sites: Fisher consistently selected sites for resting that have larger diameter conifer and hardwood trees, larger diameter snags, more abundant large trees and snags, and more abundant logs than at random sites. Sites used for foraging, traveling, seeking mates: Although results indicate complex vertical and horizontal structure is important to fishers, strong patterns of use or habitat selection were not found.
Fourth-order	Selection or use of specific resources within home ranges	Rest Structures: Fishers primarily used deformed or deteriorating live trees and snags for resting. The species of tree used appeared less important than the presence of a suitable microstructure (e.g., mistletoe brooms, cavities, nests of other species) for resting. Dens: Female fishers use cavities in trees to give birth and shelter their young. Den trees used for reproduction were old and were always among the largest diameter trees in the vicinity.

[88]. We have adopted this hierarchical approach to describe habitats selected by fishers.

Some researchers have hypothesized that fishers require old-growth conifer forests for survival [98]. However, habitat studies during the past 20 years demonstrate that fishers are not dependent on old-growth forests *per se*, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. Raley et al. [88] suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include high proportions of mid- to late-seral forests.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments [24]. The Department calculated the mean elevation of each Public Land Survey [99] section in which fishers were detected in California from 1993-2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 5). Habitats at higher elevations may be less favorable for fishers due to the

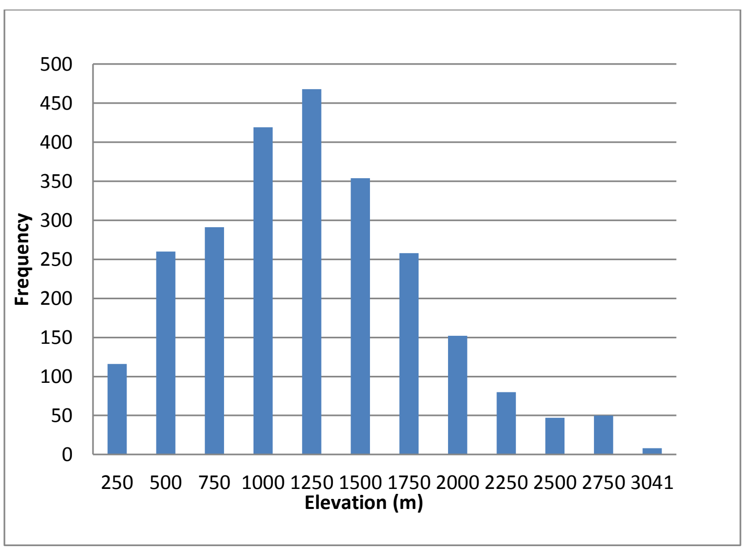


Figure 5. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993-2013. California Department of Fish and Wildlife, 2014.

depth of the winter snowpack that may constrain their movements [100], because the abundance of den, structure, rest structures, and prey may be limited [88], or for other unknown reasons.

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa pine [53,85,101]. Tree species' composition may be less important to fishers than components of forest structure that affect foraging success and provide resting and denning sites [98]. Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale ([53,85,102,103].

Hardwoods were more common in fisher home ranges in California compared elsewhere in western North America, [24]. This may be related to the use of hardwoods for resting and their importance as habitat for prey. In general, based on a number of studies in eastern North America and in California, high canopy closure is an important component of fisher habitat, especially at the rest site and den site level [25,53,85,102]. At the stand and site scale, forest structural attributes considered beneficial to fishers include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground [25].

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare and most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have occurred, active fishers were associated with complex forest structures [88]. Raley et al. ([88]) reviewed several studies ([102,104–106]) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated [88]. The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers to distinguish among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions [88].

During periods when fishers are not actively hunting or traveling, they use structures for resting which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey [24,107]. Fishers typically rest in large deformed or deteriorating live trees, snags, and logs and the forest conditions surrounding these sites frequently include structural elements of late-seral forests [88]. The characteristics of rest structures used by fishers are extremely consistent in western North America, based on an extensive review by Raley et al. [88]. They summarized the results of studies from 12 different geographic regions of more than 2,260 rest structures in western North America and reported that secondarily, fishers rested in snags and logs. The species of tree or log used for resting appeared to be less important than the presence of a suitable microstructure in which to rest (e.g., cavity, platform) [88]. Microstructures used by fishers for resting include~~:~~ platforms formed as a result of fungal infections, nests, or woody debris; cavities in trees or snags; and logs or debris piles created during timber harvest operations [49,52,86,108,109][49]. Rest structures appear to be reused infrequently by the same fisher. In southern Oregon, Aubry and Raley [49] located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion.

Comment [RAP4]: This is an inappropriate use of a colon where none is needed.

A meta-analysis conducted by Aubry et al. [107] of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. [88]). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (> 100 years) for suitable microstructures to develop [88].

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits [88]. However, hollow logs are used for reproduction (i.e., maternal dens) occasionally [49] and Grinnell et al. [3] reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree [88]. Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose

dens with openings small enough to exclude potential predators and aggressive male fishers [88].

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times larger in diameter on average than other trees in the vicinity of the den [52,65,104] as cited by Raley et al. [88]. Depending on the growing conditions, considerable time may be needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits. Information collected from more than 330 dens used by fishers for reproduction indicates that most cavities used were created by decay caused by heart-rot fungi [52,66,110]. Infection by heart-rot fungi is only initiated in living trees [111,112] and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens [88]. Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age [110].

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fisher in California [102,103,113,114]. The newest model was developed by the Conservation Biology Institute and the USFWS (FWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the FWS-CBI model consists of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

The FWS-CBI models ~~predict~~ describe the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) [109], 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities ~~utilized~~ used was from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

Comment [RAP5]: Most models, including this one, are correlation models and, therefore, can not be used to predict anything till they have been tested. If they are shown to be able to predict, one still does not know why they can predict because they do not show functional relationships between fisher use and habitat.

For the southern Sierra Nevada and where it blended into the northern Sierra Nevada, the variables used in the FWS-CBI model were basal-area-weighted canopy height,

minimum temperature of the coldest month, tassel-cap greenness[24], and dense forest (percent in forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The FWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables. Other recent models [96, 106] have primarily been focused on predicting habitat in the northwestern part of California or have been derived from far fewer fisher detections [97].

The final FWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as “high quality”, model values associated with habitats avoided by fishers were designated as “low quality”, and habitats that were neither avoided nor selected were considered “intermediate”. The “low quality” habitat category may include non-habitat (not used) as well as areas used infrequently by fishers relative to its availability. This FWS-CBI model was considered to be the best information available depicting the amount and distribution of habitats potentially suitable for fisher within the historical range depicted by Grinnell et al. [3] and the species’ current range in California (Figures 6 and 7).

[24] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

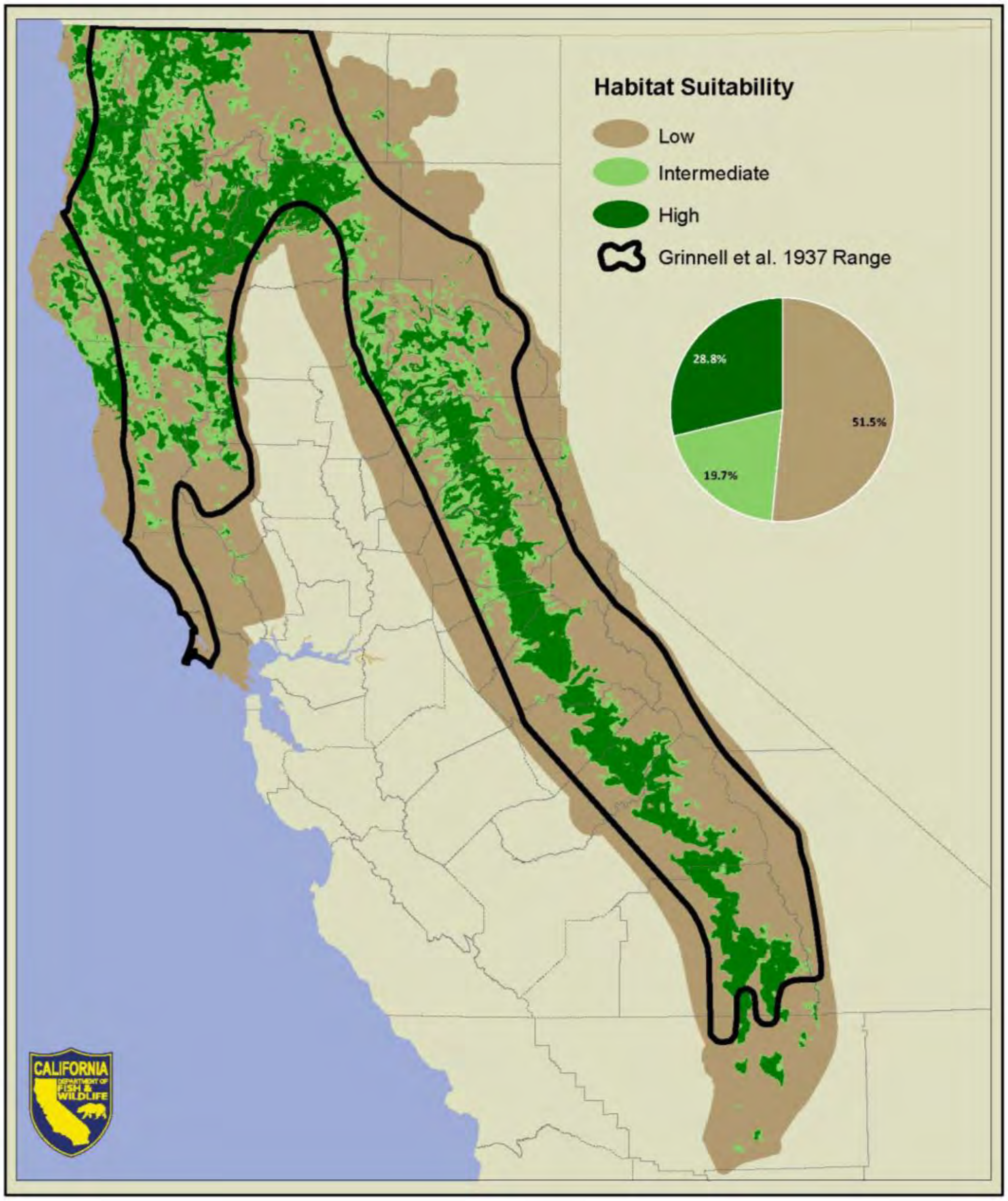


Figure 6. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

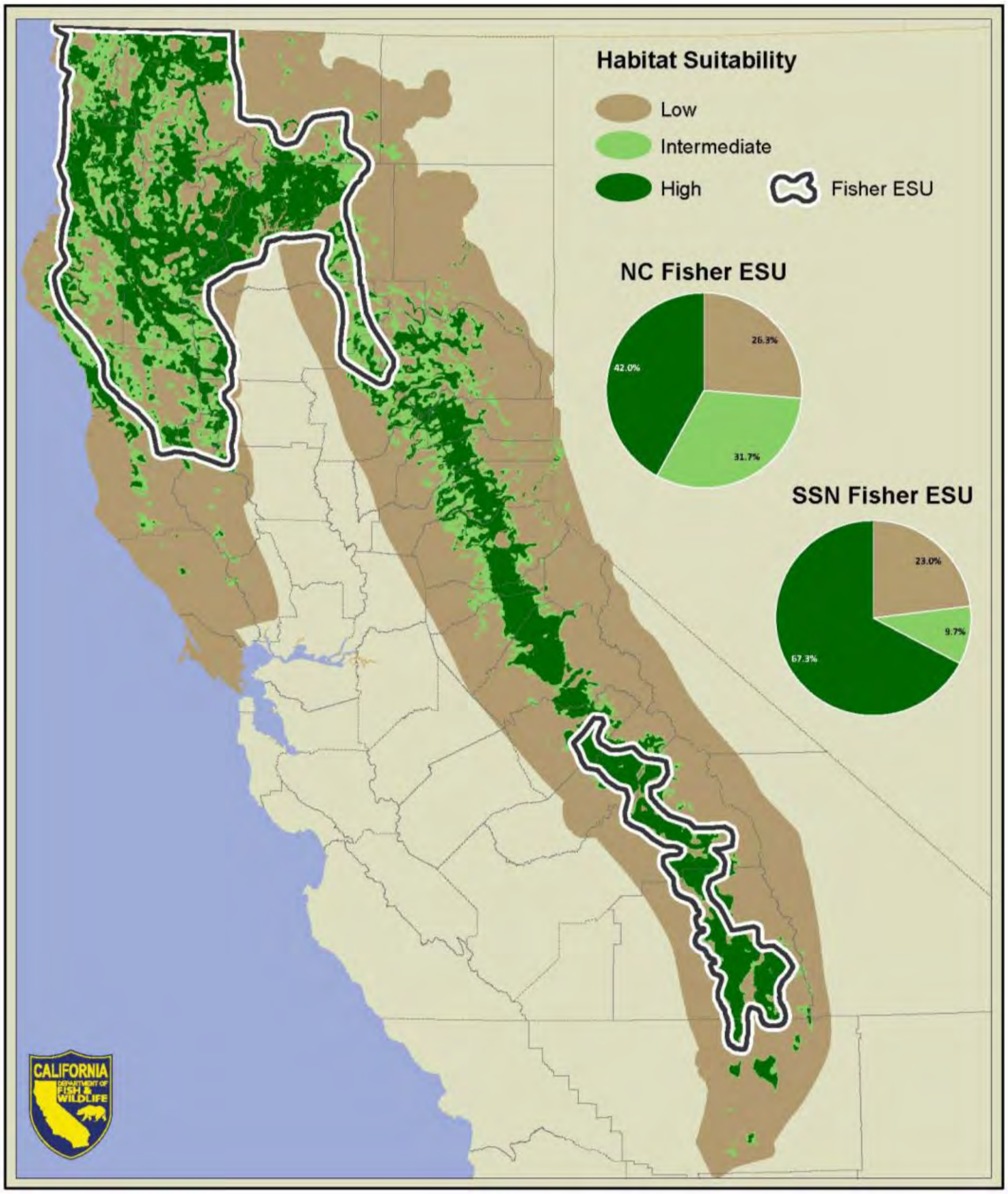


Figure 7. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Conservation Status

Regulatory Status

The fisher is currently designated by the Department as a Species of Special Concern[25] and as a candidate species at both the state[26] and federal[27] levels. Fishers are considered a sensitive species by the USFS and the Bureau of Land Management.

Habitat Essential for the Continued Existence of the Species

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists [3,31] and researchers in modern times [2,25,115–118]. However, the size, age, structure, and scale of forests essential for fisher are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular

---

[25] Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, "Species of Special Concern" is an administrative designation and carries no formal legal status.

[26] A species becomes a state candidate upon the Fish and Game Commission's determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted [California Code of Regulations (Cal. Code Regs), tit. 14, § 670.1(e)(2)]. During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

[27] Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

forest types (e.g., old-growth conifers) habitat for survival [98]. However, studies of fisher habitat use over the past two decades demonstrate that they are not dependent on old-growth forests *per se*, nor are they associated with any particular forest type [88]. Fishers are found in a variety of low- to mid-elevation forest types [105,119–122] that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. These landscapes are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Most studies of habitat use and selection by fishers have focused on structures used for denning and resting, in part because those aspects of fisher ecology are more easily studied than habitat selection for foraging. Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young [52]. Aubry and Raley [49], reported that the sizes of den entrances used by female fishers were typically just large enough to for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir [52], found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110].

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning [88]. These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large and considerable time (>100 years) may be required for suitable cavities to develop [88].

Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. However, forest structure important for fishers

should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers [28] .

Distribution Trend

Comparing the historical range of fishers in California estimated by Grinnell et al. [3] to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Lake and Marin counties. However, recent genetic analyses indicate some of the area considered to be a modern gap [35,36] in the historical distribution of fishers in the northern and central Sierra Nevada may have been long standing and pre-dated European settlement [29,40]. Yet, Grinnell et al. [3] and Price [31] suggest that fishers were present in this region post European settlement. This indicates that the gap was narrower historically than during contemporary times.

Despite extensive surveys from 1989-1995 [36] and 1996-2002 [35] for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled.

Since the 1990s, detections of fishers have increased along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County (Figure 3). It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier surveys. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number

of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [3]. In that year, only 14 fishers were reported taken by trappers in the state, with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau of Labor Statistics). Grinnell et al. [3] concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers [123]. Most animals were taken in a single trapping season (1920) when 120 fishers were harvested [124]. Despite concerns about the scarcity of fishers in the state, trapping of fisher was not prohibited until 1946 [125].

Grinnell et al. [3] noted that “Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township.” They roughly estimated the fisher population in California at fewer than 300 animals statewide with a density of 1 or 2 animals per township [93 km^2 (36 mi^2)] in good fisher range. For perspective, substantially higher numbers of fisher are captured for radio-collaring/study purposes in various studies in the present day: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were captured as part of an effort to translocate the species to the Southern Cascades and northern Sierra Nevada from 2009-2012 from widely distributed locations in northern California. Over a period of 28 days in 2012, 19 fishers were captured in vicinity of the translocation release site in the northern Sierra Nevada that were likely the offspring of animals translocated to the area [126]. Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers during this effort was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*).

Formatted: Pattern: Clear (Yellow)

Despite the paucity of empirical data, there are several estimates of fisher population size in northern California. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of

adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. However, he believed the estimate to be useful for general planning and risk assessment.

Self et al. (2008 SPI comment information) derived two separate “preliminary” estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a “deterministic expert method” and an “analytic model based approach” to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 (95% confidence interval [CI]: 1,848 - 4,550) fishers. Estimates for the southern Sierra Nevada population were 598 using the deterministic expert method and 548 (95% CI: 247 – 849) fishers based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates.

Estimates of the number of fishers in the southern Sierra Nevada indicate that despite using different approaches, the population is quite small. Lamberson et al. [127], using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Spencer et al. [128] estimated the size of the fisher population in the southern Sierra Nevada by extrapolating previous density estimates of Jordan [129], using data from the USFS regional population monitoring program (USDA Forest Service 2006), and linking a regional habitat suitability model to life history attributes. Using these data, they estimated 160-350 fishers in the southern Sierra Nevada population, of which 55-120 were estimated to be adult females. More recent work by Spencer et al. [119] estimated the southern Sierra Nevada fisher population at 300 individuals. Estimates of the number of fishers in California vary depending on the source, but range from 1,000 to approximately 4,500 fishers statewide.

Population Trend in California

No data are available that document long-term trends in fisher populations statewide in California. Despite genetic evidence indicating a long-standing historical separation of fishers in northern California from those in the southern Sierra Nevada [28], fishers reportedly occurred in the central and northern Sierra Nevada post-European settlement

[3,31], but were likely not abundant based on the scarcity of records from this region. By the late 1800s, habitat changes and harvest by trappers may have reduced the abundance of fishers in this region to low levels. The apparent scarcity of fishers in the central and northern Sierra Nevada by the early 1900s is supported by the work of Grinnell et al. [3] and the lack of specimens from that region.

In northern California, Matthews et al. [130] reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. However, continued monitoring of this population indicates that overall the population density has increased by 2012-2013, but only to about half of that estimated in 1998.

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 [131]. Detection rates at segments increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995, lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection ratios (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed.

Swiers et al. [132], collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers et. al. found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of abundance and population growth indicated that the population size was stable, although estimates of survival and recruitment suggested high population turnover [132].

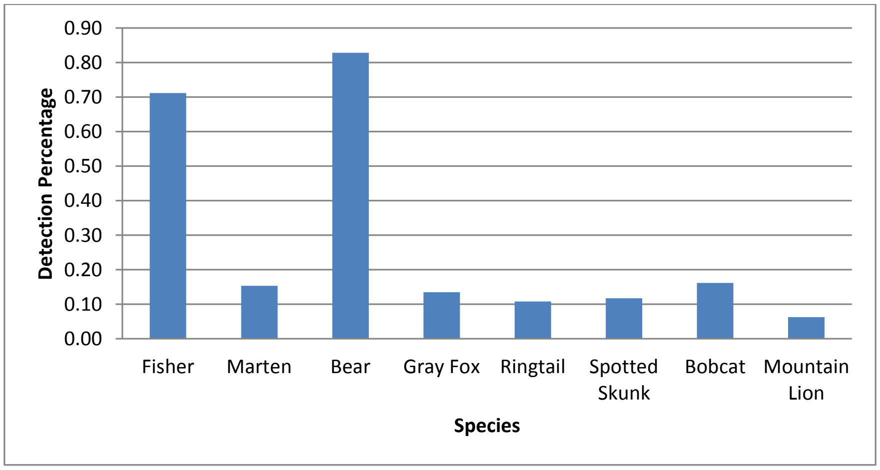


Figure 8. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

Tucker et al. [28] concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated European settlement. Tucker et al. [28] also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-European settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries. The southern extent of fisher habitat in the southern Sierra may have contained sufficient high quality habitat to serve as a refugium supporting enough fishers to constitute a founding population (J. Tucker, pers. comm.). Tucker et al. [28] using genetic techniques estimated that the total current population size of fishers in northwestern California could range from 258-2850 and the southern Sierra Nevada population could range from 334-3380.

Monitoring of fisher populations in northern California has been limited, but several studies are providing insight into the distribution and trends in occupancy rates of fishers in the state. Estimates of trends in occupancy have been used as surrogates for trends in abundance for some species of wildlife [133], in part, because it is more cost

effective and feasible than monitoring direct measures of abundance. Zielinski et al. [134] implemented a monitoring program for fishers in the southern Sierra Nevada over an 8 year period (2002-2009) and modeled trends in occupancy by combining the effects of detection probability and occupancy. They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest in the southeastern portion of their study area (0.261) and highest in the western portions of their study area (southwestern zone = 0.583) [134]. They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra did not appear to be declining.

The Department has conducted a large-scale monitoring project for forest carnivores, including fishers, as part of its Ecoregion Biodiversity Monitoring (EBM) program in the Klamath and East Franciscan ecoregions of northern California since 2011. EBM surveys for carnivores were conducted using camera traps within hexagons established by the Forest and Inventory Assessment system [135]. All the sites selected for survey occurred in forested habitats and were selected randomly (although land ownership, road access, and safety issues occasionally precluded completely random placement of plots). A Bayesian hierarchical model was used to estimate occupancy and detection probabilities for fisher across stations nested within plots within ecoregions (Furnas et al. unpublished manuscript). A total of 85 plots containing 169 stations were surveyed across the entire 2.8 million-ha study area during 2011 and 2012. The overall occupancy estimate for fisher was 0.438 [90% CI: 0.390-0.493] for stations, and 0.622 [90% CI: 0.569-0.685] for station pairs. The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.

Threats (Factors Affecting the Ability of Fishers to Survive and Reproduce)

Evolutionarily Significant Units

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing

separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) Fisher ESU and SSN (southern Sierra Nevada) Fisher ESU. The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by the Third District Court of Appeal that the term "species or subspecies" as used in sections 2062 and 2067 of the CESA includes Evolutionarily Significant Units[28]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species [136].

ESU boundaries for fisher represent the Department's assessment of the current range of the species in the state, considering the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between them (Figure 9). Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events.

Habitat Loss and Degradation

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic [24,52,98,108–110,117]. Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers particularly vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires [5,25]. Buskirk and Powell [98] found that at the landscape scale, the abundance and distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.

[28] 156 Cal.App.4th 1535, 68 Cal.Rptr.3d 391

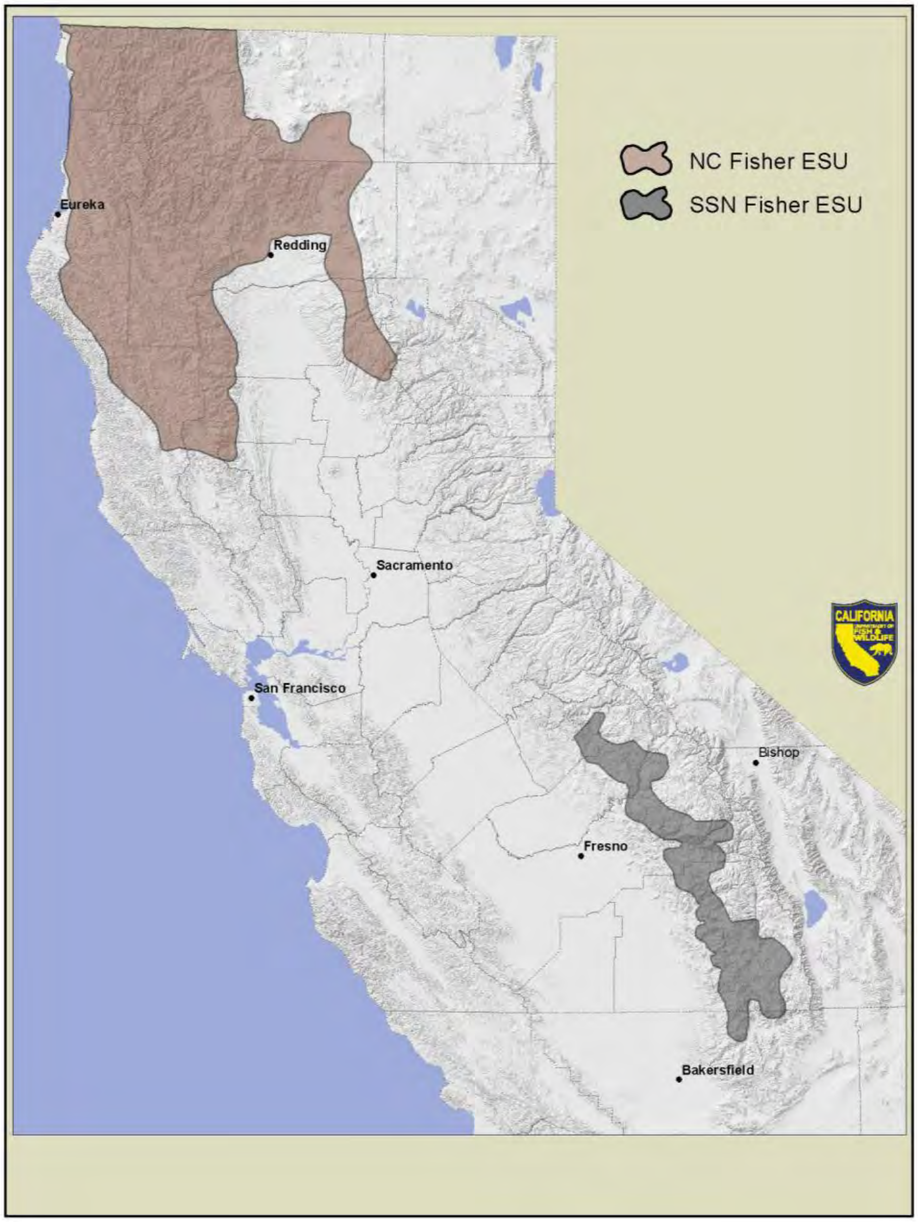


Figure 9. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and Wildlife, 2014.

Fishers have frequently been associated with old-growth forests and some researchers have hypothesized that they require those forests for survival. Habitat studies in recent decades demonstrate that fishers ~~are~~ do not depend~~ent~~ on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. However, the home ranges of fishers often include high proportions of mid- to late-seral forests [88].

Comment [RAP6]: Look for other instances of "dependent" that can be changed to "depend".

Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age and structural features of many forests in California. Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. Besides the direct removal of trees through timber harvest, management practices and policies have had many indirect effects on forested landscapes [24]. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Generally, timber harvest has substantially simplified the species composition and structure of forests [137,138]. Habitat elements used by fishers such as microstructures for denning can take decades to develop and a substantial reduction in the density of these elements from landscapes supporting fisher would likely reduce the distribution and abundance of fisher in the state.

Of the historical range of the fisher in California estimated by Grinnell et al. [3], nearly 61% is in public ownership and about 37% is privately owned (Figure 10). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (NPS) (Figure 11). Private lands within the NC Fisher ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 12). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades [139]. Sawtimber volume (net volume in board feet of sawlogs harvested from commercial tree species containing at least one 12-foot sawlog or two noncontiguous 8 foot sawlogs) harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 13 and 14).

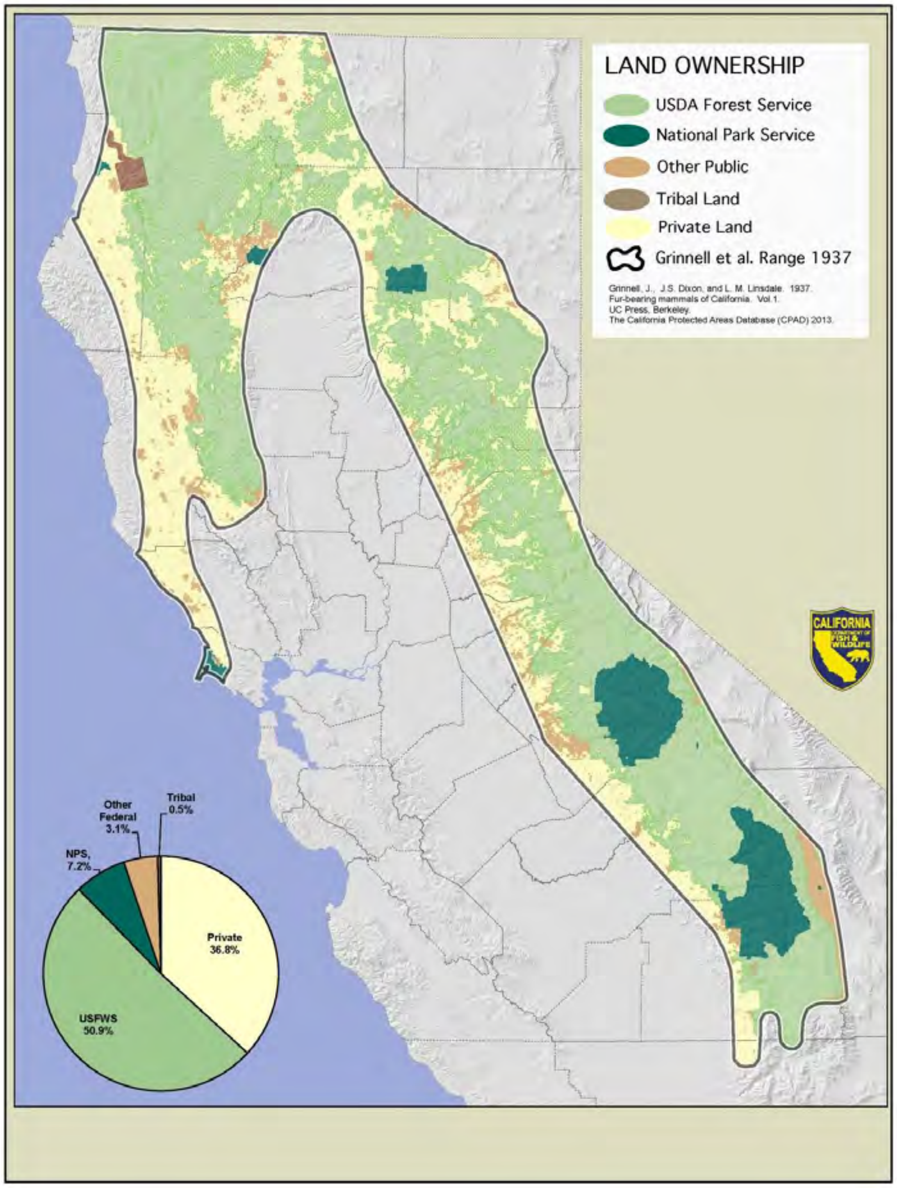


Figure 10. Landownership within the historical range of fisher depicted by Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

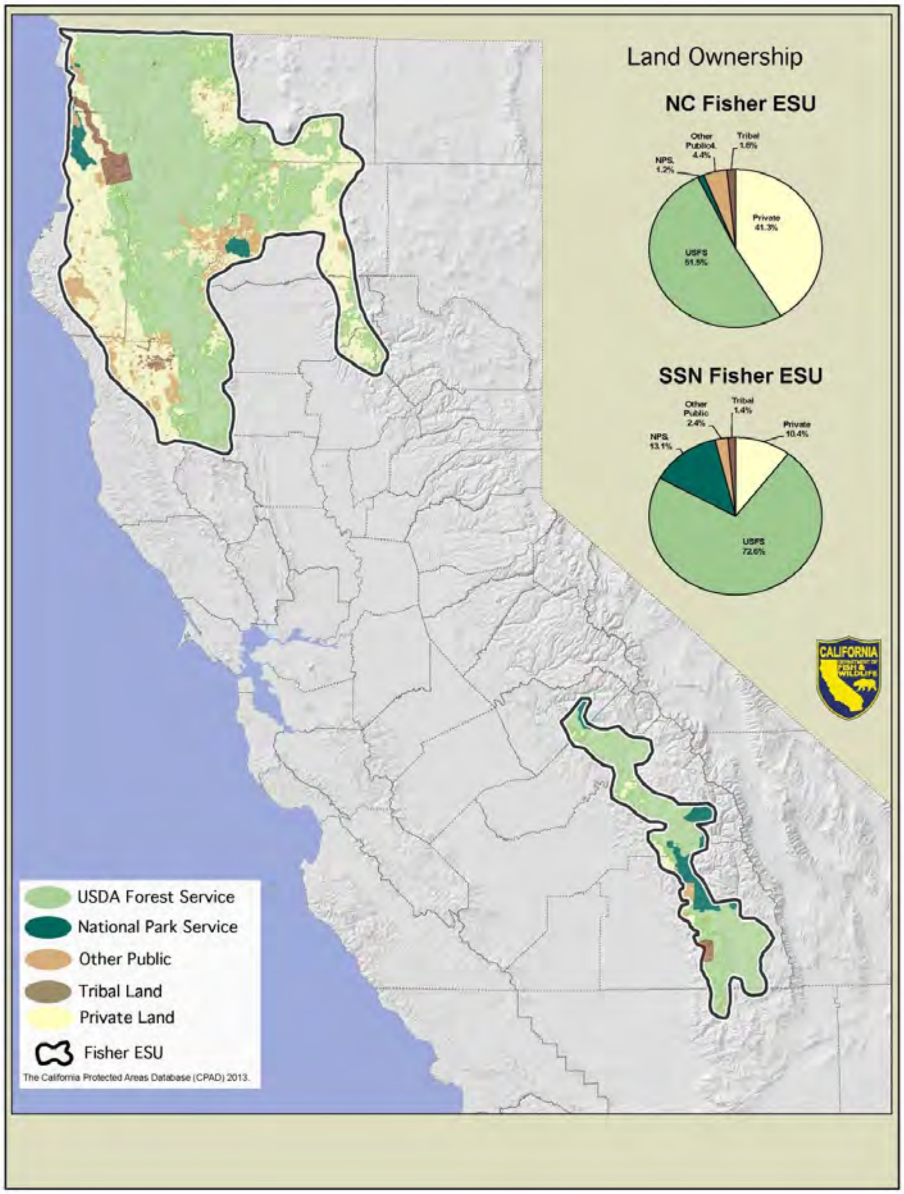


Figure 11. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

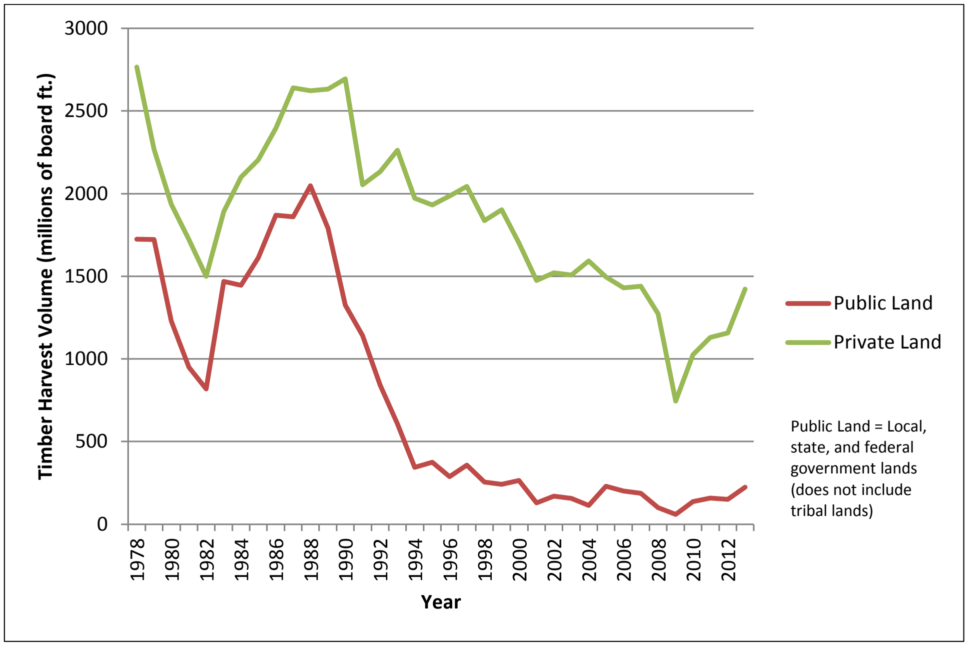


Figure 12. Volume of timber harvested on public and private lands in California (1978-2013) [140].

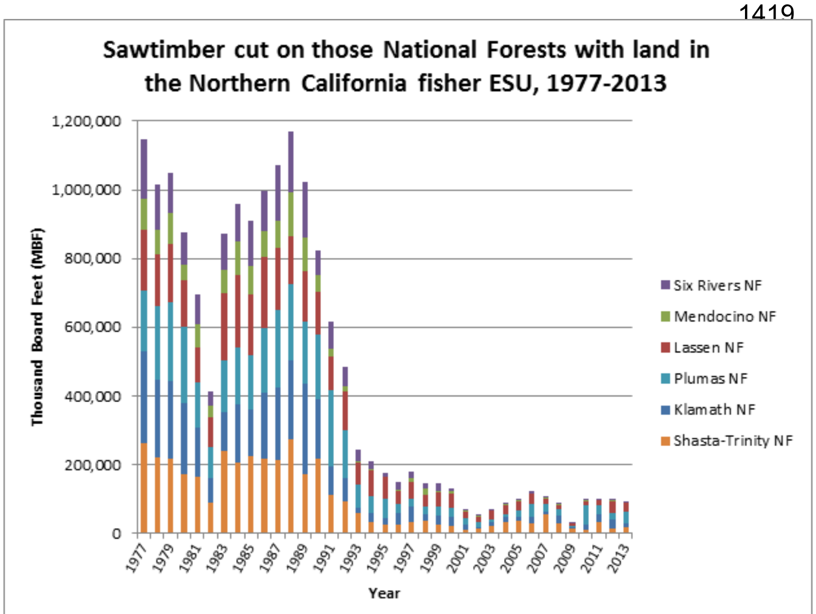


Figure 13. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 [139].

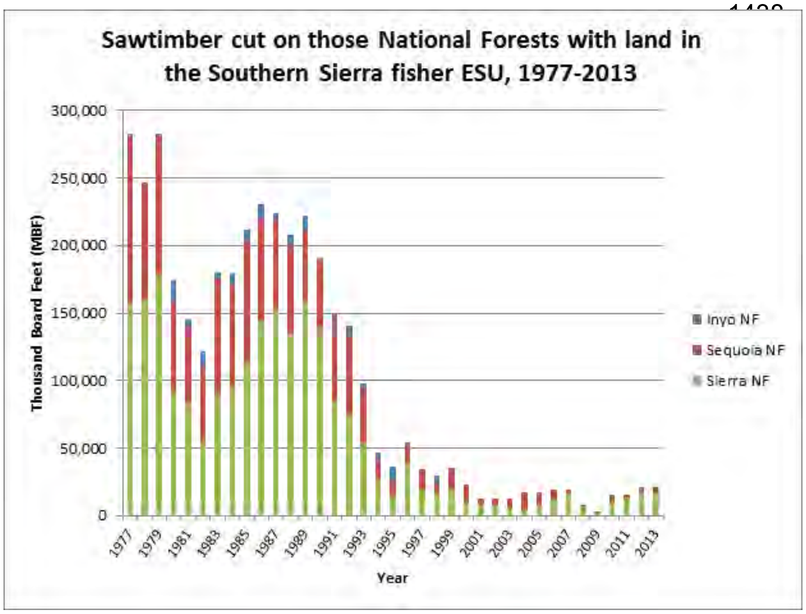


Figure 14. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 [139].

Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. This could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected. However, fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been intensively managed for timber production (Figure 15).

A more proximal concern for the long-term viability of fishers across their range in California is the presence of suitable denning and resting sites and habitats capable of supporting foraging activities. However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California.

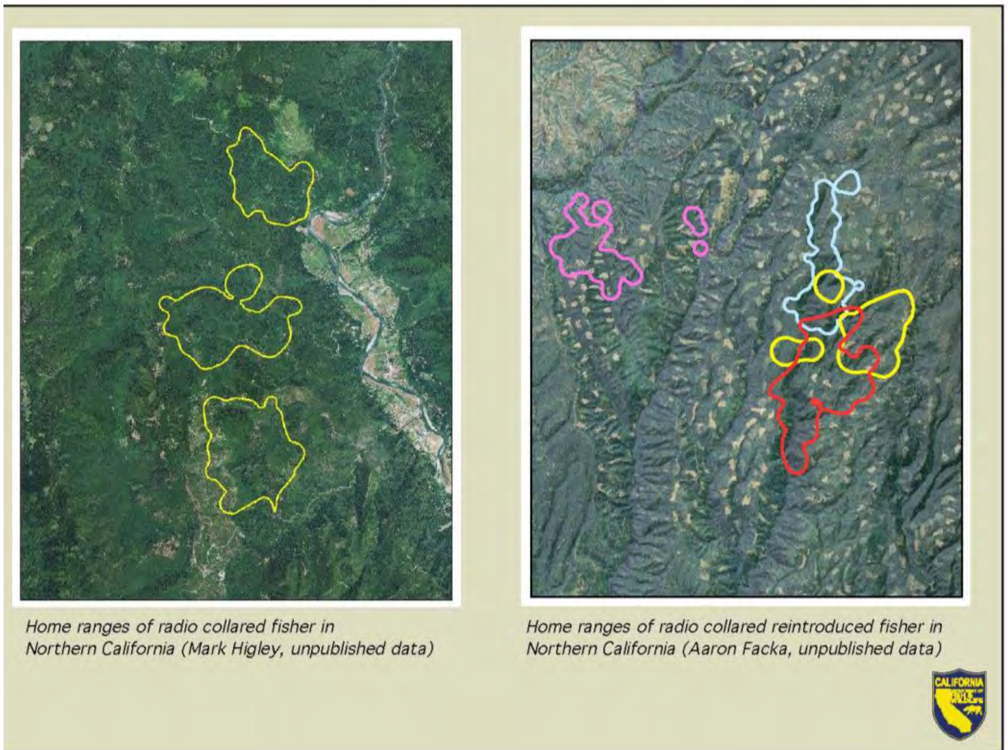


Figure 15. Home ranges of female fishers on managed landscapes in northern California and the northern Sierra Nevada, 2014.

Population Size and Isolation

Grinnell et al. [3], considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. However, few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century [36,38]. However, recent genetic work by Knaus et al. [29] and Tucker et al. [28] indicates fishers in the southern Sierra Nevada became isolated from northern California populations long before European settlement.

Based on Tucker et al. [28], the fisher population in California experienced a significant decline of approximately 90% long before European Settlement, resulting in the isolation of fisher populations in northern California from fishers in the Sierra Nevada. Tucker et al. [28] pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene [141] and would be consistent with the divergence dates of fisher populations in California reported by Knaus et al. [29]. However, in California there were two “mega-droughts” during the Medieval Warm Period (MWP) that lasted over 200 and 140 years each from 832-1074 and 1122-1299 AD, respectively. These droughts may have caused fisher populations to contract isolating the population in the Sierra Nevada from fishers elsewhere in the state [28].

In addition to this early population contraction, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19th century and early 20th century [28]. Tucker et al. [40] suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20th century while fisher in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable based on estimates of occupancy from 2002-2009 [134].

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. Fishers in the southern Sierra Nevada are geographically isolated from breeding populations of fishers elsewhere in the state and do not appear to be expanding their range northward. Should fishers in the southern Sierra Nevada expand their range northward, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, fishers in either location do not appear to be dispersing towards each other and natural contact in the near-term (50 years) is unlikely.

Although fishers in northern California are effectively isolated from fishers in the southern Sierra Nevada, they are part of a regional population that extends into southern Oregon. A fisher that was marked by researchers in Oregon was

subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California [38,91,142,143].

Although fishers do not fully occupy their assumed historical distribution, their population is likely higher than when densities of fishers were estimated by Grinnell et al. [3] at 1-2 per township in good habitat.

Predation and Disease

Predation and disease (including toxins) appear to be the most significant causes of mortality for California fishers. Since 2007, the causes of mortality for radio-collared and opportunistically found fishers from one area in northern California (Hoopa) and the southern Sierra Nevada have been analyzed through gross necropsies, histology, toxicology, and molecular methods. In a sample of 128 fishers from these two populations that died between 2007-2012, predation was the most common cause of mortality (52%), followed by disease/toxins (24%), and vehicular strikes (8%) (M. Gabriel, unpublished data). The proportion of fishers dying from each cause did not differ among these monitored populations, or by sex, which suggests that the relative impact of each source of mortality is similar for both male and female fishers and throughout fisher range in California (M. Gabriel, unpublished data). Preliminary assessment of mortality data from 2010-2013 for the northern Sierra Nevada population recently established through translocation is also consistent with these findings (D. Clifford, M. Gabriel and C. Wengert, unpublished data).

Predation: DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project (SNAMP) and King's River projects identified bobcats (*Lynx rufus*) as the predator of 25 sampled fishers (50%), mountain lions (*Puma concolor*) as the predator of 20 sampled fishers (40%) and coyotes (*Canis latrans*) as the predator of 4 fishers (8%). The single remaining carcass had both bobcat and mountain lion DNA present [144].

The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes

killed an equal number of male and female fishers [144]. This finding suggests that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19/25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival [144].

The proportion of fisher mortalities caused by predation found by Wengert [144] is higher than previously reported in California [145] and British Columbia [52]. Powell and Zielinski [25] suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert [144] indicate that predation is a significant mortality factor for native fisher populations in California. Whether or not some forest management practices favor the existence of more generalist predators (like bobcats) over specialist predators like fishers is not known. However, Wengert [146] found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Disease: A number of viral, bacterial, and parasitic diseases have been documented in fisher. Canine distemper virus (CDV) infection, a cause of significant morbidity and mortality in other carnivore populations [147], was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 [148]. Three of these animals died within a 2-week period from April 22-May 5 and were found within 20 km (12.4 mi) of each other, while the fourth fisher died during an immobilization event 4 months later approximately 70 km (43.5 mi) away from the initial cases. Infection with CDV decreases immune function, thus vital capacity co-infections with other pathogens are common [147].

Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal's ability to survive a capture and immobilization event. The source of the infections in these fishers, as well as pertinent transmission routes remain unclear, but the temporal and spatial distribution of the fisher CDV mortalities, as well as the similarity of the virus isolates, suggest two spillover events from one or multiple other sympatric carnivore species.

In California, CDV mortalities in gray foxes and raccoons are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, CDV has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) [149] and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) [150]. Furthermore, highly virulent biotypes of CDV can be transmitted and cause high mortalities in multiple carnivore species [151] . This scenario was evident by a 2009 CDV outbreak in Switzerland that killed red foxes (*Vulpes vulpes*), Eurasian badgers (*Meles meles*), stone (*Martes foina*) and pine (*Martes martes*) martens, a Eurasian lynx (*Lynx lynx*) and a domestic dog [151].

Although CDV can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 3). Of 98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to CDV [152]. From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the SNAMP area were exposed to CDV [152]. Evidence to date and experiences with other species underscore the fact that CDV has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus (CPV), both potentially significant pathogens for *Martes* species [153], have not been documented in fishers in California. However, virus shedding[29] of CPV has been documented in fisher [152], and clinically significant illness due to CPV was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern California are commonly exposed to and infected with CPV: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 2).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) [154], American minks (*Mustela vision*) [155], and free-ranging southern sea

[29] Viral release following reproduction in a host-cell.

otters (*Enhydra lutris*) [156]. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania [157].

Table 2. Prevalence of exposure to canine distemper, canine parvo virus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 [140].

	Canine Distemper Percent (No. sampled)	Canine Parvo Virus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) [158], but mortalities of fishers from these diseases have not been reported. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers [153]. Plague is known to cause mortality in other mustelids, is a serious zoonotic[30] risk [159] and is endemic in many parts of California.

Other documented disease-caused fisher mortalities included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers and other *Pekania* and *Martes* species harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases,

[30]Zoonotic diseases are contagious diseases that can spread between animals and humans.

infections and infestations are usually associated with minimal morbidity and mortality [153]. Banci [121] noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell [2].

Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye damage, there were no vision deficits or eye damage noted in affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions [160]. In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination [161]. Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fisher and may have been responsible for local declines in fishers, the Department is not aware of studies indicating that disease is significantly limiting fisher populations in California.

Human Population Growth and Development

The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance from 1970 to 2010 [162,163], the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state [164] and those numbers are expected to reach approximately 53 million by 2060 [165], an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average [166].

The California Department of Forestry and Fire Protection (CAL FIRE) estimated that statewide, between 2000 and 2040, about 2.6 million acres of private forests and

rangelands will be impacted by new development [167]. New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 890,000 ha (2.2 million acres). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fisher was comparatively low (6%).

Within the NC and SSN Fisher ESUs, future human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 16, Table 4). This represents an increase of about 1% in the acres developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because parcels of that size likely provide some fisher habitat post-development. In the NC Fisher ESU, slightly more than half of development as of 2010 occurred in habitats predicted to be of intermediate or high value to fishers (Table 5). That percentage is not expected to change substantially by 2030. Within the SSN Fisher ESU, about 60% of past development occurred in habitats predicted to be of intermediate or high value to fishers and that proportion is also not predicted to change substantially by 2030.

Duane [168] identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 17, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). However, the effects of future development on fishers are uncertain. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

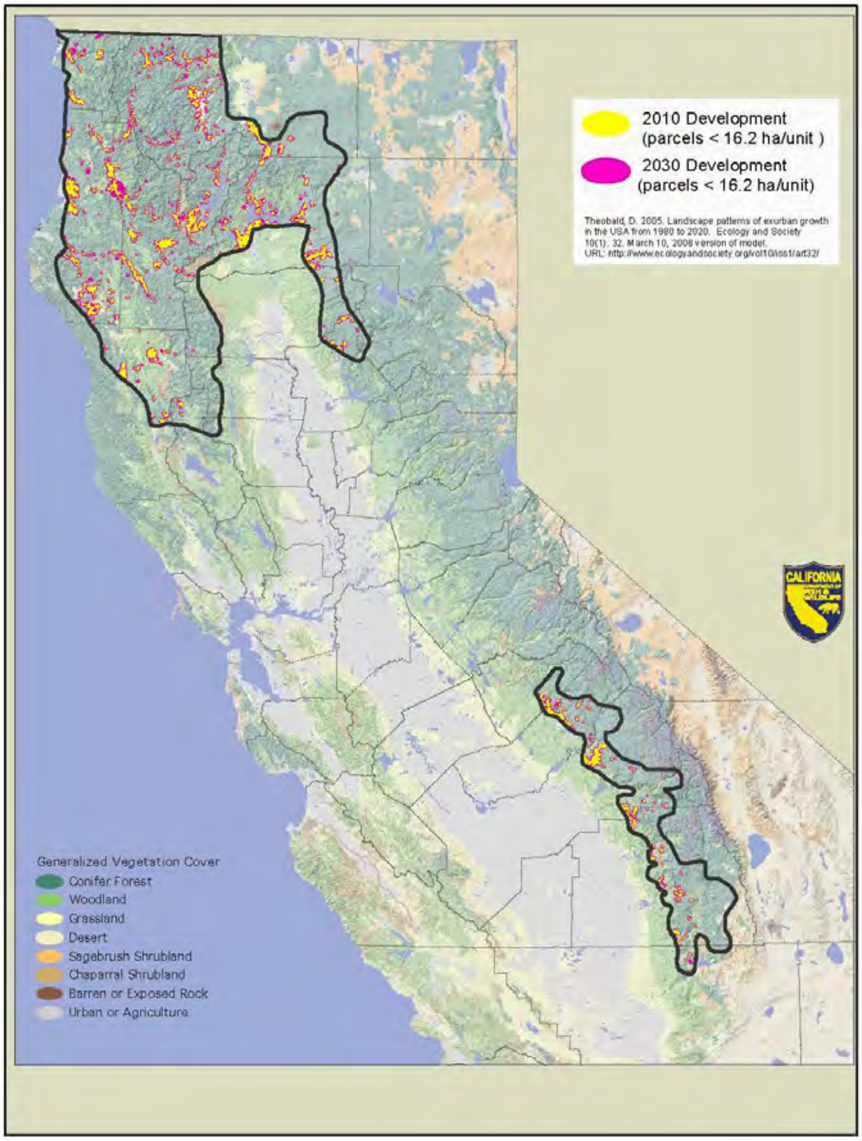


Figure 16. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169]. California Department of Fish and Wildlife, 2014.

Table 3. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of Total	Projected Development (2030)	Percent of Total
NC Fisher	4,103,639 (10,140,312)	129,764 (320,654)	3%	160,757 (397,240)	4%
SSN Fisher	778,273 (1,923,155)	32,361 (79,966)	4%	35,845 (88,576)	5%

Table 4. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)					
Evolutionarily Significant Unit	Low	Percent of Total	Intermediate	Percent of Total	High	Percent of Total
NC Fisher (2010)	55,954 (138,264)	43%	33,065 (81,706)	26%	39,831 (98,425)	31%
NC Fisher (2030)	69,856 (172,617)	44%	41,952 (103,666)	26%	48,030 (118,684)	30%
SSN Fisher (2010)	11,942 (29,510)	37%	4,213 (10,411)	13%	16,205 (40,044)	50%
SSN Fisher (2030)	14,158 (34,986)	39%	4,758 (11,758)	13%	16,929 (41,832	47%

Figure 17. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Disturbance

Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats the species typically occupies. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off road vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be comparatively high. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied, however, monitoring radio-collared females with young provides some insight into their sensitivity

to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. However, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. Most watersheds on private timberlands are harvested at a rate of 1-3% annually (J. Croteau, pers. comm.). Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data).

Recreational use of habitats occupied by fisher in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Roads

Fishers occupying habitats containing roads occasionally are struck by vehicles and killed [53,56,100,126]. Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data).

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fisher in California and have been hypothesized to be a potential barrier to dispersal [24,91,170], they have not been demonstrated to limit fisher populations. Roads have not shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County [126].

Fire

Wildfires are a natural part of California's forest ecology and most frequently start as a result of lightning strikes. Wildfires affect habitats used by fisher and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, and the extent of individual fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. [171], believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey.

Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s [172]. In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression [172]. In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok [173] who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act

that established fire exclusion as a national policy and formed the basis for USFS and NPS policies of absolute suppression of fires until those policies were reconsidered in the 1960s [174].

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 102,000 ha/year (252,047 ac/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 [174]. This was based on an estimate of the high fire return interval and was assumed to be similar to the fire rotation [174]. Prior to European settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting [175] and to reduce catastrophic fires [176]. Fires set by indigenous people and fires started by lightning have been estimated to have burned from 2.3 to greater than 5.3 million ha (5.6 to > 13 million acres) annually in California [177].

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more frequent [178]. Westerling et al. [179] found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fisher in California.

In the Sierra Nevada, the severity and the area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy [178]. Miller et al. [180] examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased.

In 1992, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the

largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged post-fire and replanted trees rapidly after the burn [181]. In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, SPI unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fisher using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly comprised of areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm).

The Rim Fire burned approximately 104,000 ha (257,000 ac) in Tuolumne County in August 2013. This fire was situated just north of the SSN ESU. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra population until the vegetation recovers sufficiently to facilitate its use by fishers.

While the frequency and extent of wildfires in the California have increased in recent years, the area burned annually is substantially smaller than in pre-historic (pre-1800) times when 1.8 – 4.8 million ha (4.4 – 11.9 million ac) of the state burned annually [174]. Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity [182] (Figures 18 and 19).

Lawler et al. [183] predicted that fires will be more frequent but less intense by the end of the 21st century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods [184]. Westerling et al. [185], modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California, and potential increases in burned area in the Sierra Nevada

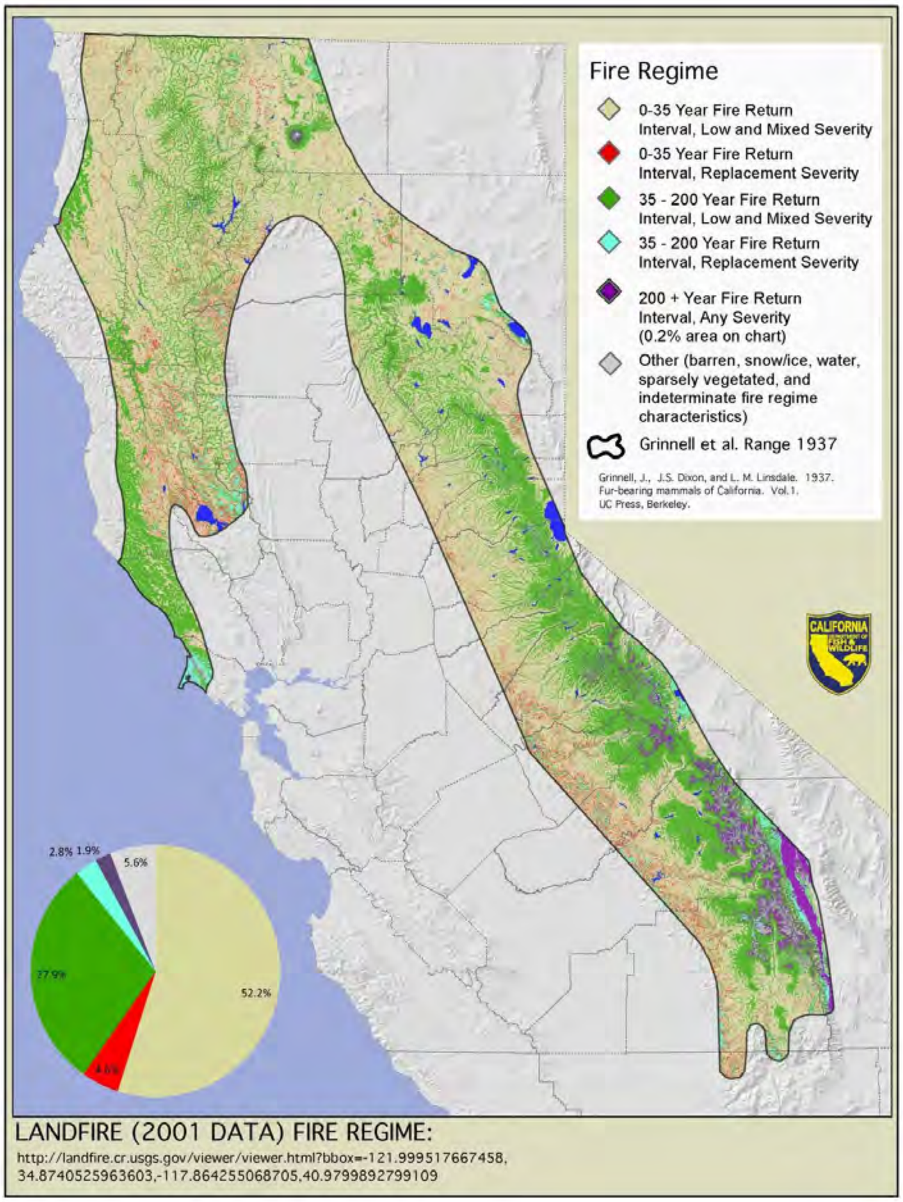


Figure 18. Presumed historical fire regimes within the historical range of fisher in California described by Grinnell et al. [3]. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

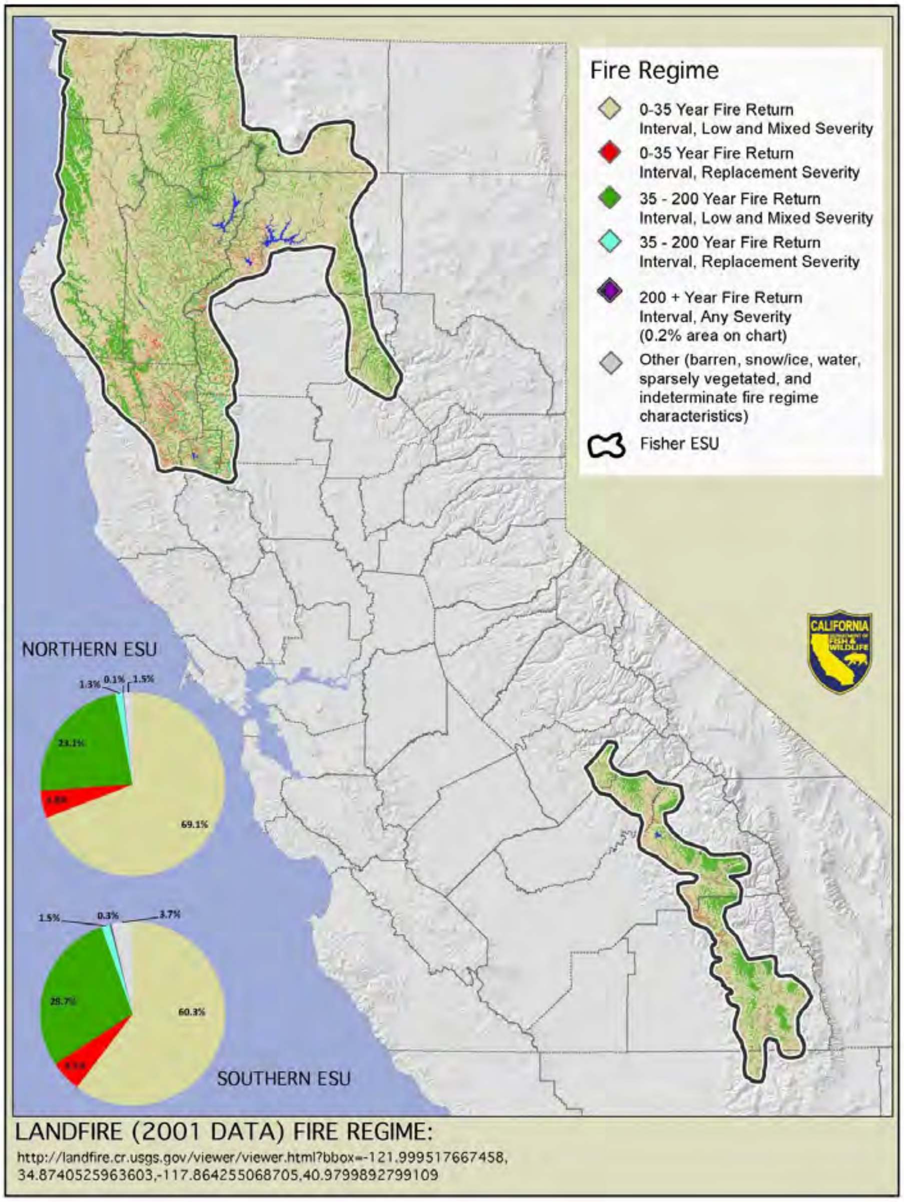


Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

appeared greatest in mid-elevation sites on the west side of the range [185]. However, the authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predications for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover [171,186,187].

Toxicants

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs) in California fisher populations has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range [153]. Although the source of toxicants to fishers has not been conclusively determined, numerous reports from remediation operations of illegal marijuana cultivation sites (MJCSs) on public, private, and tribal forest lands indicate the presence of a large amount of pesticides, including ARs, at these sites.[31] The presence of a large number of MJCSs within habitat occupied by fisher populations and the lack of other probable sources of ARs suggest that the AR exposure is largely occurring on the cultivation sites.

Fishers are opportunistic generalist predators and can be exposed to toxicants through several routes. They can be exposed directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such tastes as sucrose, bacon, cheese, peanut butter and apple) would also likely appeal to fishers [189]. Furthermore, there have been reports of intentional wildlife poisoning by adding

[31] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As growth sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reports remediating more than 600 large-scale MJCSs on just two of California's 17 national forests [188].

pesticides to food items such as canned tuna or sardines [188]. Many of the pesticides found at MJCSs are liquid formulations that can easily be mixed into food.

As carnivores, fishers could also be exposed to toxicants secondarily through prey. This is likely the primary means of AR exposure because of the toxin's persistence in the body tissue of poisoned prey items; secondary exposure of mustelids to ARs has occurred in rodent control operations [190]. Tertiary AR exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed [191] and may be possible in fishers that eat smaller carnivores. Lastly, AR exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer has occurred [189,191].

Anticoagulant Rodenticides: ARs cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impair an animal's ability to produce several key clotting factors. ARs fall into two categories (generations) based on toxicological characteristics and use patterns: first and second generation anticoagulant rodenticides (FGARs and SGARs, respectively). FGARs, developed in the 1940s, are less toxic than SGARs, and require consecutive days of intake by a rodent to achieve a lethal dose. FGARs have a lower ability to accumulate in biological tissue and are metabolized more rapidly [192,193]. There are 60 FGAR products registered in California. Labeled uses of FGARs are commensal rodent (house mice, Norway rats, and roof rats) control and agricultural field rodent control.

Development of SGARs began in the 1970s as resistance to FGARs began to appear in some rodent populations. SGARs have the same mechanism of action as FGARs but have a higher affinity for the target enzymes, leading to greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days) [192,193]. A lethal dose may be consumed at a single feeding. The several days' lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are 79 SGAR products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum. Labeled uses are for the control of commensal rodents in and around residences, agricultural buildings, and industrial facilities, such as food processing facilities and commercial facilities. SGAR products must be placed within 100 feet of man-made structures and may not be used for control of field rodents.

The unexpected discovery of AR residues in a fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project research team prompted monitoring of AR exposure in carcasses of fishers submitted for necropsy from research projects located throughout the fisher's range in California. The livers of 58 fishers that died from 2006-2011 were tested; 79% were positive for AR exposure. Four of these fishers died from AR poisoning. The number of different AR compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers [189]. Of the fishers tested, 96% were exposed to SGARs and the exposure of fishers to ARs was geographically widespread [189].

Gabriel et al. [189] documented the amount of toxicants found at one illegal MJCS in Humboldt County. Among other toxicants, 0.68 kg (1.5 lbs) of brodifacoum, as well as 2.9 kg (6.5 lbs) worth of empty AR bait containers were found. Based on the LD50 value for a domestic dog, it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption.

The sublethal impacts of AR exposure to fishers are not fully known. Sublethal effects may include increased susceptibility to disease [194], behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes [195], and reduced reproductive success. The contribution of AR (and other pesticides found on MJCSs) exposure to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer MJCSs located within their home ranges [196]. Studies have suggested that embryos are more sensitive to anticoagulants than are adults [197–199]. AR-related fisher mortalities were concentrated temporally in mid-April and mid-May which is the denning period for fisher females [189]. This raises concerns that mothers could expose their kits to ARs through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Higher AR-related mortalities in spring may be a consequence of more ARs being used at this time to protect young marijuana plants from rodent damage than at other times of the year.

On July 1, 2014, SGARs products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials and their legal use was limited to certified private applicators, certified commercial applicators, or those under their direct supervision. The placement of SGAR bait will generally be prohibited more than

15 m (50 ft) from man-made structures. These new regulations may limit the availability of SGARs, but how effective they will be at reducing the use of SGARs at MJCSs is unknown.

Other Potential Toxicants: Other pesticides deployed at MGCSs have likely caused fisher mortalities: 3 fishers in northern California were suspected to have died as a result of exposure to the carbamate toxin-methomyl cholecalciferol and bromethalin (Gabriel, unpublished data). Pests include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at MJCSs that were presumably used to combat them (Table 6). Some of the organophosphates and carbamates used on MJCSs are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use [200,201]. Volunteer reclamation crews reported that AR and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 [196]. Sixty-eight kilograms of AR and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort in public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km [189].

ARs are persistent in liver tissue, thus the compounds can be detected in liver tissue of sublethally exposed animals for several months following the exposure. Other pesticides such as carbofuran and methamidophos, which are present at the same sites, are more likely to cause immediate mortality, but are much less likely to be detected in fishers because carcasses would need to be recovered at MJCSs to confirm exposure.

Population-level Impacts: Although it is well documented that anticoagulant rodenticides (ARs) used both legally and illegally have caused mortalities of non-target wildlife species, including fishers [189,192,202–204], the question of whether or not lethal and sublethal exposure to ARs or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed.

To estimate the extent of the current fisher range potentially impacted by MJCSs, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi) and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 20) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.

Table 5. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (MJCSs) (CDFW, IERC, HSVTC unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Class	**Mammalian Toxicity Range**	**Relative Frequency of Occurrence at MJCSs[1]**	**Evidence of Exposure or Toxicity (Gabriel et al. unpublished)**
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Not Detected
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as "occasional" or "common" based on the highest occurrence for any product in each class.

Although AR poisoning resulting in mortality has been documented in four fishers from two geographically separated populations and AR exposure is highly prevalent and geographically widespread [189], the cumulative impact of individual toxicity and exposure is hard to quantify at the population level. Determination of poisoning and exposure usually requires collection of carcasses, and therefore data are only available

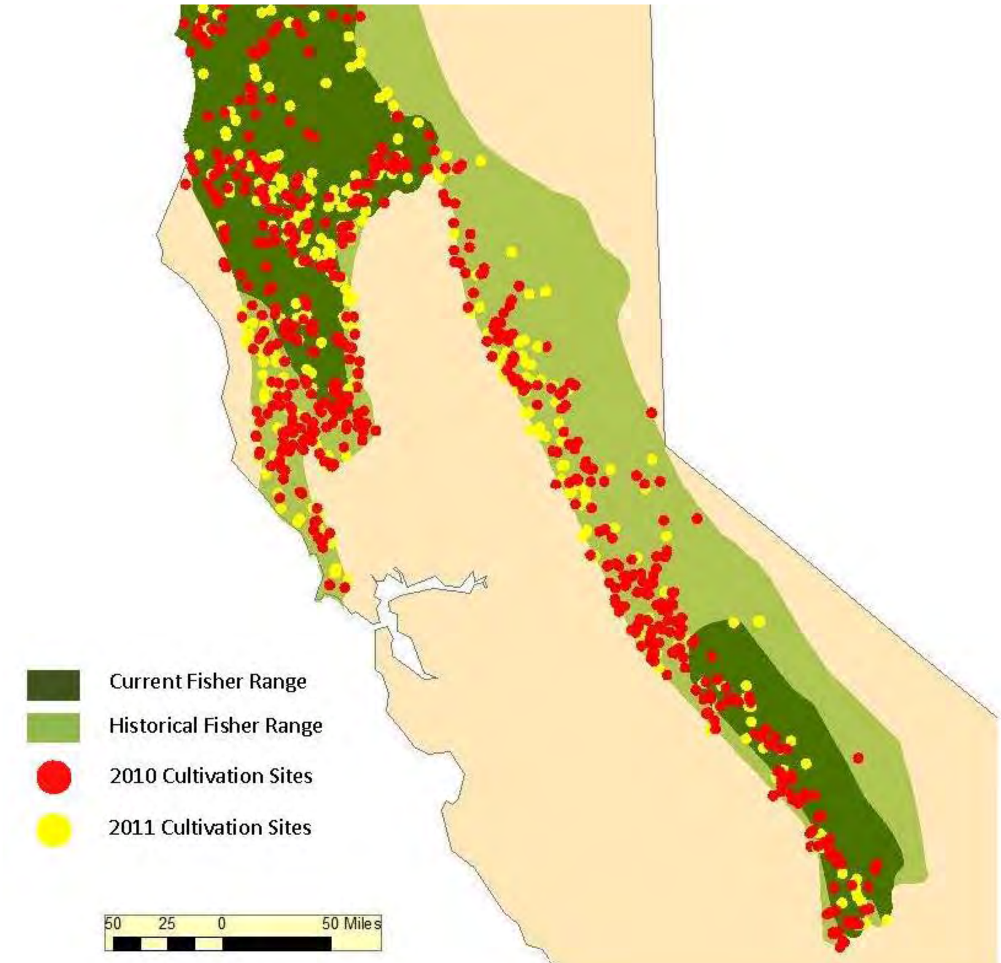


Figure 20. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

for fisher populations where ongoing intensive research (often involving a substantial number of radio collared animals) is conducted. Accordingly, pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected.

Despite these limitations, recent research from the well-monitored southern Sierra Nevada fisher population in California has revealed that female fishers with more MJCSs in their home ranges had higher rates of mortality and a higher likelihood of being exposed to one or more AR compounds [196]. Despite this association, further study is needed to demonstrate that chronic or sublethal AR or other pesticide exposure could predispose a fisher to death from another cause (aka indirect effect). These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival [194,205–212].

Exposure to AR through either milk or placental routes was identified in a dependent fisher kit that died after its mother was killed [189]. Additionally, Gabriel and colleagues observed that AR mortalities occurred in the spring (April-May), a time when adult females are rearing dependent young. Low birth weight, stillbirth, abortion, and bleeding, inappetance and lethargy of neonates have all been documented in other species as a result of exposure to ARs, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of MJCSs located within an individual's home range may start to address this question.

Reductions in prey availability due to pesticide use at MJCSs could potentially impact fisher population vital rates through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant [192], there is potential that MJCSs could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species [213–216]. However, the level of small mammal mortality at MJCSs remains largely unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey remain speculative.

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. A sublethal dose of AR can produce significant clotting abnormalities and some hemorrhaging (Eason and Murphy 2001). Predators with liver concentrations of ARs as low as 0.03ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey [192]. Accordingly, fishers exposed to ARs may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Challenges to investigating toxicant threats from MJCSs within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors [217].

The high prevalence of AR exposure in fishers and other species throughout California indicates the potential for additive and synergistic associations with pesticide exposure at MJCSs and consequently increased mortality from other causes. Small, isolated fisher populations, such as occurs in the SSN Fisher ESU, are of concern because they are more vulnerable to stochastic events than larger populations and a reduction in survivorship may cause a decline or inhibit growth.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s [218,219]. Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years [183]. Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe [218].

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago [220,221]. Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase in California by approximately 2.4 C in California by the 2060s (Pierce et al. [222]) and by 2 to 5 C by 2100 (Cayan et al. [223]). Projections of

precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation [224–226]. However, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation [227]. Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase [222,228]. Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack [229]. These patterns are expected to continue [223–225,230] and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 [231]. Forests throughout the state will likely become more dry [223,224,229].

The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra, rest sites are often located near water [108]. Zielinski et al. [108] suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Warming is predicted throughout the range of the fisher in California [183]. Pierce et al. [222] projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN Fisher ESU may experience greater warming than those occupying portions of the NC Fisher ESU.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their "climatically suitable" range within California by the year 2100 [183]. However, the distribution and climate data for those models was assessed at a 50 x 50 km grid; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California's montane environments, temperature and other climatic variables

Comment [RAP7]: I think you mean that model used a grid constructed of 50x50 km cells. A grid of 50x50 km would have small cells, maybe 1x1 km cells. You make this mistake elsewhere – at least line 2235.

can change considerably over relatively small distances [232]. Thus, the diversity of the physical environment within areas occupied by fisher may buffer some of the projected effects of a changing climate [233].

Climate change is likely to ~~indirectly~~ affect fishers indirectly by altering the species composition and structural components of habitats used by fishers in California [183,234]. Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change [179,183,184]. To evaluate potential future climate-driven changes to habitats used by fisher in the state, Lawler et al. [183] combined model projections of fire regimes and vegetation response in California by Lenihan et al. [234] with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs by 2071-2100, as compared to mean cover from 1961-1990 (Table 7).

Comment [RAP8]:

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands [183]. If woodlands and grasslands within the fisher ESUs expand considerably in the future as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others unsuitable. However, Lawler et al. [183] also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the “floristic conditions” for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. [183] cautioned that their habitat modeling was based on a 10 x 10 km grid, which was a “high resolution for this type of model” and that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales. They further noted that the modeled changes are broad, landscape-scale patterns that will be “filtered” by variability in topography, vegetation and other factors.

Table 6. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. [183].

Klamath Mountains - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

Hayoe et al. [225] modeled California vegetation over the same period as Lawler et al. [183] and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. [235] predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100. In the southern Sierra, Koopman et al. [236] modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. [236] also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas.

Burns et al. [237] assessed potential changes in mammal species within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to Yosemite

National Park. Burns et al. [237] suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such "reshuffling" of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health [229,238,239]. Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward [240–242]. Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes [243]. Changes in forest vegetation due to invasive plant species may impact fisher prey species composition and abundance. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state.

Existing Management, Monitoring, and Research Activities

U.S. Forest Service

The majority of land within the current range of the fisher in California is public (approximately 55%) and the majority of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. [3], encompassed all or portions of ~~13 National Forests including~~ the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia National Forests as well as the Tahoe Basin Management Unit.

USFS sensitive species, such as fisher, are plant and animal species identified by the Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within the USFS Pacific Southwest Region are treated as though they were federally listed as threatened or endangered (USDA 1990).

Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA), USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11 National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

U.S. Forest Service – Specially Designated Lands, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan (NWFP) was adopted to guide the management of over 24 million acres of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (NSO) [244]. Adoption of the NWFP resulted in amendment of USFS and the Bureau of Land Management (BLM) management plans to include measures to conserve the NSO and other species, including the fisher, on federal lands.

The NWFP created an extensive and large network of late-successional and old-growth forest (Figure 21). These lands are designated as Congressionally Reserved Areas and Late Successional Reserves and are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan; however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, NSOs, and sites occupied by other species. Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody ([245]).

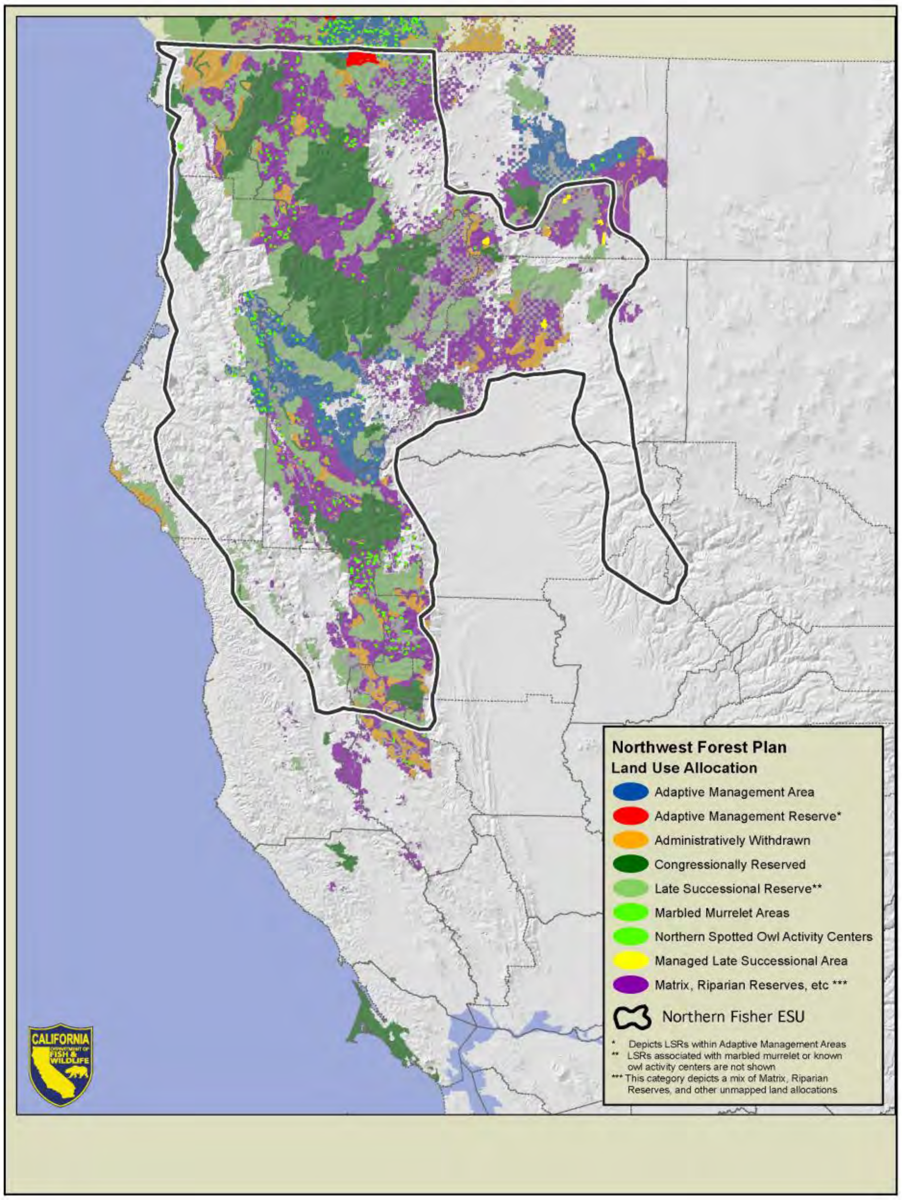


Figure 21. Northwest Forest Plan land use allocations [246]. California Department of Fish and Wildlife, 2014.

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the NSO, the US Fish and Wildlife Service recognized the importance of implementation of the NWFP to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the NSO did not alter land use allocations or change the Standards and Guidelines for management under the NWFP, nor did the rule establish any management plan or prescriptions for the management of critical habitat. However, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the NSO. Those include conservation of older forest, high-value habitat, areas occupied by NSOs, and active management of forests to restore ecosystem health in many parts of the NSO's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality NSO habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised NSO Recovery Plan. NSO critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 22).

Sierra Nevada Forest Plan Amendment (SNFPA): The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the SNFPA by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (USDA 2004). It also amended Land Management Plans for National Forests within the Sierra Nevada.

The Record of Decision for the SNFPA contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the SNFPA conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;

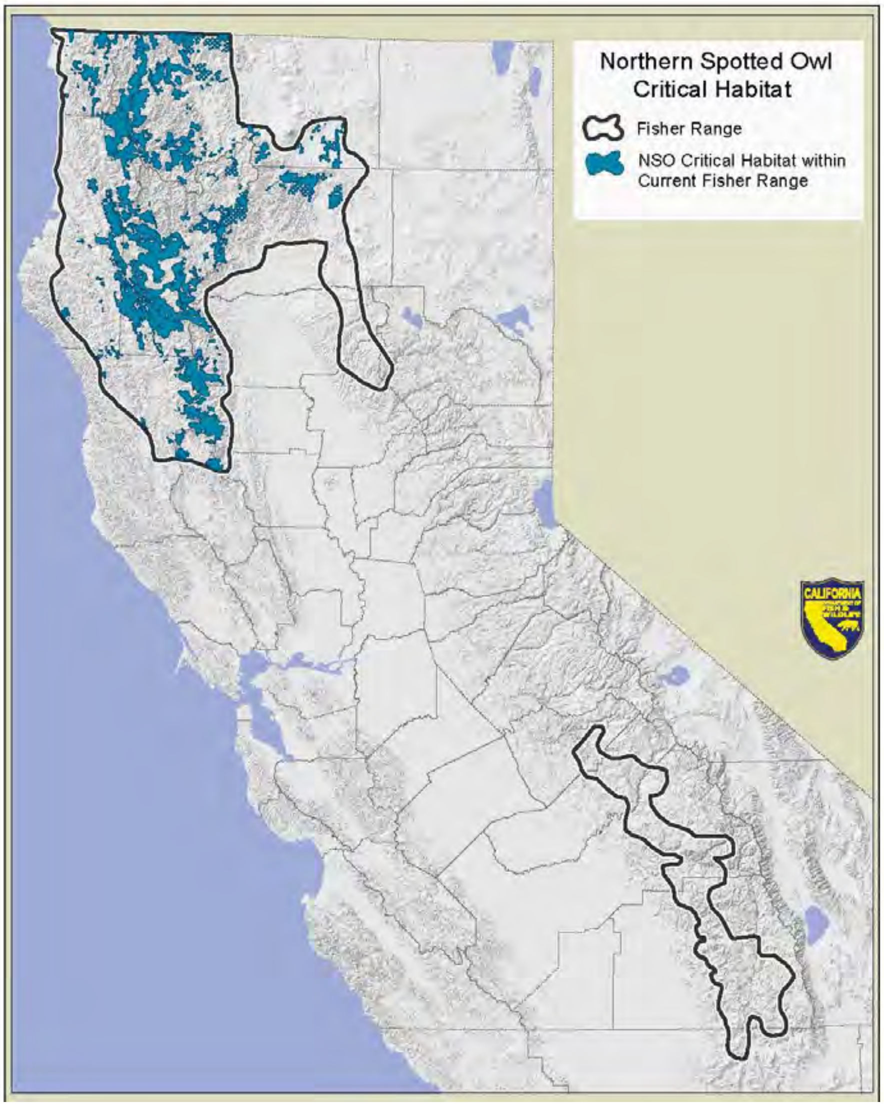


Figure 22. Distribution of northern spotted owl critical habitat within the current estimated range of the fisher in California.

- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and

- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The SNFPA established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit them by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra fisher conservation area
- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 4.9 million acres within the historical range of the fisher described by Grinnell et al. [3]. Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 3.5 million acres and 10 wilderness areas encompassing the southern Sierra population totaling about 416,000 acres. Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 328,315 acre Giant Sequoia National Monument (Monument) is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within the Monument are intended to be managed to support viable populations of these species. Three categories of land allocations within the Monument have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (311,150 acres). The current Management Plan for the Monument lists specific objectives to study and adaptively manage fisher and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project (SNAMP): The SNAMP was initiated in 2005 to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health [247]. A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) and focused on four response variables, including fishers. Researchers are studying factors that may limit the fisher population within SNAMP's study site in the southern Sierra Nevada. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation [248].

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007, in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada [249]. The project area encompasses about 53~~,~~2~~00~~ ~~ha~~km^2 (~~131,460 ac~~205 mi^2) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting

Comment [RAP9]:

Formatted: Superscript

Formatted: Superscript

structures have been identified [249]. Predation has been the primary cause of death of the fishers studied.

Bureau of Land Management

Management of Bureau of Land Management (BLM) lands are authorized under approved Resource Management Plans (RMPs) prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra RMP) include conservation strategies for fishers and other special status species. The Sierra RMP contains objectives to sustain and manage mixed evergreen forest ecosystems in to support viable populations of fisher by conserving denning, resting, and foraging habitats [250]. This plan contains provisions to manage lands within the RMP to support large trees and snags, to provide habitat connectivity among federal lands, and making acquisition of fisher habitat a priority when evaluating private lands for purchase [250].

Management of BLM lands within NSO range are also subject to provisions of the NWFP. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fisher associated with late-successional and old-growth forests [245].

National Park Service

Compared to other public lands which are primarily administered for multiple uses, national parks are among the most protected lands in the nation [251]. The National Park Service (NPS) does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

State Lands

State lands comprise only about one percent of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA). During CEQA review for proposed projects on state lands within fisher range and where suitable habitat is present, potential impacts to fishers are specifically evaluated because the species is a Department of Fish and Wildlife Species of Special Concern. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (CCR, Title 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the FPRs) that require the preparation and approval of Timber Harvesting Plans (THPs) prior to harvesting trees on California timberlands.

Private Timberlands

The Department estimates that approximately 39% of current fisher range in California is comprised of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act and associated FPRs promulgated by the State Board of Forestry and Fire Protection (BOF). The FPRs are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans (THPs) prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to BOF's rules; and (2) information and direction to timber operators so they comply with BOF's rules (CCR, Title 14, § 1034). The preparation and approval of THPs is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

Under the FPRs (CCR, Title 14, § 897(b)(1)(B)), forest management shall "maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed." Although the FPRs do not require measures specifically designed to protect fishers, elements of these rules provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fisher may be ~~voluntarily~~ retained voluntarily to achieve post-harvest stocking requirements under the FPR subsection relating to "decadent or

Formatted: Pattern: Clear (Yellow)

deformed trees of value to wildlife" (FPR 912.7(b)(3), 932.7(b)(3), 952.7(b)(3)). Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (WLPZs).

Formatted: Pattern: Clear (Yellow)

WLPZs are defined areas along streams where the FPRs restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but WLPZs may encompass 15 – 45 m (50-150 ft) on each side of a watercourse 30-91m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. In some locations, WLPZs may constitute 15% or more of a watershed (J. Croteau, pers. comm.). Drier regions of the state with lower stream densities have a much lower proportion of the landscape in WLPZs. Where WLPZs allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes.

Timberland owners with relatively small acreages [<1,012 ha (2,500 acres)] may prepare Non-Industrial Timber Management Plans (NTMPs) designed to provide long-term forest cover on enrolled ownerships which may provide habitat suitable for use by fishers.

For ownerships encompassing at least 50,000 acres, the FPRs require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (CCR, Title 14, § 1091.1, § 913.11, § 933.11, and § 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option is likely to provide forested habitat that is suitable for fishers. However, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare THPs and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The FPRs impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees

[trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Portions of the FPRs (CCR, Title 14, §§ 919.16, 939.16, and 959.16) relate to late succession forest stands[32] on private lands. Proposals to harvest late successional stands where the stands' amount, distribution, or functional wildlife habitat value will be reduced and result in a significant adverse impact on the environment must include a discussion of how the species primarily associated with late successional stands will be affected. When long-term significant adverse effects on fish, wildlife, and listed species associated primarily with late successional forests are identified, feasible mitigation measures to mitigate or avoid adverse effects must be incorporated into THPs, Sustained Yield Plans, or NTMPs. Where these impacts cannot be avoided or mitigated, measures taken to reduce them and justification for overriding concerns must be provided.

Some private companies, including large industrial timberland owners and non-industrial timber owners, have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These may include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Private Timberlands – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1992, the Forest Stewardship Council (FSC) was formed to create a voluntary, market-based approach to improve forest practices worldwide [252]. FSC's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity [253]. In California, approximately 1.6 million acres of forest lands are FSC certified [254].

[32] Late Succession Forest Stands refers to stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to “take,” as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq*.)(ESA), threatened and endangered species. Applicants for incidental take permits under Section 10 of the ESA must submit an HCP that specifies, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. An HCP may include conservation measures for candidate species, proposed species, and other species not listed under the ESA at the time an HCP is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six HCPs in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods HCP specifically addresses fisher, although other HCPs contain provisions intended to benefit species such as NSO (e.g., Green Diamond Resources Company and Fruit Growers Supply Company) that may also benefit fishers.

Fisher Translocation: From 2009-2012, the Department translocated[33] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra-Pacific Industries (SPI). This effort, the first of its kind in California, was undertaken in cooperation with SPI, USFWS, and North Carolina State University. A primary conservation concern for fisher has been the apparent reduction in overall distribution in the state. Fishers have been successfully translocated many times to reestablish the species in North America [26], and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California [256].

Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites [256]. Those lands represented most of the large, relatively contiguous tracts of SPI land within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto SPI’s property, including habitat suitability of candidate release sites, prey availability, genetics, potential impacts to

[33] Translocation refers to the human-mediated movement of living organisms from one area for release in another area [255].

other species with special status, disease, predation, and the effects of removing animals on donor populations.

Table 7. Approved Habitat Conservation Plans within the range of the fisher in California.

HCP Name	Location	Area (acres)	Permit Period	Covered Species
Green Diamond Resources Company	Del Norte & Humboldt counties	407,000	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	211,000	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Fruit Growers Supply Company	Siskiyou County	152,000	2012-2062 (50 years)	• coho salmon (Southern Oregon/Northern California Coasts ESU) • steelhead (Klamath Mountains Province ESU) • Chinook salmon (Upper Klamath and Trinity Rivers ESU) • northern spotted owl • Yreka phlox
Green Diamond Resources Company	Humboldt and Del Norte counties	417,000	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander
Fisher Family	Mendocino County	24	2007-2057	• Behren's silverspot butterfly • Point Arena mountain

			50 years	beaver
AT&T	Mendocino County	11	2002-2012 10 years	• Point Arena mountain beaver

From late 2009 through late 2011, 40 fishers (24F, 16M) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release [126]. A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young [126].

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 were born on Stirling [126]. On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California [126]. Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group comprised 47% of the population, suggesting relatively high levels of reproduction and recruitment [126].

Candidate Conservation Agreement with Assurances: A “Candidate Conservation Agreement with Assurances for Fisher” (CCAA) between the USFWS and SPI regarding translocation of fisher to a portion of SPI’s lands in the northern Sierra Nevada was approved on May 15, 2008. CCAAs are intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to SPI should USFWS eventually list fisher under the federal ESA. This 20-year permit covers timber management activities on SPI’s Stirling Management Area, an approximately 160,000-acre tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fisher. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society to study the ecology of fishers. Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California.

Management and Monitoring Recommendations

The Department has implemented a number of actions designed to better understand fisher in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the BOF, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, and university researchers, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

1. Support independent research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term,

multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.

5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations, potential effects of toxicants and their potential effects on fisher and fisher prey. It may be possible to partner with existing studies and surveys to collect some of the data needed.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends. Fishers translocated elsewhere in North America have rarely been monitored and this translocation is the first effort of its kind in the state. Continued monitoring is critical to answer questions about how fishers use managed landscapes and to determine if the project is successful in the long-term and, if not, why it failed.

7. In the southern Sierra Nevada, collaborate with land management agencies and researchers to expand connectivity between core habitats and to facilitate population expansion.

8. Assess the potential for assisted dispersal of juvenile fishers or translocation of adults from the southern Sierra population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region.

Summary of Listing Factors

CESA directs the Department to prepare this report regarding the status of the fisher in California based upon the best scientific information. Key to the Department's analyses are six relevant factors highlighted in regulation. Under the California Code of Regulations, Title 14, § 670.1, subd. (i)(1)(A), a "species shall be listed as endangered or threatened...if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:”

(1) present or threatened modification or destruction of its habitat;
(2) overexploitation;
(3) predation;
(4) competition;
(5) disease; or
(6) other natural occurrences or human-related activities

Also key are the definitions of endangered and threatened species, respectively, in the Fish and Game Code. CESA defines endangered species as one “which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease.” (Fish & G. Code, § 2062.) A threatened species under CESA is one “that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA].” (*Id.*, § 2067.)

Fishers in California occur in two separate and isolated populations that differ genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units where appropriate in its analysis of listing factors.

Present or Threatened Modification or Destruction of its Habitat

Considerable research has been conducted to understand the habitat associations of fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types [105,119–122]. Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. Forested landscapes with these characteristics are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Thresholds for these attributes for fishers are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

Management of Federal Lands: Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The majority of federal actions must comply with NEPA. This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

The status of fisher as a sensitive species on USFS and BLM lands in California provides consideration for the species as guided by land management plans adopted by these agencies. As a result, substantial federal lands currently occupied by fishers in the state are managed to provide habitat for fishers, although specific guidelines are frequently lacking. Federal lands designated as wilderness areas or as National Parks are likely to provide long-term protection of fisher habitat. However, some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur.

Management of Private Lands: Timber harvest activities on private lands are regulated by various provisions of the Z'Berg Nejedly Forest Practice Act of 1973 and additional rules promulgated by the State Board of Forestry and Fire Protection. These rules are enforced by CAL FIRE and, although some timber harvest activities are exempt from these rules, they apply to all commercial harvesting activities on private lands.

The FPRs promulgated under the act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. However, information about what constitutes the “existing wildlife community” is frequently lacking in THPs, and specific guidelines to retain habitat for fishers and other terrestrial mammals are not incorporated into the FPRs.

Timber management activities subject to the FPRs can reduce the suitability of habitats used by fishers or render some areas unsuitable. These changes may be short-term or long-term, depending on a number of factors including the type of silviculture used, intermediate treatments conducted while forests regrow, timber site growing potential, and the time between timber rotations.

Fishers are able to utilize a diversity of forest types and seral stages. An aspect of forest management important to the suitability and long-term viability of fishers is the retention and recruitment of habitat elements for denning, resting, and to support prey populations in sufficient number and in locations where they can be successfully captured by fisher. The FPRs require the retention of unmerchantable snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However, live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites. No provision is provided in the rules to specifically recruit snags.

The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. The time interval between harvests may also affect the distribution and abundance of habitat structures used by fishers. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity [88]. Frequent harvest entries to salvage dead, dying, and diseased trees likely reduce the availability of these habitat elements. Retention of forest cover and large trees is a requirement of the FPRs along streams (i.e., WLPZs), with the width of these areas determined by stream class, slope, and the presence of anadromous salmonids.

The FPRs do not specifically require the retention or recruitment of hardwoods and, in some cases, their harvest may be required to meet stocking standards. Hardwoods may also be intentionally killed ("hack-and-squirt" herbicide application or felled) individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of habitats used by the species. Various hardwood species provide potential den and rest trees and habitat used by fisher prey. Although the FPRs do not require retention of hardwoods, the Department is not aware of data indicating that their removal on commercial timberlands has substantially affected the distribution or abundance of fishers in California.

Depending on their location, WLPZs may comprise up to 15 percent of private ownerships managed for timber production. Drier regions of the state with lower stream densities have a much lower proportion of the landscape designated as WLPZs. Where they are managed to retain or recruit trees suitable for denning and resting, WLPZs may provide a network of older forest structure within managed forest landscapes beneficial to fishers and provide denning, resting, and foraging habitat for fishers. Outside of WLPZs, trees suitable for denning or resting by fishers are not required to be retained; however they may be intentionally left by landowners to meet post-harvest stocking requirements.

The effects of future timber harvest activities on habitats used by fishers cannot be accurately predicted as changes in regulations, policies, and market conditions influence management intensity. Independent of the FPRs, trees of value to fishers may remain on landscapes through timber rotations because they are unmerchantable, are located in areas where access is infeasible, or because of company policies. Some private companies have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Fire: In recent decades the frequency, severity, and extent of fires has increased in California. This has varied statewide, with the greatest increases in fires severe enough to eliminate forest stands occurring in the Sierra Nevada, southern Cascades, and Klamath Mountains. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. However, the contemporary extent of wildfires burning annually in California is considerably less than the estimated 1.8 million ha (4.5 million ac) that burned annually in the state prehistorically (pre 1800) [174].

The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due its small size, the comparatively linear distribution of the habitat available, and predicted future climate changes. Timber harvest activities in portions of the southern Sierra Nevada occupied by fisher are largely under federal management. These National Forests in the SSN ESU have adopted specific guidelines to protect habitats used by fishers.

Within the NC Fisher ESU, fishers are comparatively widespread across a matrix of public and private forest lands. With the exceptions of Lake, Sonoma, and Marin counties, fishers currently occur throughout much of the historical range assumed by Grinnell et al. [3].

Overexploitation

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable ([123]. The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917-1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers [3] and were also likely harvested by trappers seeking other furbearers [123].

Since the mid-1800s, the distribution of fisher in North America contracted substantially, in part, due to over-trapping and mortality from predator control programs [26]. Over-trapping of fisher has been considered a significant cause of its decline in California [3]. By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season [3]. Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fisher a prize catch.

Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period from 1920-1924 was only 46 animals [3]. Fishers were considered to be rare in California by the early 1920s [124]. Grinnell et al. [3] considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of fisher in California [3]. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue.

The high value trappers obtained for the pelts of fisher in the early 1900s, the species' vulnerability to trapping [8], and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations [26]. Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [124]. However, despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fisher was not prohibited until 1946 [125]. Although commercial trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (see Lewis et al. [123]). Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers [8], or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations [8] and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (Fish & G. Code, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designee are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 23), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to

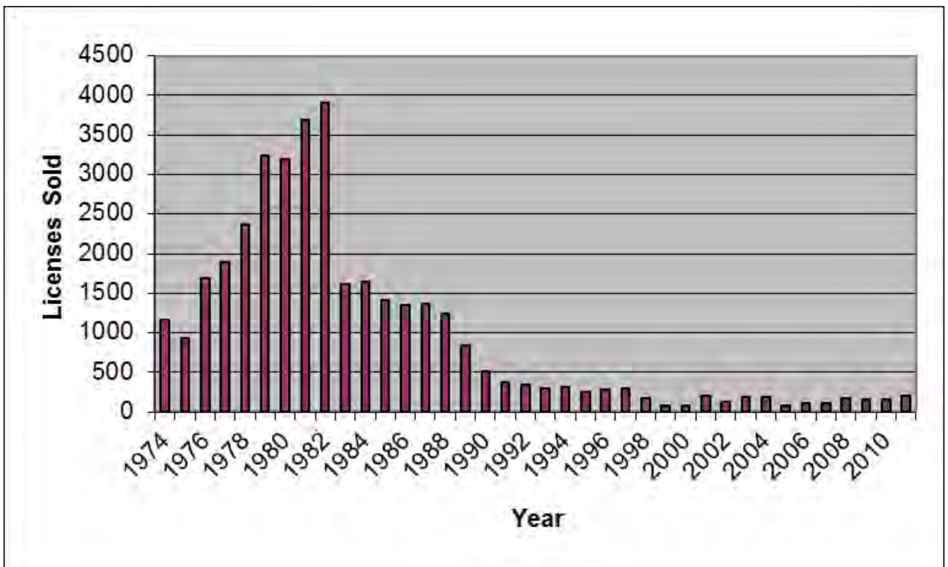


Figure 23. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

increase [257]. From the early 1980s through the present, license sales have continued to decrease with average sales from 2000-2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. However, throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators typically work in close proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by certain species of wildlife. However, fishers are not permitted to be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).

Currently and in the foreseeable future, the likelihood of fishers being overexploited in California is low, based on the prohibition against commercial or recreational take of fishers, low level of commercial and recreational trapping and prohibition of body-gripping traps. The Department is not aware of any data indicating that the potential risk to fisher populations from incidental take due to trapping differs significantly for populations in NC or SSN Fisher ESUs.

Predation

Recent research indicates predation is a substantial cause of mortality for fishers in California [144]. This research, using DNA amplified from fisher carcasses, identified bobcat, mountain lion, and coyote as predators of fishers, with predation attributed to bobcat being the most frequent (50%).

The risk of predation is likely heightened when fishers occupy habitats in close proximity to open and brushy habitats (G. Wengert, pers. comm.), both habitats used extensively by bobcats. Female fishers are more likely to be predated by bobcats and this occurs most frequently during the breeding season when young fishers ~~are ~~depend~~ent~~ on their mothers for survival. Fragmentation of forested landscapes may increase the abundance of some small mammal species used by fishers as prey, but it may also favor potential predators adapted to early successional habitats. However, fishers have co-evolved with the suite of predators naturally occurring within their range and adverse population level effects on fishers due to predation have not been documented.

Currently, there is no information indicating differential risk of predation to fisher in the NC or SSN Fisher ESUs. Based on a sample of 50 fisher carcasses from these regions, no difference in the relative frequencies of predation by bobcat or mountain lion was found. Fishers in the SSN Fisher ESU are likely at greater risk of population level effects of predation due to the small size of their population compared to northern California. However, fishers in the southern Sierra Nevada have apparently been isolated in that region for decades or longer and, at times, their numbers may have been smaller than they are today. The abundance of potential predators of fishers during those periods is unknown, but they likely co-occurred with fisher populations in the region.

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood [24]. Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines [24,25,106]. Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Also, the relative similarities in body size, body shape, and prey between fisher and martens suggest the potential for competition between these species [24]. However, in California, martens typically occur at higher elevations than fisher and thus may have evolved strategies to minimize competition by separation and by exploiting somewhat different habitats. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have evolved with other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California. There is no evidence that fisher populations in either NC or SSN Fisher ESUs are adversely affected by competition with other species. However, landscape level habitat changes that favor population increases in competitors may intensify interspecific competition.

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years [152,158,161,258]. Fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or spill over from other species of carnivores.

Canine distemper virus (CDV) is common in gray fox and raccoon populations in California and both species occur in habitats occupied by fishers. Although studies have shown that fisher may survive CDV infections, outbreaks of highly virulent biotypes have been responsible for the near extirpation of other carnivore species including other mustelids. Deaths caused by other pathogens potentially significant for *Martes* (i.e., rabies, canine parvo virus), have not been documented for fisher in California. Although canine parvo virus has been documented to cause clinical disease in fishers, testing to date indicates that the disease is circulating in California fishers without causing population level impacts.

Exposure of fishers to *Toxoplasma gondii* in both northern California and the southern Sierra Nevada has been documented. Although this parasite has caused mortality in other mustelids, it has not been documented as a source of mortality in fisher. This is also the case for known vector borne pathogens. Fisher harbor numerous ecto- and endoparasites and, although some can serve as vectors for other diseases, they are usually associated with minimal morbidity and mortality.

There is no evidence indicating that the prevalence of pathogens potentially affecting fishers in the state differs significantly between populations within the NC and SSN Fisher ESUs. The fisher population in the southern Sierra Nevada is likely at a higher risk of diseases that cause significant morbidity or mortality due to the population's isolation and comparatively small size. Although there is no evidence that CDV has caused substantial population declines in fisher, it is a pathogen of conservation concern for fisher and health surveillance of populations is prudent to detect and intervene to the extent possible, if needed.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution of fisher in California appears to have changed substantially before and after European Settlement. Although its precise distribution prior to the 1800s is unknown, based on recent genetic evidence, the fisher population in the state declined dramatically and contracted into two separate populations long before that time. Further reductions in range and abundance were likely post-European Settlement due to over trapping, predator control programs, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. Since trapping of fishers was prohibited in 1946 and the use of body-gripping traps was banned in 1998, the number of fishers in California has increased to levels likely higher than existed during the period of unregulated trapping in the mid-1800s to early 1900s.

The fisher population within the SSN Fisher ESU is likely at greater risk of extirpation due to its small size (recently estimated at <250 individuals [134]), limited geographic range, and isolation compared to fishers in northern California. Small, isolated populations are subject to an increased risk of extinction from stochastic (random) environmental or demographic events. Small populations are also at greater risk of adverse impacts resulting from the loss of genetic diversity, including inbreeding depression. The probability of this occurring in fisher occupying either the NC Fisher ESU or the SSN Fisher ESU is unknown. Events such as drought, high intensity fires, and disease, should they occur, have a higher probability of adversely affecting the fisher population in the southern Sierra Nevada. Currently, fishers nearest to the southern Sierra Nevada population are those translocated to the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). Fishers within the SSN Fisher ESU are likely to remain isolated in the foreseeable future due to that distance and potential barriers to movement.

Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population [40]. Fishers within the NC Fisher ESU are also largely isolated from other populations of fishers, although their population is contiguous with a small population in southern Oregon. Despite its isolation, the fisher population in northern California is comparatively large, distributed over a large geographic area, and its distribution has apparently not contracted, and may have slightly expanded, in recent decades. Over the last 8 years, occupancy rates of fishers in the southern Sierra have been stable [134]. Although long-term monitoring of population abundance and trends is lacking for fishers within the NC Fisher ESU, surveys from this region and recent estimates of relatively high rates of occupancy indicate that the population has not declined substantially in recent decades.

Toxicants

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and potentially to other toxicants. ARs have caused the deaths of some fishers, and within the SSN Fisher ESU there is a correlation between the presence of MJCSs within a fisher's home range and reduced survival. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data have been collected to quantify usage. In addition, use practices are largely unknown. Food containers that appear to have been spiked with pesticides and piles of bait have been found on MJCSs indicating intended poisoning of wildlife. However, containers are often found onsite without signs of where the material was applied. In addition, it is important that MJCSs be searched for fisher and other wildlife carcasses, that these be quantified, and that the appropriate body tissues be analyzed for residues of contaminants.

There is incomplete understanding of effects of contaminants on fishers. Also unknown is the effect of multiple exposures of the same contaminant, similar contaminants, and contaminants with different modes of action. It is also unknown if there are potentially additive effects of contaminants with other stressors on individual fishers. ARs may also have indirect effects by predisposing fishers to other sources of mortality such as predation or accidents. AR toxicants were found at MJCSs in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented.

Although limited population level monitoring of fishers has occurred, the species' distribution in California does not appear to have changed appreciably in decades. If toxicant use has been widespread, long-term, and caused substantial mortality, it is likely that new gaps in the range of fishers or declines in capture rates would have been observed due to the extensive efforts conducted since the early 1990s to detect and study the species. However, evidence of exposure in fishers and the documented deaths of a number of animals indicate this is a potentially significant threat that should be closely monitored and evaluated. Exposure to toxicants at MJCSs has been documented in both the NC and SSN Fisher ESU, but there is insufficient information to determine the relative risk to either population. However, the potential risk to fishers within the SSN Fisher ESU may be greater due to its comparatively small population size.

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant communities. The effect of warming temperatures on mountain ecosystems will most likely be complex and predicting how ecosystems will be affected in particular areas is difficult. Some bioclimatic modeling (Lawler et al. [183]) broadly predicts that the climate in much of California may be unsuitable for fishers by 2100. Several papers that have modeled vegetation change suggest that within those portions of California currently occupied by fishers, conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation) [183,225,235]. These predictions notwithstanding, they are based on long-term models that utilize broad climate and vegetation parameters that largely do not reflect the fine-scale variation (in both climate and vegetation diversity) typically found in the topographically and ecologically diverse montane habitats of California.

Fishers within the SSN Fisher ESU are likely more vulnerable to the potentially adverse effects of warming climate than fishers in northern California. The comparatively small size of the population in the southern Sierra, its linear distribution, and potential barriers to dispersal (the 2013 Rim Fire area, river canyons, etc.) increase the likelihood that it will become fragmented and decline in size during this century. The fisher population within the NC Fisher ESU is comparatively large and well distributed geographically, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain.

While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state, and its severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century. As the 21st century progresses and population data continue to be compiled, scientists will become better informed as to effects of a warming environment on California's fisher population. Continued monitoring of fisher distribution and survival over the ensuing decades will provide information about the immediacy of this threat.

Listing Recommendation

“Endangered species” means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (FGC §2062). "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter” (FGC §2067).

The Department recommends that designation of the fisher in California as threatened/endangered is _______.

Protection Afforded by Listing

CESA defines “take” to mean “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful absent take authorization from the Department (FGC §§ 2080 et seq. and 2835). Take can be authorized by the Department pursuant to FGC §§ 2081.1, 2081, 2086, 2087 and 2835 (NCCP).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fisher would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fisher because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Economic Considerations

The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).

Literature Cited

1. Douglas CW, Strickland MA (1999) Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

2. Powell RA (1993) The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

3. Grinnell J, Dixon JS, Linsdale JM, University of California B, Museum of Vertebrate Zoology (1937) Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. Berkeley, Calif.: University of California press.

4. Buskirk SW, Ruggiero LF (1994) American Marten. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 186.

5. Lewis JC, Stinson DW (1998) Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

6. Coulter M. (1966) The ecology and management of fishers in Maine Syracuse, New York, USA: University, Syracuse.

7. Pittaway RJ (1978) Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Nat Can 105: 487–489.

8. Douglas CW, Strickland MA (1987) Fisher. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. Ontario, Canada: Ontario Ministry of Natural Resources.

9. Erxleben JCP (1777) Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

10. Goldman FA (1935) New American mustelids of the genera Martes, Gulo, and Lutra. Proc Biol Soc Wash 48: 175–186.

11. Rhoads SN (1898) Contributions to a revision of the North American beavers, otters and fishers. Trans Am Philos Soc 19: 417–439.

12. Hagmeier EM (1959) A reevaluation of the subspecies of fisher. Can Field Nat 73: 185–197.

13. Hosoda T, Suzuki H, Harada M, Tsuchiya K, Han S-H, et al. (2000) Evolutionary trends of the mitochondrial lineage differentiation in species of genera Martes and Mustela. Genes Genet Syst 75: 259–267.

14. Stone KD, Cook JA (2002) Molecular evolution of Holarctic martens (genus Martes, Mammalia: Carnivora: Mustelidae). Mol Phylogenet Evol 24: 169–179.

15. Koepfli K-P, Deere K, Slater G, Begg C, Begg K, et al. (2008) Multigene phylogeny of the Mustelidae: resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biol 6: 10.

16. Sato JJ, Wolsan M, Minami S, Hosoda T, Sinaga MH, et al. (2009) Deciphering and dating the red panda's ancestry and early adaptive radiation of Musteloidea. Mol Phylogenet Evol 53: 907–922.

17. Wolsan M, Sato JJ (2010) Effects of data incompleteness on the relative performance of parsimony and Bayesian approaches in a supermatrix phylogenetic reconstruction of Mustelidae and Procyonidae (Carnivora). Cladistics 26: 168–194.

18. Nyakatura K, Bininda-Emonds OR (2012) Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. BMC Biol 10: 12.

19. Sato JJ, Wolsan M, Prevosti FJ, D'Elía G, Begg C, et al. (2012) Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Mol Phylogenet Evol 63: 745–757.

20. Baldy R, Beck R, Carpenter C, Carpenter W, Golla V, et al. (1996) Hupa language dictionary. Second. Hoopa, CA: Hoopa Valley Tribal Council. 131 p.

21. Samuels JX, Cavin J (2013) The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. J Vertebr Paleontol 33: 448–454. doi:10.1080/02724634.2013.722155.

22. Eshelman R, Grady F (1984) Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. In: McDonald JN, Bird SO, editors. The Quaternary of Virginia - A symposium volume. Charlottsville, Virginia: VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Vol. 75. pp. 43–70.

23. Graham RW, Graham MA (1994) The late Quaternary distribution of Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

24. Lofroth EC, Raley CM, Finley LL, Naney RH (2010) Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

25. Powell RA, Zielinski WJ (1994) Fisher. General Technical Report. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Available: http://treesearch.fs.fed.us/pubs/27328. Accessed 11 October 2013.

26. Lewis JC, Powell RA, Zielinski WJ (2012) Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7: n/a. doi:http://dx.doi.org/10.1371/journal.pone.0032726.

27. Gibilisco CJ (1994) Distributional dynamics of modern Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables,

and fishers: biology and conservation. , Ithaca, New York, USA: Cornell University Press.

28. Tucker JM, Schwartz MK, Truex RL, Pilgrim KL, Allendorf FW (2012) Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS One 7.

29. Knaus BJ, Cronn R, Liston A, Pilgrim K, Schwartz MK (2011) Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC Ecol 11: 10.

30. Grinnell, J, Dixon J, Linsdale M (1930) Vertebrate natural history of a section of northern California through the Lassen Peak region. University of California Publications in Zoology. 594 p.

31. Price WW (1894) Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE Biol J 4: 315–332.

32. Aubry KB, Jagger LA (2006) The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. In: Santos-Reis M, Birks JDS, O'Doherty EC, Proulx G, editors. Martes in Carnivore Communities. Alberta, Canada: Alpha Wildl. Publ.

33. McKelvey KS, Aubry KB, Schwartz MK (2008) Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58: 549–555.

34. Aubry KB, Lewis JC (2003) Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biol Conserv 114: 79–90. doi:http://dx.doi.org/10.1016/S0006-3207(03)00003-X.

35. Zielinski WJ, Truex RL, Schlexer FV, Campbell LA, Carroll C (2005) Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. J Biogeogr 32: 1385–1407.

36. Zielinski WJ, Kucera TE, Barrett RH (1995) Current distribution of the fisher, Martes pennanti, in California. Calif Fish Game 81: 104–112.

37. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

38. Drew RE, Hallett JG, Aubry KB, Cullings KW, Koepf SM, et al. (2003) Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Mol Ecol 12: 51–62.

39. Talking Glossary: "Haplotype" (n.d.). Available: http://www.genome.gov/glossary/index.cfm?id=99. Accessed 4 September 2014.

40. Tucker JM (2013) Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada The University of Montana.

41. Wright PL, Coulter MW (1967) Reproduction and growth in Maine fishers. J Wildl Manag: 70–87.

42. Leonard RD (1986) Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Can Field-Nat Ott ON 100: 32–44.

43. Eadie WR, Hamilton WJ (1958) Reproduction in the fisher in New York. N Y Fish Game J 5: 77–83.

44. Frost HC, Krohn WB (1997) Factors affecting the reproductive success of captive female fishers. In: Proulx G, Bryant HN, Woodward PM, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB. pp. 100–109.

45. Paragi TF, Arthur SM, Krohn WB (1994) Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Can Field-Nat Ott ON 108: 52–57.

46. Arthur SM, Krohn WB (1991) Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J Mammal: 72–2.

47. Mead RA (1994) Reproduction in Martes. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 404–422.

48. Frost HC, Krohn WB, Wallace CR (1997) Age-specific reproductive characteristics in fishers. J Mammal 78: 598–612.

49. Aubry KB, Raley CM (2006) Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report. Olympia, WA: USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory.

50. Higley JM, Matthews S (2006) Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report. Hoopa Valley Tribe and Wildlife Conservation Society.

51. Self S, Callas R (2006) Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pac Ind Calif Dep Fish Game.

52. Weir RD, Corbould FB (2008) Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Prince George, British Columbia, Canada: Peace/Williston Fish & Wildlife Compensation Program.

53. Truex RL, Zielinski WJ, Golightly RT, Barrett RH, Wisely SM (1998) A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft Rep Submitt Calif Dep Fish Game U S For Serv Pac Southwest Res Stn Arcata Calif.

54. Hall ER (1942) Gestation period in the fisher with recommendations for the animal$\backslash$’s protection in California. Calif Fish Game 28: 143–147.

55. Paragi TF, Krohn WB, Arthur SM (1994) Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildl 51: 1–11.

56. York EC (1996) Fisher population dynamics in north-central Massachusetts University of Massachusetts at Amherst.

57. Matthews SM, Higley JM, Rennie KM, Green RE, Goddard CA, et al. (2013) Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. J Mammal 94: 100–108.

58. Bachelot A, Binart N (2005) Corpus luteum development: lessons from genetic models in mice. Curr Top Dev Biol 68: 49–84. doi:10.1016/S0070-2153(05)68003-9.

59. Kelly GM (1977) Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas University of Massachusetts. Available: http://agris.fao.org/agris-search/search/display.do?f=2013/US/US2013054260005426.xml;US201300542658. Accessed 11 October 2013.

60. Crowley SK, Krohn WB, Paragi TF (n.d.) A comparison of fisher reproductive estimates. Trans Northeast Sect Wildl Soc 47: 36–42.

61. Weir RD (2003) Status of the fisher in British Columbia. BC Minist Sustain Resour Manage Conserv Data Cent BC Minist Water Land Air Prot Biodivers Branch Vic BC Wildl Bull No B-105 38pp: 3.

62. Arthur SM, Paragi TF, Krohn WB (1993) Dispersal of juvenile fishers in Maine. J Wildl Manag 57: 868.

63. Higley JM, Matthews S (2009) Fisher habitat use and population monitoring on the Hoopa Valley Reservation, California Final Report USFWS TWG U-12-NA-1. Hoopa Val Tribe Hoopa Calif USA.

64. King CM, Powell RA, Powell C (2007) The natural history of weasels and stoats: ecology, behavior, and management. Oxford University Press New York.

65. Paragi TF (1990) Reproductive biology of female fishers in southcentral Maine University of Maine at Orono. Available: http://www.library.umaine.edu/theses/theses.asp?Cmd=abstract&ID=MARC1647. Accessed 11 October 2013.

66. Reno MA, Rulon K, James C (2008) Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

67. Aging Experience, Accuracy and Precision (n.d.). Available: http://www.matsonslab.com/aging-experience-accuracy-and-precision.html. Accessed 6 September 2014.

68. Brown RN, Gabriel MW, Wengert G, Matthews S, Higley JM, et al. (2006) Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Trans West Sect Wildl Soc 42: 40–46.

69. Sandra Martin (1994) Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael RA, Powell RA, editors. Martens, sables and

fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 297–315.

70. Zielinski WJ, Duncan NP (2004) Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. J Mammal 85: 470–477.

71. Golightly RT, Penland TF, Zielinski WJ, Higley JM (2006) Fisher diet in the Klamath/north coast bioregion. Final Rep US Fish Wildl Serv Scotia Pac Humboldt State Spons Programs Found Arcata Calif.

72. Zielinski WJ, Duncan NP, Farmer EC, Truex RL, Clevenger, et al. (1999) Diet of fishers (Martes pennanti) at the southernmost extent of their range. J Mammal 80: 961–971.

73. Grenfell WE, Fasenfest M (1979) Winter food habits of fisher (Martes pennanti) in northwestern California. Calif Fish Game 65: 186–189.

74. Bioregions of California (n.d.). Available: http://biodiversity.ca.gov/bioregions.html. Accessed 5 September 2014.

75. Powell RA, Brander RB (1977) Adaptations of fishers and porcupines to their predator prey system. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula. pp. 45–53.

76. Powell SM, York EC, Fuller TK (1997) Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta, Edmonton. pp. 279–305.

77. Weir RD, Harestad AS, Wright RC (2005) Winter Diet Of Fishers In British Columbia. Northwest Nat 86: 12–19. doi:http://dx.doi.org/10.1898/1051-1733(2005)086[0012:WDOFIB]2.0.CO;2.

78. Kuehn DW (1989) Winter foods of fishers during a snowshoe hare decline. J Wildl Manag: 688–692.

79. Burt WH (1943) Territoriality and home range concepts as applied to mammals. J Mammal 24: 346–352.

80. Buck S, Mullis C, Mossman AS (1983) Corral Bottom-Hayfork Bally Fisher Study: final report. Arcata, CA: Humboldt State University and USDA Forest Service.

81. Johnson SA (1984) Home range, movements, and habitat use of fishers in Wisconsin University of Wisconsin–Stevens Point.

82. Arthur SM, Krohn WB, Gilbert JR (1989) Home range characteristics of adult fishers. J Wildl Manag 53: 674–679.

83. Jones JL (1991) Habitat use of fisher in northcentral Idaho University of Idaho.

84. Garant Y, Crete M (1997) Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Can Field-Nat Ott ON 111: 359–364.

85. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Home Range Characteristics Of Fishers in California. J Mammal 85: 649–657.

86. Yaeger JS (2005) Habitat at fisher resting sites in the Klamath Province of northern California [Master's Thesis]. Arcata, CA: Humboldt State University. Available: http://www.fws.gov/yreka/fisher/Literature/Yaeger%202005.pdf. Accessed 11 October 2013.

87. Koen EL, Bowman J, Findlay CS, Zheng L (2007) Home Range and Population Density of Fishers in Eastern Ontario. J Wildl Manag 71: 1484–1493. doi:http://dx.doi.org/10.2193/2006-133.

88. Raley CM, Lofroth EC, Truex RL, Yaeger JS, Higley JM (2012) Habitat ecology of fishers in western North America. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press.

89. Mabry KE, Shelley EL, Davis KE, Blumstein DT, Vuren DHv (2013) Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

90. Strickland MA (1994) Harvest management of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 149–164.

91. Aubry K, Wisely S, Raley C, Buskirk S (2004) Zoogeography, Spacing Patterns, and Dispersal in Fishers. In: Harrison DJ, Fuller AK, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. New York, NY: Springer. pp. 201–220.

92. Greenwood PJ (1980) Mating systems, philopatry and dispersal in birds and mammals. Anim Behav 28: 1140–1162.

93. Stephen Dobson F (1982) Competition for mates and predominant juvenile male dispersal in mammals. Anim Behav 30: 1183–1192.

94. De Vos A (1951) Overflow and dispersal of marten and fisher from wildlife refuges. J Wildl Manag 15: 164–175.

95. Hamilton WJ, Cook AH, Hamilton WF (1955) The biology and management of the fisher in New York. N Y Fish Game J 2: 13–35.

96. Powell RA (1979) Ecological energetics and foraging strategies of the fisher (Martes pennanti). J Anim Ecol: 195–212.

97. Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

98. Buskirk SW, Powell RA (1994) Habitat Ecology of Fishers and American Martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 283–296. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

99. The Public Land Survey System (PLSS) (n.d.). Available: http://nationalatlas.gov/articles/boundaries/a_plss.html. Accessed 4 September 2014.

100. Krohn WB, Arthur SM, Paragi TF (1994) Mortality and vulnerability of a heavily trapped fisher population. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

101. Klug Jr RR (1997) Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections Humboldt State University.

102. Carroll C, Zielinski WJ, Noss RF (1999) Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conserv Biol 13: 1344–1359.

103. Davis FW, Seo C, Zielinski WJ (2007) Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecol Appl 17: 2195–2213.

104. Slauson KM, Zielinski WJ, Holm GW (2003) Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final Rep USDA For Serv Pac Southwest Res Stn Arcata Calif USA.

105. Weir RD, Harestad AS (2003) Scale-dependent habitat selectivity by fishers in south-central British Columbia. J Wildl Manag 67: 73–82.

106. Campbell LA (2004) Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada University of California. Available: http://www.fs.fed.us/psw/programs/snrc/staff/campbell/campbell_dissertation.pdf. Accessed 11 October 2013.

107. Aubry KB, Raley CM, Buskirk SW, Zielinski WJ, Schwartz MK, et al. (2013) Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. J Wildl Manag 77: 965–974.

108. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Resting habitat selection by fishers in California. J Wildl Manag 68: 475–492.

109. Purcell KL, Mazzoni AK, Mori SR, Boroski BB (2009) Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. For Ecol Manag 258: 2696–2706.

110. Davis LR (2009) Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau Dept. of Biological Sciences-Simon Fraser University. Available: http://summit.sfu.ca/item/9870. Accessed 10 October 2013.

111. Bull EL, Parks CG, Torgersen TR (1997) Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

112. Manion PD (n.d.) Tree disease concepts. Second. New Jersey, USA: Prentice Hall Career and Technology.

113. Zielinski WJ, Dunk JR, Yaeger JS, LaPlante DW (2010) Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. For Ecol Manag 260: 1579–1591.

114. California Wildlife Habitat Relationships System (2008). Sacramento, California: California Department of Fish and Wildlife: California Interagency Wildlife Task Group.

115. Weir RD, Corbould FB (2010) Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. J Wildl Manag 74: 405–410.

116. Buck SG, Mullis C, Mossman AS, Coolahan C (1994) Habitat use by fishers in adjoining heavily and lightly harvested forest. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 368–376.

117. Jones JL, Garton EO (1994) Selection of successional stages by fishers in north-central Idaho. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 377–387.

118. De Vos A (1952) The ecology and management of fisher and marten in Ontario. Available: http://www.citeulike.org/group/15497/article/9675279. Accessed 21 August 2014.

119. Spencer W, Rustigian-Romsos H, Strittholt J, Scheller R, Zielinski W, et al. (2011) Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biol Conserv 144: 788–803.

120. Hagmeier EM (1956) Distribution of marten and fisher in North America. Can Field Nat 70: 149–168.

121. Banci V (1989) A fisher management strategy for British Columbia. Victoria, British Columbia, Canada: Ministry of Environment.

122. Powell RA (1994) Structure and spacing of Martes populations. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA. pp. 101–121.

123. Lewis JC, Zielinski WJ (1996) Historical harvest and incidental capture of fishers in California. Northwest Sci 70: 291–297.

124. Dixon JS (1925) A closed season needed for fisher, marten, and wolverine. Calif Fish Game 11: 23–25.

125. Gould GI Jr (1987) Forest Mammal Survey and Inventory. Calif. Dept. of Fish and Game.

126. Powell RA, Facka AN, Clifford DL, Beach C, Smith K (2013) Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

127. Lamberson RH, Truex RL, Zielinski WJ, Macfarlane D (2000) Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata CA Humboldt State Univ.

128. Spencer WD, Rustigian H, Strittholt JR, Scheller R, Syphard A (2008) Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

129. Jordan MJ (2007) Fisher ecology in the Sierra National Forest, California Berkeley, Calif.: University of California, Berkeley. Available: http://www.carnivoreconservation.org/files/thesis/jordan_2007_phd.pdf. Accessed 11 October 2013.

130. Matthews SM, Mark Higley J, Scott Yaeger J, Fuller TK (2011) Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildl Soc Bull 35: 69–75.

131. Diller L, Hamm K, Lamphear D, Thompson J (2008) Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Korbel, CA: Green Diamond Resource Company.

132. Swiers RC (2013) Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. [Raleigh, North Carolina]: North Carolina State University,.

133. Noon BR, Bailey LL, Sisk TD, McKelvey KS (2012) Efficient Species-Level Monitoring at the Landscape Scale. Conserv Biol 26: 432–441.

134. Zielinski WJ, Baldwin JA, Truex RL, Tucker JM, Flebbe PA (2013) Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. J Fish Wildl Manag 4: 3–19.

135. Bechtold WA, Patterson PL (2005) The enhanced forest inventory and analysis program: national sampling design and estimation procedures. General Technical Report. Asheville, North Carolina: US Department of Agriculture Forest Service, Southern Research Station.

136. Waples R (1991) Definition of a “species” under teh Endangered Species Act: Application to Pacific salmon. Technical menorandum. NOAA.

137. Franklin JF, Spies TA, Pelt RV, Carey AB, Thornburgh DA, et al. (2002) Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. For Ecol Manag 155: 399–423.

138. Thompson ID, Baker JA, Ter-Mikaelian M (2003) A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. For Ecol Manag 177: 441–469.

139. USDA Forest Service (2014) Forest Management: Cut and sold reports. Available: http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml. Accessed 22 August 2014.

140. California Timber Harvest Statistics - harvyr2.pdf (n.d.). Available: http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf. Accessed 6 September 2014.

141. Barnosky AD, Koch PL, Feranec RS, Wing SL, Shabel AB (2004) Assessing the causes of Late Pleistocene extinctions on the continents. Science 306: 70–75.

142. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

143. Farber S, Callas RL, Yaeger JS, Schwartz MK, Pilgrim K, et al. (2010) Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report. Yreka Fish and Wildlife Office, Yreka, California: USDI Fish and Wildlife Service.

144. Wengert GW, Gabriel MW, Matthews SM, Higley JM, Sweitzer R, et al. (2013) Intraguild Predation on Fishers in California: Patterns of Predation by Three Larger Carnivores. Rev J Wildl Manag.

145. Buck SG (1982) Habitat utilization by fisher (Martes pennanti) near Big Bar, California [Master's Thesis]. Arcata, CA: Humboldt State University.

146. Wengert GM (2013) Ecology of intraguild predation on fishers (Martes pennanti) in California UNIVERSITY OF CALIFORNIA, DAVIS. Available: http://gradworks.umi.com/36/14/3614292.html. Accessed 4 September 2014.

147. Williams ES (2001) Canine distemper. In: Williams ES, Barker RICK, editors. Infectious diseases of wild mammals. Ames, Iowa: Iowa State University Press. p. 50.

148. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

149. Williams ES, Thorne ET, Appel MJ, Belitsky DW (1988) Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. J Wildl Dis 24: 385–398.

150. Timm SF, Munson L, Summers BA, Terio KA, Dubovi EJ, et al. (2009) A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). J Wildl Dis 45: 333–343.

151. Origgi FC, Plattet P, Sattler U, Robert N, Casaubon J, et al. (2012) Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Vet Pathol Online 49: 913–929.

152. Gabriel MW, Wengert GM, Matthews SM, Higley JM, Foley JE, et al. (2010) Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). J Wildl Dis 46: 966–970.

153. Gabriel MW, Wengert GW, Brown RN (2012) Pathogens and parasites of Martes species: Management and conservation implications. In: Aubry KB, Zielinski WJ,

Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press. pp. 138–185.

154. Burns R, O'Toole ESWD, 2003 JPD (n.d.) Toxoplasma gondii infections in captive black-footed ferrets (Mustela nigripes), 1992–1998: clinical signs, serology, pathology, and prevention. J Wildl Dis 39: 787–797.

155. Pridham TJ, Belcher J (1958) Toxoplasmosis in mink. Can J Comp Med Vet Sci 22: 99–106.

156. Cole RA, Lindsay DS, Howe DK, Roderick CL, Dubey JP, et al. (2000) Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). J Parasitol 86: 526–530.

157. Larkin JL, Gabriel M, Gerhold RW, Yabsley MJ, Wester JC, et al. (2011) Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. J Parasitol 97: 425–429. doi:http://dx.doi.org/10.1645/GE-2623.1.

158. Brown RN, Gabriel MW, Wengert GW, Matthews S, Higley JM, et al. (2008) Pathogens associated with fishers. Final Report USFWS-813335G021. Yreka, CA.

159. Williams ES, Mills K, Kwiatkowski DR, Thorne ET, Boerger-Fields A (1994) Plague in a black-footed ferret (Mustela nigripes). J Wildl Dis 30: 581–585.

160. Weinmann R, Raskas HJ, Roeder RG (1974) Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proc Natl Acad Sci 71: 3426–3430.

161. Clifford DL, Woods L, Gabriel MW, Tkach V, Hoberg E, et al. (2012) Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

162. CDOF (2011) E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. Sacramento, California: State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-6/2000-10/.

163. CDOF (1991) E-6 County Population Estimates and Components of Change— July 1, 1970–1990. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/view.php#objCollapsiblePanelEstimatesAnchor.

164. CDOF (2013) E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php.

165. CDOF (2013) Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

166. Bunn D, Mummert A, Hoshovsky M, Gilardi K, Shanks S (2007) California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

167. FRAP (2003) The changing California: Forest and range 2003 assessment. CalFire. Available: http://frap.fire.ca.gov/data/assessment2003/index.html.

168. Duane TP (1996) Human Settlement 1850-2040. In: Center WR, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. Davis, CA, USA.: University of California.

169. Theobald D (2005) Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecol Soc 10.

170. Garroway CJ, Bowman J, Wilson PJ (2011) Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Mol Ecol 20: 3978–3988.

171. Safford HD (2006) Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report. Vallejo, California: USDA Forest Service, Pacific Southwest Region.

172. Stephens SL, Sugihara NG (2006) Fire management and policy since European settlement. Fire in California's Ecosystems. Berkeley, California: University of California Press. pp. 431–443.

173. Show SB, Kotok EI (1923) Forest fires in California, 1911-1920: an analytical study. Washington D.C., USA: US Department of Agriculture. Available: http://scholarsarchive.library.oregonstate.edu/jspui/handle/1957/11024. Accessed 11 October 2013.

174. Stephens SL, Martin RE, Clinton NE (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. For Ecol Manag 251: 205–216. doi:http://dx.doi.org/10.1016/j.foreco.2007.06.005.

175. Taylor AH, Skinner CN (1998) Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. For Ecol Manag 111: 285–301.

176. Anderson MK (2006) The use of fire by Native Americans in California. In: Sugihara NG, Van Wagtendonk JW, Shaffer KE, Fites-Kaufman J, Thode AE, editors. Fire in California's Ecosystems. University of California Press. p. 596.

177. Martin RE, Sapsis DB (1992) Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

178. Miller JD, Safford HD, Crimmins M, Thode AE (2009) Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12: 16–32.

179. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW (2006) Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

180. Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecol Appl 22: 184–203.

181. Zhang J, Webster J, Powers RF, Mills J (2008) Reforestation after the Fountain Fire in Northern California: An Untold Success Story. J For 106: 425–430.

182. LANDFIRE-Fire Regime Product Descriptions (n.d.). Available: http://www.landfire.gov/NationalProductDescriptions13.php. Accessed 4 September 2014.

183. Lawler JJ, Safford HD, Girvetz EH (2012) Martens and fishers in a changing climate. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press. pp. 371–397.

184. Fried JS, Torn, Mills E (2004) The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Clim Change 64: 169–191. doi:http://dx.doi.org/10.1023/B:CLIM.0000024667.89579.ed.

185. Westerling AL, Bryant BP, Preisler HK, Holmes TP, Hidalgo HG, et al. (2011) Climate change and growth scenarios for California wildfire. Clim Change 109: 445–463.

186. Mckenzie D, Gedalof Z, Peterson DL, Mote P (2004) Climatic Change, Wildfire, and Conservation. Conserv Biol 18: 890–902.

187. Krawchuk MA, Moritz MA (2012) Fire and Climate Change in California. Calif Energy Comm Publ Number CEC-500-2012-026.

188. Gabriel MW, Wengert GW, Higley JM, Krogan S (2013) Silent forests? Rodenticides on illegal marijuana crops harm wildlife. Wildl Prof Spring.

189. Gabriel MW, Woods LW, Poppenga R, Sweitzer RA, Thompson C, et al. (2012) Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

190. Alterio N (1996) Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. N Z J Zool 23: 331–338.

191. Moriarty JG, Riley PD, Sureiys LE, Sikich JA (2013) Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: from mountain lions to rodents. Proceedings of the 25th Vertebrate Pest Conference. Vol. 25. pp. 144–148.

192. Erickson WA, Urban DJ (2004) Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

193. Fisher P, O'Connor C, Wright G, Easton CT (2003) Persistence of four anticoagulant rodenticides in livers of laboratory rats. New Zealand Department of Conservation.

194. Riley SPD, Bromley C, Poppenga RH, Uzal FA, al et (2007) Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. J Wildl Manag 71: 1874–1884.

195. Cox P, Smith R. (n.d.) Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. 15th Vertebrate Pest Conference. Davis, CA, USA.: University of California.

196. Thompson C, Sweitzer R, Gabriel M, Purcell K, Barrett R, et al. (2013) Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conserv Lett.

197. Laas FJ, Forss DA, Godfreyi MER (1985) Retention of brodifacoum in sheep tissues and excretion in faeces. N Z J Agric Res 28: 357–359.

198. Godfrey MER, Lyman CP (1980) Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). N Z J Exp Agric 8: 1–5.

199. Munday JS, Thompson LJ (2003) Brodifacoum toxicosis in two neonatal puppies. Vet Pathol Online 40: 216–219.

200. Jansman H, van Tulden P (2012) Persecution and poisoning of birds of prey in the Netherlands. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 139–142.

201. Mineau P, Lyon L, McMillin S (2012) Impacts of carbofuran on birds in Canada and the United States. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 219–222.

202. Anderson B, Borges S, Graber K, Hartless C, Housenger J, et al. (2011) Risks of non-compliant rodenticides to nontarget wildlife. Washington D.C., USA: United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division.

203. Berny PJ, Buronfosse T, Buronfosse F, Lamarque F, Lorgue G (1997) Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35: 1817–1829.

204. Ruder MG, Poppenga RH, Bryan JA, Bain M, Pitman J, et al. (2011) Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. J Wildl Dis 47: 212–216.

205. Janeway CA, Travers P, Walport M (2007) Immunobiology. 7th ed. New York, New York, USA: Garland Science.

206. Li Q, Kawada T (2006) The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cell Mol Immunol 3: 171–178.

207. Zabrodskii PF, Lim VG, Strel'tsova EV (2012) Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksp Klin Farmakol 75: 35.

208. Vidal D, Alzaga V, Luque-Larena JJ, Mateo R, Arroyo L, et al. (2009) Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Sci Total Environ 408: 267–271. doi:http://dx.doi.org/10.1016/j.scitotenv.2009.10.001.

209. Gordon CJ (1994) Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicol Teratol 16: 427–453.

210. Grue CE, Hart ADM, Mineau P (1991) Biological consequences of depressed brain cholinesterase activity in wildlife. In: Mineau P, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Amsterdam, Netherlands: Elsevier Science Publishers. pp. 151–209.

211. Ahdaya SM, Shah PV, Guthrie FE (1976) Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicol Appl Pharmacol 35: 575–580.

212. Martin PA, Solomon KR (1991) Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pestic Biochem Physiol 40: 117–127.

213. Hayward MW, Jedrzejewski W, Jedrzewska B (2012) Prey preferences of the tiger Panthera tigris. J Zool 286: 221–231. doi:http://dx.doi.org/10.1111/j.1469-7998.2011.00871.x.

214. Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE (2004) Tigers and their prey: predicting carnivore densities from prey abundance. Proc Natl Acad Sci U S A 101: 4854–4858.

215. Knick ST (1990) Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildl Monogr: 3–42.

216. Knick ST, Hellgren EC, Seal US (1993) Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Can J Zool Can Zool 71: 1448–1453.

217. Colvin, B., Jackson W. (1991) Secondary poisoning hazards associated with rodenticide use. In: Magallona E., editor. 11th International Congress Plant Protection. Manila, Phillipines.

218. Pachauri RK, Reisinger A (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergov Panel Clim Change 1.

219. Solomon S, Qin D, Manning M, ALLEY R, BERNTSEN T, et al. (2007) Technical Summary. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press. pp. 19–91.

220. Bonfils C, Duffy PB, Santer BD, Wigley TML, Lobell DB, et al. (2008) Identification of external influences on temperatures in California. Clim Change 87: 43–55. doi:10.1007/s10584-007-9374-9.

221. Tingley MW, Koo MS, Moritz C, Rush AC, Beissinger SR (2012) The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Glob Change Biol 18: 3279–3290.

222. Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, et al. (2013) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Clim Dyn 40: 839–856. doi:http://dx.doi.org/10.1007/s00382-012-1337-9.

223. Cayan D, Tyree M, Pierce D, Das T (2012) Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

224. Littell JS, Elsner MM, Mauger G, Lutz E, Hamlet AF, et al. (2011) Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. University of Washington, College of the Environment.

225. Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. (2004) Emissions pathways, climate change, and impacts on California. Proc Natl Acad Sci U S A 101: 12422–12427.

226. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, et al. (2007) Regional climate projections. In: Susan S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, Vol. 4.

227. Cayan D, Tyree M, Dettinger M, Hidalgo H, Das T, et al. (2009) Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. Calif Clim Change Cent CEC-500-2009-014-D.

228. Pierce DW, Cayan DR, Das T, Maurer EP, Miller NL, et al. (2013) The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. J Clim. Available: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00766.1. Accessed 14 October 2013.

229. Halofsky JE, Peterson DL, O'Halloran KA, Hawkins-Hoffman C (2011) Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available: http://www.treesearch.fs.fed.us/pubs/38702. Accessed 14 October 2013.

230. Salathe EP, Leung Lr, Qian Y, Zhang Y (2010) Regional climate model projections for the State of Washington. Clim Change 102: 51–75. doi:http://dx.doi.org/10.1007/s10584-010-9849-y.

231. Ralph M (2011) Water supply and flooding. In: Pierce DW, editor. California Climate Extremes Workshop Report. La Jolla, CA: Scripps Institution of Oceanography.

232. Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, et al. (2009) The velocity of climate change. Nature 462: 1052–1055. doi:10.1038/nature08649.

233. Moritz C, Agudo R (2013) The Future of Species Under Climate Change: Resilience or Decline? Science 341: 504–508. doi:10.1126/science.1237190.

234. Lenihan JM, Drapek R, Bachelet D, Neilson RP (2003) Climate change effects on vegetation distribution, carbon, and fire in California. Ecol Appl 13: 1667–1681.

235. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al. (2011) The impact of climate change on California's ecosystem services. Clim Change 109: 465–484. doi:10.1007/s10584-011-0313-4.

236. Koopman ME, Nauman RS, Leonard JL (2010) Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

237. Burns CE, Johnston KM, Schmitz OJ (2003) Global climate change and mammalian species diversity in U.S. national parks. Proc Natl Acad Sci 100: 11474–11477.

238. Littell JS, Oneil EE, McKenzie D, Hicke JA, Lutz JA, et al. (2010) Forest ecosystems, disturbance, and climatic change in Washington State, USA. Clim Change 102: 129–158. doi:http://dx.doi.org/10.1007/s10584-010-9858-x.

239. Spies TA, Giesen TW, Swanson FJ, Franklin JF, Lach D, et al. (2010) Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landsc Ecol 25: 1185–1199. doi:http://dx.doi.org/10.1007/s10980-010-9483-0.

240. Paradis A, Elkinton J, Hayhoe K, Buonaccorsi J (2008) Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitig Adapt Strateg Glob Change 13: 541–554.

241. Safranyik L, Carroll AL, Regniere J, Langor DW, Riel WG, et al. (2010) Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Can Entomol 142: 415–442.

242. Trần JK, Ylioja T, Billings RF, Régnière J, Ayres MP (2007) Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecol Appl 17: 882–899.

243. Vose JM, Peterson DL, Patel-Weynand T (2012) Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

244. USDA Forest Service, USDI Bureau of Land Management (1994) Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team]. 569 p. Available: http://archive.org/details/finalsupplementa03v1unit. Accessed 2 September 2014.

245. USDA Forest Service, USDI Bureau of Land Management (1994) Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

246. The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data (n.d.). Available: http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml. Accessed 5 September 2014.

247. Sulak A, Huntsinger L (2012) Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. J For 110: 312–317.

248. Smith T (2014) What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. Available: http://snamp.cnr.berkeley.edu/teams/fisher. Accessed 1 September 2014.

249. Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics (n.d.). Available: http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/. Accessed 1 September 2014.

250. USDI Bureau of Land Management (2008) Sierra Resource Management Plan and Record of Decision. Folsom, CA: Bureau of Land Management.

251. Hannibal ME (2012) America's Next Best Idea: The National Park System Looks to the Future. George Wright Forum 29: 380–384.

252. FSC Forest Stewardship Council U.S. (FSC-US) · Our History (n.d.). Available: https://us.fsc.org/our-history.180.htm. Accessed 2 September 2014.

253. FSC Forest Stewardship Council U.S. (FSC-US) · Mission and Vision (n.d.). Available: https://us.fsc.org/mission-and-vision.187.htm. Accessed 2 September 2014.

254. preview.fsc-certified-acres-by-state.a-204.pdf (n.d.). Available: https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf. Accessed 2 September 2014.

255. IUCN, SSC (2013) Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

256. Callas RL, Figura P (2008) Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. Sacramento, California: California Department of Fish and Game.

257. Gould GI, Escallier J (1989) Licensed trapper's and dealer's report. Sacramento, California: California Department of Fish and Game.

258. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

Conservation Biology Institute

CONSERVATION BIOLOGY INSTITUTE

A 501(c)3 tax-exempt organization

815 Madison Avenue
San Diego, California 92116
Phone: (619)296-0164
Email: *wdspencer@consbio.org*
www.consbio.org

November 23, 2014

To: Richard Callas, California Department of Fish and Wildlife

Subject: Comments on Draft Status Review of the Fisher in California

Thank you for the opportunity to review and comment on the October 1, 2014, draft status review of the fisher in California. The Conservation Biology Institute is a nonprofit research and planning institution that performs applied research and provides scientific guidance and review for conservation plans. I am an ecologist and wildlife conservation biologist with over 30 years of ecological research experience in California and the west. I have led a variety of studies concerning fishers and fisher habitat in California, and I serve as the chair of the Fisher Technical Team that is developing a conservation strategy for the southern Sierra Nevada fisher population.

General Comments

The status review is generally thorough and well written, but there is room for improvement in many sections and in the overall approach to assessing threats to the species and determining its conservation status. I have made a few suggested changes and inserted many comments in "track changes" within the draft document. A few over-arching concerns:

Additional fisher assessments and conservation efforts

There is much recent and ongoing planning and analysis concerning fisher conservation in California that seems to be ignored in the status review. In particular, there is a collaborative, multi-agency effort underway to create a southern Sierra Nevada Fisher Conservation Strategy (SSNFCS)[1] that is not even mentioned in the status review, despite that CDFW is one of the agencies represented on the SSNFCS Fisher Interagency Leadership Team (FIALT). The team has produced a SSN Fisher Conservation

[1] http://www.fs.usda.gov/detail/r5/plants-animals/wildlife/?cid=STELPRDB5426714

Assessment (SSNFCA) and is currently drafting a Conservation Strategy based on the Assessment. The SSNFCA provides more updated and in-depth reviews of fisher research and monitoring efforts in the region than does the status review, including a much more detailed and nuanced review of fisher habitat requirements and threats to fishers and fisher habitat. The SSNFCA is currently being finalized based on independent peer review and will be provided to CDFW when complete (expected by December 15, 2014). I recommend reviewing that document and incorporating relevant information, as suggested in numerous comments I inserted in the draft status review.

The status review also does not acknowledge nor appear to benefit from the extensive deliberations and information sharing by two fisher working groups in California: the California Fisher Working Group and the SSN Fisher Working Group. These groups meet at least annually (generally in association with the annual conference of the Western Section of The Wildlife Society) to provide updates on fisher research findings and issues and discuss important aspects of fisher conservation. The SSNFWG also maintains a list of fisher research and monitoring priorities (available upon request). It seems that these existing conservation planning efforts and collaborations should at least be described in the section of the status review entitled Existing Management, Monitoring, and Research Activities.

<u>Lack of justification for "not warranted" opinion</u>

The current draft of the status review does not present a conclusion as to whether fishers throughout California, or in either of the two identified Evolutionarily Significant Units (ESUs), are warranted for listing. However, the cover letter soliciting my peer review of the document states that the Department believes that listing is "not warranted." Despite a lengthy review of possible threats to fishers, the status review provides no comprehensive or integrative analysis to support a listing determination one way or another. The Department should lay out a comprehensive and transparent analysis of how these various threats may cumulatively affect the likely extirpation of fishers in each ESU as a basis for determining whether listing is warranted.

I am not suggesting what the results of such an analysis should be, but it seems clear that the SSN ESU, at least, is threatened with possible extirpation due to its small size, narrow habitat arrangement, reduced genetic diversity, diverse and synergistic mortality factors, and threats of very large and severe wildfires and other disturbances that can fragment the population into even smaller and more isolated subpopulations. As detailed in the SSNFCA, fisher dispersal across major canyons is already rare, especially for female fishers (Tucker et al. 2014), and recent wildfires (e.g., the Rim, French, and Aspen fires) have probably exacerbated the situation. Because the SSN fisher population is already genetically depauperate and subdivided (Tucker et al. 2014), such events greatly increase the probability of local extirpations and ultimately extirpation of the entire SSN ESU. Such synergistic events and processes should be carefully considered by the Department in its analysis of conservation status. Currently, the status simply reviews the nature of various threats as if they are independent of one another, without considering how they interact to affect the population as a whole.

Oversimplification of fisher habitat requirements

The status review states multiple times that fishers "are not dependent on old-growth forests" and that fishers use a wide variety of forest types and seral stages. As far as they go, such statements may be true, but they are not sufficiently balanced by the large amount of scientific evidence suggesting that dense, late-seral forests provide superior habitat conditions for fishers, and may well be required to sustain a breeding population. Note that simply observing a fisher in a particular habitat type (e.g., in early seral or open canopied forest) doesn't imply that such a type is "suitable" to support a fisher home range or to sustain a population.

Sections of the status review pertaining to habitat use and essential habitat elements could be improved by reducing reliance on the general, rangewide fisher literature and studies from outside California, and focusing more on recent habitat studies in California, some of which appear to be missing from these sections. See the SSNFCA for additional literature review.

The SSNFCA also provides updated habitat models at various scales, including separate models for fisher foraging, resting, denning, and dispersal habitats. Fishers, especially males, will occasionally forage in or disperse through vegetation types that do not provide all their life requisites. However, female home ranges are closely associated with large areas of dense, mature forests; and natal and maternal dens are highly constrained to being in areas of very dense, often multi-storied, canopies in mature forest stands supporting very large trees and dead wood structures. On average, ~80% of the area of breeding female home ranges in the SSN consist of CWHR High Reproductive Fisher Habitat Value (CWHR classes 4D, 5M, 5D, and 6)[2].

Insufficient analysis of some listing factors

The review is very uneven in its treatment of various threats and the listing factors, with lengthy reviews of some factors not considered by scientists to be very high threats, and more cursory reviews of other factors that are considered of greater concern. For example, the review has a lengthy description of historic trapping effects on fishers even though fisher trapping has long been banned in California and is no longer considered a threat in the state. Similarly, there is a lengthy review of fisher diseases, although diseases are not necessarily considered an imminent threat to fisher persistence, and monitoring for and attempting to counter disease outbreaks would be very difficult and costly (D. Clifford, personal communications).

[2] Spencer et al., unpublished analysis of 83 adult female home ranges from three radio-telemetry studies in the SSN ESU as part of the SSN Fisher Conservation Strategy.

In contrast, the review of fire as a threat—while heavy on the history of fire and fire management in the state and with some discussion of possible effects of fire on fisher habitat elements—provides inadequate treatment of the biggest concern, which is loss and fragmentation of habitat over large areas by very large and severe fires (Scheller et al. 2011). A major focus of the SSN Fisher Conservation Strategy is restoring more naturally heterogeneous habitat conditions that are less likely to support very large, severe fires. Similarly, the review provides a lot of information about historic and current logging patterns in California, with some treatment of possible effects on fishers, but it seems to ignore that commercial timber harvest is just one of many sorts of vegetation management actions that affect fisher habitat, many of which are more common and widespread than logging, at least in the SSN.

In the review of fisher diets, the review mentions that porcupines and lagomorphs are uncommonly found in fisher diets in California, compared to other regions. This observation deserves elaboration, especially since porcupines appear to have been extirpated from large areas of the Sierra Nevada, including within the SSN ESU. The department should investigate this in more detail and evaluate the causes, including whether rodenticide poisoning associated with marijuana grow sites may be contributing to the loss of porcupines from large areas. Not only are porcupines an important prey species in other portions of the fisher's geographic range, they are also "ecosystem engineers" that help recruit essential habitat elements (deformed trees, platforms, cavities, etc.) for fishers and other wildlife.

<u>Poor organization in some sections</u>

I've inserted comments suggesting reorganization and shortening of some sections of the review to reduce redundancy and enhance clarity. Some sections provide lengthy historical reviews of information not directly germane to current and future threats to fishers (e.g., the history of federal fire policies and state trapping policies). Such information could be conveyed more briefly to establish context for what is really important: what are the current and future conditions as they pertain to fisher conservation or extirpation?

The section on habitat use could be shorter and clearer if organized using the scalar hierarchy summarized in Table 1. Also, see the SSNFCA for updated habitat models, including separate models for fisher foraging, resting, denning, and dispersal habitats. The review should recognize the importance of these various functional habitat categories, and that female denning habitat is the most limiting and most important to sustaining a population. Also critical is maintaining and improving potential dispersal habitat between areas suitable for supporting breeding females.

The section on population trends in California should be reorganized to more clearly reflect what is known or not about trends in the two ESUs. Currently, the section switches inconsistently between discussions concerning different general regions of the state (northern, southern, northwestern, etc.), specific ecoregions (Klamath, East

Fransiscan, etc.), individual counties, or even local study areas without clearly contrasting or discussing their implications for the ESUs or the state as a whole. Because the environmental contexts and threats differ greatly between the two ESUs, they should be addressed in separate subsections for clarity. The review should start with the broadest scales for context and step down to finer-scale assessments or specific study areas that provide insights on the regional trends. For example, the discussion of trends for the SSN ESU should begin with an overview of information pertaining to historic range contraction and some re-expansion at the range scale, followed by recent occupancy trends within the current ESU area and in three recognized population subdivisions of the ESU (Zielinski et al. 2013), followed by discussions of more local or fine-grained patterns from field studies within the ESU.

Conclusions

For the most part, the status review provides a useful first-cut overview of the status of fishers in California, but it should be updated to reflect recent literature, as well as unpublished analyses prepared for the SSNFCA and SSNFCS. The revision should focus more specifically on the conservation implications of available information for the two identified ESUs. It should also establish and follow a transparent and objective analytical framework that integrates all the various threats to each ESU in a biologically meaningful way. Although a formal, quantitative population viability analysis for each ESU would be preferable, even an informal but structured assessment of how various threats may interact to affect population status and trends would be an improvement. Such an analysis should consider the specific geographic arrangements of habitats and threats in each ESU, such as the potential for fires, timber harvest, or other factors to fragment populations and increase extinction probabilities.

I hope the Department finds these comments useful. Please feel free to contact me for any clarifications.

Sincerely,

Wayne Spencer

Dr. Wayne D. Spencer
Director of Conservation Assessment and Planning

Literature Cited (here or in Tracked Changes)

Davis, F.W., C. Seo, and W.J. Zielinski. 2007. Regional variation in home-range-scale habitat models for fisher (*Martes pennanti*) in California. Ecological Applications 17:2195-2213.

Purcell, K.L., A.K. Mazzoni, S. Mori, and B.B. Boroski. 2009. Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. Forest Ecology and Management 258:2696-2706.

Scheller, R.M., W.D. Spencer, H. Rustigian-Romsos, A.D. Syphard, B.C. Ward, and J.R. Strittholt. 2011. Using stochastic simulation to evaluate competing risks of wildfires and fuels management on an isolated forest carnivore. Landscape Ecology 26:1491-1504.

Spencer, W.D., H.L. Rustigian, R.M. Scheller, A. Syphard, J. Strittholt, and B. Ward. 2008. Baseline evaluation of fisher habitat and population status, and effects of fires and fuels management on fishers in the southern Sierra Nevada. Unpublished report prepared for USDA Forest Service, Pacific Southwest Region. June 2008. 133 pp + appendices.

Spencer, W., H. Rustigian-Romsos, J. Strittholt, R. Scheller, W. Zielinski, and R. Truex. 2011. Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biological Conservation 144:788-803. DOI 10.1016/j.biocon.2010.10.027.

Thompson, C.M., R.A. Sweitzer, M.W. Gabriel, K. Purcell, R.H. Barrett, and R. Poppenga. 2013. Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conservation Letters 7(2):91-102. doi:10.1111/conl.12038.

Tucker, J.M., M.K. Schwartz, R.L. Truex, S.M. Wisely, and F.W. Allendorf. 2014. Sampling affects the detection of genetic subdivision and conservation implications for fisher in the Sierra Nevada. Conservation Genetics 15:123-136. doi:10/1007/s10592-013-0525-4.

Zhao, F., R.A. Sweitzer, Q. Guo, and M. Kelly. 2012. Characterizing habitats associated with fisher den structures in the southern Sierra Nevada, California using discrete return lidar. Forest Ecology and Management 280:112-119.

Zielinski, W.J., R.L. Truex, G.A. Schmidt, F.V. Schlexer, K.N. Schmidt, and R.H. Barrett. 2004a. Home range characteristics of fishers in California. Journal of Mammalogy 85(4):649-657.

Zielinski, W.J., R.L. Truex, G.A. Schmidt, F.V. Schlexer, K.N. Schmidt, and R.H. Barrett. 2004b. Resting habitat selection by fishers in California. Journal of Wildlife Management 68(3):475-492.

Zielinski, W.J., R.L. Truex, J.R. Dunk, and T. Gaman. 2006. Using forest inventory data to assess fisher resting habitat suitability in California. Ecological Applications 16:1010-1025.

Zielinski, W.J., A.N. Gray, J.R. Dunk, J.W. Sherlock, and G.E. Dixon. 2010. Using forest inventory and analysis data and the forest vegetation simulator to predict and monitor fisher (Martes pennanti) resting habitat suitability. USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-232.

Zielinski, W.J., J.A. Baldwin, R.L. Truex, J.M. Tucker and P.A. Flebbe. 2013. Estimating trend in occupancy for the southern Sierra fisher *Martes pennanti* population. Journal of Fish and Wildlife Management 4(1):3-19. e1944-687x. doi:10:3996/012012-JFWM-002.

Comments from W. Spencer

STATE OF CALIFORNIA

NATURAL RESOURCES AGENCY

DEPARTMENT OF FISH AND WILDLIFE

CONFIDENTIAL DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [*Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

October 1, 2014

Table of Contents

List of Figures

List of Tables

List of Appendices

(to be completed)

Appendix 1 – Public Notice
Appendix 2 – Peer Review Solicitation Letters
Appendix 3 – Public Comment Letters
Appendix 4 – Peer Review Comments

Acknowledgments

(to be completed)

This report was prepared by: ______________________

Cover photograph © J. Mark Higley, Hoopa Tribal Forestry, used with permission.

Report to the Fish and Game Commission
A Status Review of the Fisher in California
_______, 2014

Executive Summary

This document describes the current status of the fisher (Pekania pennanti) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act. On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department of Fish and Game, as it was then named (now called the Department of Fish and Wildlife) (Department), commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Despite being the most valuable furbearer in the state, trappers only reported taking 46 animals from 1920-1924. In addition to trapping, the decline of fishers has also been attributed to logging activities which may render habitats unsuitable for them.

Early researchers believed that the range of fishers in the late 1800s extended from the Oregon border south to Marin County through the Klamath Mountains and the Coast Range as well as through the southern Cascades to the southern Sierra Nevada Mountains. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to European settlement. The location and size of the gap separating these populations is unknown. However, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Formatted: Not Highlight

Currently fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population). Fishers are also found in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN Fisher ESU) from fishers in northern California (NC Fisher ESU) and the degree of genetic differentiation between them. Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals.

Comment [W1]: Need a citation. If the high estimate is from the Self et al., analysis, it is highly dubious.

Early work on fishers appeared to indicate that fishers required particular forest types (e.g., old-growth conifers) for survival. However, studies of fishers over the past two decades have demonstrated that they are not dependent on old-growth forests per se, nor are they associated with any particular forest type. Fishers are typically found at low- to mid-elevations characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Comment [W2]: Not dependent on old-growth per se, but scientific evidence (e.g., female home range size and placement) suggests old growth conditions may be optimal, and second-young growth not as good.

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used for resting (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning and the presence of a suitable cavity appears to be more important than the species of

tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (> 100 years) may be needed for trees to attain sufficient size and for a cavity large enough for a female fisher and her young to develop. Although the number of den and rest structures needed by fisher is not well known, a substantial reduction in these important habitat elements would likely reduce the distribution and abundance of fisher in the state.

Primary threats to fishers within the NC and SSN Fisher ESUs include habitat loss, toxicants, wildfire, and climate change. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests. However, fishers are widespread on public and private lands harvested for timber. A concern for the long-term viability of fishers across their range in California is the presence of suitable den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California.

Comment [W3]: Widespread doesn't necessarily imply healthy, thriving, or resilient.

Comment [W4]: May be true, but there is also evidence that fisher populations would be larger/more resilient with increased habitat quality and quantity.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service or the National Park Service. Private lands within the NC Fisher ESU and the SSN Fisher ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher contracted substantially. This difference is due to the apparent absence of fishers from the central, and portions of the northern, Sierra Nevada. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Comment [W5]: Clarify: evidence of increase ~1990s-2000s, but no evidence of expansion in past 10 years in SSN. Any evidence for this in north?

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and to other toxicants. ARs used at illegal marijuana cultivation sites have caused the deaths of some fishers and ARs may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population.

Comment [W6]: Disagree with this statement. Strong evidence that exposure reduces individual fitness and may be limiting population resilience/expansion (e.g., Thompson et al. 2013).

In recent decades the frequency, severity, and extent of wildfires has increased in California. This trend could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due to that population's small size, the linear distribution of the habitat available, and the potential for fires to increase in frequency under scenarios where the climate warms.

Comment [W7]: May be true, but it conflicting analyses about historic conditions, etc.

Climate research predicts continued climate change through 2100, with rates of change faster than occurred during the previous century. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate related changes that may occur within the range of the fisher in California. The SSN Fisher ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU, due to its comparatively small population size and susceptibility to fragmentation. However, the effects of climate change on fisher populations are unknown, will likely vary throughout the species' range, and the severity of those effects will vary depending on the extent and speed with which warming occurs.

Regulatory Framework

Petition Evaluation Process

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3) The Commission received the petition and, pursuant to Fish & G. Code § 2073, referred the petition to the Department for its evaluation and recommendation. (*Id.*, § 2073) On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*) as Threatened

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[2].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[3].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[4]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[5, 6].

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[7].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (APA) (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA,

---

[2] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[3] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[4] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

[6] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[7] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

subject to various terms and conditions[8]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[9]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[10]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its Status Review and the best science available to the Department that designating fisher as a threatened or endangered species under CESA was not warranted[11]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[12].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[13]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related

[8] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[9] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[10] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

[11] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[12] *Id.*, § 670.1, subd. (g).

[13] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[14]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as an endangered or threatened species under CESA was not warranted[15]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[16].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[17] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

---

[14] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

[15] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[16] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[17] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[18]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[19]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its February 2010 status review of the species. This report represents the Department's revised status review, based on the best scientific information available and including independent peer review by scientists with expertise relevant to the status of the fisher (Appendix X).

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail [1]. They typically appear uniformly black from a distance, but in fact are dark brown over most of their bodies with white or cream patches distributed on their undersurfaces [2]. The fur on the head and shoulder may be grizzled with gold or silver, especially in males [1]. The fisher's face is characterized by a sharp muzzle with small rounded ears [3] and forward facing eyes indicating well developed binocular vision [2]. Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0-2.5 kg (4.4-5.5 lbs) and range in length from 70-95 cm (28-34 in) and males weigh between 3.5-5.5 kg (7.7-12.1 lbs) and range from 90-120 cm (35-47 in) long [2].

[18] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh about 500-1400 g (1-3 lbs) and range in total length from about 50-68 cm (20-27 in) [4]. Fishers have a single molt in late summer and early fall, and shedding starts in late spring [2]. American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers [5].

Fishers are seldom seen, even where they are abundant. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground [6]. Females, perhaps because of their smaller body size, are more arboreal than males [2,7,8].

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the mustelidae includes wolverine, marten, weasel, mink, skunk, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America; *M. p. pennanti* [9], *M. p. columbiana* [10]; and *M. p. pacifica* [11]. However, the validity of these subspecies has been questioned [3] and [12].

More recently, genetic studies indicate that the fisher is more closely related to wolverine (*Gulo gulo*) and tayra (*Eira barbara*) of Central and South America than to other species of *Martes* [13–19]. Based on those findings, fishers have been reclassified along with wolverine and tayra into the genus *Pekania* [15,19]. In this report, we use *Pekania pennanti* as the taxonomic designation for native fishers in California.

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell [2] thought the most likely possibility was that the name originated with European settlers who noted the similarity between fishers and European polecats, which were also known as fitch ferrets. Many other names have been used for fisher including pekan, pequam, wejack, Pennant's marten, black cat, tha cho (Chippewayan), uskool (Wabanaki), otchoek (Cree), and otschilik (Ojibwa) [2]. In the native language of the Hoopa people, fisher are known as 'ista:ngq'eh-k'itiqowh [20].

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago [21]. Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) [22]. During the late Holocene which began about 4,000 years ago, fishers expanded into western North America [23], presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to European settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 1). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and coniferous forest ecosystems in western North America [24].

By the 1800s and early 1900s the fisher's range was generally greatly reduced due to trapping and large scale anthropogenic influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss [2,24,25]. However, fishers have reoccupied much of the area lost during the early 1900s, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York [25].

Native populations of fisher currently occur in Canada, the western United States (Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada [26].

Historical Range and Distribution in California

Our knowledge of the distribution of fishers in California is primarily informed by Grinnell et al. [3]. They described fishers in California as inhabiting forested mountains

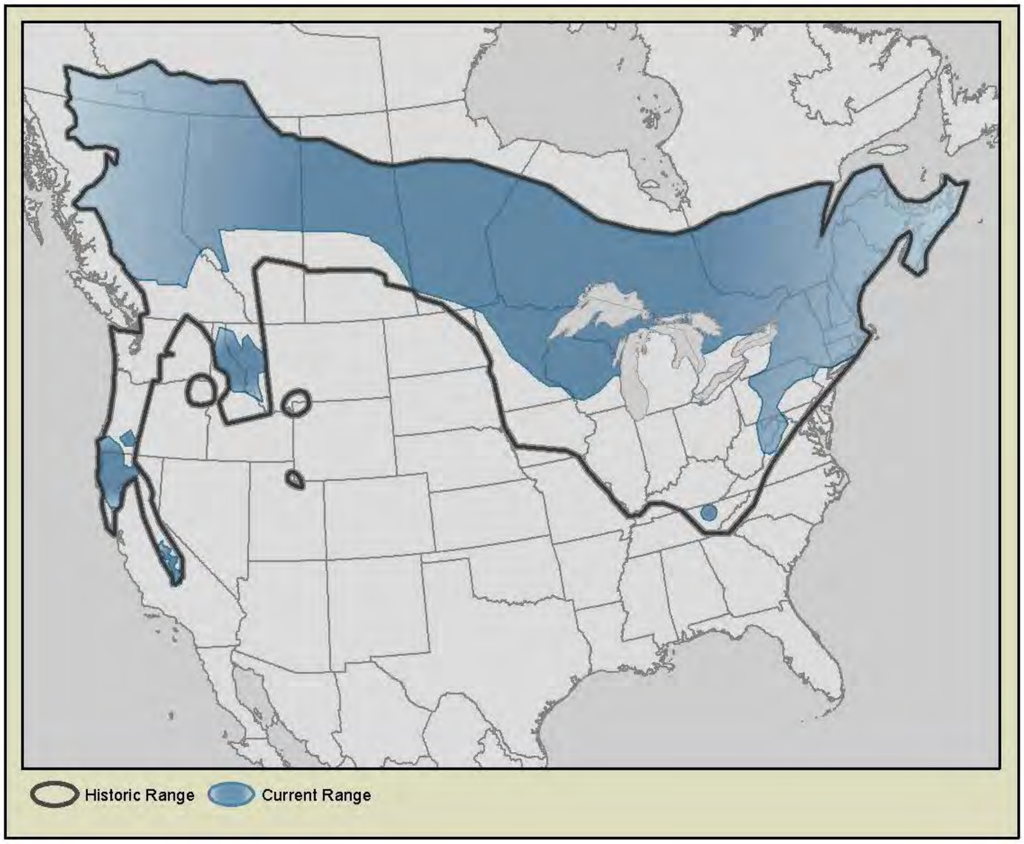


Figure 1. Presumed historical distribution (ca. 1600) and current distribution of fisher in North America. Historical distribution was derived from Giblisco [27]. Refer to Tucker et al. [28] and Knaus et al. [29] for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

Comment [W8]: Introduced populations on Olympic Peninsula and Stirling Tract not shown.

.

primarily at elevations between 610 m to 1824 m (2,000 - 5,000 ft) in the northern portions of their range and 1220 m to 2438 m (4,000 ft - 8,000 ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations. Fishers were believed to have ranged from the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County [3].

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919-1924, as well as a line demarcating what they assumed to be general range from approximately 1862-1937 (Figure 2). The point locations on the map were based on reports by trappers and the authors believed that almost all the locations were accurate, although they pointed out that some may have reflected the trapper's residence or post office. The map remains the best approximation of the distribution of fishers in California at that time, although it likely included areas unsuitable for fishers and excluded portions of the state occupied by the species.

Information presented by Grinnell et al. [3] suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. [3] appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included Lake, Marin, and Kern counties.

Evidence of fishers occupying the central and northern Sierra during the mid-1800s through the early 1900s is limited. In the northern Sierra, Grinnell et al. [3] showed two collections from Sierra County from 1919-1924. During that period in the central Sierra, Grinnell et al. reported one collection from Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County. All of these records, as well as one other record from northwestern Tuolumne County in the Tuolumne River watershed, are north of the current northern limit of the southern Sierra fisher population in the Merced River watershed.

Comment [W9]: Clarify what is meant by "collections." Are there museum specimens to verify ID and location, or do these include trapper accounts without verifiable specimens? Also, these are not shown as green on Figure 2 (as "… mentioned in text").

In the southern Cascades, Grinnell et al. [3] mentioned that fishers were trapped during the winters of 1920 and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. [30] reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National Park, near the junction of Lassen, Plumas, and Shasta counties. Additional historic records of fishers in the southern Cascades include two collections in 1897, from eastern Shasta County, that are located in the National

Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney.

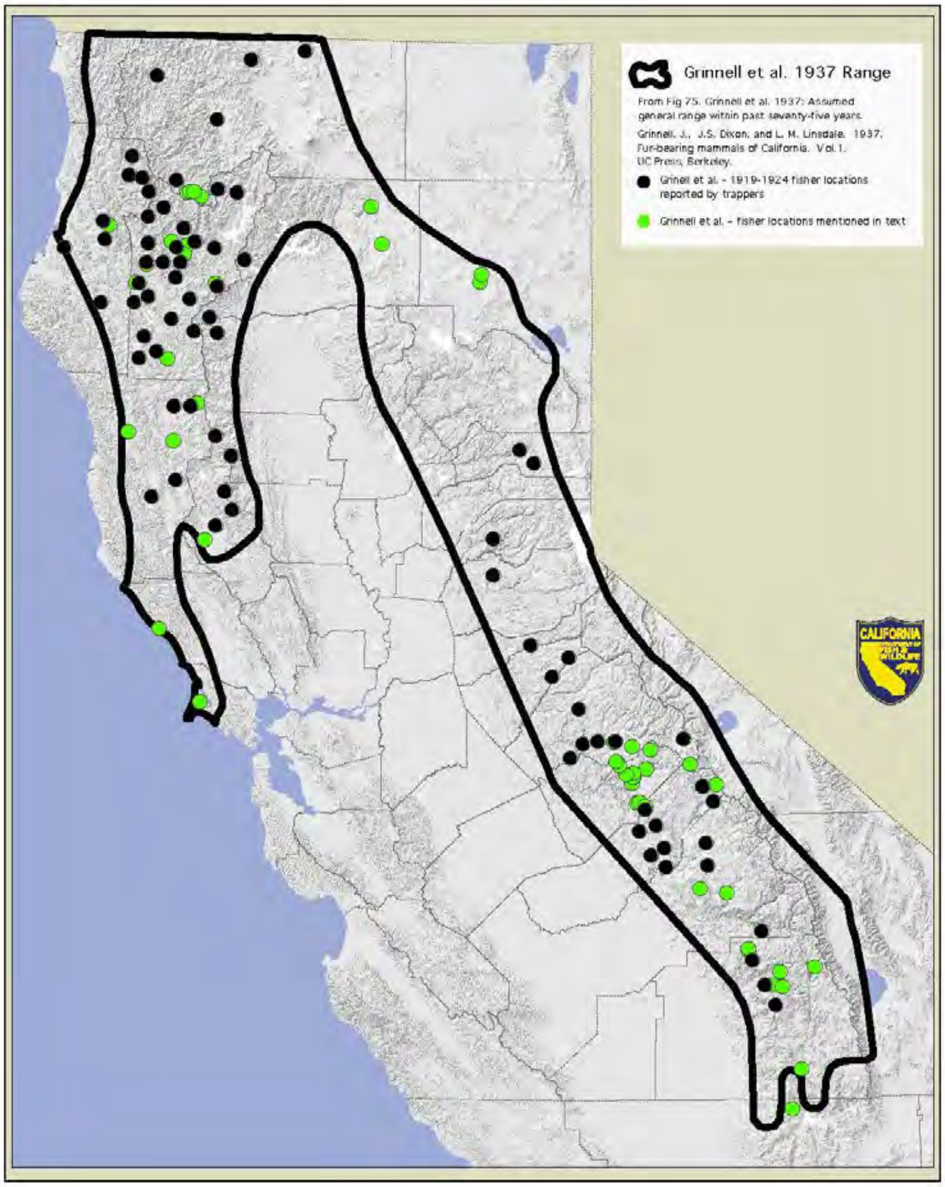


Figure 2. Assumed general range of the fisher in California from ~1850 -1925 from Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Comment [W10]: Note: some observations discussed in text are not shown as green on this figure.

Anecdotal evidence of fishers in the northern Sierra is provided in an 1894 publication describing the efforts of William Price to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada [31]. Price included notes on species that he did not collect but were "commonly known to the trappers." His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[20] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Additionally, when relevant, Price discusses more distant geographic localities for some species and their close relatives. If the fishers referenced were trapped at distant locations (e.g., the southern Sierra) it is likely those locations would have been mentioned. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred animals.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fisher in California is based on observations of the species through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

---

[20] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger [32] noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of species presence (remote cameras and track-plate boxes) [33]. In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* [34] to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be "verified" records (Figure 3). Undoubtedly, reports of

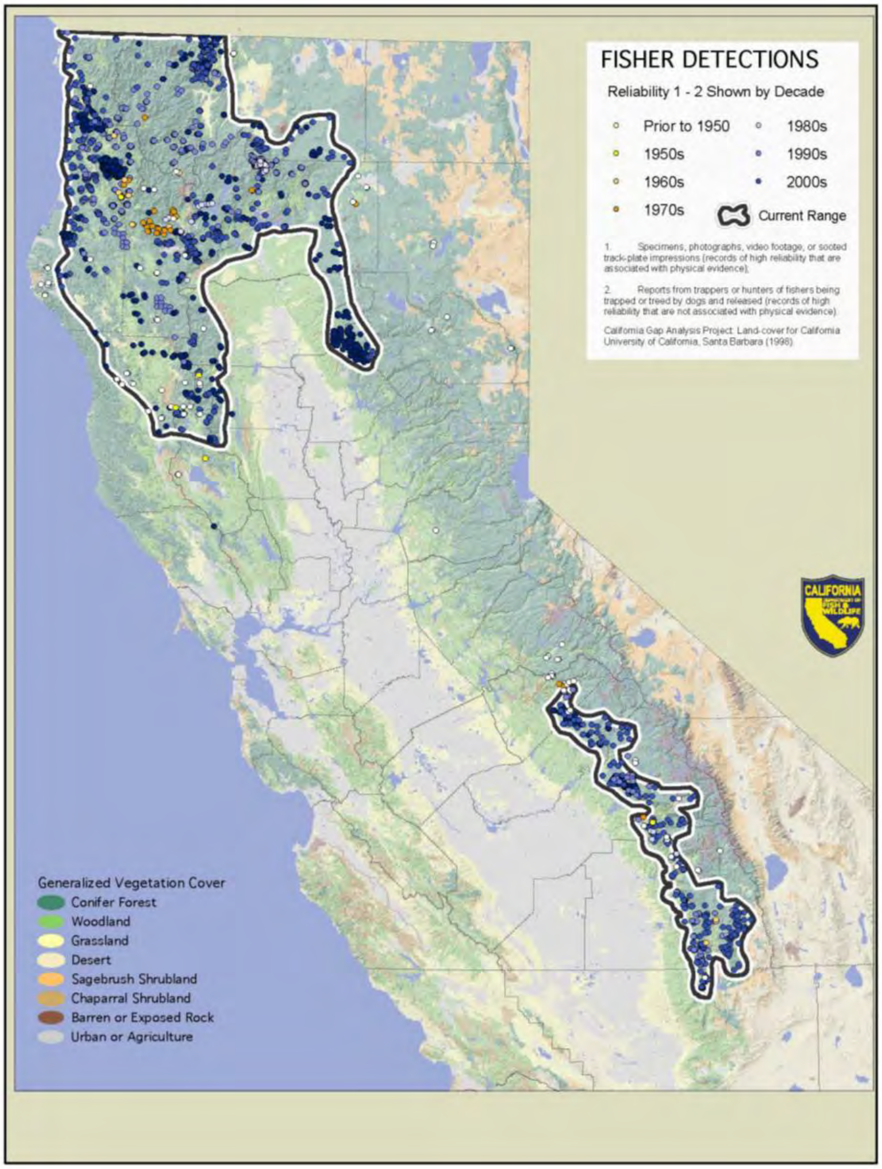


Figure 3. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis [34] were included. California Department of Fish and Wildlife, 2014.

Comment [W11]: Light colors difficult to differentiate.

fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state.

A number of broad scale, systematic surveys for fisher and other forest carnivores in the Sierra Nevada Mountains were conducted from 1989-1994 [35], from 1996-2002 [35], and from 2002-2009 (USDA 2006, USDA 2008, Truex et al. 2009). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. [35] expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction due to isolation than if they were connected to other populations. They offered several explanations to account for the lack of fishers in the region including trapping and elimination of habitat through railroad logging.

Zielinski et al. [35] could find no reason to suspect that fisher at one time did not occur where habitat was suitable throughout the Sierra Nevada and thought it likely that the fisher population had already been reduced by the time Grinnell [3] and his colleagues assessed its distribution. Price [31] supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell [3].

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the USDA Forest Service (USFS), private timber companies, and others, since the 1950s no verifiable detections of fishers have occurred in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River [35,36].

To approximate the current range of fishers in California, observations of fishers with high reliability were mapped from 1993 to the present. Those locations were overlaid using GIS on layers of forest cover and layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model) and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 3). This estimate of

current range is approximately 48% of the assumed historical range estimated by Grinnell et al. [3].

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (<5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice sheets [23]. By the late Holocene, records of fishers on the Pacific coast were common [37]. Wisely et al. [37] hypothesized that fishers then expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Currently, fishers in California occur in the northwestern portions of the state, the northern Sierra Nevada, and in the southern Sierra Nevada. Mitochondrial DNA (mtDNA) has been used in several studies to describe the genetic structure of fishers in the state [29,37,38]. Mitochondria are small maternally inherited structures in most cells that produce energy. Portions of the DNA contained within mitochondria known as D-loop regions contain nonfunctional genes and have been widely used in studies of ancestry because they are rich in mutations which are inherited. Early genetic studies of fishers by Drew et al. [38] identified three haplotypes[21] in California (haplotypes 1, 2, and 4) by sequencing mtDNA. Haplotype 1 was found in northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in extant fisher populations in British Columbia. Based on these findings, Drew et al. [38] suggested that gene flow between fishers in British Columbia and California must have occurred historically, but that these populations were now isolated.

Comment [W12]: Recast sentence: this makes it sound like mtDNA is only found "in cells that produce energy" rather than that mitochondria produce energy in cells.

Subsequent genetic investigations using nuclear microsatellite DNA and based on sequencing the entire mtDNA genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada [29,37]. Knaus et al. [29] identified three distinct haplotypes unique to fishers in California; one geographically

[21] A haplotype is a set of DNA variations (allele), or polymorphisms, that tend to be inherited together [39].

restricted to the southern Sierra Nevada Mountains and two restricted to the Siskiyou and Klamath mountain ranges. The magnitude of the differentiation between haplotypes of fishers in northern and southern California populations was substantial and considered comparable to differences exhibited among subspecies [29].

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. [29] concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error. Despite this uncertainty, Knaus et al. [29] concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Comment [W13]: Better to give a range to deal with the large uncertainties in these estimates.

Tucker et al. [40] used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fisher in northwestern California and the southern Sierra Nevada became isolated long before European settlement and estimated that the population declined substantially over a thousand years ago. This generally supports the conclusion of Knaus et al. [29] that fishers in northern and southern portions of the state became isolated prior to European settlement.

Comment [W14]: Should also cite pertinent info from Tucker et al. 2014.

Tucker et al. [40] also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fisher from disturbance beginning with the Gold Rush through the first half of the twentieth century. That portion of the range appeared to have maintained a stable population while the remainder of the southern Sierra Nevada occupied by fisher was in decline.

Reproduction and Development

Powell [2] suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April [2,6,41,42]. Females can breed at one year of age, but do not give birth until their second year [2,43,44]. They produce, at most, one litter annually and may not breed every year [8,45]. Reproductive frequency and success depend on a variety of factors including prey availability, male presence or abundance, and age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old [2,8,45,46].

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation [8,47,48]. Implantation is delayed approximately 10 months [41] and occurs shortly before giving birth (parturition) [48]. Arthur and Krohn [46] considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for an average period of 30 to 36 days [2,48]. Females give birth from about mid-March to early April [49–53] and breed approximately 6-10 days after giving birth [2,47,54]. Ovulation is presumed to be induced by copulation [2], with estrus lasting 2-8 days [54]. Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition [2]. Lofroth et al. [24] developed a~~n excellent~~ diagram ~~that illustrates~~illustrating the reproductive cycle of fishers in western North America (Figure 4).

Studies of wild fishers have reported litter sizes to range from 1-4 kits and average 1.8-2.8 [49,55–57]. Based on laboratory examination of corpora lutea[22] observed in harvested fishers, average litter size ranged from 2.3-3.7 kits [8,41–43,59–61]. These averages may be high and counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea [2]. Crowley et al. [60] found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

Comment [W15]: Consider updating this section with more specific information from recent studies, especially in southern Sierra Nevada. The SSN Fisher Conservation Assessment (SSNFCA) provides more details about denning season, reproductive output, etc., for that region.

Comment [W16]: "Suggested" seems weak. Consider recasting as "Fishers are polygynous…. (Powell [2]).

[22] The corpus luteum is a transient endocrine gland that produces essentially progesterone required for the establishment and maintenance of early pregnancy [58].

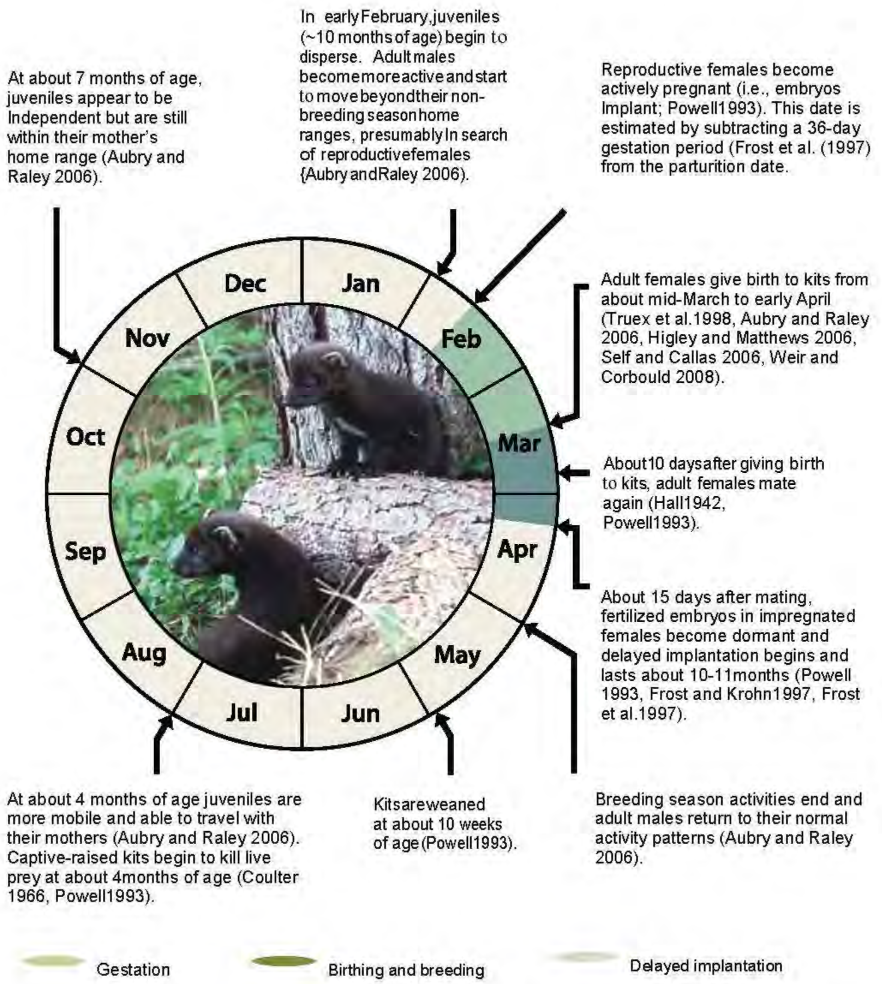


Figure 4. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. [22].

Raised in dens entirely by the female, young are born with their with eyes and ears closed, only partially covered with sparse growth of fine gray hair, and weigh about 40 g [6,25,54]. The kits' eyes open at 7-8 weeks old. They remain dependent on milk until 8-10 weeks of age, and are capable of killing their own prey at around 4 months [2,25]. Juvenile females and males become sexually mature and establish their own home

ranges at one year of age [41,62]. Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum [25]. Fishers have a relatively low annual reproductive capacity [5]. Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually reported from several studies in western North America was 64% (range = 39 – 89%) [24]. However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable.

Comment [W17]: Sentence seems out of place. Move up to beginning of section, followed by all the life history details that result in this low capacity?

A recent study in the Hoopa Valley of California reported that 62% (29 of 47) of denning opportunities were successful in weaning at least one kit from 2005-2008 [63]. Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, most ($\bar{x}$ = 78%, range = 63-90%) produced young annually from 2010-2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers [24].

Comment [W18]: See SSNFCA for similar data from SNAMP and KRFP studies.

Many kits die immediately following birth. Frost and Krohn [48] found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth [44]. In wild populations, kits have been found dead near den sites and reproductive females have been documented abandoning their dens indicating their young had died [49,50,56]. The number of fishers an individual female is able to raise until they are independent depends primarily upon food resources available to them [64]. Paragi [65] reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.

Survival

There are few studies of longevity of fishers in the wild. Powell [2] believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir [61] captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age [66]). Of

Comment [W19]: Again, consider updating with information from recent/ongoing studies in the SSN as summarized in SSN Fisher Conservation Assessment (SSNFCA). That doc summarizes data not yet published in the peer-reviewed literature. Also contact R. Swetizer, who recently submitted a manuscript on demography of fishers in the SNAMP area.

14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age [67].

In the wild, most fishers likely live far less than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years, although one of those animals lived to at least 10 years of age [66,68]. From 2009-2011, a total of 67 fishers were live-trapped in northern California as part of an effort to translocate the species to the southern Cascades and northern Sierra. The median age of those individuals was 2 years (range = 0.6 – 6). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Comment [W20]: Lots of yet-unpublished data on survival, age-structure, etc., might be available (soon?) from the SNAMP and KRFP fisher studies in SSN. Some of this data summarized in the SSNFCA, but lots yet to analyze. Contact R. Sweitzer.

Estimated survival rates of fishers vary throughout their range [24]. Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, and road density. Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation). Lofroth et al. [24] summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America documented by 8 studies, and averaged 68% for 3 studies in eastern Northern America. This difference was presumably due, in part, to the take of fisher by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts). In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range = 0.61-0.84) for adult females and 0.82 (range = 0.73-0.86) for adult males [24].

Comment [W21]: Note that this is not a factor in California.

Comment [W22]: And exposure to toxicants. See Thompson et al. (2014) demonstration that female survivorship influenced by number of known marijuana grow sites within their home ranges.

Comment [W23]: Again, see SSNFCA for updates specific to SSN population.

Comment [W24]: Updates for SSN in SSNFCA.

Food Habits

Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi [2]. Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided [2]. Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey

Comment [W25]: True, but they will also scavenge on larger species, like deer. This may increase potential of fisher roadkill if deer carcasses are not removed from the vicinity of roads quickly.

species that may be otherwise impossible to determine by more traditional techniques [24].

In a review of 13 studies of fisher diets in North America by Martin [69], five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed [24]. The proportion of different food items in the diets of fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey [2].

In California, studies indicate fishers appear to consume a greater diversity of prey than elsewhere in western North America [24,70,71]. This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey [70]. In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats [71,72]. Diets reported in these studies differed somewhat in the frequency of occurrence of specific prey items, but included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California [71], where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material [72,73].

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council [74], Golightly et al. [71] found mammals, particularly gray squirrels (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), and ground squirrels (*Spermophilus* sp.), to be the most frequently consumed prey by fishers. Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet [70–72]. This is likely due to the comparatively low densities of these species in ranges occupied by fishers in California compared to other parts of their range [72].

Comment [W26]: Yes, and porcupines appear to be nearly extirpated from mid-elevation forests in the SSN. This might be partly a function of rodenticide poisoning from trespass marijuana grow sites.

In the southern Sierra Nevada, Zielinski et al. [72] reported that small mammals comprised the majority of the diet of fishers. However, insects and lizards were also

frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. [72] also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn.

Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available [71,72,75,76]. Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers their ability to capture and handle larger versus smaller prey [24]. The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill. This has been hypothesized as a mechanism that reduces competition between the sexes for food [2]. Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey [24].

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. [72] found that during summer, the diet of female fishers compared to the diet of male fishers contained a greater proportion of small mammals. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. [77] reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley [49] found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). However, since most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits [49]. In some areas, male fishers have been found with significantly ($P<0.1$) more porcupine quills in their heads, chests, shoulders, and legs than female fishers [59,78]. It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers [2].

Movements

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities [79]. These areas have been described for fisher and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young [2]. The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not [2]. Although the home range of a female generally only overlaps the home range of a single male, a male's home range may overlap those of multiple females with the potential benefit of increased reproductive success [2].

Comment [W27]: Not sure this is true.

Lofroth et al. [24] summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. This difference in home range size, with male fishers using substantially larger areas than females, has been consistently reported [49,52,56,59,80–87]. In 9 studies in western North America the home range sizes of male fishers were 3 times larger than the home range sizes of female fishers [24]. Lofroth et al. [24] noted that home range sizes of fishers generally increase from southern to northern latitudes. Some factors that may influence the suitability of home ranges include landscape scale fragmentation, heterogeneity, and edge ecotones, but these attributes have not been well studied [88].

Comment [W28]: See SSNFCA for home range sizes in SSN.

Comment [W29]: See Sauder and Rachlow (2014) for influence of landscape-scale fragmentation on home range suitability. Also, the SSNFCS team is currently analyzing home range composition of female fishers from 3 telemetry studies in the region. Female home ranges have very high proportion of mature, dense forest (e.g., CWHR classes 4D and above), low proportion of open habitats, and high cohesion of mature, dense forest. Male home ranges are far more variable. Females seem to be very constrained to living within contiguous areas of mature, dense forest, where essentially all natal and maternal dens are located.

Dispersal: Dispersal describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. [89] as increasingly recognized to occur in three phases: 1) departing from the natal[23] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to

[23] Natal refers to the place of birth.

move through the landscape, prey resources, turnover rates of adults [52,56,62] and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities [49,52,56]. During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat [2,8,52,90]. Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females [89]. This pattern appears to hold true for fishers [49,57,91]. It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories [91]. Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient [92,93].

Comment [W30]: See SSNFCA for updated specific info for SSN population. Also, should cite appropriate findings from Tucker 2013 and Tucker et al. 2014.

Comment [W31]: See also Tucker genetic studies, which demonstrate that females are dispersal limited and seem constrained to dispersing within dense forest.

Comment [W32]: Yes. Again, see Tucker studies and discussion of dispersal data for SSN in SSNFCA.

Comment [W33]: Yes, female home ranges generally overlap home ranges of their mother, from SNAMP telemetry data.

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age [24]. In some studies, juvenile male fishers departed from their home ranges earlier than females [57]. Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home ranges. This behavior is characterized by higher mortality risk [52].

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. [62], reported mean maximum dispersal distances for male fishers [$\bar{x}$ =17.3 km (10.7 mi), range=10.9-23.0 km (6.8-14.3 mi), n=8] and for females [$\bar{x}$ =14.9 km (9.3 mi), range=7.5-22.6 km (4.7-14.0 mi), n=5]. York [56] reported mean maximum dispersal distances for males [$\bar{x}$ =25 km (15.5 mi), range=10-60 km (6.2-37.3 mi), n=10]) and for females [$\bar{x}$ =37 km (23 mi), range=12-107 km (7.5-66.5 mi), n=19]. The greater dispersal distance for

Comment [W34]: But there are abundant data for SSN on this from SNAMP and KRFP studies. Rick Sweitzer has been analyzing dispersal events. Most females settle in/adjacent to mother's home range.

juvenile females compared to males reported by York is unusual as, in other studies, males dispersed farther than females.

In the interior of British Columbia, Weir and Corbould [52], reported a mean dispersal distance from the centers of natal and established home ranges of 24.9 km (9.6 mi) for two females and 41.3 km (15.9 mi) for one male. In the southern Oregon Cascade Range, Aubry and Raley [49] reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male fishers [$\bar{x}$ = 29 km (18 mi), range 7-55 km (4.4-34.2 mi), n = 3] and female fishers [$\bar{x}$ = 6 km (3.7 mi), range 0-17 km (0-10.6 mi, n = 4]. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. [57], reported that the mean maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [$\bar{x}$ = 8.1 km (5.0 mi), range = 5.9–10.3 km (3.7-6.4 mi), n = 2) than females [$\bar{x}$ = 6.7 km (4.2 mi), range = 2.1–20.l km (1.3-12.5 mi), n = 12]. They also reported the distance between natal dens and the centroids (geometric center) of home ranges established by a single male [1.3 km (0.82 mi)] and 7 females [$\bar{x}$ = 4.0 km (2.5 mi), range 0.8-18 km (0.5-11.2 mi)].

Comment [W35]: Add information for SSN from SSNFCA and contact Rick Sweitzer for ongoing dispersal analyses.

Habitat Use

Comment [W36]: Section could be shorter and clearer with better organization and reduction of redundancies. Consider breaking into subsections by scale after introducing the 4 scales?

Comment [W37]: Section may focus too much on studies from outside California and omits a number of recent fisher habitat studies in California. See SSNFCA and citations therein.

Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers [3,94–96] have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

In their comprehensive synthesis of the habitat ecology of fishers in North America, Raley et al. [88] used a hierarchical ordering process proposed by Johnson [97] to assess habitat associations of fishers at multiple scales (Table 1). They described the fisher's geographical distribution (first-order selection) as the ecological niche occupied by the species, which is further refined at the home range scale (second-order selection). Ultimately, the selection of different environments (third-order) and of resources (fourth-order) is constrained by landscape scale processes and conditions

Table 1. Summary of habitats used by fishers categorized by hierarchical order (Johnson 1980) and a synthesis of fisher habitat studies by Raley et al. [88].

.

First-order	Geographic distribution	Fisher distribution has consistently been associated with expanses of low- to mid-elevation mixed conifer or conifer-hardwood forests with relative dense canopies.
Second-order	Selection or composition of home ranges with the geographic distribution	Characterized by a mosaic of forest types and seral stages, with relatively high proportions of mid- to late-seral conditions, but low proportions of open or non-forested habitats.
Third-order	Selection or use of different environments within home ranges	Rest Sites: Fisher consistently selected sites for resting that have larger diameter conifer and hardwood trees, larger diameter snags, more abundant large trees and snags, and more abundant logs than at random sites. Sites used for foraging, traveling, seeking mates: Although results indicate complex vertical and horizontal structure is important to fishers, strong patterns of use or habitat selection were not found.
Fourth-order	Selection or use of specific resources within home ranges	Rest Structures: Fishers primarily used deformed or deteriorating live trees and snags for resting. The species of tree used appeared less important than the presence of a suitable microstructure (e.g., mistletoe brooms, cavities, nests of other species) for resting. Dens: Female fishers use cavities in trees to give birth and shelter their young. Den trees used for reproduction were old and were always among the largest diameter trees in the vicinity.

Comment [W38]: Ongoing (unpublished) analysis in SSN shows that females are even more biased than males in having home ranges composed primarily of dense, mature forest conditions. Males appear to use a greater mosaic of vegetation types/conditions.

Comment [W39]: See SSNFCA for resting and denning habitat models. Denning habitat (used only be females in spring) is most limiting and strongly associated with contiguous, dense, mature forest conditions (e.g., CWHR 4D and above).

[88]. We have adopted this hierarchical approach to describe habitats selected by fishers.

Some researchers have hypothesized that fishers require old-growth conifer forests for survival [98]. However, habitat studies during the past 20 years demonstrate that fishers are not dependent on old-growth forests *per se*, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. Raley et al. [88] suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include high proportions of mid- to late-seral forests.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments [24]. The Department calculated the mean elevation of each Public Land Survey [99] section in which fishers were detected in California from 1993-2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 5). Habitats at higher elevations may be less favorable for fishers due to the

Comment [W40]: This would be much more meaningful if broken out by geographic region. Fishers in NW California use habitats down to sea level; fishers in SN use a relatively narrow elevation range; fishers on Kern Plateau (southeastern-most part of Sierra Nevada) use higher elevations, probably due to less snow there than occurs on the west slope of the SN.

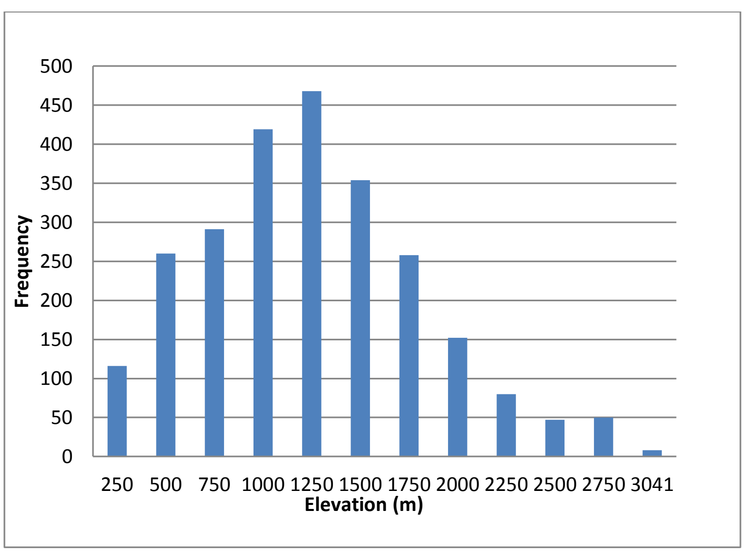


Figure 5. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993-2013. California Department of Fish and Wildlife, 2014.

Comment [W41]: More meaningful if broken down by geographic area, e.g., north coastal, north inland, SSN.

depth of the winter snowpack that may constrain their movements [100], because the abundance of den, structure, rest structures, and prey may be limited [88], or for other unknown reasons.

Comment [W42]: See SSNFCA for discussion of this.

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa pine [53,85,101]. Tree species' composition may be less important to fishers than components of forest structure that affect foraging success and provide resting and denning sites [98]. Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale ([53,85,102,103].

Comment [W43]: True, but presence of black oaks seems to be a habitat indicator for fishers in SSN, especially denning habitat. Black oaks provide good cavities for resting/denning and acorns for prey.

Comment [W44]: Also: tan oak may be an important component in north coastal areas: Scott Yaeger and Mark Higley, personal communications.

Hardwoods were more common in fisher home ranges in California compared elsewhere in western North America, [24]. This may be related to the use of hardwoods for resting and their importance as habitat for prey. In general, based on a number of studies in eastern North America and in California, high canopy closure is an important component of fisher habitat, especially at the rest site and den site level [25,53,85,102]. At the stand and site scale, forest structural attributes considered beneficial to fishers include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground [25].

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare and most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have occurred, active fishers were associated with complex forest structures [88]. Raley et al. ([88]) reviewed several studies ([102,104–106]) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated [88]. The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers to distinguish among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions [88].

Comment [W45]: Patterns may also be partially obscured by gender differences. Females may restrict activities more to mature, dense forest than males, which appear to be more tolerant of more diverse habitat mosaics, although this has not yet been quantified.

During periods when fishers are not actively hunting or traveling, they use structures for resting which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey [24,107]. Fishers typically rest in large deformed or deteriorating live trees, snags, and logs and the forest conditions surrounding these sites frequently include structural elements of late-seral forests [88]. The characteristics of rest structures used by fishers are extremely consistent in western North America, based on an extensive review by Raley et al. [88]. They summarized the results of studies from 12 different geographic regions of more than 2,260 rest structures in western North America and reported that secondarily, fishers rested in snags and logs. The species of tree or log used for resting appeared to be less important than the presence of a suitable microstructure in which to rest (e.g., cavity, platform) [88]. Microstructures used by fishers for resting include: platforms formed as a result of fungal infections, nests, or woody debris; cavities in trees or snags; and logs or debris piles created during timber harvest operations [49,52,86,108,109][49]. Rest structures appear to be reused infrequently by the same fisher. In southern Oregon, Aubry and Raley [49] located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion.

Comment [W46]: Clarify "secondarily," especially since 2 sentences earlier you said they "typically rest in … snags and logs…"

Comment [W47]: Rates of reuse should be available from the SNAMP and KRFP studies in SSN.

A meta-analysis conducted by Aubry et al. [107] of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. [88]). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (> 100 years) for suitable microstructures to develop [88].

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits [88]. However, hollow logs are used for reproduction (i.e., maternal dens) occasionally [49] and Grinnell et al. [3] reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree [88]. Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose

Comment [W48]: Why "however" given that the previous sentence just says they use cavities? A log hollow is a cavity.

dens with openings small enough to exclude potential predators and aggressive male fishers [88].

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times larger in diameter on average than other trees in the vicinity of the den [52,65,104] as cited by Raley et al. [88]. Depending on the growing conditions, considerable time may be needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits. Information collected from more than 330 dens used by fishers for reproduction indicates that most cavities used were created by decay caused by heart-rot fungi [52,66,110]. Infection by heart-rot fungi is only initiated in living trees [111,112] and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens [88]. Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age [110].

Comment [W49]: Redundant

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fisher in California [102,103,113,114]. The newest model was developed by the Conservation Biology Institute and the USFWS (FWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the FWS-CBI model consists of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

Comment [W50]: Newest only for landscape-scale (1st order selection). We also have finer scale models for resting, denning, and dispersal habitat (see SSNFCA).

The FWS-CBI models predict the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) [109], 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities utilized was from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

For the southern Sierra Nevada and where it blended into the central and northern Sierra Nevada, the variables used in the FWS-CBI model were basal-area-weighted canopy height, minimum temperature of the coldest month, tassel-cap greenness[24], and dense forest (percent in forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were total above-ground biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The FWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables. Other recent models [96, 106] have primarily been focused on predicting habitat in the northwestern part of California or have been derived from far fewer fisher detections [97].

Comment [W51]: Consider revising to recognize that the FWS-CBI model had some environmental variables not previously available for other efforts or updated since previous efforts.

The final FWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as "high quality", model values associated with habitats avoided by fishers were designated as "low quality", and habitats that were neither avoided nor selected were considered "intermediate". The "low quality" habitat category may include non-habitat (not used) as well as areas used infrequently by fishers relative to its availability. This FWS-CBI model was considered to be the best information available depicting the amount and distribution of habitats potentially suitable for fisher within the historical range depicted by Grinnell et al. [3] and the species' current range in California (Figures 6 and 7).

Comment [W52]: Note: Current thinking of the SSNFCS Fisher Technical Team is that this model basically represents foraging habitat (because nearly all data are from active fishers attracted to baited stations). We now also have resting habitat model and a denning habitat model, using locations of resting and denning observations from telemetry studies. Resting habitat is a subset of available foraging habitat, and denning habitat is a subset of resting habitat. Denning habitat is used only by adult females for a limited season. Females are much more constrained than males to siting home ranges in dense, mature forest (i.e., denning habitat) and within a much narrower elevation band. See SSNFCA.

---

[24] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

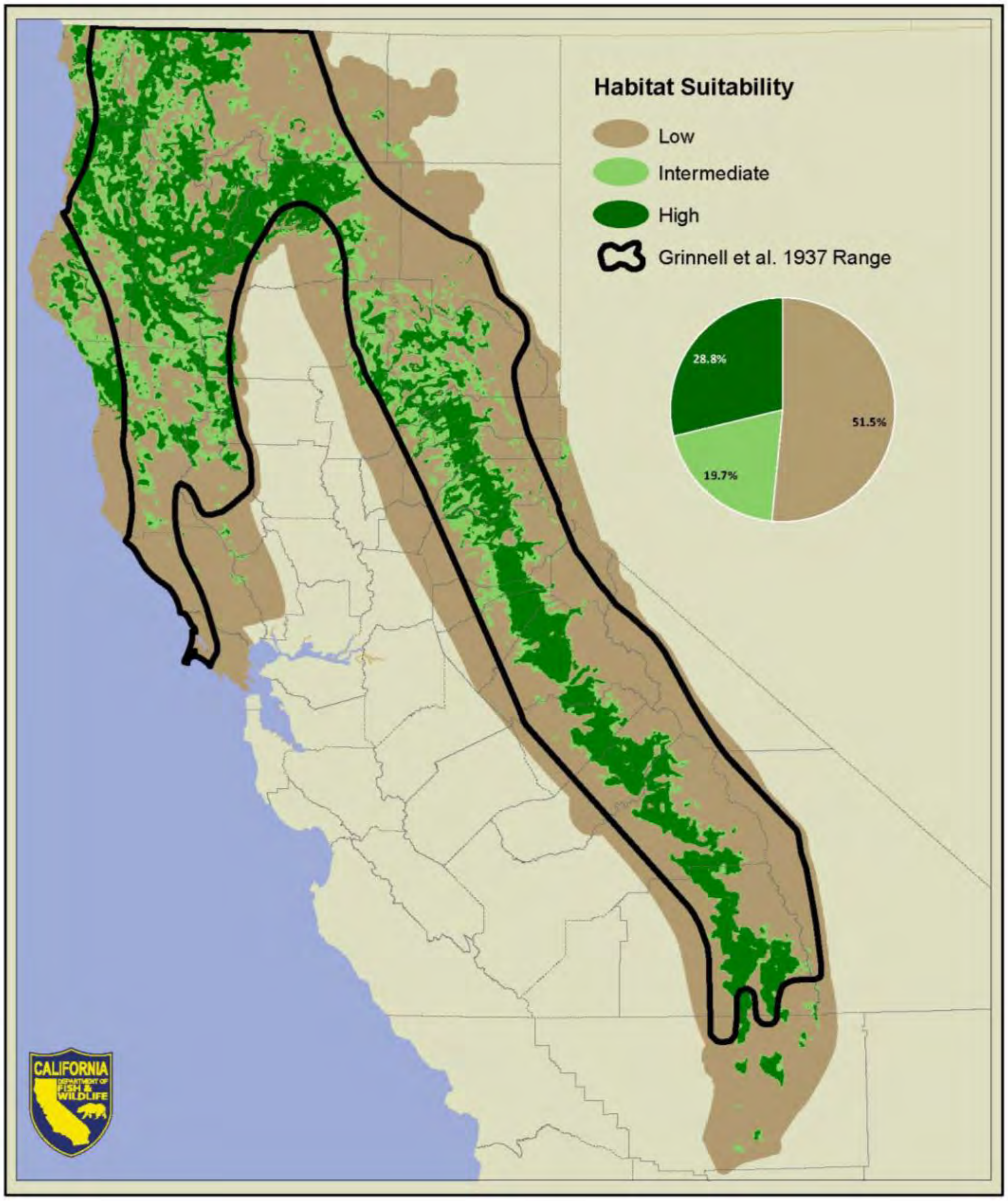


Figure 6. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

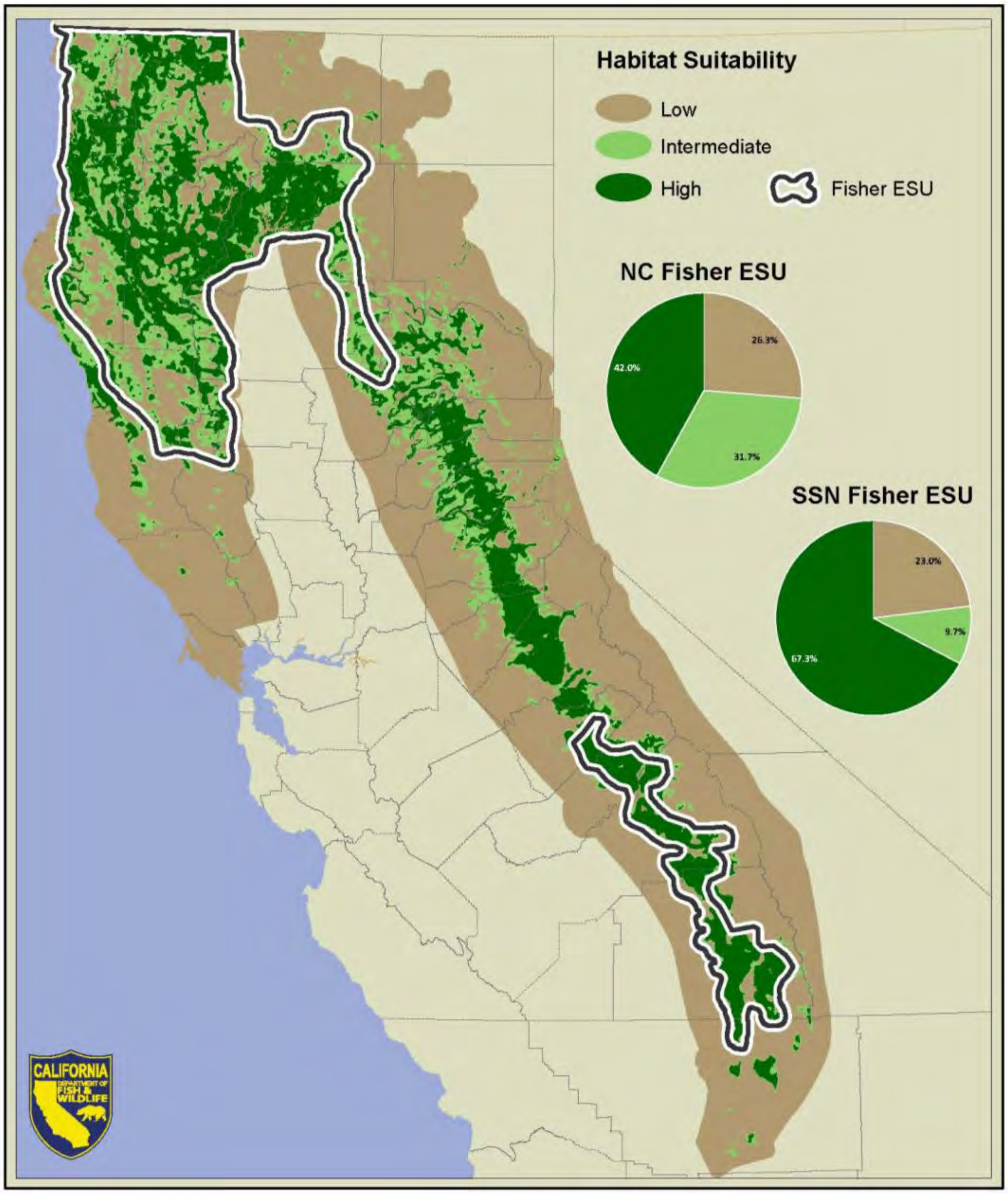


Figure 7. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Conservation Status

Regulatory Status

The fisher is currently designated by the Department as a Species of Special Concern[25] and as a candidate species at both the state[26] and federal[27] levels. Fishers are considered a sensitive species by the USFS and the Bureau of Land Management.

Comment [W53]: Update: Now it is proposed for listing as Threatened.

Habitat Essential for the Continued Existence of the Species

Comment [W54]: This section very weak. Need more review of fisher habitat selection in California and discussion of what the essential elements are. See SSNFCA and copious literature cited therein.

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists [3,31] and researchers in modern times [2,25,115–118]. However, the size, age, structure, and scale of forests essential for fisher are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular

Comment [W55]: Why stress this? We actually know a lot about fisher habitat requirements.

---

[25] Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, "Species of Special Concern" is an administrative designation and carries no formal legal status.

[26] A species becomes a state candidate upon the Fish and Game Commission's determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted [California Code of Regulations (Cal. Code Regs), tit. 14, § 670.1(e)(2)]. During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

[27] Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

forest types (e.g., old-growth conifers) habitat for survival [98]. However, studies of fisher habitat use over the past two decades demonstrate that they are not dependent on old-growth forests *per se*, nor are they associated with any particular forest type [88]. Fishers are found in a variety of low- to mid-elevation forest types [105,119–122] that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. These landscapes are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Comment [W56]: True, but evidence strongly suggests that old-growth is likely most preferred, and particular tree species are beneficial regionally (e.g., black oak in SSN, tanoak in NC.

Comment [W57]: True, but current (ongoing, not-yet-published) analyses are being used to characterize habitat in breeding female home ranges in the SSN. These strongly suggest that reproductive success is associated with a high proportion of dense, old, forest characteristics at the home range scale. The smallest female home ranges are associated with forests having old growth characteristics, including very high basal area, mostly dense (>70% canopy cover from above) and multilayered canopies, abundant large snags and logs, and high basal area of black oaks.

Most studies of habitat use and selection by fishers have focused on structures used for denning and resting, in part because those aspects of fisher ecology are more easily studied than habitat selection for foraging. Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young [52]. Aubry and Raley [49], reported that the sizes of den entrances used by female fishers were typically just large enough to for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir [52], found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110].

Comment [W58]: Redundant with above information. Consider better organizing this section to reduce redundancies and deal with issues of scale.

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning [88]. These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large, and considerable time (>100 years) may be required for suitable cavities to develop [88].

Comment [W59]: Why focus on western North America and cite literature from BC and Rockies? There are numerous publications on fisher habitat selection in California that are not cited in this section: Spencer et al. 2011, Zielinski et al. 2004a, 2004b, 2006,2010; Davis et al. 2007, Purcell et al. 2009, Thompson et al. 2011, Zhao et al. 2012, etc.

Comment [W60]: Again, redundant with above.

Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. However, forest structure important for fishers

should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers [28] .

Distribution Trend

Comment [W61]: See discussion in SSNFCA with evidence that in the SN, range contracted during 19th-20th centuries to the southernmost portion of the region (exact extent unknown, but probably south of the Kings River) and then re-expanded in the late 20th-early 21st century as far north as the Merced River.

Comparing the historical range of fishers in California estimated by Grinnell et al. [3] to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Lake and Marin counties. However, recent genetic analyses indicate some of the area considered to be a modern gap [35,36] in the historical distribution of fishers in the northern and central Sierra Nevada may have been long standing and pre-dated European settlement [29,40]. Yet, Grinnell et al. [3] and Price [31] suggest that fishers were present in this region post European settlement. This indicates that the gap was narrower historically than during contemporary times.

Despite extensive surveys from 1989-1995 [36] and 1996-2002 [35] for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled.

Since the 1990s, detections of fishers have increased along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County (Figure 3). It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier surveys. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

Comment [W62]: Some evidence of recent expansion in the southern population as well, but that this northward expansion has stalled at the Merced River (Yosemite Valley). See SSNFCA.

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number

of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [3]. In that year, only 14 fishers were reported taken by trappers in the state, with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau of Labor Statistics). Grinnell et al. [3] concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers [123]. Most animals were taken in a single trapping season (1920) when 120 fishers were harvested [124]. Despite concerns about the scarcity of fishers in the state, trapping of fisher was not prohibited until 1946 [125].

Grinnell et al. [3] noted that “Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township.” They roughly estimated the fisher population in California at fewer than 300 animals statewide with a density of 1 or 2 animals per township [93 km^2 (36 mi^2)] in good fisher range. For perspective, substantially higher numbers of fisher are captured for radio-collaring/study purposes in various studies in the present day: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were captured as part of an effort to translocate the species to the Southern Cascades and northern Sierra Nevada from 2009-2012 from widely distributed locations in northern California. Over a period of 28 days in 2012, 19 fishers were captured in vicinity of the translocation release site in the northern Sierra Nevada that were likely the offspring of animals translocated to the area [126]. Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers during this effort was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*).

Despite the paucity of empirical data, there are several estimates of fisher population size in northern California. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of

adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. However, he believed the estimate to be useful for general planning and risk assessment.

Self et al. (2008 SPI comment information) derived two separate “preliminary” estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a “deterministic expert method” and an “analytic model based approach” to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 (95% confidence interval [CI]: 1,848 - 4,550) fishers. Estimates for the southern Sierra Nevada population were 598 using the deterministic expert method and 548 (95% CI: 247 – 849) fishers based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates.

Estimates of the number of fishers in the southern Sierra Nevada indicate that despite using different approaches, the population is quite small. Lamberson et al. [127], using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Spencer et al. [128] estimated the size of the fisher population in the southern Sierra Nevada by extrapolating previous density estimates of Jordan [129], using data from the USFS regional population monitoring program (USDA Forest Service 2006), and linking a regional habitat suitability model to life history attributes. Using these data, they estimated 160-350 fishers in the southern Sierra Nevada population, of which 55-120 were estimated to be adult females. More recent work by Spencer et al. [119] estimated the southern Sierra Nevada fisher population at 300 individuals. Estimates of the number of fishers in California vary depending on the source, but range from 1,000 to approximately 4,500 fishers statewide.

Population Trend in California

No data are available that document long-term trends in fisher populations statewide in California, although recent occupancy trend estimates are available for the southern population and ~~,~~ localized studies provide some insights concerning trends in portions of the northern population. Despite genetic evidence indicating a long-standing

Comment [W63]: I disagree with emphasizing these estimates. Previous peer review showed how assumptions biased these toward high estimates, due, for example, to extrapolating densities over larger areas of potential habitat than warranted. If you retain this information , consider stating that these are likely biased high for reasons pointed out by previous peer reviews.

Comment [W64]: Density and population size estimates are currently available for portions of the SSN from the SNAMP and KRFP studies. See SSNFCA for estimates of fisher population size in Core Areas 4 (between Kings and San Joaquin Rivers) and 4 (between San Joaquin and Merced Rivers). These new density estimates could help corroborate/refine the overall size estimates for the SNN population.

Comment [W65]: Consider organizing section better, clearly separating statewide vs northern vs southern studies (see highlights). Also, should lead each subsection with the most general and scientifically defensible assessments, followed by other more localized or less certain pieces of evidence. For example, the current organization seems to give the Green Diamond studies undue emphasis, given how little they actually can say about pop status or trends, relative to more comprehensive or statistically valid studies, like Tucker et al., Zielinski et al., and Furnas et al.

Comment [W66]: Need something like this sentence to introduce and put the following information into perspective.

historical separation of fishers in northern California from those in the southern Sierra Nevada [28], fishers reportedly occurred in the central and northern Sierra Nevada post-European settlement [3,31], but were likely not abundant based on the scarcity of records from this region. By the late 1800s, habitat changes and harvest by trappers may have reduced the abundance of fishers in this region to low levels. The apparent scarcity of fishers in the central and northern Sierra Nevada by the early 1900s is supported by the work of Grinnell et al. [3] and the lack of specimens from that region.

In northern California, Matthews et al. [130] reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. However, continued monitoring of this population indicates that overall the population density has increased by 2012-2013, but only to about half of that estimated in 1998.

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 [131]. Detection rates at segments increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995, lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection ratios (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed.

Swiers et al. [132], collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers et. al. found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of abundance

Formatted: Highlight

Formatted: Highlight

Comment [W67]: Rates?

Formatted: Highlight

Comment [W68]: Not relevant to fisher population trends?

Comment [W69]: Disagree with using this as evidence of "commonness" of fishers. Detection rates also depend on how easily attracted species are to baited stations, how far they move, the range of habitat values sampled, sampling design, etc. Fishers could be at average or low densities but frequently detected at stations. The sampling design can also affect detection rates. Were stations spaced sufficiently to be independent, or could one fisher visit multiple stations?

Comment [W70]: Also, this section is about trends, not commonness.

Formatted: Highlight

Comment [W71]: Was this based on modeled or empirically measured population size? 2006-11 is not a very long period for detecting trends in a long-lived carnivore like fisher.

and population growth indicated that the population size was stable, although estimates of survival and recruitment suggested high population turnover [132].

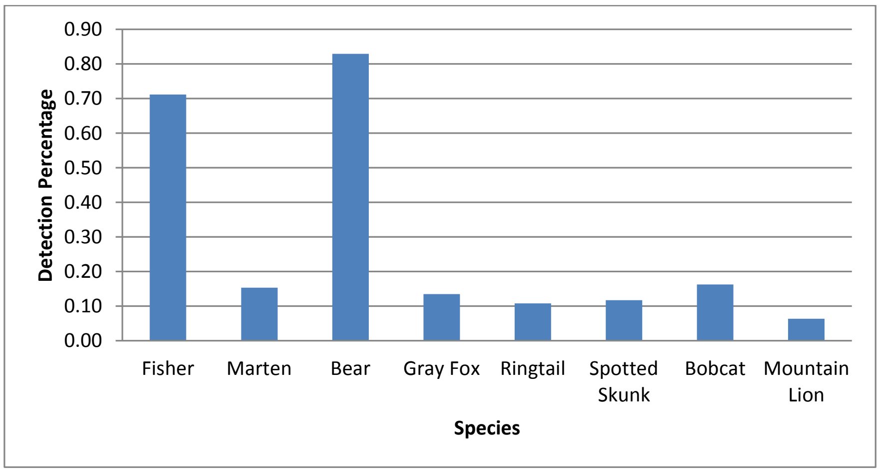


Figure 8. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

Tucker et al. [28] concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated European settlement. Tucker et al. [28] also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-European settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries. The southern extent of fisher habitat in the southern Sierra may have contained sufficient high quality habitat to serve as a refugium supporting enough fishers to constitute a founding population (J. Tucker, pers. comm.). Tucker et al. [28] using genetic techniques estimated that the total current population size of fishers in northwestern California could range from 258-2850 and the southern Sierra Nevada population could range from 334-3380.

Monitoring of fisher populations in northern California has been limited, but several studies are providing insight into the distribution and trends in occupancy rates of

Comment [W72]: Although this information might be useful, I question whether it is appropriate to make any inferences about density or abundance (relative or otherwise) from them. Need much more context about sampling area and design, etc. For ;example higher fisher than marten detections probably reflects elevation and the extreme rarity of the Humboldt marten. I would bet that some of the species with relatively low rates (e.g., gray fox) were more abundant than fisher. ETC.

Comment [W73]: General study that should be moved up in section. Was the 90% decline just for the SSN population, or statewide?

Formatted: Highlight

Comment [W74]: Statewide statement.

Formatted: Highlight

Formatted: Highlight

Formatted: Highlight

fishers in the state. Estimates of trends in occupancy have been used as surrogates for trends in abundance for some species of wildlife [133], in part, because it is more cost effective and feasible than monitoring direct measures of abundance. Zielinski et al. [134] implemented a monitoring program for fishers in the southern Sierra Nevada over an 8 year period (2002-2009) and modeled trends in occupancy by combining the effects of detection probability and occupancy. They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest in the southeastern portion of their study area (0.261) and highest in the western portions of their study area (southwestern zone = 0.583) [134]. They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra did not appear to be declining.

The Department has conducted a large-scale monitoring project for forest carnivores, including fishers, as part of its Ecoregion Biodiversity Monitoring (EBM) program in the Klamath and East Franciscan ecoregions of northern California since 2011. EBM surveys for carnivores were conducted using camera traps within hexagons established by the Forest and Inventory Assessment system [135]. All the sites selected for survey occurred in forested habitats and were selected randomly (although land ownership, road access, and safety issues occasionally precluded completely random placement of plots). A Bayesian hierarchical model was used to estimate occupancy and detection probabilities for fisher across stations nested within plots within ecoregions (Furnas et al. unpublished manuscript). A total of 85 plots containing 169 stations were surveyed across the entire 2.8 million-ha study area during 2011 and 2012. The overall occupancy estimate for fisher was 0.438 [90% CI: 0.390-0.493] for stations, and 0.622 [90% CI: 0.569-0.685] for station pairs. The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.

Threats (Factors Affecting the Ability of Fishers to Survive and Reproduce)

Evolutionarily Significant Units

Comment [W75]: This an introductory statement that should be moved up in section.

Comment [W76]: This approach has become a standard practice for numerous species as highly effective, scientifically valid, and cost effective.

Comment [W77]: This is the most scientifically defensible study of pop trends in the SN, but almost seems buried down here.

Formatted: Highlight

Comment [W78]: Need a map or description of the Zielinski et al. study zones to make this info more useful. Southeastern zone = Kern Plateau, which has lower modeled habitat value than the western portions, and the southwestern zone is that southern refugium that received less human disturbance and has the highest habitat value in the SSN. In other words, the occupancy patterns seen by Zielinski et al. correspond with predicted habitat values and historic observations, etc. See SSNFCA description of fisher core areas.

Formatted: Highlight

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) Fisher ESU and SSN (southern Sierra Nevada) Fisher ESU. The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by the Third District Court of Appeal that the term "species or subspecies" as used in sections 2062 and 2067 of the CESA includes Evolutionarily Significant Units[28]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species [136].

Comment [W79]: I agree with this designation.

ESU boundaries for fisher represent the Department's assessment of the current range of the species in the state, considering the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between them (Figure 9). Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events.

Habitat Loss and Degradation

Comment [W80]: Content of this section too narrowly focused on commercial timber harvest. There is extensive information (and debate, and research) on the role of other management activities (thinning, prescribed fire, salvage logging, stand improvement, etc.) and other disturbances (severe fires, insect outbreaks, etc.) on fisher habitat loss and degradation. At least in the SSN, timber harvest is a minor factor compared with these factors. See SSNFCA, Scheller et al. 2011, etc.

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic [24,52,98,108–110,117]. Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers particularly vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires [5,25]. Buskirk and Powell [98] found that at the landscape scale, the abundance and

[28] 156 Cal.App.4th 1535, 68 Cal.Rptr.3d 391

distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.

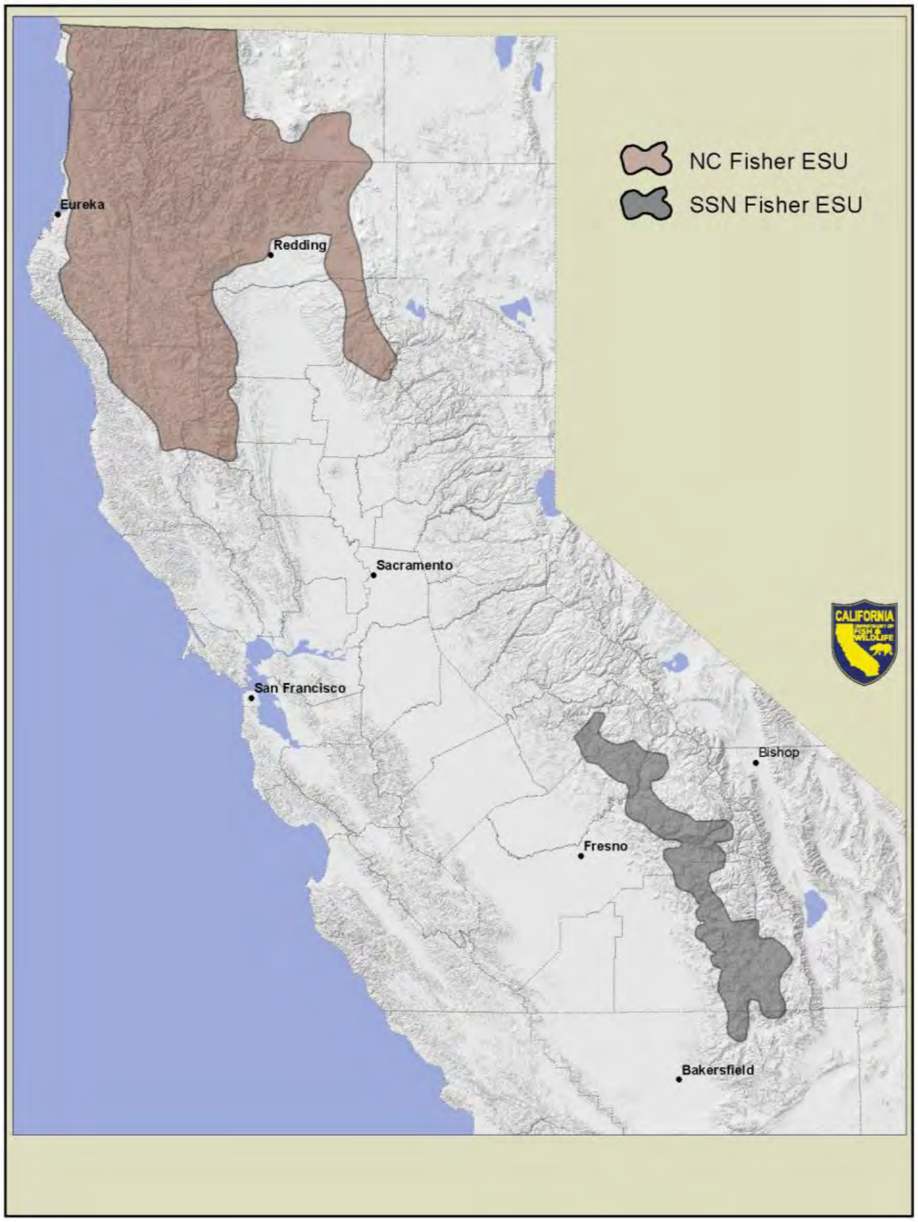


Figure 9. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and Wildlife, 2014.

Fishers have frequently been associated with old-growth forests and some researchers have hypothesized that they require those forests for survival. Habitat studies in recent decades demonstrate that fishers are not dependent on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. However, the home ranges of fishers often include high proportions of mid- to late-seral forests [88].

Comment [W81]: Yes, and adult female home ranges are even more biased toward these conditions. Note that saying fishers are not DEPENDENT ON old-growth forests is not the same as saying that old-growth forests aren't THE BEST for supporting fishers. Currently, old-growth is so limited that fishers may be "making do" with the best available, though not optimal, conditions.

Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age and structural features of many forests in California. Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. Besides the direct removal of trees through timber harvest, management practices and policies have had many indirect effects on forested landscapes [24]. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Generally, timber harvest has substantially simplified the species composition and structure of forests [137,138]. Habitat elements used by fishers such as microstructures for denning can take decades to develop and a substantial reduction in the density of these elements from landscapes supporting fisher would likely reduce the distribution and abundance of fisher in the state.

Comment [W82]: Correct. See previous comment. Current habitat conditions do not represent historical or desired habitat conditions, and fishers might be more abundant if there was more old growth.

Comment [W83]: This implies that National Parks were always protected from logging. Although they have been protected in recent decades, forests in Yosemite and other national parks were historically heavily impacted by humans, including timber harvest in large areas. Old growth is less abundant in parks than the historic condition.

Of the historical range of the fisher in California estimated by Grinnell et al. [3], nearly 61% is in public ownership and about 37% is privately owned (Figure 10). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (NPS) (Figure 11). Private lands within the NC Fisher ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 12). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades [139]. Sawtimber volume (net volume in board feet of sawlogs harvested from commercial tree species containing at least one 12-foot sawlog or two noncontiguous 8 foot sawlogs) harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 13 and 14).

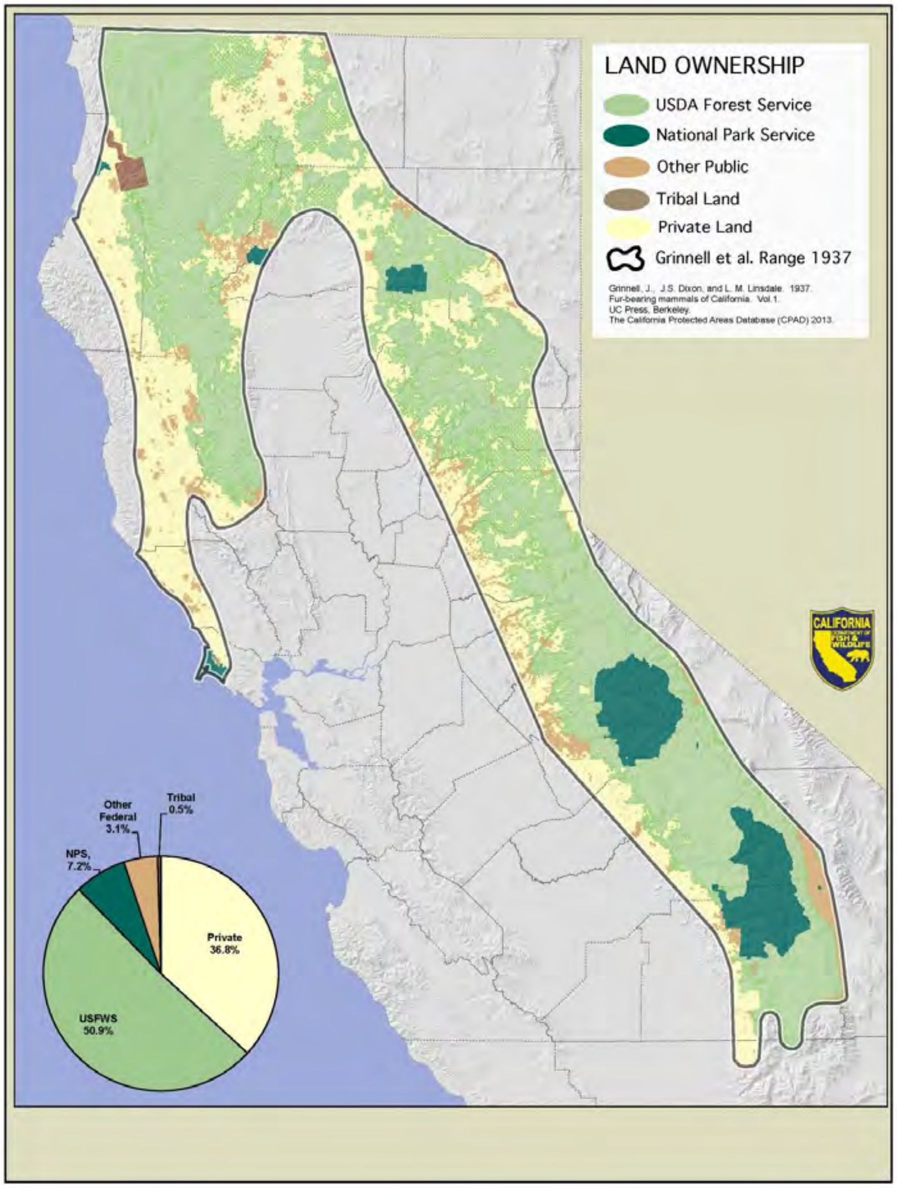


Figure 10. Landownership within the historical range of fisher depicted by Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

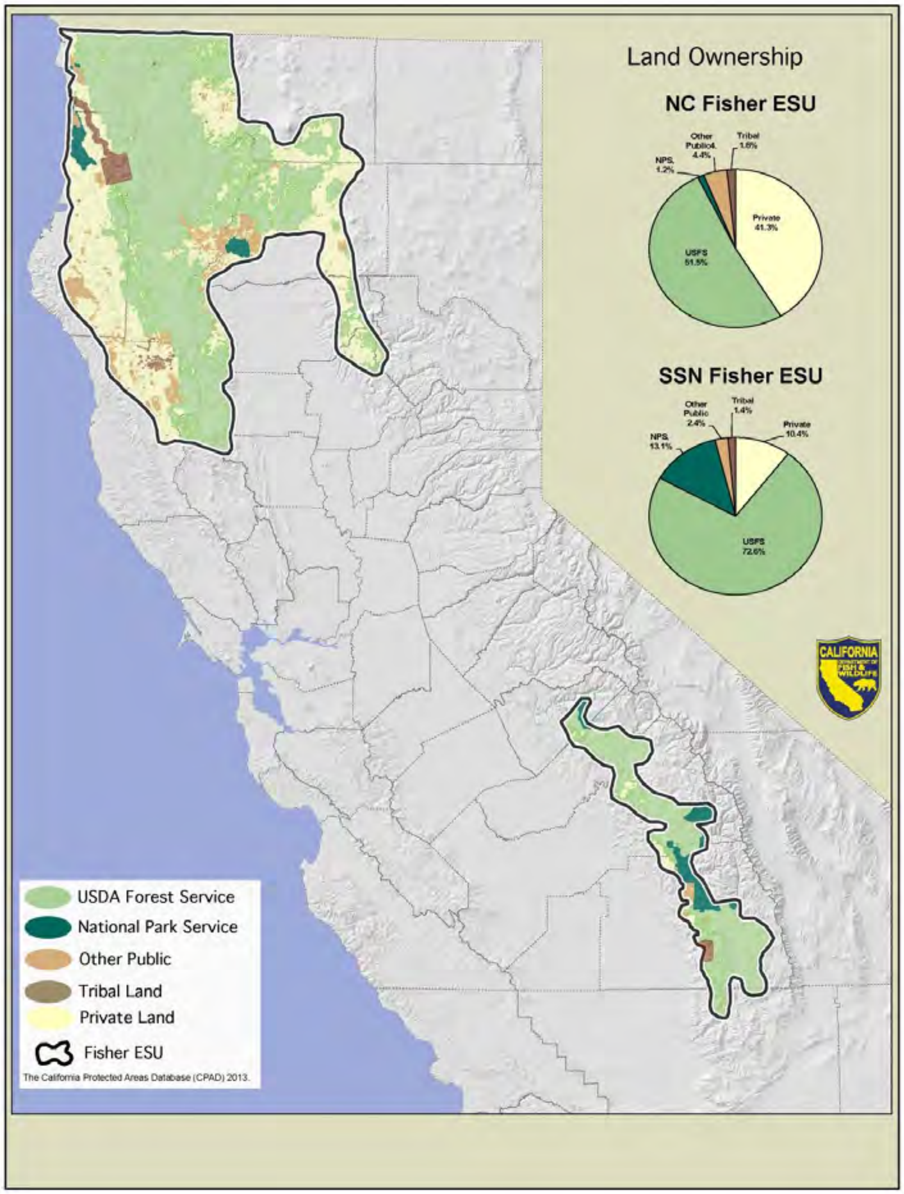


Figure 11. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

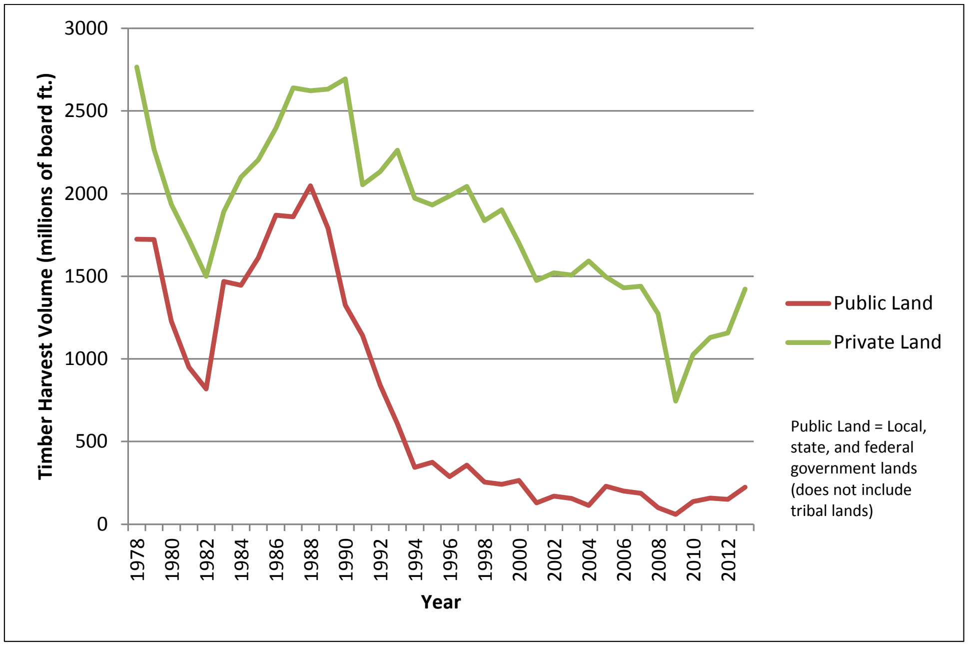


Figure 12. Volume of timber harvested on public and private lands in California (1978-2013) [140].

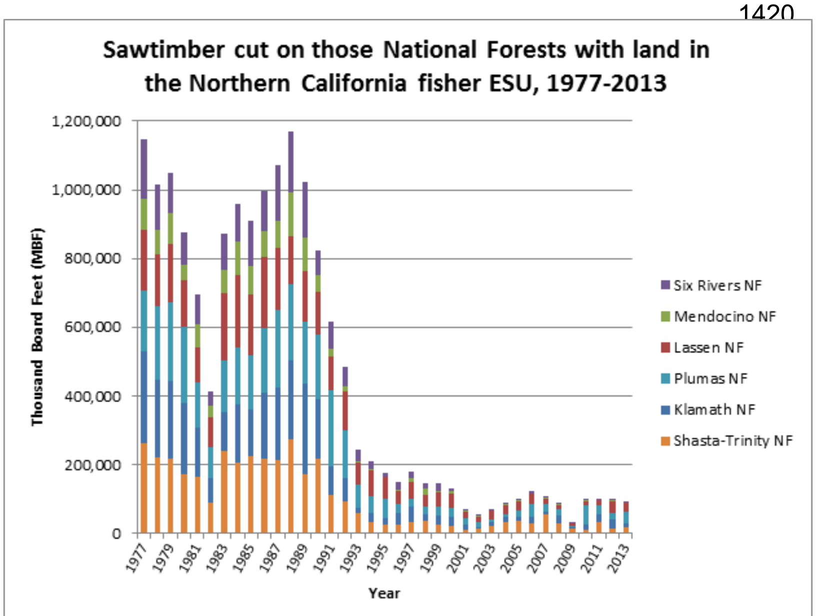


Figure 13. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 [139].

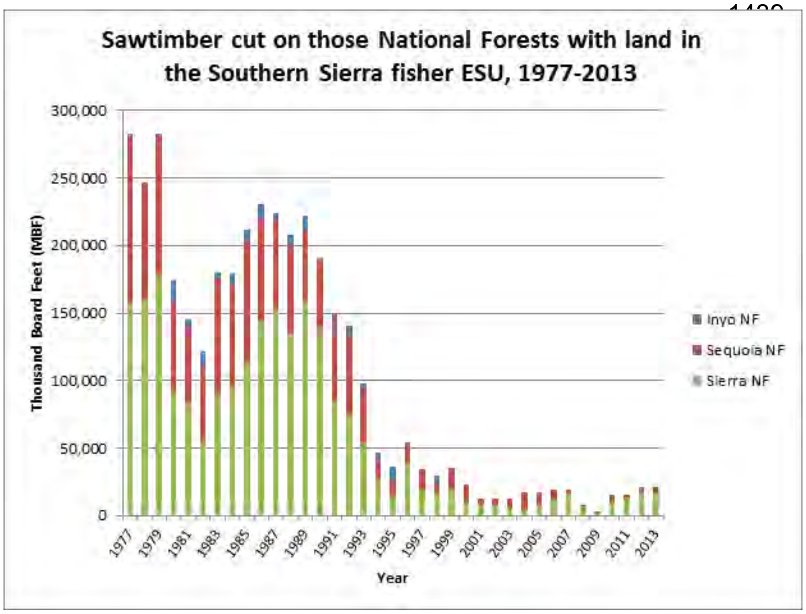


Figure 14. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 [139].

Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. This could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected. However, fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been intensively managed for timber production (Figure 15).

A more proximal concern for the long-term viability of fishers across their range in California is the presence of suitable denning and resting sites and habitats capable of supporting foraging activities. However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California.

Comment [W84]: Consider adding Stanislaus NF. Not currently occupied by fisher, but range expansion onto Stanislaus NF is a major goal of SSN Fisher Conservation Strategy.

Comment [W85]: Yes, but no evidence that they can be as abundant in these conditions. Fishers clearly avoid the most heavily managed areas and site home ranges in the areas of most contiguous, intact, dense forest available (as seen in the right side of Figure 15 and various scientific studies, like Sauder and Rachlow (2014). Also, I question characterizing management of the Hoopa Reservation (Fig 15, left) as "intensively managed for timber production." Statements like these are misleading in that they can be interpreted as "intensive timber management does not reduce fisher habitat value," with is clearly untrue. Clearcutting (even-aged management) is clearly detrimental to fishes.

Comment [W86]: How/why this determination? More proximal how?

Comment [W87]: There is no evidence that foraging habitat is limiting. Fishers will forage in a wider array of conditions than they will rest and den. Denning habitat is the limiting factor.

Comment [W88]: Evidence for this statement? We do not know if this is true, and I suspect that denning habitat is limiting.

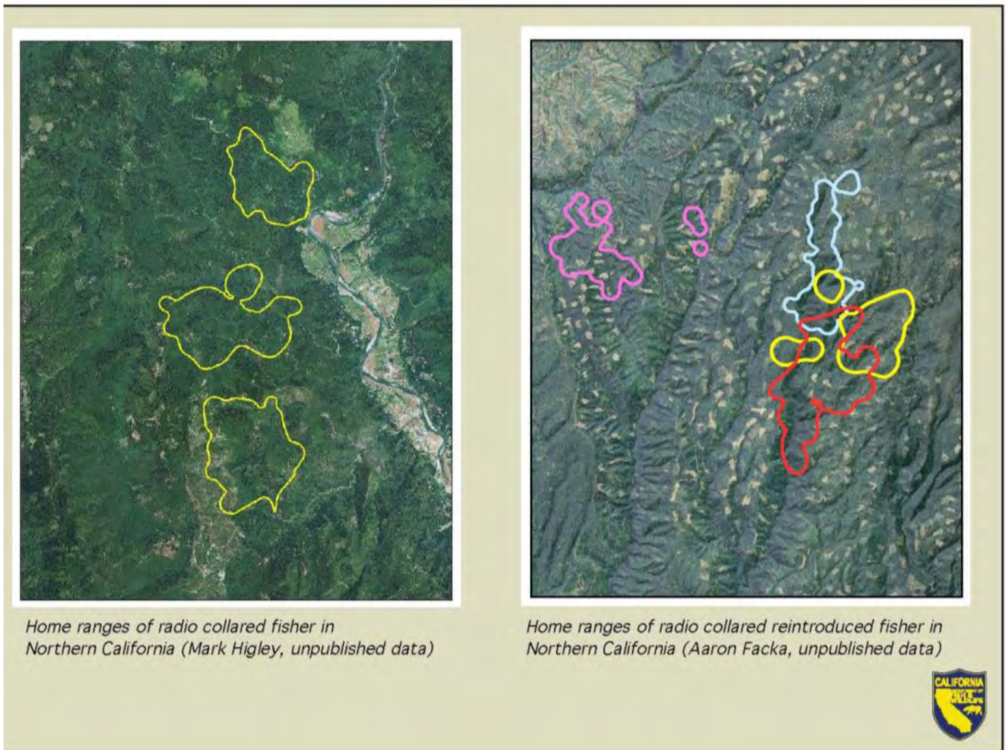


Figure 15. Home ranges of female fishers on managed landscapes in northern California and the northern Sierra Nevada, 2014.

Population Size and Isolation

Grinnell et al. [3], considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. However, few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century [36,38]. However, recent genetic work by Knaus et al. [29] and Tucker et al. [28] indicates fishers in the southern Sierra Nevada became isolated from northern California populations long before European settlement.

Comment [W89]: Captions should be more geographically specific than "northern California" and need to have scales! Are the scales the same between the two areas? If so, one cannot compared home range sizes. The left area is on Hoopa (coastal) with a completely different management scheme than that of the SPI lands (right area). Also, it is clear from right area that fishers are selecting the least heavily impacted portions of the land (avoiding denser areas of recent clearcuts). This figure not useful without more context and explanation.

Comment [W90]: This section just repeats information already provided in earlier sections. Instead it should focus on how pop size and isolation increase THREATS to the population (continued genetic degradation, stochastic events, etc.).

Based on Tucker et al. [28], the fisher population in California experienced a significant decline of approximately 90% long before European Settlement, resulting in the isolation of fisher populations in northern California from fishers in the Sierra Nevada. Tucker et al. [28] pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene [141] and would be consistent with the divergence dates of fisher populations in California reported by Knaus et al. [29]. However, in California there were two "mega-droughts" during the Medieval Warm Period (MWP) that lasted over 200 and 140 years each from 832-1074 and 1122-1299 AD, respectively. These droughts may have caused fisher populations to contract isolating the population in the Sierra Nevada from fishers elsewhere in the state [28].

In addition to this early population contraction, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19^{th} century and early 20^{th} century [28]. Tucker et al. [40] suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20^{th} century while fisher in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable based on estimates of occupancy from 2002-2009 [134].

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. Fishers in the southern Sierra Nevada are geographically isolated from breeding populations of fishers elsewhere in the state and do not appear to be expanding their range northward. Should fishers in the southern Sierra Nevada expand their range northward, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, fishers in either location do not appear to be dispersing towards each other and natural contact in the near-term (50 years) is unlikely.

Although fishers in northern California are effectively isolated from fishers in the southern Sierra Nevada, they are part of a regional population that extends into southern Oregon. A fisher that was marked by researchers in Oregon was

subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California [38,91,142,143].

Although fishers do not fully occupy their assumed historical distribution, their population is likely higher than when densities of fishers were estimated by Grinnell et al. [3] at 1-2 per township in good habitat.

Comment [W91]: None of the information hear addresses a threat to the population. Either delete section, or rewrite to focus on how pop isolation and size might affect THREATS to the pop.

Predation and Disease

Comment [W92]: Why combined? Both the nature of these threats and their effects on fisher populations are very different.

Predation and disease (including toxins) appear to be the most significant causes of mortality for California fishers. Since 2007, the causes of mortality for radio-collared and opportunistically found fishers from one area in northern California (Hoopa) and the southern Sierra Nevada have been analyzed through gross necropsies, histology, toxicology, and molecular methods. In a sample of 128 fishers from these two populations that died between 2007-2012, predation was the most common cause of mortality (52%), followed by disease/toxins (24%), and vehicular strikes (8%) (M. Gabriel, unpublished data). The proportion of fishers dying from each cause did not differ among these monitored populations, or by sex, which suggests that the relative impact of each source of mortality is similar for both male and female fishers and throughout fisher range in California (M. Gabriel, unpublished data). Preliminary assessment of mortality data from 2010-2013 for the northern Sierra Nevada population recently established through translocation is also consistent with these findings (D. Clifford, M. Gabriel and C. Wengert, unpublished data).

Comment [W93]: Why include toxins under disease? That is a separate factor and section.

Formatted: Highlight

Predation: DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project (SNAMP) and King's River projects identified bobcats (*Lynx rufus*) as the predator of 25 sampled fishers (50%), mountain lions (*Puma concolor*) as the predator of 20 sampled fishers (40%) and coyotes (*Canis latrans*) as the predator of 4 fishers (8%). The single remaining carcass had both bobcat and mountain lion DNA present [144].

The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes

killed an equal number of male and female fishers [144]. This finding suggests that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19/25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival [144].

The proportion of fisher mortalities caused by predation found by Wengert [144] is higher than previously reported in California [145] and British Columbia [52]. Powell and Zielinski [25] suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert [144] indicate that predation is a significant mortality factor for native fisher populations in California. Whether or not some forest management practices favor the existence of more generalist predators (like bobcats) over specialist predators like fishers is not known. However, Wengert [146] found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Comment [W94]: Section should address that exposure to toxicants may elevate measured predation rates by compromising fisher health and behavior (see Thompson et al. (2014).

Disease: A number of viral, bacterial, and parasitic diseases have been documented in fisher. Canine distemper virus (CDV) infection, a cause of significant morbidity and mortality in other carnivore populations [147], was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 [148]. Three of these animals died within a 2-week period from April 22-May 5 and were found within 20 km (12.4 mi) of each other, while the fourth fisher died during an immobilization event 4 months later approximately 70 km (43.5 mi) away from the initial cases. Infection with CDV decreases immune function, thus vital capacity co-infections with other pathogens are common [147].

Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal's ability to survive a capture and immobilization event. The source of the infections in these fishers, as well as pertinent transmission routes remain unclear, but the temporal and spatial distribution of the fisher CDV mortalities, as well as the similarity of the virus isolates, suggest two spillover events from one or multiple other sympatric carnivore species.

In California, CDV mortalities in gray foxes and raccoons are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, CDV has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) [149] and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) [150]. Furthermore, highly virulent biotypes of CDV can be transmitted and cause high mortalities in multiple carnivore species [151] . This scenario was evident by a 2009 CDV outbreak in Switzerland that killed red foxes (*Vulpes vulpes*), Eurasian badgers (*Meles meles*), stone (*Martes foina*) and pine (*Martes martes*) martens, a Eurasian lynx (*Lynx lynx*) and a domestic dog [151].

Although CDV can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 3). Of 98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to CDV [152]. From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the SNAMP area were exposed to CDV [152]. Evidence to date and experiences with other species underscore the fact that CDV has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus (CPV), both potentially significant pathogens for *Martes* species [153], have not been documented in fishers in California. However, virus shedding[29] of CPV has been documented in fisher [152], and clinically significant illness due to CPV was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern California are commonly exposed to and infected with CPV: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 2).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) [154], American minks (*Mustela vision*) [155], and free-ranging southern sea

[29] Viral release following reproduction in a host-cell.

otters (*Enhydra lutris*) [156]. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania [157].

Table 2~~3~~. Prevalence of exposure to canine distemper, canine parvo virus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 [140].

	Canine Distemper Percent (No. sampled)	Canine Parvo Virus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) [158], but mortalities of fishers from these diseases have not been reported. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers [153]. Plague is known to cause mortality in other mustelids, is a serious zoonotic[30] risk [159] and is endemic in many parts of California.

Other documented disease-caused fisher mortalities included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers and other *Pekania* and *Martes* species harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases,

[30]Zoonotic diseases are contagious diseases that can spread between animals and humans.

infections and infestations are usually associated with minimal morbidity and mortality [153]. Banci [121] noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell [2].

Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye damage, there were no vision deficits or eye damage noted in affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions [160]. In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination [161]. Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fisher and may have been responsible for local declines in fishers, the Department is not aware of studies indicating that disease is significantly limiting fisher populations in California.

Comment [W95]: Right. This section seems overly long relative to the threat to fisher populations. Lead section with a general statement like this, and then provide results of studies without the details.

Human Population Growth and Development

The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance from 1970 to 2010 [162,163], the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state [164] and those numbers are expected to reach approximately 53 million by 2060 [165], an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average [166].

The California Department of Forestry and Fire Protection (CAL FIRE) estimated that statewide, between 2000 and 2040, about 2.6 million acres of private forests and

rangelands will be impacted by new development [167]. New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 890,000 ha (2.2 million acres). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fisher was comparatively low (6%).

Within the NC and SSN Fisher ESUs, future human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 16, Table 4). This represents an increase of about 1% in the acres developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because parcels of that size likely provide some fisher habitat post-development. In the NC Fisher ESU, slightly more than half of development as of 2010 occurred in habitats predicted to be of intermediate or high value to fishers (Table 5). That percentage is not expected to change substantially by 2030. Within the SSN Fisher ESU, about 60% of past development occurred in habitats predicted to be of intermediate or high value to fishers and that proportion is also not predicted to change substantially by 2030.

Duane [168] identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 17, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). However, the effects of future development on fishers are uncertain. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

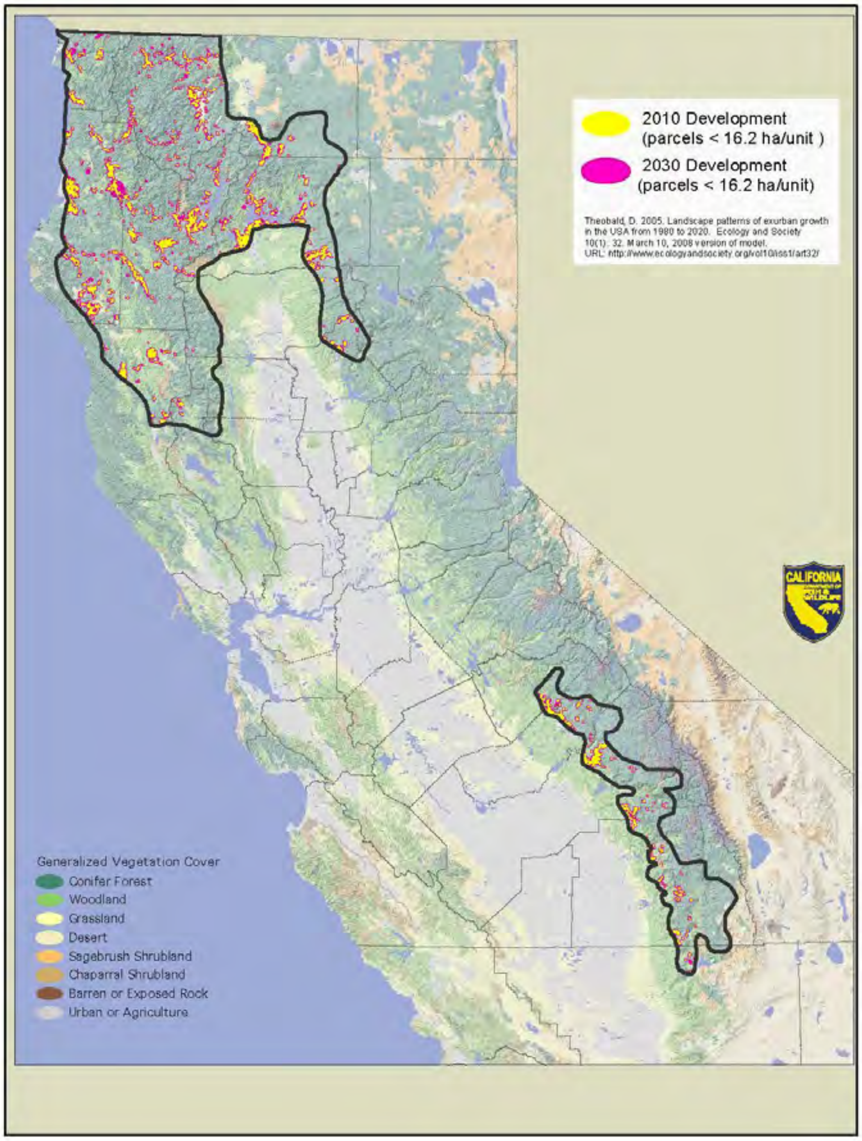


Figure 16. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169]. California Department of Fish and Wildlife, 2014.

Table 3~~4~~. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of Total	Projected Development (2030)	Percent of Total
NC Fisher	4,103,639 (10,140,312)	129,764 (320,654)	3%	160,757 (397,240)	4%
SSN Fisher	778,273 (1,923,155)	32,361 (79,966)	4%	35,845 (88,576)	5%

Table 4~~5~~. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald [169].

Comment [W96]: Consider reorganizing table to show what proportion of high/med/low habitat is affected by human development.

	Hectares (Acres)					
Evolutionarily Significant Unit	Low	Percent of Total	Intermediate	Percent of Total	High	Percent of Total
NC Fisher (2010)	55,954 (138,264)	43%	33,065 (81,706)	26%	39,831 (98,425)	31%
NC Fisher (2030)	69,856 (172,617)	44%	41,952 (103,666)	26%	48,030 (118,684)	30%
SSN Fisher (2010)	11,942 (29,510)	37%	4,213 (10,411)	13%	16,205 (40,044)	50%
SSN Fisher (2030)	14,158 (34,986)	39%	4,758 (11,758)	13%	16,929 (41,832	47%

Figure 17. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Disturbance

Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats the species typically occupies. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off road vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be comparatively high. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied, however, monitoring radio-collared females with young provides some insight into their sensitivity

to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Comment [W97]: Has it EVER been documented? Needs a citation.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. However, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. Most watersheds on private timberlands are harvested at a rate of 1-3% annually (J. Croteau, pers. comm.). Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data).

Comment [W98]: Why just timber management (which I assume refers to commercial harvest)? Concerns about thinning, prescribed fires, etc., as well.

Formatted: Highlight

Comment [W99]: C. Thompson (pers. comm.) reports a case of displacement probably due to noise of some management actions.

Recreational use of habitats occupied by fisher in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Roads

Comment [W100]: This section needs expansion. See SSNFCA for discussion of roadkill, potential population level effects due to roadkill in denning habitat, and use of culverts as road-crossing structures.

Fishers occupying habitats containing roads occasionally are struck by vehicles and killed [53,56,100,126]. Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data).

Comment [W101]: More updated and specific data exist. See SSNFCA and contact Anae Otto (head of SSN Fisher Working Group Roads Subcommittee). This committee has been collecting roadkill data, monitoring underpasses for fisher use, and installing roadcrossing improvements for fishers on Sierra NF and in Yosemite.

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fisher in California and have been hypothesized to be a potential barrier to dispersal [24,91,170], they have not been demonstrated to limit fisher populations. Roads have not shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County [126].

Fire

Wildfires are a natural part of California's forest ecology and most frequently start as a result of lightning strikes. Wildfires affect habitats used by fisher and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, and the extent of individual fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. [171], believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey.

Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s [172]. In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression [172]. In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok [173] who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act

Comment [W102]: Citations for this? Sounds like logical speculation, but any data? Vegetation near road and availability of crossing structures (culverts, etc.) likely also influences.

Comment [W103]: Also habitat conditions near the roads. Hwy 41/Wawona Rd is thru densely forested fisher denning habitat and thus may disproportionately kill mothers with dependent young.

Comment [W104]: Not sure I agree with this assessment, which needs more specifics.

Comment [W105]: Not on their own, but as one additive source of mortality in addition to others. See Spencer et al. (2011): human additive mortality, including roadkill, may be limiting population growth and expansion in the SSN.

Comment [W106]: Needs more specifics. Major freeways (like I-8i0) would likely be barriers.

Comment [W107]: Section needs expansion and more comprehensive analysis. See Scheller et al. 2011 concerning fire and vegetation management effects on fishers. There is a lot of recent literature and ongoing research on this topic, which deserves more in-depth treatment in this assessment.

Comment [W108]: Source/citation for this? Many (most?) wildfires are started by humans over large areas (especially lower elevation areas, WUI).

Comment [W109]: Effects can be positive or negative, depending on the nature of the fire (size, severity) and time since fire.

Comment [W110]: Overly simplistic. Large and severe fires can have negative effects; more frequent, less severe fires in pine and mixed-conifer forests may be beneficial. See SSNFCA and other literature on the topic.

that established fire exclusion as a national policy and formed the basis for USFS and NPS policies of absolute suppression of fires until those policies were reconsidered in the 1960s [174].

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 102,000 ha/year (252,047 ac/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 [174]. This was based on an estimate of the high fire return interval and was assumed to be similar to the fire rotation [174]. Prior to European settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting [175] and to reduce catastrophic fires [176]. Fires set by indigenous people and fires started by lightning have been estimated to have burned from 2.3 to greater than 5.3 million ha (5.6 to > 13 million acres) annually in California [177].

Comment [W111]: Seems like too much historical detail. Focus should be on science detailing how fire characteristics affect fishers.

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more frequent [178]. Westerling et al. [179] found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fisher in California.

Comment [W112]: This gets restated a lot, but there is huge variability across the west in fire regimes, regime changes, and effects on habitat. Section should focus more on specifics in California.

In the Sierra Nevada, the severity and the area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy [178]. Miller et al. [180] examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased.

In 1992, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the

largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged post-fire and replanted trees rapidly after the burn [181]. In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, SPI unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fisher using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly ~~comprised~~ composed of areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm).

The Rim Fire burned approximately 104,000 ha (257,000 ac) in Tuolumne County in August 2013. This fire was situated just north of the SSN ESU. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra population until the vegetation recovers sufficiently to facilitate its use by fishers.

Comment [W113]: See SSNFCA for maps showing modeled effects on likely movement corridor, shifting it upslope to unburned/less severely burned forests.

While the frequency and extent of wildfires in the California have increased in recent years, the area burned annually is substantially smaller than in pre-historic (pre-1800) times when 1.8 – 4.8 million ha (4.4 – 11.9 million ac) of the state burned annually [174]. Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity [182] (Figures 18 and 19).

Comment [W114]: Suggest combining figs into one. Also, the historical fire regime isn't the key factor (and most scientists agree that trying to restore historical conditions isn't an option in many areas). More pertinent are current and future trends that indicate that large, severe (canopy-replacing) fires are a threat to fisher habitat. See SSNFCA. Maps showing departure from historical fire return intervals (FRID), integrated fire hazard, etc., are more useful.

Lawler et al. [183] predicted that fires will be more frequent but less intense by the end of the 21st century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods [184]. Westerling et al. [185], modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California, and potential increases in burned area in the Sierra Nevada

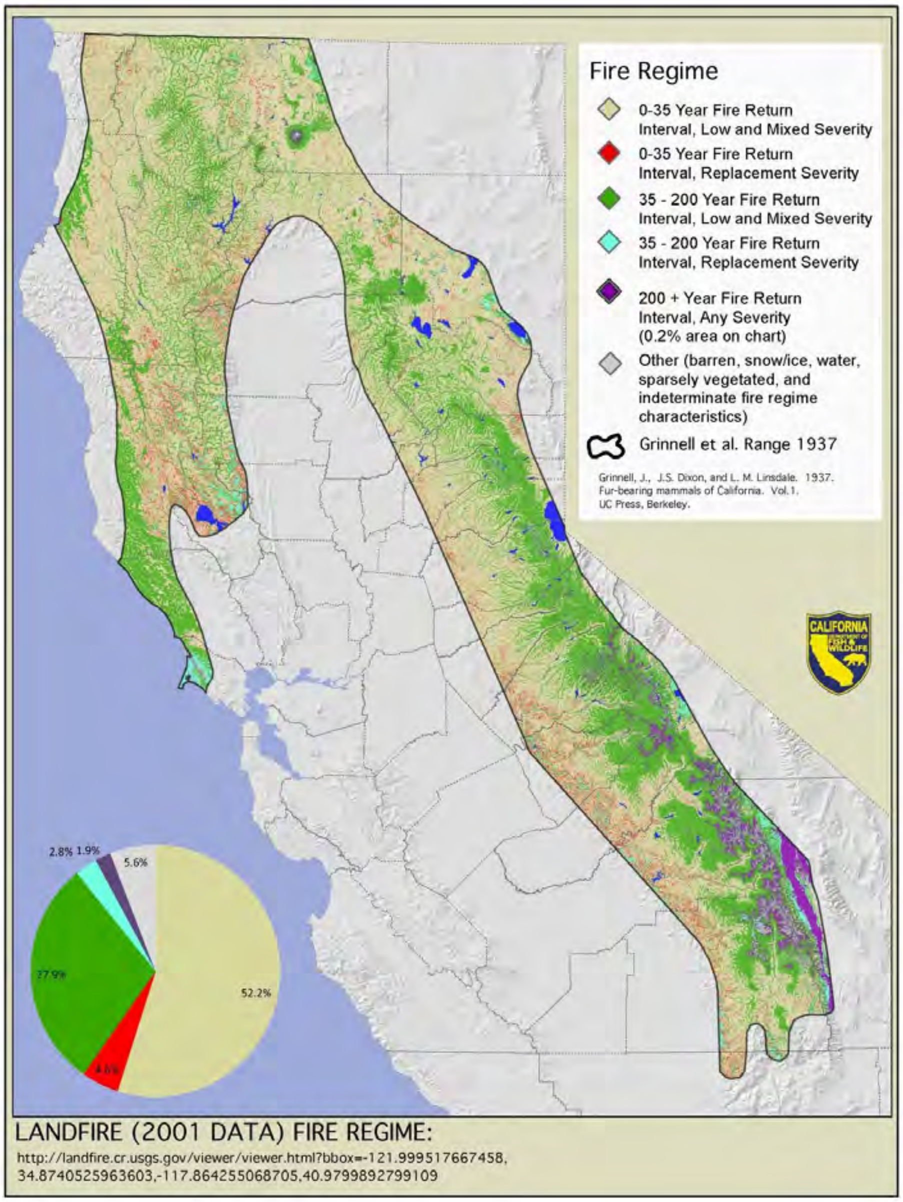


Figure 18. Presumed historical fire regimes within the historical range of fisher in California described by Grinnell et al. [3]. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

Comment [W115]: Why not combine Figs 18 and 19, just adding ESU boundary to Fig 18?

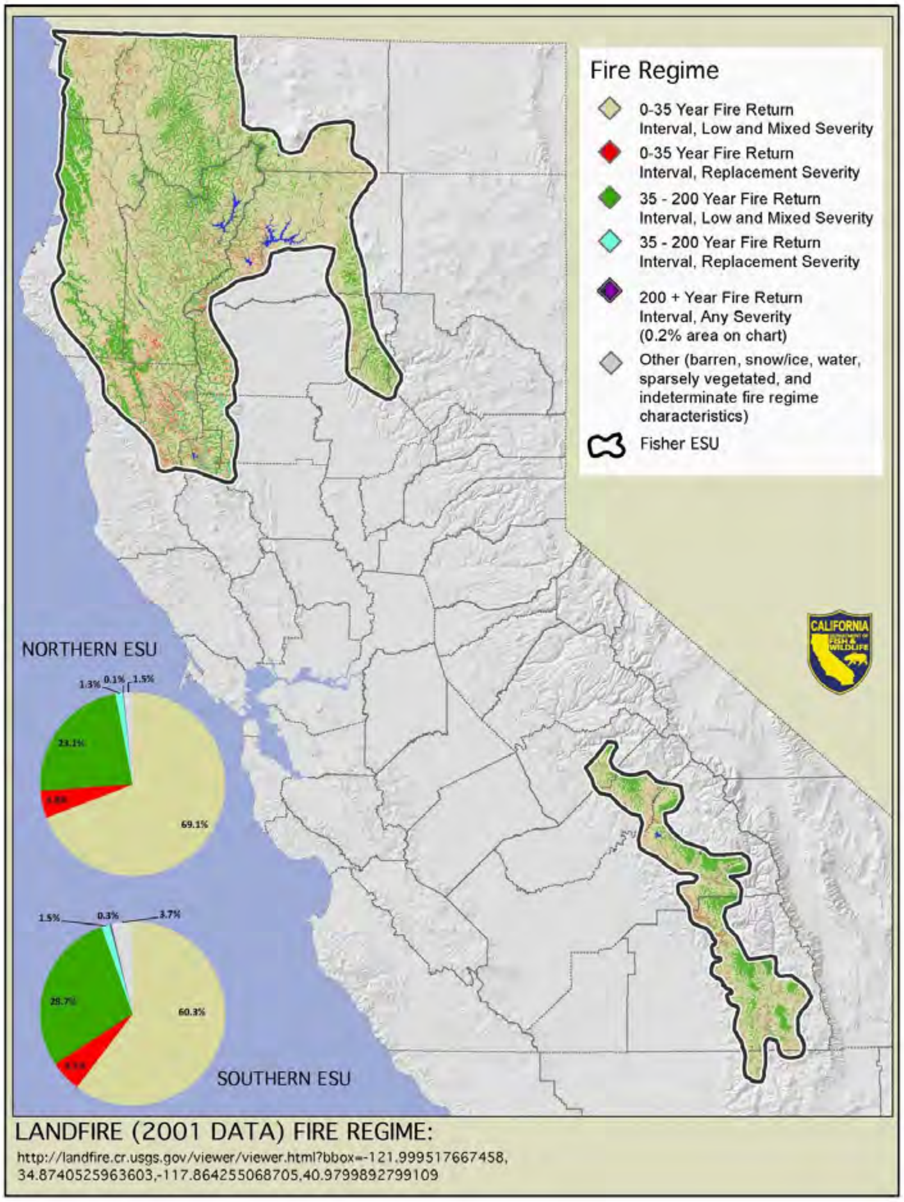


Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

appeared greatest in mid-elevation sites on the west side of the range [185]. However, the authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predications for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover [171,186,187].

Toxicants

Comment [W116]: Section is long, redundant and poorly organized. Start with an intro overview of the issue, and then organize info into subsections on ARs and other toxicants. In each subsection, provide general conclusions first, followed by more detailed scientific justification. Currently, AR info is scattered throughout with no cohesive thread.

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs) in California fisher populations has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range [153]. Although the source of toxicants to fishers has not been conclusively determined, numerous reports from remediation operations of illegal marijuana cultivation sites (MJCSs) on public, private, and tribal forest lands indicate the presence of a large amount of pesticides, including ARs, at these sites.[31] The presence of a large number of MJCSs within habitat occupied by fisher populations and the lack of other probable sources of ARs suggest that the AR exposure is largely occurring on the cultivation sites.

Comment [W117]: This qualification seems unnecessary. Illegal marijuana grow sites are clearly the overwhelming source.

Fishers are opportunistic generalist predators and can be exposed to toxicants through several routes. They can be exposed directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such tastes as sucrose, bacon, cheese, peanut butter and apple) would also likely appeal to fishers [189]. Furthermore, there have been reports of intentional wildlife poisoning by adding

[31] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As growth sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reports remediating more than 600 large-scale MJCSs on just two of California's 17 national forests [188].

pesticides to food items such as canned tuna or sardines [188]. Many of the pesticides found at MJCSs are liquid formulations that can easily be mixed into food.

Comment [W118]: And hot dogs.

As carnivores, fishers could also be exposed to toxicants secondarily through prey. This is likely the primary means of AR exposure because of the toxin's persistence in the body tissue of poisoned prey items; secondary exposure of mustelids to ARs has occurred in rodent control operations [190]. Tertiary AR exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed [191] and may be possible in fishers that eat smaller carnivores. Lastly, AR exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer has occurred [189,191].

Anticoagulant Rodenticides: ARs cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impair an animal's ability to produce several key clotting factors. ARs fall into two categories (generations) based on toxicological characteristics and use patterns: first and second generation anticoagulant rodenticides (FGARs and SGARs, respectively). FGARs, developed in the 1940s, are less toxic than SGARs, and require consecutive days of intake by a rodent to achieve a lethal dose. FGARs have a lower ability to accumulate in biological tissue and are metabolized more rapidly [192,193]. There are 60 FGAR products registered in California. Labeled uses of FGARs are commensal rodent (house mice, Norway rats, and roof rats) control and agricultural field rodent control.

Comment [W119]: The paragraphs above all focus on ARs. Suggest organizing so the intro paragraphs provide overview of ALL toxicants that may be affecting fishers and prey (including insecticides, etc.), and moving the AR-specific content in here.

Development of SGARs began in the 1970s as resistance to FGARs began to appear in some rodent populations. SGARs have the same mechanism of action as FGARs but have a higher affinity for the target enzymes, leading to greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days) [192,193]. A lethal dose may be consumed at a single feeding. The several days' lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are 79 SGAR products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum. Labeled uses are for the control of commensal rodents in and around residences, agricultural buildings, and industrial facilities, such as food processing facilities and commercial facilities. SGAR products must be placed within 100 feet of man-made structures and may not be used for control of field rodents.

The unexpected discovery of AR residues in a fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project research team prompted monitoring of AR exposure in carcasses of fishers submitted for necropsy from research projects located throughout the fisher's range in California. The livers of 58 fishers that died from 2006-2011 were tested; 79% were positive for AR exposure. Four of these fishers died from AR poisoning. The number of different AR compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers [189]. Of the fishers tested, 96% were exposed to SGARs and the exposure of fishers to ARs was geographically widespread [189].

Comment [W120]: SNAMP

Comment [W121]: Update this info. Exposure rates now estimated over 90% (M. Gabriel and C. Thompson, pers. comm.

Gabriel et al. [189] documented the amount of toxicants found at one illegal MJCS in Humboldt County. Among other toxicants, 0.68 kg (1.5 lbs) of brodifacoum, as well as 2.9 kg (6.5 lbs) worth of empty AR bait containers were found. Based on the LD50 value for a domestic dog, it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption.

The sublethal impacts of AR exposure to fishers are not fully known. Sublethal effects may include increased susceptibility to disease [194], behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes [195], and reduced reproductive success. The contribution of AR (and other pesticides found on MJCSs) exposure to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer MJCSs located within their home ranges [196]. Studies have suggested that embryos are more sensitive to anticoagulants than are adults [197–199]. AR-related fisher mortalities were concentrated temporally in mid-April and mid-May which is the denning period for fisher females [189]. This raises concerns that mothers could expose their kits to ARs through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Higher AR-related mortalities in spring may be a consequence of more ARs being used at this time to protect young marijuana plants from rodent damage than at other times of the year.

Comment [W122]: Also, since ARs prevent clotting, otherwise minor injuries can be debilitating or fatal..

On July 1, 2014, SGARs products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials and their legal use was limited to certified private applicators, certified commercial applicators, or those under their direct supervision. The placement of SGAR bait will generally be prohibited more than

15 m (50 ft) from man-made structures. These new regulations may limit the availability of SGARs, but how effective they will be at reducing the use of SGARs at MJCSs is unknown.

Comment [W123]: Growers smuggle them in with no regard for regulations.

Comment [W124]: Actually, it is clear this will have no effect on MJCSs, which are run by criminals with no respect for regulations. Only increased law enforcement and cleanups will help.

Other Potential Toxicants: Other pesticides deployed at MGCSs have likely caused fisher mortalities: 3 fishers in northern California were suspected to have died as a result of exposure to the carbamate toxin-methomyl cholecalciferol and bromethalin (Gabriel, unpublished data). Pests include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at MJCSs that were presumably used to combat them (Table 6). Some of the organophosphates and carbamates used on MJCSs are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use [200,201]. Volunteer reclamation crews reported that AR and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 [196]. Sixty-eight kilograms of AR and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort in public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km [189].

Comment [W125]: I believe this is ARs, which they apply along irrigation lines to prevent rodents chewing on them.

ARs are persistent in liver tissue, thus the compounds can be detected in liver tissue of sublethally exposed animals for several months following the exposure. Other pesticides such as carbofuran and methamidophos, which are present at the same sites, are more likely to cause immediate mortality, but are much less likely to be detected in fishers because carcasses would need to be recovered at MJCSs to confirm exposure.

Comment [W126]: Wrong subsection. Organize section better.

Population-level Impacts: Although it is well documented that anticoagulant rodenticides (ARs) used both legally and illegally have caused mortalities of non-target wildlife species, including fishers [189,192,202–204], the question of whether or not lethal and sublethal exposure to ARs or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed.

Comment [W127]: Thompson et al. 2013 documented reduced survival for female fishers with more MJCSs in their home ranges. This probably has a population level effect, especially given the coincident seasonality of growsites and denning season.

To estimate the extent of the current fisher range potentially impacted by MJCSs, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi) and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 20) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.

Comment [W128]: Citation?

Table 5~~6~~. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (MJCSs) (CDFW, IERC, HSVTC unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Class	**Mammalian Toxicity Range**	**Relative Frequency of Occurrence at MJCSs[1]**	**Evidence of Exposure or Toxicity (Gabriel et al. unpublished)**
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Not Detected
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as “occasional” or “common” based on the highest occurrence for any product in each class.

Although AR poisoning resulting in mortality has been documented in four fishers from two geographically separated populations and AR exposure is highly prevalent and geographically widespread [189], the cumulative impact of individual toxicity and exposure is hard to quantify at the population level. Determination of poisoning and exposure usually requires collection of carcasses, and therefore data are only available

Comment [W129]: AR section.

Comment [W130]: Update: It is more now.

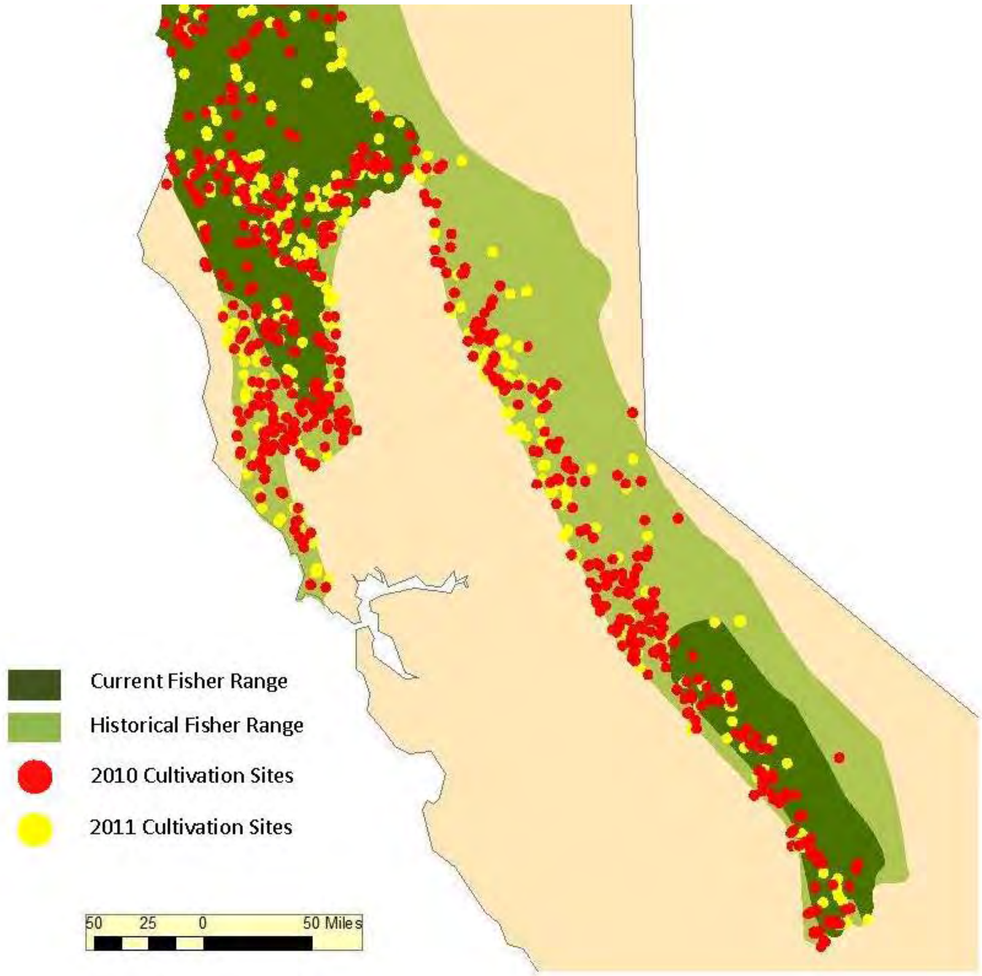


Figure 20. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

for fisher populations where ongoing intensive research (often involving a substantial number of radio collared animals) is conducted. Accordingly, pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected.

Despite these limitations, recent research from the well-monitored southern Sierra Nevada fisher population in California has revealed that female fishers with more MJCSs in their home ranges had higher rates of mortality and a higher likelihood of being exposed to one or more AR compounds [196]. Despite this association, further study is needed to demonstrate that chronic or sublethal AR or other pesticide exposure could predispose a fisher to death from another cause (aka indirect effect). These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival [194,205–212].

Comment [W131]: I agree that more study is needed, but this sentence seems to downplay the likely high significance of these effects.

Exposure to AR through either milk or placental routes was identified in a dependent fisher kit that died after its mother was killed [189]. Additionally, Gabriel and colleagues observed that AR mortalities occurred in the spring (April-May), a time when adult females are rearing dependent young. Low birth weight, stillbirth, abortion, and bleeding, inappetance and lethargy of neonates have all been documented in other species as a result of exposure to ARs, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of MJCSs located within an individual's home range may start to address this question.

Reductions in prey availability due to pesticide use at MJCSs could potentially impact fisher population vital rates through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant [192], there is potential that MJCSs could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species [213–216]. However, the level of small mammal mortality at MJCSs remains largely unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey remain speculative.

Comment [W132]: Only small mammals? I strongly suspect that the apparent decline and absence of porcupines from large areas (e.g., mid elevation forests of the SSN) is due to, or exacerbated by, the MJCS rodenticide issue. And porcupines are important fisher prey in other regions where they co-occur.

Comment [W133]: Yes, but, there is strong inference behind this speculation. Downplaying potential significance of such factors seems to bias the assessment toward a finding of "not warranted."

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. A sublethal dose of AR can produce significant clotting abnormalities and some hemorrhaging (Eason and Murphy 2001). Predators with liver concentrations of ARs as low as 0.03ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey [192]. Accordingly, fishers exposed to ARs may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Comment [W134]: This topic mentioned above. Organize content.

Challenges to investigating toxicant threats from MJCSs within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors [217].

The high prevalence of AR exposure in fishers and other species throughout California indicates the potential for additive and synergistic associations with pesticide exposure at MJCSs and consequently increased mortality from other causes. Small, isolated fisher populations, such as occurs in the SSN Fisher ESU, are of concern because they are more vulnerable to stochastic events than larger populations and a reduction in survivorship may cause a decline or inhibit growth.

Comment [W135]: Good summary info to use in the introductory paragraphs of this toxicant section.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s [218,219]. Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years [183]. Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe [218].

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago [220,221]. Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase in California by approximately 2.4 C ~~in California~~ by the 2060s (Pierce et al. [222]) and by 2 to 5 C by 2100 (Cayan et al. [223]). Projections of

Comment [W136]: There are strong regional patterns to such trends within California.

precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation [224–226]. However, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation [227]. Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase [222,228]. Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack [229]. These patterns are expected to continue [223–225,230] and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 [231]. Forests throughout the state will likely become more dry [223,224,229].

The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra, rest sites are often located near water [108]. Zielinski et al. [108] suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Warming is predicted throughout the range of the fisher in California [183]. Pierce et al. [222] projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN Fisher ESU may experience greater warming than those occupying portions of the NC Fisher ESU.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their “climatically suitable” range within California by the year 2100 [183]. However, the distribution and climate data for those models was assessed at a 50 x 50 km grid; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California’s montane environments, temperature and other climatic variables

can change considerably over relatively small distances [232]. Thus, the diversity of the physical environment within areas occupied by fisher may buffer some of the projected effects of a changing climate [233].

Climate change is likely to indirectly affect fishers by altering the species composition and structural components of habitats used by fishers in California [183,234]. Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change [179,183,184]. To evaluate potential future climate-driven changes to habitats used by fisher in the state, Lawler et al. [183] combined model projections of fire regimes and vegetation response in California by Lenihan et al. [234] with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs by 2071-2100, as compared to mean cover from 1961-1990 (Table 7).

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands [183]. If woodlands and grasslands within the fisher ESUs expand considerably in the future as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others unsuitable. However, Lawler et al. [183] also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the "floristic conditions" for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. [183] cautioned that their habitat modeling was based on a 10 x 10 km grid, which was a "high resolution for this type of model" and that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales. They further noted that the modeled changes are broad, landscape-scale patterns that will be "filtered" by variability in topography, vegetation and other factors.

Table 6~~7~~. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. [183].

Klamath Mountains - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

Hayoe et al. [225] modeled California vegetation over the same period as Lawler et al. [183] and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. [235] predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100. In the southern Sierra, Koopman et al. [236] modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. [236] also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas.

Burns et al. [237] assessed potential changes in mammal species within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to Yosemite

National Park. Burns et al. [237] suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such “reshuffling” of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health [229,238,239]. Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward [240–242]. Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes [243]. Changes in forest vegetation due to invasive plant species may impact fisher prey species composition and abundance. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state.

Existing Management, Monitoring, and Research Activities

U.S. Forest Service

The majority of land within the current range of the fisher in California is public (approximately 55%) and the majority of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. [3], encompassed all or portions of 13 National Forests including the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia as well as the Tahoe Basin Management Unit.

USFS sensitive species, such as fisher, are plant and animal species identified by the Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within the USFS Pacific Southwest Region are treated as though they were federally listed as threatened or endangered (USDA 1990).

Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA), USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11 National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

Comment [W137]: Not Sequoia?

U.S. Forest Service – Specially Designated Lands, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan (NWFP) was adopted to guide the management of over 24 million acres of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (NSO) [244]. Adoption of the NWFP resulted in amendment of USFS and the Bureau of Land Management (BLM) management plans to include measures to conserve the NSO and other species, including the fisher, on federal lands.

The NWFP created an extensive and large network of late-successional and old-growth forest (Figure 21). These lands are designated as Congressionally Reserved Areas and Late Successional Reserves and are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan; however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, NSOs, and sites occupied by other species. Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody ([245]).

Comment [W138]: Designated?

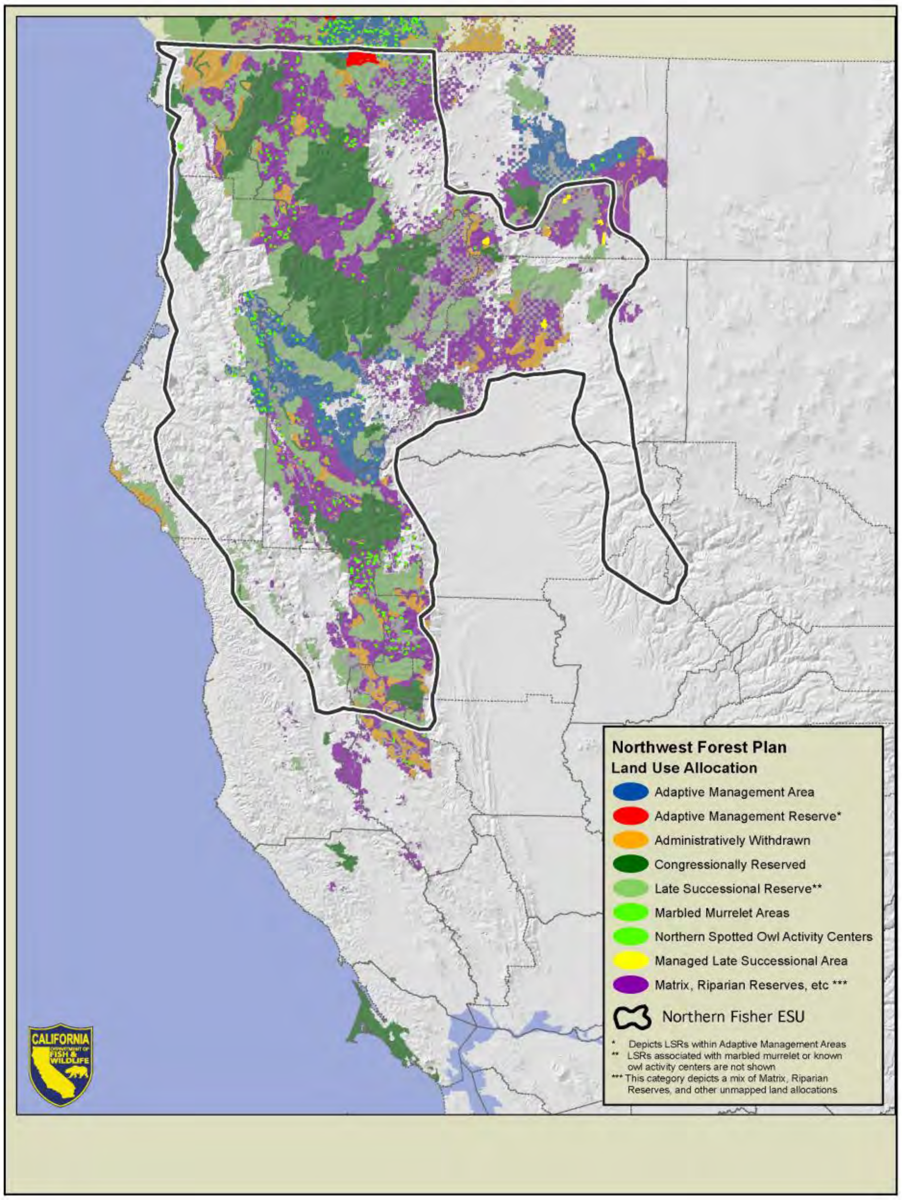


Figure 21. Northwest Forest Plan land use allocations [246]. California Department of Fish and Wildlife, 2014.

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the NSO, the US Fish and Wildlife Service recognized the importance of implementation of the NWFP to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the NSO did not alter land use allocations or change the Standards and Guidelines for management under the NWFP, nor did the rule establish any management plan or prescriptions for the management of critical habitat. However, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the NSO. Those include conservation of older forest, high-value habitat, areas occupied by NSOs, and active management of forests to restore ecosystem health in many parts of the NSO's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality NSO habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised NSO Recovery Plan. NSO critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 22).

Sierra Nevada Forest Plan Amendment (SNFPA): The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the SNFPA by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (USDA 2004). It also amended Land Management Plans for National Forests within the Sierra Nevada.

The Record of Decision for the SNFPA contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the SNFPA conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;

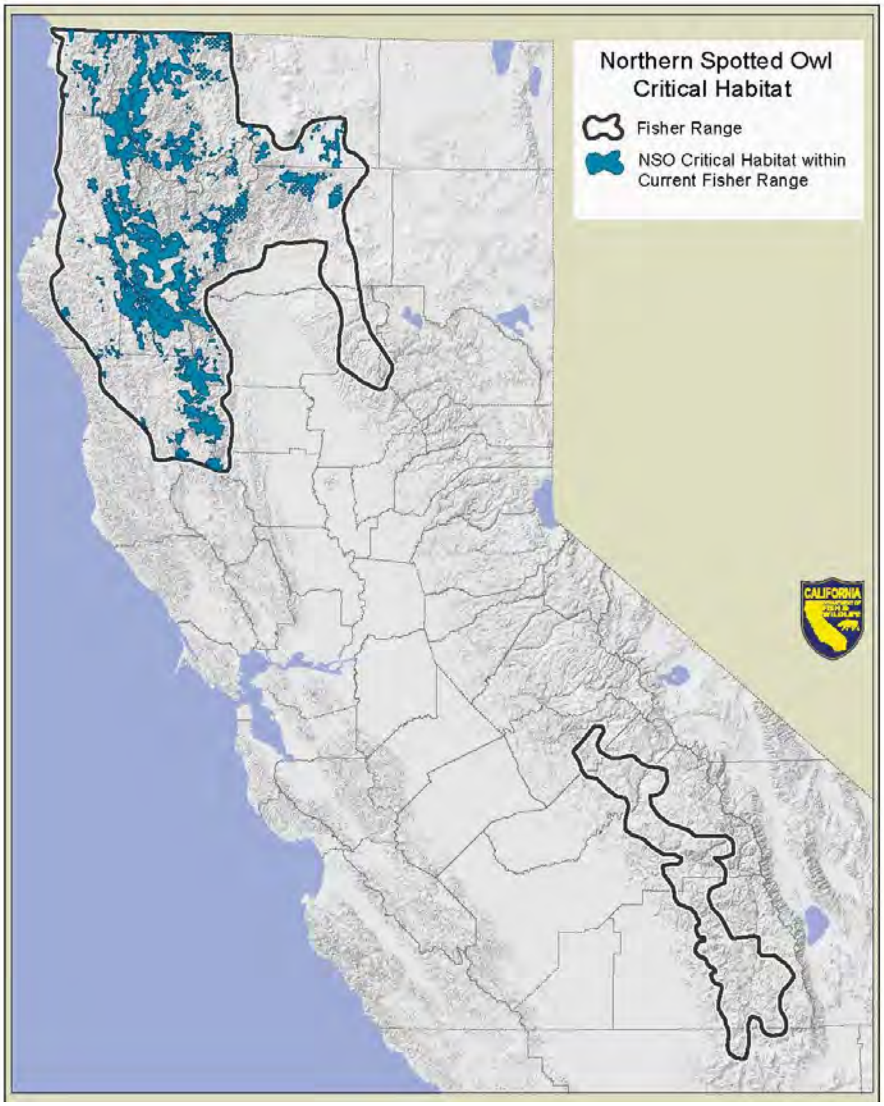


Figure 22. Distribution of northern spotted owl critical habitat within the current estimated range of the fisher in California.

- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and

- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The SNFPA established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit them by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra fisher conservation area
- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 4.9 million acres within the historical range of the fisher described by Grinnell et al. [3]. Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 3.5 million acres and 10 wilderness areas encompassing the southern Sierra population totaling about 416,000 acres. Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 328,315 acre Giant Sequoia National Monument (Monument) is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within the Monument are intended to be managed to support viable populations of these species. Three categories of land allocations within the Monument have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (311,150 acres). The current Management Plan for the Monument lists specific objectives to study and adaptively manage fisher and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project (SNAMP): The SNAMP was initiated in 2005 to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health [247]. A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) and focused on four response variables, including fishers. Researchers are studying factors that may limit the fisher population within SNAMP's study site in the southern Sierra Nevada. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation [248].

Comment [W139]: This CDFW assessment doesn't seem to benefit much from the massive amount of useful data generated by this study (and the KRFP, below). Lots of new insights on fisher biology, threats, management needs, etc., come from these studies, much of it summarized in the SSNFCA and being used to develop the SSN Fisher Conservation Strategy.

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007, in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada [249]. The project area encompasses about 53,200 ha (131,460 ac) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting structures have been identified [249]. Predation has been the primary cause of death of the fishers studied.

Comment [W140]: Why this one tidbit of results? The study has also revealed threats of MJCS, habitat relationships, demography, etc., etc.

Bureau of Land Management

Management of Bureau of Land Management (BLM) lands are authorized under approved Resource Management Plans (RMPs) prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra RMP) include conservation strategies for fishers and other special status species. The Sierra RMP contains objectives to sustain and manage mixed evergreen forest ecosystems in to support viable populations of fisher by conserving denning, resting, and foraging habitats [250]. This plan contains provisions to manage lands within the RMP to support large trees and snags, to provide habitat connectivity among federal lands, and making acquisition of fisher habitat a priority when evaluating private lands for purchase [250].

Management of BLM lands within NSO range are also subject to provisions of the NWFP. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fisher associated with late-successional and old-growth forests [245].

National Park Service

Compared to other public lands which are primarily administered for multiple uses, national parks are among the most protected lands in the nation [251]. The National Park Service (NPS) does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

State Lands

State lands comprise only about one percent of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA). During CEQA review for proposed projects on state lands within fisher range and where suitable habitat is present, potential impacts to fishers are specifically evaluated because the

species is a Department of Fish and Wildlife Species of Special Concern. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (CCR, Title 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the FPRs) that require the preparation and approval of Timber Harvesting Plans (THPs) prior to harvesting trees on California timberlands.

Private Timberlands

The Department estimates that approximately 39% of current fisher range in California is comprised of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act and associated FPRs promulgated by the State Board of Forestry and Fire Protection (BOF). The FPRs are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans (THPs) prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to BOF's rules; and (2) information and direction to timber operators so they comply with BOF's rules (CCR, Title 14, § 1034). The preparation and approval of THPs is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

Under the FPRs (CCR, Title 14, § 897(b)(1)(B)), forest management shall "maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed." Although the FPRs do not require measures specifically designed to protect fishers, elements of these rules provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fisher may be voluntarily retained to achieve post-harvest stocking requirements under the FPR subsection relating to "decadent or deformed trees of value to wildlife" (FPR 912.7(b)(3), 932.7(b)(3), 952.7(b)(3)). Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (WLPZs).

Comment [W141]: Break out by NC and SSN ESUs. I suspect the proportion is much highe in north than south.

WLPZs are defined areas along streams where the FPRs restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but WLPZs may encompass 15 – 45 m (50-150 ft) on each side of a watercourse 30-91m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. In some locations, WLPZs may constitute 15% or more of a watershed (J. Croteau, pers. comm.). Drier regions of the state with lower stream densities have a much lower proportion of the landscape in WLPZs. Where WLPZs allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes.

Timberland owners with relatively small acreages [<1,012 ha (2,500 acres)] may prepare Non-Industrial Timber Management Plans (NTMPs) designed to provide long-term forest cover on enrolled ownerships which may provide habitat suitable for use by fishers.

For ownerships encompassing at least 50,000 acres, the FPRs require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (CCR, Title 14, § 1091.1, § 913.11, § 933.11, and § 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option is likely to provide forested habitat that is suitable for fishers. However, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare THPs and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The FPRs impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees [trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Portions of the FPRs (CCR, Title 14, §§ 919.16, 939.16, and 959.16) relate to late succession forest stands[32] on private lands. Proposals to harvest late successional stands where the stands' amount, distribution, or functional wildlife habitat value will be reduced and result in a significant adverse impact on the environment must include a discussion of how the species primarily associated with late successional stands will be affected. When long-term significant adverse effects on fish, wildlife, and listed species associated primarily with late successional forests are identified, feasible mitigation measures to mitigate or avoid adverse effects must be incorporated into THPs, Sustained Yield Plans, or NTMPs. Where these impacts cannot be avoided or mitigated, measures taken to reduce them and justification for overriding concerns must be provided.

Some private companies, including large industrial timberland owners and non-industrial timber owners, have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These may include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Private Timberlands – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1992, the Forest Stewardship Council (FSC) was formed to create a voluntary, market-based approach to improve forest practices worldwide [252]. FSC's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity [253]. In California, approximately 1.6 million acres of forest lands are FSC certified [254].

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to "take," as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq.*)(ESA), threatened and endangered species. Applicants for incidental take

[32] Late Succession Forest Stands refers to stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

permits under Section 10 of the ESA must submit an HCP that specifies, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. An HCP may include conservation measures for candidate species, proposed species, and other species not listed under the ESA at the time an HCP is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six HCPs in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods HCP specifically addresses fisher, although other HCPs contain provisions intended to benefit species such as NSO (e.g., Green Diamond Resources Company and Fruit Growers Supply Company) that may also benefit fishers.

Comment [W142]: Note: All within NC ESU.

Fisher Translocation: From 2009-2012, the Department translocated[33] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra-Pacific Industries (SPI). This effort, the first of its kind in California, was undertaken in cooperation with SPI, USFWS, and North Carolina State University. A primary conservation concern for fisher has been the apparent reduction in overall distribution in the state. Fishers have been successfully translocated many times to reestablish the species in North America [26], and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California [256].

Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites [256]. Those lands represented most of the large, relatively contiguous tracts of SPI land within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto SPI's property, including habitat suitability of candidate release sites, prey availability, genetics, potential impacts to other species with special status, disease, predation, and the effects of removing animals on donor populations.

[33] Translocation refers to the human-mediated movement of living organisms from one area for release in another area [255].

Table 7~~8~~. Approved Habitat Conservation Plans within the range of the fisher in California.

HCP Name	**Location**	**Area (acres)**	**Permit Period**	**Covered Species**
Green Diamond Resources Company	Del Norte & Humboldt counties	407,000	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	211,000	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Fruit Growers Supply Company	Siskiyou County	152,000	2012-2062 (50 years)	• coho salmon (Southern Oregon/Northern California Coasts ESU) • steelhead (Klamath Mountains Province ESU) • Chinook salmon (Upper Klamath and Trinity Rivers ESU) • northern spotted owl • Yreka phlox
Green Diamond Resources Company	Humboldt and Del Norte counties	417,000	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander
Fisher Family	Mendocino County	24	2007-2057 50 years	• Behren's silverspot butterfly • Point Arena mountain beaver
AT&T	Mendocino County	11	2002-2012 10 years	• Point Arena mountain beaver

From late 2009 through late 2011, 40 fishers (24F, 16M) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release [126]. A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young [126].

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 were born on Stirling [126]. On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California [126]. Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group comprised 47% of the population, suggesting relatively high levels of reproduction and recruitment [126].

Candidate Conservation Agreement with Assurances: A "Candidate Conservation Agreement with Assurances for Fisher" (CCAA) between the USFWS and SPI regarding translocation of fisher to a portion of SPI's lands in the northern Sierra Nevada was approved on May 15, 2008. CCAAs are intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to SPI should USFWS eventually list fisher under the federal ESA. This 20-year permit covers timber management activities on SPI's Stirling Management Area, an approximately 160,000-acre tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge

Comment [W143]: Anything relevant for the Tule River Tribe in the SSN? Their land includes occupied fisher habitat.

of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fisher. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society to study the ecology of fishers. Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California.

Management and Monitoring Recommendations

The Department has implemented a number of actions designed to better understand fisher in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the BOF, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, and university researchers, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

1. Support independent research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term, multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.

5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations, potential effects of toxicants and their potential effects on fisher and fisher prey. It may be possible to partner with existing studies and surveys to collect some of the data needed.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends. Fishers translocated elsewhere in North America have rarely been monitored and this translocation is the first effort of its kind in the state. Continued monitoring is critical to answer questions about how fishers use managed landscapes and to determine if the project is successful in the long-term and, if not, why it failed.

7. In the southern Sierra Nevada, collaborate with land management agencies and researchers to expand connectivity between core habitats and to facilitate population expansion.

Comment [W144]: Why no mention of the SSNFCS, which is a collaborative interagency planning effort to conserve and recover the SSN fisher population and its habitat? CDFW has a slot on the Fisher Interagency Leadership Team (FIALT), the decision-making body for the effort.

8. Assess the potential for assisted dispersal of juvenile fishers or translocation of adults from the southern Sierra population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region.

Summary of Listing Factors

CESA directs the Department to prepare this report regarding the status of the fisher in California based upon the best scientific information. Key to the Department's analyses are six relevant factors highlighted in regulation. Under the California Code of Regulations, Title 14, § 670.1, subd. (i)(1)(A), a "species shall be listed as endangered or threatened...if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:"

(1) present or threatened modification or destruction of its habitat;
(2) overexploitation;

(3) predation;
(4) competition;
(5) disease; or
(6) other natural occurrences or human-related activities

Also key are the definitions of endangered and threatened species, respectively, in the Fish and Game Code. CESA defines endangered species as one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease." (Fish & G. Code, § 2062.) A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]." (*Id.*, § 2067.)

Fishers in California occur in two separate and isolated populations that differ genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units where appropriate in its analysis of listing factors.

Present or Threatened Modification or Destruction of its Habitat

Considerable research has been conducted to understand the habitat associations of fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types [105,119–122]. Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. Forested landscapes with these characteristics are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Thresholds for these attributes for fishers are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

Management of Federal Lands: Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The

Comment [W145]: … and with dense, often multi-layered canopy structure. High canopy cover (>60%) is consistently identified as important by habitat studies at all scales.

Comment [W146]: Abundant analyses have been conducted, and are ongoing, for the SSNFCS, including statistical characterization of such "thresholds" and especially statistical characterization of the needs of breeding females (most important to sustaining/increasing population size). It is surprising that CDFW hasn't been more engaged in this effort, which would strongly affect the content of this assessment.

majority of federal actions must comply with NEPA. This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

The status of fisher as a sensitive species on USFS and BLM lands in California provides consideration for the species as guided by land management plans adopted by these agencies. As a result, substantial federal lands currently occupied by fishers in the state are managed to provide habitat for fishers, although specific guidelines are frequently lacking. Federal lands designated as wilderness areas or as National Parks are likely to provide long-term protection of fisher habitat. However, some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur.

Management of Private Lands: Timber harvest activities on private lands are regulated by various provisions of the Z'Berg Nejedly Forest Practice Act of 1973 and additional rules promulgated by the State Board of Forestry and Fire Protection. These rules are enforced by CAL FIRE and, although some timber harvest activities are exempt from these rules, they apply to all commercial harvesting activities on private lands.

The FPRs promulgated under the act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. However, information about what constitutes the "existing wildlife community" is frequently lacking in THPs, and specific guidelines to retain habitat for fishers and other terrestrial mammals are not incorporated into the FPRs.

Timber management activities subject to the FPRs can reduce the suitability of habitats used by fishers or render some areas unsuitable. These changes may be short-term or long-term, depending on a number of factors including the type of silviculture used, intermediate treatments conducted while forests regrow, timber site growing potential, and the time between timber rotations.

Fishers are able to utilize a diversity of forest types and seral stages. An aspect of forest management important to the suitability and long-term viability of fishers is the retention and recruitment of habitat elements for denning, resting, and to support prey

Comment [W147]: True as a general statement, but home ranges are dominated by dense, late-seral stages, especially for females. Fishers will forage in diverse types and stages, but resting and denning are almost exclusively in forests with late seral characteristics and very dense canopies.

populations in sufficient number and in locations where they can be successfully captured by fisher. The FPRs require the retention of unmerchantable snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However, live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites. No provision is provided in the rules to specifically recruit snags.

The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. The time interval between harvests may also affect the distribution and abundance of habitat structures used by fishers. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity [88]. Frequent harvest entries to salvage dead, dying, and diseased trees likely reduce the availability of these habitat elements. Retention of forest cover and large trees is a requirement of the FPRs along streams (i.e., WLPZs), with the width of these areas determined by stream class, slope, and the presence of anadromous salmonids.

The FPRs do not specifically require the retention or recruitment of hardwoods and, in some cases, their harvest may be required to meet stocking standards. Hardwoods may also be intentionally killed ("hack-and-squirt" herbicide application or felled) individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of habitats used by the species. Various hardwood species provide potential den and rest trees and habitat used by fisher prey. Although the FPRs do not require retention of hardwoods, the Department is not aware of data indicating that their removal on commercial timberlands has substantially affected the distribution or abundance of fishers in California.

Depending on their location, WLPZs may comprise up to 15 percent of private ownerships managed for timber production. Drier regions of the state with lower stream densities have a much lower proportion of the landscape designated as WLPZs. Where they are managed to retain or recruit trees suitable for denning and resting, WLPZs may provide a network of older forest structure within managed forest landscapes beneficial to fishers and provide denning, resting, and foraging habitat for fishers. Outside of WLPZs, trees suitable for denning or resting by fishers are not required to be retained;

however they may be intentionally left by landowners to meet post-harvest stocking requirements.

The effects of future timber harvest activities on habitats used by fishers cannot be accurately predicted as changes in regulations, policies, and market conditions influence management intensity. Independent of the FPRs, trees of value to fishers may remain on landscapes through timber rotations because they are unmerchantable, are located in areas where access is infeasible, or because of company policies. Some private companies have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Fire: In recent decades the frequency, severity, and extent of fires has increased in California. This has varied statewide, with the greatest increases in fires severe enough to eliminate forest stands occurring in the Sierra Nevada, southern Cascades, and Klamath Mountains. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. However, the contemporary extent of wildfires burning annually in California is considerably less than the estimated 1.8 million ha (4.5 million ac) that burned annually in the state prehistorically (pre 1800) [174].

Comment [W148]: Frequency is not the issue: size and severity (which are correlated) are the issue.

Comment [W149]: Not just occupied. Conservation goals in SSN include expanding the population into historically occupied habitats from which fishers were extirpated. Fires, such as the Rim Fire, are greatly impacting this goal.

The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due its small size, the comparatively linear distribution of the habitat available, and predicted future climate changes. Timber harvest activities in portions of the southern Sierra Nevada occupied by fisher are largely under federal management. These National Forests in the SSN ESU have adopted specific guidelines to protect habitats used by fishers.

Comment [W150]: What are these? These forests are actively engaged in developing such guidelines via the SSNFCSt.

Within the NC Fisher ESU, fishers are comparatively widespread across a matrix of public and private forest lands. With the exceptions of Lake, Sonoma, and Marin counties, fishers currently occur throughout much of the historical range assumed by Grinnell et al. [3].

Overexploitation

Comment [W151]: Section seems overly long given that trapping has been a non-issue for some time now. Suggest a quick overview of the historic nature of this threat, followed by the current situation.

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable ([123]. The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917-1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers [3] and were also likely harvested by trappers seeking other furbearers [123].

Since the mid-1800s, the distribution of fisher in North America contracted substantially, in part, due to over-trapping and mortality from predator control programs [26]. Over-trapping of fisher has been considered a significant cause of its decline in California [3]. By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season [3]. Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fisher a prize catch.

Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period from 1920-1924 was only 46 animals [3]. Fishers were considered to be rare in California by the early 1920s [124]. Grinnell et al. [3] considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of fisher in California [3]. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue.

The high value trappers obtained for the pelts of fisher in the early 1900s, the species' vulnerability to trapping [8], and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations [26]. Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [124]. However, despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fisher was not prohibited until 1946 [125]. Although commercial

trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (see Lewis et al. [123]). Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers [8], or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations [8] and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (Fish & G. Code, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designee are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 23), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly

over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to

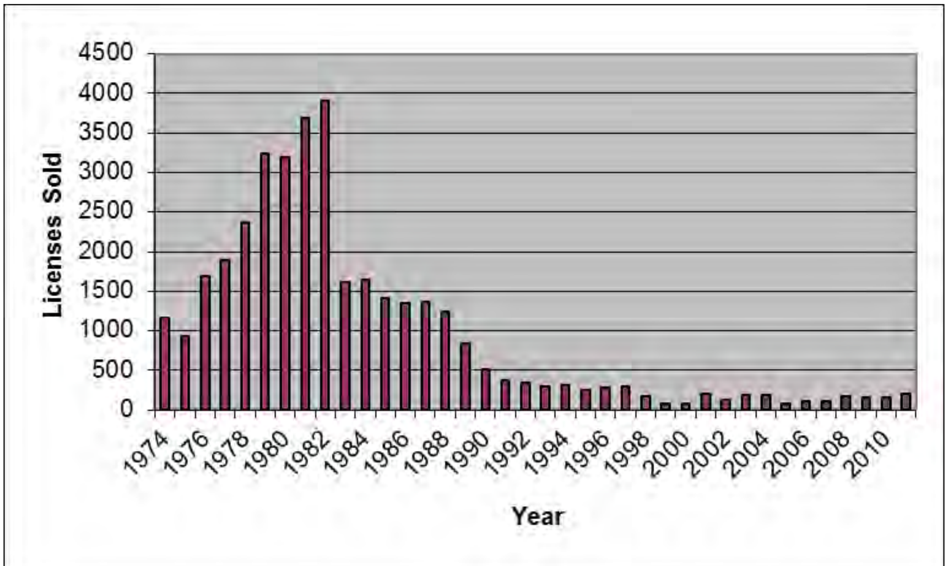


Figure 23. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

increase [257]. From the early 1980s through the present, license sales have continued to decrease with average sales from 2000-2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. However, throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators typically work in close proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by certain species of wildlife. However, fishers are not permitted to be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).

Currently and in the foreseeable future, the likelihood of fishers being overexploited in California is low, based on the prohibition against commercial or recreational take of fishers, low level of commercial and recreational trapping and prohibition of body-gripping traps. The Department is not aware of any data indicating that the potential risk to fisher populations from incidental take due to trapping differs significantly for populations in NC or SSN Fisher ESUs.

Predation

Recent research indicates predation is a substantial cause of mortality for fishers in California [144]. This research, using DNA amplified from fisher carcasses, identified bobcat, mountain lion, and coyote as predators of fishers, with predation attributed to bobcat being the most frequent (50%).

The risk of predation is likely heightened when fishers occupy habitats in close proximity to open and brushy habitats (G. Wengert, pers. comm.), both habitats used extensively by bobcats. Female fishers are more likely to be predated by bobcats and this occurs most frequently during the breeding season when young fishers are dependent on their mothers for survival. Fragmentation of forested landscapes may increase the abundance of some small mammal species used by fishers as prey, but it may also favor potential predators adapted to early successional habitats. However, fishers have co-evolved with the suite of predators naturally occurring within their range and adverse population level effects on fishers due to predation have not been documented.

Currently, there is no information indicating differential risk of predation to fisher in the NC or SSN Fisher ESUs. Based on a sample of 50 fisher carcasses from these regions, no difference in the relative frequencies of predation by bobcat or mountain lion was found. Fishers in the SSN Fisher ESU are likely at greater risk of population level effects of predation due to the small size of their population compared to northern California. However, fishers in the southern Sierra Nevada have apparently been isolated in that region for decades or longer and, at times, their numbers may have been smaller than they are today. The abundance of potential predators of fishers during those periods is unknown, but they likely co-occurred with fisher populations in the region.

Comment [W152]: There is speculation (backed by some evidence) that bobcats, coyotes, and mountain lions have expanded into fisher habitat due to fragmentation and linear openings, such as roads and skid trails. Normally, these predators are rare/absent in the dense, mature forests used by fishers (especially denning females), but denning females are being predated in these areas now. See SSNFCA.

Comment [W153]: Contact R. Sweitzer concerning recent demographic analysis of effects of predation and other threats on SSN fisher population.

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood [24]. Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines [24,25,106]. Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Also, the relative similarities in body size, body shape, and prey between fisher and martens suggest the potential for competition between these species [24]. However, in California, martens typically occur at higher elevations than fisher and thus may have evolved strategies to minimize competition by separation and by exploiting somewhat different habitats. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have evolved with other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California. There is no evidence that fisher populations in either NC or SSN Fisher ESUs are adversely affected by competition with other species. However, landscape level habitat changes that favor population increases in competitors may intensify interspecific competition.

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years [152,158,161,258]. Fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or spill over from other species of carnivores.

Canine distemper virus (CDV) is common in gray fox and raccoon populations in California and both species occur in habitats occupied by fishers. Although studies have shown that fisher may survive CDV infections, outbreaks of highly virulent biotypes have been responsible for the near extirpation of other carnivore species including other mustelids. Deaths caused by other pathogens potentially significant for *Martes* (i.e., rabies, canine parvo virus), have not been documented for fisher in California. Although

canine parvo virus has been documented to cause clinical disease in fishers, testing to date indicates that the disease is circulating in California fishers without causing population level impacts.

Exposure of fishers to *Toxoplasma gondii* in both northern California and the southern Sierra Nevada has been documented. Although this parasite has caused mortality in other mustelids, it has not been documented as a source of mortality in fisher. This is also the case for known vector borne pathogens. Fisher harbor numerous ecto- and endoparasites and, although some can serve as vectors for other diseases, they are usually associated with minimal morbidity and mortality.

There is no evidence indicating that the prevalence of pathogens potentially affecting fishers in the state differs significantly between populations within the NC and SSN Fisher ESUs. The fisher population in the southern Sierra Nevada is likely at a higher risk of diseases that cause significant morbidity or mortality due to the population's isolation and comparatively small size. Although there is no evidence that CDV has caused substantial population declines in fisher, it is a pathogen of conservation concern for fisher and health surveillance of populations is prudent to detect and intervene to the extent possible, if needed.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution of fisher in California appears to have changed substantially before and after European Settlement. Although its precise distribution prior to the 1800s is unknown, based on recent genetic evidence, the fisher population in the state declined dramatically and contracted into two separate populations long before that time. Further reductions in range and abundance were likely post-European Settlement due to over trapping, predator control programs, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. Since trapping of fishers was prohibited in 1946 and the use of body-gripping traps was banned in 1998, the number of fishers in California has increased to levels likely higher than existed during the period of unregulated trapping in the mid-1800s to early 1900s.

The fisher population within the SSN Fisher ESU is likely at greater risk of extirpation due to its small size (recently estimated at <250 individuals [134]), limited geographic range, and isolation compared to fishers in northern California. Small, isolated

populations are subject to an increased risk of extinction from stochastic (random) environmental or demographic events. Small populations are also at greater risk of adverse impacts resulting from the loss of genetic diversity, including inbreeding depression. The probability of this occurring in fisher occupying either the NC Fisher ESU or the SSN Fisher ESU is unknown. Events such as drought, high intensity fires, and disease, should they occur, have a higher probability of adversely affecting the fisher population in the southern Sierra Nevada. Currently, fishers nearest to the southern Sierra Nevada population are those translocated to the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). Fishers within the SSN Fisher ESU are likely to remain isolated in the foreseeable future due to that distance and potential barriers to movement.

Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population [40]. Fishers within the NC Fisher ESU are also largely isolated from other populations of fishers, although their population is contiguous with a small population in southern Oregon. Despite its isolation, the fisher population in northern California is comparatively large, distributed over a large geographic area, and its distribution has apparently not contracted, and may have slightly expanded, in recent decades. Over the last 8 years, occupancy rates of fishers in the southern Sierra have been stable [134]. Although long-term monitoring of population abundance and trends is lacking for fishers within the NC Fisher ESU, surveys from this region and recent estimates of relatively high rates of occupancy indicate that the population has not declined substantially in recent decades.

Toxicants

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and potentially to other toxicants. ARs have caused the deaths of some fishers, and within the SSN Fisher ESU there is a correlation between the presence of MJCSs within a fisher’s home range and reduced survival. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data have been collected to quantify usage. In addition, use practices are largely unknown. Food containers that appear to have been spiked with pesticides and piles of bait have been found on MJCSs indicating intended poisoning of wildlife. However, containers are often found onsite without signs of where the material was

applied. In addition, it is important that MJCSs be searched for fisher and other wildlife carcasses, that these be quantified, and that the appropriate body tissues be analyzed for residues of contaminants.

There is incomplete understanding of effects of contaminants on fishers. Also unknown is the effect of multiple exposures of the same contaminant, similar contaminants, and contaminants with different modes of action. It is also unknown if there are potentially additive effects of contaminants with other stressors on individual fishers. ARs may also have indirect effects by predisposing fishers to other sources of mortality such as predation or accidents. AR toxicants were found at MJCSs in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented.

Although limited population level monitoring of fishers has occurred, the species' distribution in California does not appear to have changed appreciably in decades. If toxicant use has been widespread, long-term, and caused substantial mortality, it is likely that new gaps in the range of fishers or declines in capture rates would have been observed due to the extensive efforts conducted since the early 1990s to detect and study the species. However, evidence of exposure in fishers and the documented deaths of a number of animals indicate this is a potentially significant threat that should be closely monitored and evaluated. Exposure to toxicants at MJCSs has been documented in both the NC and SSN Fisher ESU, but there is insufficient information to determine the relative risk to either population. However, the potential risk to fishers within the SSN Fisher ESU may be greater due to its comparatively small population size.

Comment [W154]: This paragraph should add findings from Thompson et al. (2013) that female fisher mortality is lower in home ranges with more MJCSs.

Comment [W155]: Not sure I agree with this speculation. Toxicants can reduce population size and reproduction without creating gaps in where fishers are detected. Camera detections are a very coarse metric of population status.

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant communities. The effect of warming

temperatures on mountain ecosystems will most likely be complex and predicting how ecosystems will be affected in particular areas is difficult. Some bioclimatic modeling (Lawler et al. [183]) broadly predicts that the climate in much of California may be unsuitable for fishers by 2100. Several papers that have modeled vegetation change suggest that within those portions of California currently occupied by fishers, conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation) [183,225,235]. These predictions notwithstanding, they are based on long-term models that utilize broad climate and vegetation parameters that largely do not reflect the fine-scale variation (in both climate and vegetation diversity) typically found in the topographically and ecologically diverse montane habitats of California.

Fishers within the SSN Fisher ESU are likely more vulnerable to the potentially adverse effects of warming climate than fishers in northern California. The comparatively small size of the population in the southern Sierra, its linear distribution, and potential barriers to dispersal (the 2013 Rim Fire area, river canyons, etc.) increase the likelihood that it will become fragmented and decline in size during this century. The fisher population within the NC Fisher ESU is comparatively large and well distributed geographically, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain.

While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state, and its severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century. As the 21st century progresses and population data continue to be compiled, scientists will become better informed as to effects of a warming environment on California's fisher population. Continued monitoring of fisher distribution and survival over the ensuing decades will provide information about the immediacy of this threat.

Listing Recommendation

“Endangered species” means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (FGC §2062). "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter” (FGC §2067).

The Department recommends that designation of the fisher in California as threatened/endangered is ________.

Comment [W156]: Cover letter says Department feels listing is not warranted. Rationale for this, given size of population and documented threats?

Protection Afforded by Listing

CESA defines “take” to mean “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful absent take authorization from the Department (FGC §§ 2080 et seq. and 2835). Take can be authorized by the Department pursuant to FGC §§ 2081.1, 2081, 2086, 2087 and 2835 (NCCP).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and

ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fisher would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fisher because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Economic Considerations

The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).

Literature Cited

1. Douglas CW, Strickland MA (1999) Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

2. Powell RA (1993) The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

3. Grinnell J, Dixon JS, Linsdale JM, University of California B, Museum of Vertebrate Zoology (1937) Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. Berkeley, Calif.: University of California press.

4. Buskirk SW, Ruggiero LF (1994) American Marten. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 186.

5. Lewis JC, Stinson DW (1998) Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

6. Coulter M. (1966) The ecology and management of fishers in Maine Syracuse, New York, USA: University, Syracuse.

7. Pittaway RJ (1978) Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Nat Can 105: 487–489.

8. Douglas CW, Strickland MA (1987) Fisher. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. Ontario, Canada: Ontario Ministry of Natural Resources.

9. Erxleben JCP (1777) Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

10. Goldman FA (1935) New American mustelids of the genera Martes, Gulo, and Lutra. Proc Biol Soc Wash 48: 175–186.

11. Rhoads SN (1898) Contributions to a revision of the North American beavers, otters and fishers. Trans Am Philos Soc 19: 417–439.

12. Hagmeier EM (1959) A reevaluation of the subspecies of fisher. Can Field Nat 73: 185–197.

13. Hosoda T, Suzuki H, Harada M, Tsuchiya K, Han S-H, et al. (2000) Evolutionary trends of the mitochondrial lineage differentiation in species of genera Martes and Mustela. Genes Genet Syst 75: 259–267.

14. Stone KD, Cook JA (2002) Molecular evolution of Holarctic martens (genus Martes, Mammalia: Carnivora: Mustelidae). Mol Phylogenet Evol 24: 169–179.

15. Koepfli K-P, Deere K, Slater G, Begg C, Begg K, et al. (2008) Multigene phylogeny of the Mustelidae: resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biol 6: 10.

16. Sato JJ, Wolsan M, Minami S, Hosoda T, Sinaga MH, et al. (2009) Deciphering and dating the red panda's ancestry and early adaptive radiation of Musteloidea. Mol Phylogenet Evol 53: 907–922.

17. Wolsan M, Sato JJ (2010) Effects of data incompleteness on the relative performance of parsimony and Bayesian approaches in a supermatrix phylogenetic reconstruction of Mustelidae and Procyonidae (Carnivora). Cladistics 26: 168–194.

18. Nyakatura K, Bininda-Emonds OR (2012) Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. BMC Biol 10: 12.

19. Sato JJ, Wolsan M, Prevosti FJ, D'Elía G, Begg C, et al. (2012) Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Mol Phylogenet Evol 63: 745–757.

20. Baldy R, Beck R, Carpenter C, Carpenter W, Golla V, et al. (1996) Hupa language dictionary. Second. Hoopa, CA: Hoopa Valley Tribal Council. 131 p.

21. Samuels JX, Cavin J (2013) The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. J Vertebr Paleontol 33: 448–454. doi:10.1080/02724634.2013.722155.

22. Eshelman R, Grady F (1984) Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. In: McDonald JN, Bird SO, editors. The Quaternary of Virginia - A symposium volume. Charlottsville, Virginia: VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Vol. 75. pp. 43–70.

23. Graham RW, Graham MA (1994) The late Quaternary distribution of Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

24. Lofroth EC, Raley CM, Finley LL, Naney RH (2010) Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

25. Powell RA, Zielinski WJ (1994) Fisher. General Technical Report. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Available: http://treesearch.fs.fed.us/pubs/27328. Accessed 11 October 2013.

26. Lewis JC, Powell RA, Zielinski WJ (2012) Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7: n/a. doi:http://dx.doi.org/10.1371/journal.pone.0032726.

27. Gibilisco CJ (1994) Distributional dynamics of modern Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables,

and fishers: biology and conservation. , Ithaca, New York, USA: Cornell University Press.

28. Tucker JM, Schwartz MK, Truex RL, Pilgrim KL, Allendorf FW (2012) Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS One 7.

29. Knaus BJ, Cronn R, Liston A, Pilgrim K, Schwartz MK (2011) Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC Ecol 11: 10.

30. Grinnell, J, Dixon J, Linsdale M (1930) Vertebrate natural history of a section of northern California through the Lassen Peak region. University of California Publications in Zoology. 594 p.

31. Price WW (1894) Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE Biol J 4: 315–332.

32. Aubry KB, Jagger LA (2006) The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. In: Santos-Reis M, Birks JDS, O'Doherty EC, Proulx G, editors. Martes in Carnivore Communities. Alberta, Canada: Alpha Wildl. Publ.

33. McKelvey KS, Aubry KB, Schwartz MK (2008) Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58: 549–555.

34. Aubry KB, Lewis JC (2003) Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biol Conserv 114: 79–90. doi:http://dx.doi.org/10.1016/S0006-3207(03)00003-X.

35. Zielinski WJ, Truex RL, Schlexer FV, Campbell LA, Carroll C (2005) Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. J Biogeogr 32: 1385–1407.

36. Zielinski WJ, Kucera TE, Barrett RH (1995) Current distribution of the fisher, Martes pennanti, in California. Calif Fish Game 81: 104–112.

37. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

38. Drew RE, Hallett JG, Aubry KB, Cullings KW, Koepf SM, et al. (2003) Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Mol Ecol 12: 51–62.

39. Talking Glossary: “Haplotype” (n.d.). Available: http://www.genome.gov/glossary/index.cfm?id=99. Accessed 4 September 2014.

40. Tucker JM (2013) Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada The University of Montana.

41. Wright PL, Coulter MW (1967) Reproduction and growth in Maine fishers. J Wildl Manag: 70–87.

42. Leonard RD (1986) Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Can Field-Nat Ott ON 100: 32–44.

43. Eadie WR, Hamilton WJ (1958) Reproduction in the fisher in New York. N Y Fish Game J 5: 77–83.

44. Frost HC, Krohn WB (1997) Factors affecting the reproductive success of captive female fishers. In: Proulx G, Bryant HN, Woodward PM, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB. pp. 100–109.

45. Paragi TF, Arthur SM, Krohn WB (1994) Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Can Field-Nat Ott ON 108: 52–57.

46. Arthur SM, Krohn WB (1991) Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J Mammal: 72–2.

47. Mead RA (1994) Reproduction in Martes. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 404–422.

48. Frost HC, Krohn WB, Wallace CR (1997) Age-specific reproductive characteristics in fishers. J Mammal 78: 598–612.

49. Aubry KB, Raley CM (2006) Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report. Olympia, WA: USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory.

50. Higley JM, Matthews S (2006) Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report. Hoopa Valley Tribe and Wildlife Conservation Society.

51. Self S, Callas R (2006) Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pac Ind Calif Dep Fish Game.

52. Weir RD, Corbould FB (2008) Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Prince George, British Columbia, Canada: Peace/Williston Fish & Wildlife Compensation Program.

53. Truex RL, Zielinski WJ, Golightly RT, Barrett RH, Wisely SM (1998) A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft Rep Submitt Calif Dep Fish Game U S For Serv Pac Southwest Res Stn Arcata Calif.

54. Hall ER (1942) Gestation period in the fisher with recommendations for the animal$\backslash$’s protection in California. Calif Fish Game 28: 143–147.

55. Paragi TF, Krohn WB, Arthur SM (1994) Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildl 51: 1–11.

56. York EC (1996) Fisher population dynamics in north-central Massachusetts University of Massachusetts at Amherst.

57. Matthews SM, Higley JM, Rennie KM, Green RE, Goddard CA, et al. (2013) Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. J Mammal 94: 100–108.

58. Bachelot A, Binart N (2005) Corpus luteum development: lessons from genetic models in mice. Curr Top Dev Biol 68: 49–84. doi:10.1016/S0070-2153(05)68003-9.

59. Kelly GM (1977) Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas University of Massachusetts. Available: http://agris.fao.org/agris-search/search/display.do?f=2013/US/US2013054260005426.xml;US201300542658. Accessed 11 October 2013.

60. Crowley SK, Krohn WB, Paragi TF (n.d.) A comparison of fisher reproductive estimates. Trans Northeast Sect Wildl Soc 47: 36–42.

61. Weir RD (2003) Status of the fisher in British Columbia. BC Minist Sustain Resour Manage Conserv Data Cent BC Minist Water Land Air Prot Biodivers Branch Vic BC Wildl Bull No B-105 38pp: 3.

62. Arthur SM, Paragi TF, Krohn WB (1993) Dispersal of juvenile fishers in Maine. J Wildl Manag 57: 868.

63. Higley JM, Matthews S (2009) Fisher habitat use and population monitoring on the Hoopa Valley Reservation, California Final Report USFWS TWG U-12-NA-1. Hoopa Val Tribe Hoopa Calif USA.

64. King CM, Powell RA, Powell C (2007) The natural history of weasels and stoats: ecology, behavior, and management. Oxford University Press New York.

65. Paragi TF (1990) Reproductive biology of female fishers in southcentral Maine University of Maine at Orono. Available: http://www.library.umaine.edu/theses/theses.asp?Cmd=abstract&ID=MARC1647. Accessed 11 October 2013.

66. Reno MA, Rulon K, James C (2008) Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

67. Aging Experience, Accuracy and Precision (n.d.). Available: http://www.matsonslab.com/aging-experience-accuracy-and-precision.html. Accessed 6 September 2014.

68. Brown RN, Gabriel MW, Wengert G, Matthews S, Higley JM, et al. (2006) Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Trans West Sect Wildl Soc 42: 40–46.

69. Sandra Martin (1994) Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael RA, Powell RA, editors. Martens, sables and

fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 297–315.

70. Zielinski WJ, Duncan NP (2004) Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. J Mammal 85: 470–477.

71. Golightly RT, Penland TF, Zielinski WJ, Higley JM (2006) Fisher diet in the Klamath/north coast bioregion. Final Rep US Fish Wildl Serv Scotia Pac Humboldt State Spons Programs Found Arcata Calif.

72. Zielinski WJ, Duncan NP, Farmer EC, Truex RL, Clevenger, et al. (1999) Diet of fishers (Martes pennanti) at the southernmost extent of their range. J Mammal 80: 961–971.

73. Grenfell WE, Fasenfest M (1979) Winter food habits of fisher (Martes pennanti) in northwestern California. Calif Fish Game 65: 186–189.

74. Bioregions of California (n.d.). Available: http://biodiversity.ca.gov/bioregions.html. Accessed 5 September 2014.

75. Powell RA, Brander RB (1977) Adaptations of fishers and porcupines to their predator prey system. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula. pp. 45–53.

76. Powell SM, York EC, Fuller TK (1997) Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta, Edmonton. pp. 279–305.

77. Weir RD, Harestad AS, Wright RC (2005) Winter Diet Of Fishers In British Columbia. Northwest Nat 86: 12–19. doi:http://dx.doi.org/10.1898/1051-1733(2005)086[0012:WDOFIB]2.0.CO;2.

78. Kuehn DW (1989) Winter foods of fishers during a snowshoe hare decline. J Wildl Manag: 688–692.

79. Burt WH (1943) Territoriality and home range concepts as applied to mammals. J Mammal 24: 346–352.

80. Buck S, Mullis C, Mossman AS (1983) Corral Bottom-Hayfork Bally Fisher Study: final report. Arcata, CA: Humboldt State University and USDA Forest Service.

81. Johnson SA (1984) Home range, movements, and habitat use of fishers in Wisconsin University of Wisconsin–Stevens Point.

82. Arthur SM, Krohn WB, Gilbert JR (1989) Home range characteristics of adult fishers. J Wildl Manag 53: 674–679.

83. Jones JL (1991) Habitat use of fisher in northcentral Idaho University of Idaho.

84. Garant Y, Crete M (1997) Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Can Field-Nat Ott ON 111: 359–364.

85. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Home Range Characteristics Of Fishers in California. J Mammal 85: 649–657.

86. Yaeger JS (2005) Habitat at fisher resting sites in the Klamath Province of northern California [Master's Thesis]. Arcata, CA: Humboldt State University. Available: http://www.fws.gov/yreka/fisher/Literature/Yaeger%202005.pdf. Accessed 11 October 2013.

87. Koen EL, Bowman J, Findlay CS, Zheng L (2007) Home Range and Population Density of Fishers in Eastern Ontario. J Wildl Manag 71: 1484–1493. doi:http://dx.doi.org/10.2193/2006-133.

88. Raley CM, Lofroth EC, Truex RL, Yaeger JS, Higley JM (2012) Habitat ecology of fishers in western North America. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press.

89. Mabry KE, Shelley EL, Davis KE, Blumstein DT, Vuren DHv (2013) Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

90. Strickland MA (1994) Harvest management of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 149–164.

91. Aubry K, Wisely S, Raley C, Buskirk S (2004) Zoogeography, Spacing Patterns, and Dispersal in Fishers. In: Harrison DJ, Fuller AK, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. New York, NY: Springer. pp. 201–220.

92. Greenwood PJ (1980) Mating systems, philopatry and dispersal in birds and mammals. Anim Behav 28: 1140–1162.

93. Stephen Dobson F (1982) Competition for mates and predominant juvenile male dispersal in mammals. Anim Behav 30: 1183–1192.

94. De Vos A (1951) Overflow and dispersal of marten and fisher from wildlife refuges. J Wildl Manag 15: 164–175.

95. Hamilton WJ, Cook AH, Hamilton WF (1955) The biology and management of the fisher in New York. N Y Fish Game J 2: 13–35.

96. Powell RA (1979) Ecological energetics and foraging strategies of the fisher (Martes pennanti). J Anim Ecol: 195–212.

97. Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

98. Buskirk SW, Powell RA (1994) Habitat Ecology of Fishers and American Martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 283–296. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

99. The Public Land Survey System (PLSS) (n.d.). Available: http://nationalatlas.gov/articles/boundaries/a_plss.html. Accessed 4 September 2014.

100. Krohn WB, Arthur SM, Paragi TF (1994) Mortality and vulnerability of a heavily trapped fisher population. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

101. Klug Jr RR (1997) Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections Humboldt State University.

102. Carroll C, Zielinski WJ, Noss RF (1999) Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conserv Biol 13: 1344–1359.

103. Davis FW, Seo C, Zielinski WJ (2007) Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecol Appl 17: 2195–2213.

104. Slauson KM, Zielinski WJ, Holm GW (2003) Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final Rep USDA For Serv Pac Southwest Res Stn Arcata Calif USA.

105. Weir RD, Harestad AS (2003) Scale-dependent habitat selectivity by fishers in south-central British Columbia. J Wildl Manag 67: 73–82.

106. Campbell LA (2004) Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada University of California. Available: http://www.fs.fed.us/psw/programs/snrc/staff/campbell/campbell_dissertation.pdf. Accessed 11 October 2013.

107. Aubry KB, Raley CM, Buskirk SW, Zielinski WJ, Schwartz MK, et al. (2013) Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. J Wildl Manag 77: 965–974.

108. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Resting habitat selection by fishers in California. J Wildl Manag 68: 475–492.

109. Purcell KL, Mazzoni AK, Mori SR, Boroski BB (2009) Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. For Ecol Manag 258: 2696–2706.

110. Davis LR (2009) Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau Dept. of Biological Sciences-Simon Fraser University. Available: http://summit.sfu.ca/item/9870. Accessed 10 October 2013.

111. Bull EL, Parks CG, Torgersen TR (1997) Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

112. Manion PD (n.d.) Tree disease concepts. Second. New Jersey, USA: Prentice Hall Career and Technology.

113. Zielinski WJ, Dunk JR, Yaeger JS, LaPlante DW (2010) Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. For Ecol Manag 260: 1579–1591.

114. California Wildlife Habitat Relationships System (2008). Sacramento, California: California Department of Fish and Wildlife: California Interagency Wildlife Task Group.

115. Weir RD, Corbould FB (2010) Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. J Wildl Manag 74: 405–410.

116. Buck SG, Mullis C, Mossman AS, Coolahan C (1994) Habitat use by fishers in adjoining heavily and lightly harvested forest. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 368–376.

117. Jones JL, Garton EO (1994) Selection of successional stages by fishers in north-central Idaho. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 377–387.

118. De Vos A (1952) The ecology and management of fisher and marten in Ontario. Available: http://www.citeulike.org/group/15497/article/9675279. Accessed 21 August 2014.

119. Spencer W, Rustigian-Romsos H, Strittholt J, Scheller R, Zielinski W, et al. (2011) Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biol Conserv 144: 788–803.

120. Hagmeier EM (1956) Distribution of marten and fisher in North America. Can Field Nat 70: 149–168.

121. Banci V (1989) A fisher management strategy for British Columbia. Victoria, British Columbia, Canada: Ministry of Environment.

122. Powell RA (1994) Structure and spacing of Martes populations. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA. pp. 101–121.

123. Lewis JC, Zielinski WJ (1996) Historical harvest and incidental capture of fishers in California. Northwest Sci 70: 291–297.

124. Dixon JS (1925) A closed season needed for fisher, marten, and wolverine. Calif Fish Game 11: 23–25.

125. Gould GI Jr (1987) Forest Mammal Survey and Inventory. Calif. Dept. of Fish and Game.

126. Powell RA, Facka AN, Clifford DL, Beach C, Smith K (2013) Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

127. Lamberson RH, Truex RL, Zielinski WJ, Macfarlane D (2000) Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata CA Humboldt State Univ.

128. Spencer WD, Rustigian H, Strittholt JR, Scheller R, Syphard A (2008) Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

129. Jordan MJ (2007) Fisher ecology in the Sierra National Forest, California Berkeley, Calif.: University of California, Berkeley. Available: http://www.carnivoreconservation.org/files/thesis/jordan_2007_phd.pdf. Accessed 11 October 2013.

130. Matthews SM, Mark Higley J, Scott Yaeger J, Fuller TK (2011) Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildl Soc Bull 35: 69–75.

131. Diller L, Hamm K, Lamphear D, Thompson J (2008) Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Korbel, CA: Green Diamond Resource Company.

132. Swiers RC (2013) Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. [Raleigh, North Carolina]: North Carolina State University,.

133. Noon BR, Bailey LL, Sisk TD, McKelvey KS (2012) Efficient Species-Level Monitoring at the Landscape Scale. Conserv Biol 26: 432–441.

134. Zielinski WJ, Baldwin JA, Truex RL, Tucker JM, Flebbe PA (2013) Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. J Fish Wildl Manag 4: 3–19.

135. Bechtold WA, Patterson PL (2005) The enhanced forest inventory and analysis program: national sampling design and estimation procedures. General Technical Report. Asheville, North Carolina: US Department of Agriculture Forest Service, Southern Research Station.

136. Waples R (1991) Definition of a “species” under teh Endangered Species Act: Application to Pacific salmon. Technical menorandum. NOAA.

137. Franklin JF, Spies TA, Pelt RV, Carey AB, Thornburgh DA, et al. (2002) Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. For Ecol Manag 155: 399–423.

138. Thompson ID, Baker JA, Ter-Mikaelian M (2003) A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. For Ecol Manag 177: 441–469.

139. USDA Forest Service (2014) Forest Management: Cut and sold reports. Available: http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml. Accessed 22 August 2014.

140. California Timber Harvest Statistics - harvyr2.pdf (n.d.). Available: http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf. Accessed 6 September 2014.

141. Barnosky AD, Koch PL, Feranec RS, Wing SL, Shabel AB (2004) Assessing the causes of Late Pleistocene extinctions on the continents. Science 306: 70–75.

142. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

143. Farber S, Callas RL, Yaeger JS, Schwartz MK, Pilgrim K, et al. (2010) Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report. Yreka Fish and Wildlife Office, Yreka, California: USDI Fish and Wildlife Service.

144. Wengert GW, Gabriel MW, Matthews SM, Higley JM, Sweitzer R, et al. (2013) Intraguild Predation on Fishers in California: Patterns of Predation by Three Larger Carnivores. Rev J Wildl Manag.

145. Buck SG (1982) Habitat utilization by fisher (Martes pennanti) near Big Bar, California [Master's Thesis]. Arcata, CA: Humboldt State University.

146. Wengert GM (2013) Ecology of intraguild predation on fishers (Martes pennanti) in California UNIVERSITY OF CALIFORNIA, DAVIS. Available: http://gradworks.umi.com/36/14/3614292.html. Accessed 4 September 2014.

147. Williams ES (2001) Canine distemper. In: Williams ES, Barker RICK, editors. Infectious diseases of wild mammals. Ames, Iowa: Iowa State University Press. p. 50.

148. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

149. Williams ES, Thorne ET, Appel MJ, Belitsky DW (1988) Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. J Wildl Dis 24: 385–398.

150. Timm SF, Munson L, Summers BA, Terio KA, Dubovi EJ, et al. (2009) A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). J Wildl Dis 45: 333–343.

151. Origgi FC, Plattet P, Sattler U, Robert N, Casaubon J, et al. (2012) Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Vet Pathol Online 49: 913–929.

152. Gabriel MW, Wengert GM, Matthews SM, Higley JM, Foley JE, et al. (2010) Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). J Wildl Dis 46: 966–970.

153. Gabriel MW, Wengert GW, Brown RN (2012) Pathogens and parasites of Martes species: Management and conservation implications. In: Aubry KB, Zielinski WJ,

Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press. pp. 138–185.

154. Burns R, O'Toole ESWD, 2003 JPD (n.d.) Toxoplasma gondii infections in captive black-footed ferrets (Mustela nigripes), 1992–1998: clinical signs, serology, pathology, and prevention. J Wildl Dis 39: 787–797.

155. Pridham TJ, Belcher J (1958) Toxoplasmosis in mink. Can J Comp Med Vet Sci 22: 99–106.

156. Cole RA, Lindsay DS, Howe DK, Roderick CL, Dubey JP, et al. (2000) Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). J Parasitol 86: 526–530.

157. Larkin JL, Gabriel M, Gerhold RW, Yabsley MJ, Wester JC, et al. (2011) Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. J Parasitol 97: 425–429. doi:http://dx.doi.org/10.1645/GE-2623.1.

158. Brown RN, Gabriel MW, Wengert GW, Matthews S, Higley JM, et al. (2008) Pathogens associated with fishers. Final Report USFWS-813335G021. Yreka, CA.

159. Williams ES, Mills K, Kwiatkowski DR, Thorne ET, Boerger-Fields A (1994) Plague in a black-footed ferret (Mustela nigripes). J Wildl Dis 30: 581–585.

160. Weinmann R, Raskas HJ, Roeder RG (1974) Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proc Natl Acad Sci 71: 3426–3430.

161. Clifford DL, Woods L, Gabriel MW, Tkach V, Hoberg E, et al. (2012) Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

162. CDOF (2011) E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. Sacramento, California: State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-6/2000-10/.

163. CDOF (1991) E-6 County Population Estimates and Components of Change— July 1, 1970–1990. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/view.php#objCollapsiblePanelEstimatesAnchor.

164. CDOF (2013) E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php.

165. CDOF (2013) Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

166. Bunn D, Mummert A, Hoshovsky M, Gilardi K, Shanks S (2007) California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

167. FRAP (2003) The changing California: Forest and range 2003 assessment. CalFire. Available: http://frap.fire.ca.gov/data/assessment2003/index.html.

168. Duane TP (1996) Human Settlement 1850-2040. In: Center WR, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. Davis, CA, USA.: University of California.

169. Theobald D (2005) Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecol Soc 10.

170. Garroway CJ, Bowman J, Wilson PJ (2011) Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Mol Ecol 20: 3978–3988.

171. Safford HD (2006) Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report. Vallejo, California: USDA Forest Service, Pacific Southwest Region.

172. Stephens SL, Sugihara NG (2006) Fire management and policy since European settlement. Fire in California's Ecosystems. Berkeley, California: University of California Press. pp. 431–443.

173. Show SB, Kotok EI (1923) Forest fires in California, 1911-1920: an analytical study. Washington D.C., USA: US Department of Agriculture. Available: http://scholarsarchive.library.oregonstate.edu/jspui/handle/1957/11024. Accessed 11 October 2013.

174. Stephens SL, Martin RE, Clinton NE (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. For Ecol Manag 251: 205–216. doi:http://dx.doi.org/10.1016/j.foreco.2007.06.005.

175. Taylor AH, Skinner CN (1998) Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. For Ecol Manag 111: 285–301.

176. Anderson MK (2006) The use of fire by Native Americans in California. In: Sugihara NG, Van Wagtendonk JW, Shaffer KE, Fites-Kaufman J, Thode AE, editors. Fire in California's Ecosystems. University of California Press. p. 596.

177. Martin RE, Sapsis DB (1992) Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

178. Miller JD, Safford HD, Crimmins M, Thode AE (2009) Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12: 16–32.

179. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW (2006) Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

180. Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecol Appl 22: 184–203.

181. Zhang J, Webster J, Powers RF, Mills J (2008) Reforestation after the Fountain Fire in Northern California: An Untold Success Story. J For 106: 425–430.

182. LANDFIRE-Fire Regime Product Descriptions (n.d.). Available: http://www.landfire.gov/NationalProductDescriptions13.php. Accessed 4 September 2014.

183. Lawler JJ, Safford HD, Girvetz EH (2012) Martens and fishers in a changing climate. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press. pp. 371–397.

184. Fried JS, Torn, Mills E (2004) The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Clim Change 64: 169–191. doi:http://dx.doi.org/10.1023/B:CLIM.0000024667.89579.ed.

185. Westerling AL, Bryant BP, Preisler HK, Holmes TP, Hidalgo HG, et al. (2011) Climate change and growth scenarios for California wildfire. Clim Change 109: 445–463.

186. Mckenzie D, Gedalof Z, Peterson DL, Mote P (2004) Climatic Change, Wildfire, and Conservation. Conserv Biol 18: 890–902.

187. Krawchuk MA, Moritz MA (2012) Fire and Climate Change in California. Calif Energy Comm Publ Number CEC-500-2012-026.

188. Gabriel MW, Wengert GW, Higley JM, Krogan S (2013) Silent forests? Rodenticides on illegal marijuana crops harm wildlife. Wildl Prof Spring.

189. Gabriel MW, Woods LW, Poppenga R, Sweitzer RA, Thompson C, et al. (2012) Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

190. Alterio N (1996) Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. N Z J Zool 23: 331–338.

191. Moriarty JG, Riley PD, Sureiys LE, Sikich JA (2013) Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: from mountain lions to rodents. Proceedings of the 25th Vertebrate Pest Conference. Vol. 25. pp. 144–148.

192. Erickson WA, Urban DJ (2004) Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

193. Fisher P, O’Connor C, Wright G, Easton CT (2003) Persistence of four anticoagulant rodenticides in livers of laboratory rats. New Zealand Department of Conservation.

194. Riley SPD, Bromley C, Poppenga RH, Uzal FA, al et (2007) Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. J Wildl Manag 71: 1874–1884.

195. Cox P, Smith R. (n.d.) Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. 15th Vertebrate Pest Conference. Davis, CA, USA.: University of California.

196. Thompson C, Sweitzer R, Gabriel M, Purcell K, Barrett R, et al. (2013) Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conserv Lett.

197. Laas FJ, Forss DA, Godfreyi MER (1985) Retention of brodifacoum in sheep tissues and excretion in faeces. N Z J Agric Res 28: 357–359.

198. Godfrey MER, Lyman CP (1980) Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). N Z J Exp Agric 8: 1–5.

199. Munday JS, Thompson LJ (2003) Brodifacoum toxicosis in two neonatal puppies. Vet Pathol Online 40: 216–219.

200. Jansman H, van Tulden P (2012) Persecution and poisoning of birds of prey in the Netherlands. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 139–142.

201. Mineau P, Lyon L, McMillin S (2012) Impacts of carbofuran on birds in Canada and the United States. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 219–222.

202. Anderson B, Borges S, Graber K, Hartless C, Housenger J, et al. (2011) Risks of non-compliant rodenticides to nontarget wildlife. Washington D.C., USA: United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division.

203. Berny PJ, Buronfosse T, Buronfosse F, Lamarque F, Lorgue G (1997) Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35: 1817–1829.

204. Ruder MG, Poppenga RH, Bryan JA, Bain M, Pitman J, et al. (2011) Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. J Wildl Dis 47: 212–216.

205. Janeway CA, Travers P, Walport M (2007) Immunobiology. 7th ed. New York, New York, USA: Garland Science.

206. Li Q, Kawada T (2006) The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cell Mol Immunol 3: 171–178.

207. Zabrodskii PF, Lim VG, Strel'tsova EV (2012) Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksp Klin Farmakol 75: 35.

208. Vidal D, Alzaga V, Luque-Larena JJ, Mateo R, Arroyo L, et al. (2009) Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Sci Total Environ 408: 267–271. doi:http://dx.doi.org/10.1016/j.scitotenv.2009.10.001.

209. Gordon CJ (1994) Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicol Teratol 16: 427–453.

210. Grue CE, Hart ADM, Mineau P (1991) Biological consequences of depressed brain cholinesterase activity in wildlife. In: Mineau P, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Amsterdam, Netherlands: Elsevier Science Publishers. pp. 151–209.

211. Ahdaya SM, Shah PV, Guthrie FE (1976) Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicol Appl Pharmacol 35: 575–580.

212. Martin PA, Solomon KR (1991) Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pestic Biochem Physiol 40: 117–127.

213. Hayward MW, Jedrzejewski W, Jedrzewska B (2012) Prey preferences of the tiger Panthera tigris. J Zool 286: 221–231. doi:http://dx.doi.org/10.1111/j.1469-7998.2011.00871.x.

214. Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE (2004) Tigers and their prey: predicting carnivore densities from prey abundance. Proc Natl Acad Sci U S A 101: 4854–4858.

215. Knick ST (1990) Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildl Monogr: 3–42.

216. Knick ST, Hellgren EC, Seal US (1993) Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Can J Zool Can Zool 71: 1448–1453.

217. Colvin, B., Jackson W. (1991) Secondary poisoning hazards associated with rodenticide use. In: Magallona E., editor. 11th International Congress Plant Protection. Manila, Phillipines.

218. Pachauri RK, Reisinger A (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergov Panel Clim Change 1.

219. Solomon S, Qin D, Manning M, ALLEY R, BERNTSEN T, et al. (2007) Technical Summary. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press. pp. 19–91.

220. Bonfils C, Duffy PB, Santer BD, Wigley TML, Lobell DB, et al. (2008) Identification of external influences on temperatures in California. Clim Change 87: 43–55. doi:10.1007/s10584-007-9374-9.

221. Tingley MW, Koo MS, Moritz C, Rush AC, Beissinger SR (2012) The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Glob Change Biol 18: 3279–3290.

222. Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, et al. (2013) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Clim Dyn 40: 839–856. doi:http://dx.doi.org/10.1007/s00382-012-1337-9.

223. Cayan D, Tyree M, Pierce D, Das T (2012) Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

224. Littell JS, Elsner MM, Mauger G, Lutz E, Hamlet AF, et al. (2011) Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. University of Washington, College of the Environment.

225. Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. (2004) Emissions pathways, climate change, and impacts on California. Proc Natl Acad Sci U S A 101: 12422–12427.

226. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, et al. (2007) Regional climate projections. In: Susan S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, Vol. 4.

227. Cayan D, Tyree M, Dettinger M, Hidalgo H, Das T, et al. (2009) Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. Calif Clim Change Cent CEC-500-2009-014-D.

228. Pierce DW, Cayan DR, Das T, Maurer EP, Miller NL, et al. (2013) The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. J Clim. Available: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00766.1. Accessed 14 October 2013.

229. Halofsky JE, Peterson DL, O'Halloran KA, Hawkins-Hoffman C (2011) Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available: http://www.treesearch.fs.fed.us/pubs/38702. Accessed 14 October 2013.

230. Salathe EP, Leung Lr, Qian Y, Zhang Y (2010) Regional climate model projections for the State of Washington. Clim Change 102: 51–75. doi:http://dx.doi.org/10.1007/s10584-010-9849-y.

231. Ralph M (2011) Water supply and flooding. In: Pierce DW, editor. California Climate Extremes Workshop Report. La Jolla, CA: Scripps Institution of Oceanography.

232. Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, et al. (2009) The velocity of climate change. Nature 462: 1052–1055. doi:10.1038/nature08649.

233. Moritz C, Agudo R (2013) The Future of Species Under Climate Change: Resilience or Decline? Science 341: 504–508. doi:10.1126/science.1237190.

234. Lenihan JM, Drapek R, Bachelet D, Neilson RP (2003) Climate change effects on vegetation distribution, carbon, and fire in California. Ecol Appl 13: 1667–1681.

235. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al. (2011) The impact of climate change on California's ecosystem services. Clim Change 109: 465–484. doi:10.1007/s10584-011-0313-4.

236. Koopman ME, Nauman RS, Leonard JL (2010) Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

237. Burns CE, Johnston KM, Schmitz OJ (2003) Global climate change and mammalian species diversity in U.S. national parks. Proc Natl Acad Sci 100: 11474–11477.

238. Littell JS, Oneil EE, McKenzie D, Hicke JA, Lutz JA, et al. (2010) Forest ecosystems, disturbance, and climatic change in Washington State, USA. Clim Change 102: 129–158. doi:http://dx.doi.org/10.1007/s10584-010-9858-x.

239. Spies TA, Giesen TW, Swanson FJ, Franklin JF, Lach D, et al. (2010) Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landsc Ecol 25: 1185–1199. doi:http://dx.doi.org/10.1007/s10980-010-9483-0.

240. Paradis A, Elkinton J, Hayhoe K, Buonaccorsi J (2008) Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitig Adapt Strateg Glob Change 13: 541–554.

241. Safranyik L, Carroll AL, Regniere J, Langor DW, Riel WG, et al. (2010) Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Can Entomol 142: 415–442.

242. Trần JK, Ylioja T, Billings RF, Régnière J, Ayres MP (2007) Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecol Appl 17: 882–899.

243. Vose JM, Peterson DL, Patel-Weynand T (2012) Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

244. USDA Forest Service, USDI Bureau of Land Management (1994) Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team]. 569 p. Available: http://archive.org/details/finalsupplementa03v1unit. Accessed 2 September 2014.

245. USDA Forest Service, USDI Bureau of Land Management (1994) Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

246. The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data (n.d.). Available: http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml. Accessed 5 September 2014.

247. Sulak A, Huntsinger L (2012) Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. J For 110: 312–317.

248. Smith T (2014) What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. Available: http://snamp.cnr.berkeley.edu/teams/fisher. Accessed 1 September 2014.

249. Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics (n.d.). Available: http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/. Accessed 1 September 2014.

250. USDI Bureau of Land Management (2008) Sierra Resource Management Plan and Record of Decision. Folsom, CA: Bureau of Land Management.

251. Hannibal ME (2012) America's Next Best Idea: The National Park System Looks to the Future. George Wright Forum 29: 380–384.

252. FSC Forest Stewardship Council U.S. (FSC-US) · Our History (n.d.). Available: https://us.fsc.org/our-history.180.htm. Accessed 2 September 2014.

253. FSC Forest Stewardship Council U.S. (FSC-US) · Mission and Vision (n.d.). Available: https://us.fsc.org/mission-and-vision.187.htm. Accessed 2 September 2014.

254. preview.fsc-certified-acres-by-state.a-204.pdf (n.d.). Available: https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf. Accessed 2 September 2014.

255. IUCN, SSC (2013) Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

256. Callas RL, Figura P (2008) Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. Sacramento, California: California Department of Fish and Game.

257. Gould GI, Escallier J (1989) Licensed trapper's and dealer's report. Sacramento, California: California Department of Fish and Game.

258. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

USDA Forest Service
Pacific Southwest Research Station

Research & Development
Pacific Southwest Research Station

Richard Callas
Senior Environmental Scientist
California Department of Fish and Wildlife

21 November 2014

Richard,

Thank you for the opportunity to review the CDFW fisher status review. Overall, I would say that this represents a significant improvement over the previous effort, particularly a better representation of peer-reviewed literature and a more thorough review of important topics. And the decision to identify northern and southern Evolutionary Significant Units appears warranted based on the biology, behavior, physiology, and genetic history of the species.

I do have a number of comments regarding the use or inclusion of data. A detailed list follows, however I believe several topics are worth highlighting.

1. Reproductive output / litter size – As written, the document suggests that while there is some variation in litter size it's generally consistent range-wide. In fact, there is a pronounced gradient with the highest litter sizes in the Northeastern US and Eastern Canada, decreasing to the southwest with the smallest letters being reported in the southern Sierra Nevadas. I have included a figure demonstrating this in the detailed comments. This is a particularly relevant trend because given the small size of the southern Sierra population and the diversity of risks currently faced, the southern ESU defined by the Department can be expected to be less resilient to population fluctuation than other subpopulations.

2. The differential shape between the northern and southern ESU populations is not discussed, nor is the risk posed to the southern ESU by fires such as the Aspen/French. The northern population inhabits a fairly contiguous landscape, while the southern ESU occupies a landscape that is elongated, with 4-5 core habitat areas connected by narrow bottlenecks at river canyons. This type of habitat configuration is at high risk of fragmentation. In fact we have recently observed such fragmentation with the 2013 Aspen and 2014 French fires. As described in the detailed comments, the two fires burned on opposite sides of the San Joaquin drainage in subsequent years, effectively breaking connectivity between two core habitat areas. Because the southern ESU population is small and at high risk from stochastic events, the shape of the habitat and the risk of further fragmentation is a critical consideration.

3. Information on the effects of marijuana gardens and toxicants needs to be updated. The document states that 4 fishers have died from AR poisoning. I believe the current statistic is 12 documented mortalities statewide directly attributed AR or pesticide poisoning. To put this into perspective, combined the Kings River and SNAMP research projects have recorded 121 mortalities of collared fishers since 2007. Cause of death has been determined for 93. Seven are direct AR poisoning. That means that 8% of all observed mortality can be directly attributed to AR poisoning, a likely underestimate due to

reasons highlighted in the document. Furthermore, it has been shown that a 10% increase in mortality can be sufficient to cause population decline. So if sublethal effects inflate natural mortality by only 2%, a conservative estimate given the overall exposure rate, this factor alone can inhibit expansion or even initiate decline.

Overall, I believe the Department has done an admirable job of summarizing what is known about fishers within California. I also believe that the Department has made a strong argument for the consideration of the southern ESU as threatened given the small population size, unique genetic material, and diverse risks. CDFW code states, a “species shall be listed as endangered or threatened … if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors…”. Below, I outlined the six listing factors and my opinion on the associated risk based on available data.

Listing Factor	***Northern ESU***	***Southern ESU***
1. Present or threatened modification of habitat	As I am relatively unfamiliar with habitat modification issues in the northern ESU, I will defer to the Department’s judgment there.	High risk. The combination of the shape of fisher habitat in the southern ESU, the increase in regional fire severity, and the conflict between fisher habitat conservation and fuel management objectives strongly suggests that the S ESU is at high risk of further fragmentation.
2. Overexploitation	Low risk.	Low risk.
3. Predation	Moderate risk. Predation has been shown to be a limiting factor. It has been shown to increase following the habitat conversion associated with fires. And there is strong evidence that exposure to toxicants increases an animal’s risk of predation. While the link between toxicant exposure and increased predation risk for fisher is currently circumstantial, no counter-argument has been proposed.	High risk. Same as Northern ESU, yet the impacts are significantly greater due to the small size of the southern population. Furthermore, increases in shrub density following fire and the linear edges generated by mechanical vegetation management can be expected to increase predation rates.
4. Competition	Low risk. No change from historic conditions.	Low risk. No change from historic conditions.
5. Disease	Low risk. Fishers show evidence of exposure to multiple pathogens, but there do not appear to be population-level implications.	Low risk, same as northern ESU.
6. Other natural or human-related activities.	High risk. I do not have hard numbers for the northern ESU as I do for the southern, yet I know that the number of grow sites is greater. The northern population can be expected to be more resilient due to the spatial extent.	High risk. As stated above, AR poisoning accounts for 8% of all documented mortality in the southern Sierras, not accounting for sublethal effects. Given the timing of most AR mortalities, associated with the denning season, and the documented transfer of toxins to nursing kits, this has the potential to inhibit population recovery even without a related increase in morbidity.

So given the presentation of data, I confess that I am surprised at what I understand the Department's position to be. In the letter provided to me, it states that "the Department believes the available science indicates that listing the species as threatened or endangered under CESA is not warranted". Yet throughout the status review a case seems to be repeatedly made that the southern population, designated as an Evolutionary Significant Unit, is at high risk of local extirpation from a variety of causes. For example, all sources seem to agree that the population consists of <500 adults, it has been severely impacted by human activities, both historic and current, and that there is ongoing isolation and fragmentation. Furthermore the combination of a unique genotype and local adaptations to warmer temperatures would appear to make the southern ESU particularly valuable in the face of climate change.

Given that the Department took the step to identify northern and southern ESUs, the rationale for a "not warranted" decision for the southern ESU is unclear. If that is to be the Department's recommendation, then more evidence needs to be included refuting the points I have mentioned. A more detailed list of comments, referenced by line number, follows.

Please feel free to contact me if anything is unclear or if I can help in any other way.

Sincerely,

11/23/2014

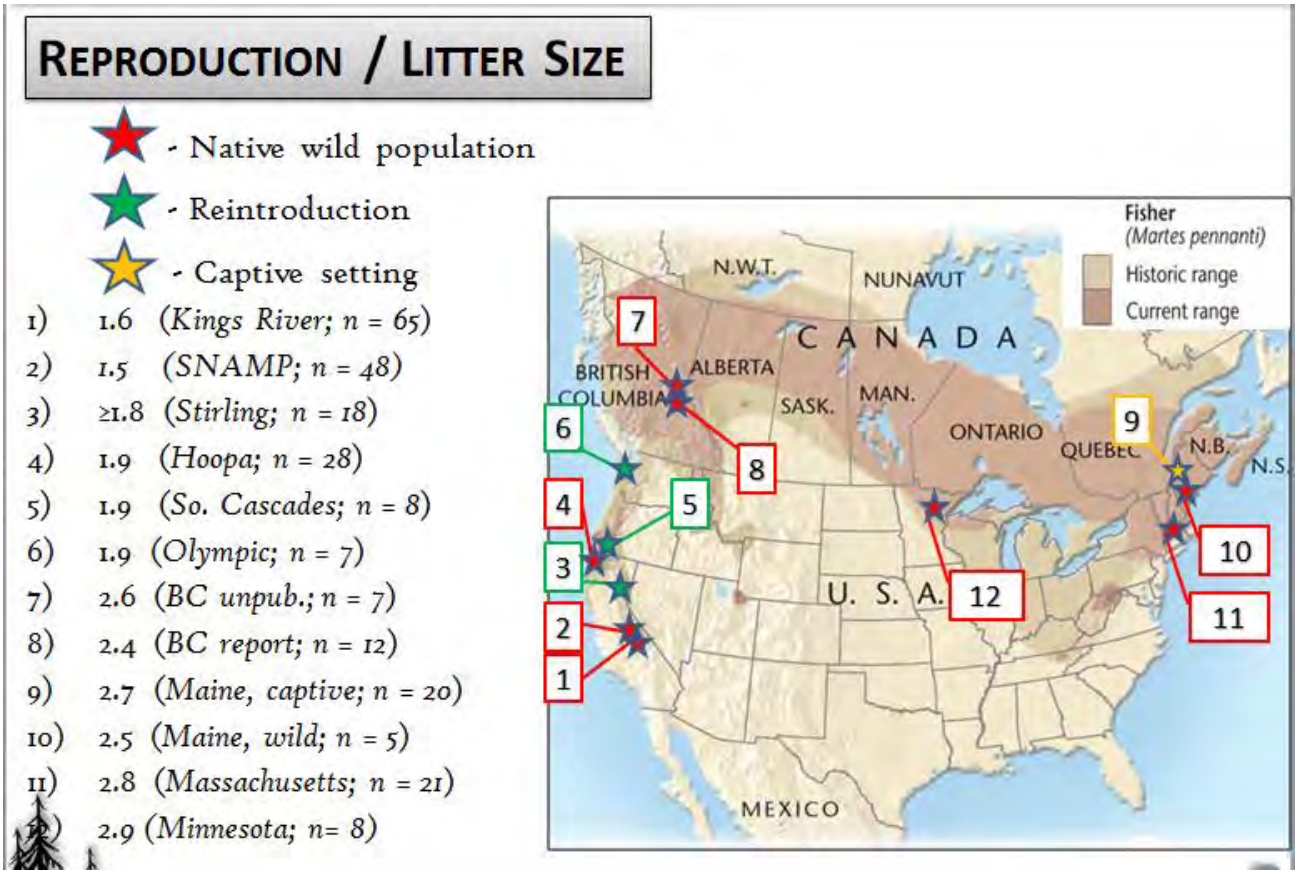
X Craig Thompson

Craig Thompson
Research Wildlife Ecologist, USFS PSW
Signed by: CRAIG THOMPSON

Craig Thompson, PhD
Research Wildlife Ecologist
USDA Forest Service, Pacific Southwest Research Station
2081 E Sierra Av, Fresno, CA 93710
559-916-6223
cthompson05@fs.fed.us

Detailed comments, listed by line number.

619: One point that is worth noting here is that there is a noticeable decline in litter size along a rough northeast to southwest gradient, with the smallest litter sizes being reported in the Southern Sierra ESU population. Causes for this are currently unknown; however climate and prey-base related issues have been speculated on. For example, fishers in the Southern Sierra ESU depend on smaller bodied prey, potentially making it more difficult for breeding females to acquire sufficient food while tending kits. Below is a graphic developed by Rebecca Green (USFS PSW) highlighting this trend. This lower reproductive output would make it more difficult for the S CA ESU to recover from stochastic events.



884: Dispersal data is available from the Sierra Nevada Adaptive Management Project in the Southern Sierras a well. Based on the Euclidian distance between the centroids of natal home ranges and subsequent established territories, dispersal distance was 5.76 ± 1.26 km for females and 9.81 ± 2.22 km for males (insignificant difference, $p = 0.10$). These values were calculated using aerial telemetry, following collared juveniles as they dispersed, N = 24 females and 19 males. When least cost path analysis is used as opposed to Euclidian distance, the values change to 8.76 ± 2.11 km for females and 13.48 ± 3.71 km for males (still an insignificant difference, $p = 0.25$).

978 - 980: Confusing phrase. If fishers rest secondarily in logs and snags, what do they primarily rest in?

1347 - 1352: This seems an important point. Fishers in the southern ESU exist at the southern extent of the North American range and can therefore be expected to be better suitable for handling increasing temperatures. Data from BC indicates that fishers use subterranean rest sites when the ambient temperature drops below a certain threshold. In the southern Sierras, there are indications that fishers use subterranean rest sites when the temperature *exceeds* certain thresholds.

1457 - 1462: The document states that timber harvest is the primary large-scale management activity with the potential to degrade habitat. That may be true in the northern ESU, however it is untrue in the southern ESU. In the southern ESU, the primary public land management activity impacting fisher habitat is fuel reduction, and the primary conflict is understory / ladder fuel management. Retaining large trees is generally not in conflict with fire management. Retaining sufficient canopy cover and creating resilient forests with reduced ladder fuels yet retaining the understory heterogeneity necessary for the prey base is more problematic. Potential fragmentation of suitable territory is an unknown risk, yet a recent analysis of fisher habitat use in the Rocky Mountains indicates that mid-scale heterogeneity is a primary driver of home range placement (J. Sauder, IDFG, unpublished work).

1809 - 1826: It is worth mentioning the Highway 41 culvert project being managed by Anae Otto of the Sierra National Forest Bass Lake District and Pam Flick of Defenders of Wildlife. Under a grant from CalTrans, they have been documenting fisher use of culverts along a stretch of highway considered to be a significant threat to fishers in the northern region of the southern ESU, and retrofitting existing culverts in Yosemite National Park to facilitate wildlife use.

1903 - 1907: While they do not compare to the Rim Fire in acreage, the 2013 Aspen Fire and the 2014 French Fire may represent a more severe threat to the southern ESU. Fisher habitat in the southern Sierras is a string of core habitat areas connected by narrow corridors. In subsequent summers, the Aspen and French fires burned on opposite sides of the San Joaquin drainage, below the Mammoth Pool Dam. This area has been identified by both modelling and field data as an important corridor between two areas of higher quality habitat. Severity varied between the two fires; the Aspen fire was considered mixed severity while the French fire was considered high severity. Yet taken together, the fires represent an internal fragmentation of an already small population. Habitat modelling by the Conservation Biology Institute has identified approximately six such bottlenecks, and all are at risk of destruction via natural or anthropogenic disturbance. It is also worth noting that the Rim Fire was a human-caused event.

2083: This number should be updated; I believe there are currently 12 documented cases of direct AR poisoning statewide, 7 in the southern ESU and 5 in the northern.

2647: The Tule River Reservation represents a significant portion of fisher habitat in the southern ESU and should be mentioned. While they do not have an active research branch similar to the Hoopa Tribe, they have cooperated with state and federal agencies and are concerned with fisher conservation. Similar to the Hoopa Tribe, they have ongoing problems with trespass marijuana cultivation on their lands as well.

2850 – 2853: The statement that fewer acres burn presently than prehistorically is flawed and misleading. Fishers clearly co-evolved with an active fire regime, yet as stated many times within this document the current fire regime is fundamentally different. Fire severity has increased following years of suppression activities, so to compare current and past acreage is inappropriate. The Rim Fire represents a watershed event in Sierra Nevada management, and fire ecologists expect the frequency of those events to increase in future years. Current fires are more destructive and represent a greater loss of habitat that historic fires, regardless of acreage. Therefore it is misleading to suggest that current fires do not threaten habitat connectivity or population integrity because historically more acreage burned.

2859 – 2860: Relying solely on national forest guidelines to protect fishers from timber and fuel management activities does not seem like a reasonable position for CDFW to take. National forest managers are caught between conservation on one hand and fire/fuel management on the other, and their priorities vary by location and project. Yet the state's position should be based solely on the evidence at hand, not on what other agencies may or may not do.

2994 - 2996: This statement, that adverse population impacts of predation have not been documented, is untrue. As stated on lines 2988-2989, the risk of predation is heightened by proximity to brushy or edge habitats. On the Hoopa Reservation, a 73% population decline was observed between 1998 and 2005. One contributing factor to this decline was a fire which converted a portion of the habitat to brush. Bobcat activity increased, and predation subsequently increased. Given the likelihood that fire activity will increase in future years and that fires often result in the short-term conversion of forest to shrubland, increased predation is possibility. And a 73% population decline is clearly an "adverse population level effect".

3003 - 3007: Yes, fishers have coexisted with predators for many years. However there is strong experimental and circumstantial evidence that sublethal exposure to toxicants can make individuals more likely to be predated upon. Therefore given the evidence of widespread exposure, it seems a safe assumption that predation rates are likely currently inflated. As stated elsewhere in the document, this needs additional research and documentation yet the risk should be mentioned here.

3167 - 3170: As stated earlier, the 2013 Aspen and 2014 French fires should be referenced here. It is not "likely" that fragmentation of the southern ESU will occur during this century. It is a fact and we're watching it occur. While the damage is hopefully not permanent, those two fires effectively isolated portions of the southern ESU.

Comments from J. Tucker

STATE OF CALIFORNIA
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND WILDLIFE

CONFIDENTIAL DRAFT – DO NOT DISTRIBUTE

REPORT TO THE FISH AND GAME COMMISSION
A STATUS REVIEW OF THE
FISHER
(*Pekania* [*Martes*] *pennanti*) IN CALIFORNIA

CHARLTON H. BONHAM, DIRECTOR
CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

October 1, 2014

Table of Contents

List of Figures

List of Tables

List of Appendices

(to be completed)

Appendix 1 – Public Notice
Appendix 2 – Peer Review Solicitation Letters
Appendix 3 – Public Comment Letters
Appendix 4 – Peer Review Comments

Acknowledgments

(to be completed)

This report was prepared by: ________________________

Report to the Fish and Game Commission
A Status Review of the Fisher in California
_______, 2014

Executive Summary

This document describes the current status of the fisher (*Pekania pennanti*) in California as informed by the scientific information available to the Department of Fish and Wildlife (Department).

Formatted: Font: Italic

On January 23, 2008, the Center for Biological Diversity petitioned the Fish and Game Commission (Commission) to list the fisher as a threatened or endangered species under the California Endangered Species Act. On March 4, 2009, after a series of meetings to consider the petition, the Commission designated the fisher as a candidate species under CESA.

Consistent with the Fish and Game Code and controlling regulation, the Department of Fish and Game, as it was then named (now called the Department of Fish and Wildlife) (Department), commenced a 12-month status review of Pacific fisher. At the completion of that status review, the Department recommended to the Commission that designating fisher as a threatened or endangered species under CESA was not warranted. On June 23, 2010, the Commission determined that designating Pacific fisher as an endangered or threatened species under CESA was not warranted. That determination was challenged by the Center for Biological Diversity and, in response to a court order granting the Center's petition for a writ of mandate, the Commission set aside its findings. In September 2012, the Department reinitiated its status review of fisher.

The fisher is a native carnivore in the family Mustelidae which includes wolverine, marten, weasel, mink, skunk, badger, and otter. It is associated with forested environments throughout its range in California and elsewhere in North America. Concern about the status of fisher in California was expressed in the early 1900s in response to declines in the number of animals harvested by trappers. Despite being the most valuable furbearer in the state, trappers only reported taking 46 animals from 1920-1924. In addition to trapping, the decline of fishers has also been attributed to logging activities which may render habitats unsuitable for them.

Comment [JT1]: Also predator control is thought to have contributed to historical population declines (Douglas and Strickland 1987, Aubry and Lewis 2003)

Early researchers believed that the range of fishers in the late 1800s extended from the Oregon border south to Marin County through the Klamath Mountains and the Coast Range as well as through the southern Cascades to the southern Sierra Nevada Mountains. However, recent genetic research indicates that the distribution of fishers in the Sierra Nevada was likely discontinuous, and populations in northern California were isolated from fishers in the Sierra Nevada prior to European settlement. The location and size of the gap separating these populations is unknown. However, it is reasonable to conclude that the gap was smaller than it is today based on records of fishers from that region during the late 1800s and early 1900s.

Currently fishers occur in northwestern portions of the state – the Klamath Mountains, Coast Range, southern Cascades, and northern Sierra Nevada (reintroduced population). Fishers are also found in the southern Sierra Nevada, south of the Merced River. For this Status Review, the Department designated fishers inhabiting northern California and the southern Sierra Nevada as two separate Evolutionarily Significant Units (ESUs). This distinction was made based on the reproductive isolation of fishers in the southern Sierra Nevada (SSN Fisher ESU) from fishers in northern California (NC Fisher ESU) and the degree of genetic differentiation between them. Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable. Statewide, estimates of the number of fishers range from 1,000 to approximately 4,500 individuals.

Early work ~~on fishers~~ appeared to indicate that fishers required particular forest types (e.g., old-growth conifers) for survival. However, studies of fishers over the past two decades have demonstrated that they are not dependent on old-growth forests per se, nor are they associated with any particular forest type. Fishers are typically found at low- to mid-elevations characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests.

Comment [JT2]: Repetitive text

Fishers primarily use live trees, snags, and logs for resting. These structures are typically large and the microstructures used for resting (e.g., cavities) can take decades to develop. Dens used by female fishers for reproduction are almost exclusively found in live trees or snags. Both conifers and hardwood trees are used for denning and the presence of a suitable cavity appears to be more important than the species of

tree. Dens are important to fishers for reproduction because they shelter fisher kits from temperature extremes and predators. Trees used as dens are typically large in diameter and are consistently among the largest available in the vicinity. Considerable time (> 100 years) may be needed for trees to attain sufficient size and develop ~~for~~ a cavity large enough for a female fisher and her young. ~~to develop~~. Although the number of den and rest structures needed by fisher is not well known, a substantial reduction in these important habitat elements would likely reduce the distribution and abundance of fisher in the state.

Primary threats to fishers within the NC and SSN Fisher ESUs include habitat loss, toxicants, wildfire, and climate change. Most forest landscapes in California occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest and fire suppression. Generally, these activities substantially simplified the species composition and structure of forests. However, fishers are widespread on public and private lands harvested for timber. A concern for the long-term viability of fishers across their range in California is the presence of suitable den sites, rest sites, and habitats capable of supporting foraging activities. At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California.

Within the fisher's current range in the state, greater than 50% of the land base is administered by the US Forest Service or the National Park Service. Private lands within the NC Fisher ESU and the SSN Fisher ESU represent about 41% and 10% of the total area, respectively. Comparing the area assumed to be occupied by fishers in the early 1900s to the distribution of contemporary detections of fishers, it appears the range of the fisher contracted substantially. This difference is due to the apparent absence of fishers from the central, and portions of the northern, Sierra Nevada. This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years.

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and to other toxicants. ARs used at illegal marijuana cultivation sites have caused the deaths of some fishers and ARs may affect fishers indirectly by increasing their susceptibility to other sources of mortality such as predation. Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population.

Comment [JT3]: Awkward wording, suggested revision

Comment [JT4]: I would recommend including percentages/rates of exposure in each study area to better summarize the nature of this issue

Comment [JT5]: This statement is not accurate – Thompson et al.2014 documented that female fisher survival was related to the number of grow sites they encounter.

Thompson, Craig, et al. "Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California." *Conservation Letters* 7.2 (2014): 91-102.

Comment [JT6]: As written I think this summary paragraph significantly understates the magnitude of the threat of AR's/toxicants to these populations.

In recent decades the frequency, severity, and extent of wildfires has increased in California. This trend could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due to that population's small size, the linear distribution of the habitat available, and the potential for fires to increase in frequency under scenarios where the climate warms.

Climate research predicts continued climate change through 2100, with rates of change faster than occurred during the previous century. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers. These changes will likely not be uniform and considerable uncertainty exists regarding climate related changes that may occur within the range of the fisher in California. The SSN Fisher ESU is likely at greater risk of experiencing potentially adverse effects of a warming climate than fishers in the NC ESU, due to its comparatively small population size and susceptibility to fragmentation. However, the effects of climate change on fisher populations are unknown, will likely vary throughout the species' range, and the severity of those effects will vary depending on the extent and speed with which warming occurs.

Regulatory Framework

Petition Evaluation Process

On January 23, 2008, the Center for Biological Diversity (Center) petitioned the Commission to list the fisher as a threatened or endangered species pursuant to the California Endangered Species Act[1] (CESA) (Cal. Reg. Notice Register 2008, No. 8-Z, p. 275; see also Cal. Code Regs., tit. 14, § 670.1, subd. (a); Fish & G. Code, § 2072.3) The Commission received the petition and, pursuant to Fish & G. Code § 2073, referred the petition to the Department for its evaluation and recommendation. (*Id.*, § 2073) On June 27, 2008, the Department submitted its initial Evaluation of Petition: Request of Center for Biological Diversity to List the Pacific fisher (*Martes pennanti*) as Threatened

Comment [JT7]: Need to reference somehow the latin name change from Martes to Pekania since fisher is referred to as Pekania in the text up until now, and the taxonomy section is not until later in the document (perhaps a footnote?).

[1] The definitions of endangered and threatened species for purposes of CESA are found in Fish & G. Code, §§ 2062 and 2067, respectively.

or Endangered (June 2008) (hereafter, the 2008 Candidacy Evaluation Report) to the Commission, recommending that the petition be rejected pursuant to Fish and Game Code section 2073.5, subdivision (a)(1)[2].

On August 7, 2008, the Commission considered the Department's 2008 Candidacy Evaluation Report and related recommendation, public testimony, and other relevant information, and voted to reject the Center's petition to list the fisher as a threatened or endangered species. In so doing, the Commission determined there was not sufficient information to indicate that the petitioned action may be warranted[3].

On February 5, 2009, the Commission voted to delay the adoption of findings ratifying its August 2008 decision, indicating it would reconsider its earlier action at the next Commission meeting[4]. On March 4, 2009, the Commission set aside its August 2008 determination rejecting the Center's petition, designating the fisher as a candidate species under CESA[5, 6].

In reaching its decision, the Commission considered the petition, the Department's 2008 Candidacy Evaluation Report, public comment, and other relevant information, and determined, based on substantial evidence in the administrative record of proceedings, that the petition included sufficient information to indicate that the petitioned action may be warranted. The Commission adopted findings to the same effect at its meeting on April 8, 2009, publishing notice of its determination as required by law on April 24, 2009[7].

On April 8, 2009, the Commission also took emergency action pursuant to the Fish and Game Code (Fish & G. Code, § 240.) and the Administrative Procedure Act (APA) (Gov. Code, § 11340 et seq.), authorizing take of fisher as a candidate species under CESA,

---

[2] See also Cal. Code Regs., tit. 14, § 670.1, subd. (d).

[3] Cal. Code Regs., tit. 14, § 670.1, subd. (e)(1); see also Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[4] Cal. Reg. Notice Register 2009, No. 8-Z, p. 285.

[5] The definition of a "candidate species" for purposes of CESA is found in Fish & G. Code, § 2068.

[6] Fish & G. Code, § 2074.2, subd. (a)(2), Cal. Code Regs., tit. 14, § 670.1, subd. (e)(2).

[7] Cal. Reg. Notice Register 2009, No. 17-Z, p. 609; see also Fish & G. Code, §§ 2074.2, subd. (b), 2080, 2085.

subject to various terms and conditions[8]. The Commission extended the emergency take authorization for fisher on two occasions, effective through April 26, 2010[9]. The emergency take authorization was repealed by operation of law on April 27, 2010.

Consistent with the Fish and Game Code and controlling regulation, the Department commenced a 12-month status review of fisher following published notice of its designation as a candidate species under CESA. As part of that effort, the Department solicited data, comments, and other information from interested members of the public, and the scientific and academic community. The Department submitted a preliminary draft of its status review for independent peer review by a number of individuals acknowledged to be experts on the fisher, possessing the knowledge and expertise to critique the scientific validity of the report[10]. The effort culminated with the Department's final Status Review of the Fisher (*Martes pennanti*) in California (February 2010) (Status Review), which the Department submitted to the Commission at its meeting in Ontario, California, on March 3, 2010. The Department recommended to the Commission based on its Status Review and the best science available to the Department that designating fisher as a threatened or endangered species under CESA was not warranted[11]. Following receipt, the Commission made the Department's Status Review available to the public, inviting further review and input[12].

On March 26, 2010, the Commission published notice of its intent to begin final consideration of the Center's petition to designate fisher as an endangered or threatened species at a meeting in Monterey, California, on April 7, 2010[13]. At that meeting, the Commission heard testimony regarding the Center's petition, the Department's Status Review, and an earlier draft of the Status Review that the Department released for peer review beginning on January 23, 2010 (Peer Review Draft). Based on these comments, the Commission continued final action on the petition until its May 5, 2010 meeting in Stockton, California, a meeting where no related

---

[8] See Fish & G. Code, §§ 240, 2084, adding Cal. Code Regs., tit. 14, § 749.5; Cal. Reg. Notice Register 2009, No. 19-Z, p. 724.

[9] *Id.,* 2009, No. 45-Z, p. 1942; Cal. Reg. Notice Register 2010, No. 5-Z, p. 170.

[10] Fish & G. Code, §§ 2074.4, 2074.8; Cal. Code Regs., tit. 14, § 670.1, subd. (f)(2).

[11] Fish & G. Code, § 2074.6; Cal. Code Regs., tit. 14, § 670.1, subd. (f).

[12] *Id.*, § 670.1, subd. (g).

[13] Cal. Reg. Notice Register 2010, No. 13-Z, p. 454.

action occurred for lack of quorum. That same day, however, the Department provided public notice soliciting additional scientific review and related public input until May 28, 2010, regarding the Department's Status Review and the related peer review effort. The Department briefed the Commission on May 20, 2010, regarding additional scientific and public review, and on May 25, 2010, the Department released the Peer Review Draft to the public, posting the document on the Department's webpage. On June 9, 2010, the Department forwarded to the Commission a memorandum and related table summarizing, evaluating, and responding to the additional scientific input regarding the Status Review and related peer review effort.

On June 23, 2010, at its meeting in Folsom, California, the Commission considered final action regarding the Center's petition to designate fisher as an endangered or threatened species under CESA[14]. In so doing, the Commission considered the petition, public comment, the Department's 2008 Candidacy Evaluation Report, the Department's 2010 Status Review, and other information included in the Commission's administrative record of proceedings. Following public comment and deliberation, the Commission determined, based on the best available science, that designating fisher as an endangered or threatened species under CESA was not warranted[15]. The Commission adopted findings to the same effect at its meeting in Sacramento on September 15, 2010, publishing notice of its findings as required by law on October 1, 2010[16].

The Center brought a legal challenge and *Center for Biological Diversity v. California Fish & Game Commission, et al*.[17] was heard in San Francisco Superior Court on April 24, 2012. On July 20, 2012, Judge Kahn signed an order granting Petitioner Center's petition for a writ of mandate. The order specified that a writ issue requiring the Department to solicit independent peer review of the Department's Status Report and listing recommendation, and the Commission to set aside its findings and reconsider its decision. On September 5, 2012, judgment issued, and on September 12, 2012, Petitioners filed a notice of entry of judgment with the court.

---

[14] See generally Fish & G. Code, § 2075.5; Cal. Code Regs., tit. 14, § 670.1, subd. (i).

[15] Fish & G. Code, § 2075.5(1); Cal. Code Regs., tit. 14, § 670.1, subd. (i)(2).

[16] Cal. Reg. Notice Register 2010, No. 40-Z, pp. 1601-1610; see also Fish & G. Code, §§ 2075.5, subd. (1), 2080, 2085.

[17] Super. Ct. San Francisco County, 2012, No. CGC-10-505205

Consistent with that order, at its Los Angeles meeting on November 7, 2012, the Commission set aside its September 15, 2010 finding that listing the fisher as threatened or endangered was not warranted[18]. Having provided related notice, the fisher again became a candidate species under the California Endangered Species Act[19]. In September 2012, the Department reinitiated a status review of fisher pursuant to the court's order following related action by the Commission.

Department Status Review

Following the Commission's action on November 7, 2012, designating the fisher as a candidate species and pursuant to Fish and Game Code section 2074.4, the Department solicited information from the scientific community, land managers, state, federal and local governments, forest products industry, conservation organizations, and the public to revise its February 2010 status review of the species. This report represents the Department's revised status review, based on the best scientific information available and including independent peer review by scientists with expertise relevant to the status of the fisher (Appendix X).

Biology and Ecology

Species Description

Fishers have a slender weasel-like body with relatively short legs and a long well-furred tail [1]. They typically appear uniformly black from a distance, but in fact are dark brown over most of their bodies with white or cream patches distributed on their undersurfaces [2]. The fur on the head and shoulder may be grizzled with gold or silver, especially in males [1]. The fisher's face is characterized by a sharp muzzle with small rounded ears [3] and forward facing eyes indicating well developed binocular vision [2]. Sexual dimorphism is pronounced in fishers, with females typically weighing slightly less than half the weight of males and being considerably shorter in overall body length. Female fishers typically weigh between 2.0-2.5 kg (4.4-5.5 lbs) and range in length from 70-95 cm (28-34 in) and males weigh between 3.5-5.5 kg (7.7-12.1 lbs) and range from 90-120 cm (35-47 in) long [2].

[18] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2080, 2085

[19] Cal. Reg. Notice Reg. 2013, No. 12-Z, pp. 487-488; see also Fish & G. Code, §§ 2074.2, 2085

Fishers are commonly confused with the smaller American marten (*M. americana*), which as adults weigh about 500-1400 g (1-3 lbs) and range in total length from about 50-68 cm (20-27 in) [4]. Fishers have a single molt in late summer and early fall, and shedding starts in late spring [2]. American martens are lighter in color (cinnamon to milk chocolate), have an irregular cream to bright amber throat patch, and have ears that are more pointed and a proportionately shorter tail than fishers [5].

Fishers are seldom seen, even where they are abundant. Although the arboreal ability of fishers is often emphasized, most hunting takes place on the ground [6]. Females, perhaps because of their smaller body size, are more arboreal than males [2,7,8].

Systematics

Classification: The fisher is a member of the order Carnivora, family Mustelidae and, until recently, was placed in subfamily Mustelinae, and the genus *Martes*. In North America, the mustelidae includes wolverine, marten, weasel, mink, skunk, badger, and otter. Based on morphology, three subspecies of fisher have been recognized in North America; *M. p. pennanti* [9], *M. p. columbiana* [10]; and *M. p. pacifica* [11]. However, the validity of these subspecies has been questioned [3] and [12].

More recently, genetic studies indicate that the fisher is more closely related to wolverine (*Gulo gulo*) and tayra (*Eira barbara*) of Central and South America than to other species of *Martes* [13–19]. Based on those findings, fishers have been reclassified along with wolverine and tayra into the genus *Pekania* [15,19]. In this report, we use *Pekania pennanti* as the taxonomic designation for ~~native~~ fishers. ~~in California.~~

Comment [JT8]: Unneccesary text

Common Name Origin and Synonyms: Fishers do not fish and the origin of their name is uncertain. Powell [2] thought the most likely possibility was that the name originated with European settlers who noted the similarity between fishers and European polecats, which were also known as fitch ferrets. Many other names have been used for fisher including pekan, pequam, wejack, Pennant's marten, black cat, tha cho (Chippewayan), uskool (Wabanaki), otchoek (Cree), and otschilik (Ojibwa) [2]. In the native language of the Hoopa people, fisher are known as 'ista:ngq'eh-k'itiqowh [20].

Geographic Range and Distribution

The fisher is endemic to North America. A *Pekania* fossil from eastern Oregon provides evidence that the ancestors of contemporary fishers occurred in North America approximately 7 million years ago [21]. Modern fishers appear in the fossil record in Virginia during the late Pleistocene (126,000-11,700 years ago) [22]. During the late Holocene which began about 4,000 years ago, fishers expanded into western North America [23], presumably as glacial ice sheets retreated and were replaced by forests.

The accounts of early naturalists, assumptions about the historical extent of fisher habitat, and the fossil record suggest that prior to European settlement of North America (ca. 1600) fishers were distributed across Canada and in portions of the eastern and western United States (Figure 1). Fishers are associated with boreal forests in Canada, mixed deciduous-evergreen forests in eastern North America, and coniferous forest ecosystems in western North America [24].

By the 1800s and early 1900s the fisher's range was generally greatly reduced due to trapping and large scale anthropogenic influenced changes in forest structure associated with logging, altered fire regimes, and habitat loss [2,24,25]. However, fishers have reoccupied much of the area lost during the early 1900s, including portions of northern British Columbia to Idaho and Montana in the West, from northeastern Minnesota to Upper Michigan and northern Wisconsin in the Midwest, and in the Appalachian Mountains of New York [25].

Comment [JT9]: Again, I think predator control should be included on this list of factors contributing to the historical reductions in fisher populations

Native populations of fisher currently occur in Canada, the western United States (Oregon, California, Idaho, and Montana) and in portions of the northeastern United States (North Dakota, Minnesota, Wisconsin, Michigan, New York, Massachusetts, New Hampshire, Vermont, and Maine). To augment or reintroduce populations, fishers have been translocated to the Olympic Peninsula in Washington State, the Cascade Range in Oregon, the northern Sierra Nevada and southern Cascades in California, and to various locations in eastern North America and Canada [26].

Historical Range and Distribution in California

Our knowledge of the distribution of fishers in California is primarily informed by Grinnell et al. [3]. They described fishers in California as inhabiting forested mountains

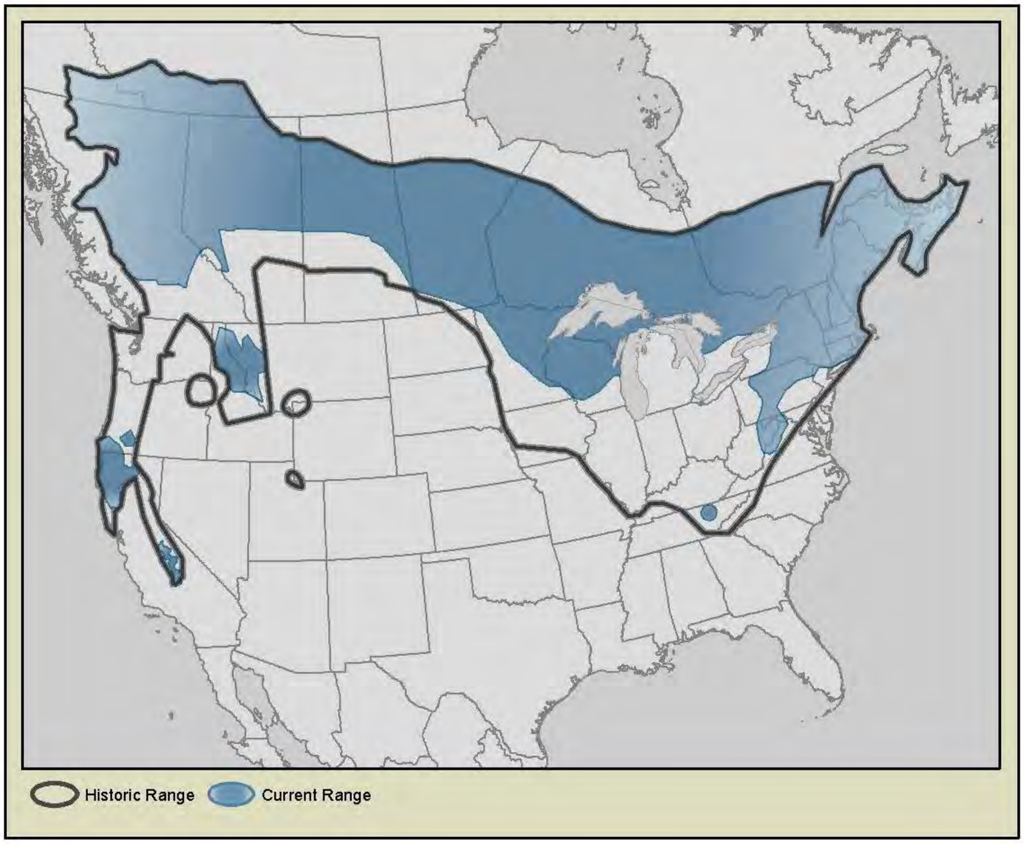


Figure 1. Presumed historical distribution (ca. 1600) and current distribution of fisher in North America. Historical distribution was derived from Giblisco [27]. Refer to Tucker et al. [28] and Knaus et al. [29] for additional insight regarding the potential historical distribution of fishers in the southern Cascades and Sierra Nevada.

primarily at elevations between 610 m to 1824 m (2,000 - 5,000 ft) in the northern portions of their range and 1220 m to 2438 m (4,000 ft - 9000~~8,000~~ ft) in the Mount Whitney region, although vagrant individuals were reported to occur beyond those elevations. Fishers were believed to have ranged from the Oregon border south to Lake and Marin counties and eastward to Mount Shasta and south throughout the main Sierra Nevada mountains to Greenhorn Mountain in north central Kern County [3].

Comment [JT10]: In the USFS Sierra Nevada Carnivore Monitoring Program we have about 10-20% (depending on year) of fisher detections on the Sequoia National Forest at stations above 8000 feet. (ref would be J. Tucker unpublished data).

Grinnell and his colleagues produced a map of fisher distribution which included locations where fishers were reported by trappers from 1919-1924, as well as a line demarcating what they assumed to be general range from approximately 1862-1937 (Figure 2). The point locations on the map were based on reports by trappers and the authors believed that almost all the locations were accurate, although they pointed out that some may have reflected the trapper's residence or post office. The map remains the best approximation of the distribution of fishers in California at that time, although it likely included areas unsuitable for fishers and excluded portions of the state occupied by the species.

Information presented by Grinnell et al. [3] suggested that at the time of their publication (1937), fishers were distributed throughout much of northwestern California and south along the west slope of the Sierra Nevada to near Mineral King in Tulare County. Grinnell et al. [3] appear to have believed that the range of fishers in the "present time" was reduced compared to the area encompassed by their "assumed general range" from approximately 1862-1937, which included Lake, Marin, and Kern counties.

Evidence of fishers occupying the central and northern Sierra during the mid-1800s through the early 1900s is limited. In the northern Sierra, Grinnell et al. [3] showed two ~~collections~~ locations from Sierra County from 1919-1924. During that period in the central Sierra, Grinnell et al. reported one ~~collection~~ location from Placer County, one from El Dorado County, one from Amador County, and two from Calaveras County. All of these records, as well as one other record from northwestern Tuolumne County in the Tuolumne River watershed, are north of the current northern limit of the southern Sierra fisher population in the Merced River watershed. However, there are no specimens in museum collections from any location in the Sierra Nevada north of Yosemite National Park.

In the southern Cascades, Grinnell et al. [3] mentioned that fishers were trapped during the winters of 1920 and 1930 on the ridge just west of Eagle Lake in Lassen County. In a separate publication on the natural history of the Lassen Peak region, Grinnell et al. [30] reported that the pelt of the Eagle Lake fisher taken in 1920 sold for $65 and that "people who live in the section say that fishers are sometimes trapped in the 'lake country' to the west of Eagle Lake." The term "lake country" presumably refers to an area of abundant lakes in the modern-day Caribou Wilderness and the eastern portion of Lassen Volcanic National Park, near the junction of Lassen, Plumas, and Shasta

Comment [JT11]: The central/northern fisher reports in Grinnell were not actual specimen colletions (or those specimens were not archived) there is no record of an associated physical specimen in either the text of Grinnel et al. 1937 or in current museum collections at MVZ or the Smithsonian.

It overstates the reliability of these locations to imply that they have associated physical specimen according to the rating system described on page 15.

Comment [JT12]: I think it is important to include that none of these reported locations north of the Merced River have physical specimens present in museum collections. See figure 2, tableS1 in Tucker et al 2012.

counties. Additional historic records of fishers in the southern Cascades include two collections in 1897, from eastern Shasta County, that are located in the National Museum of Natural History. One specimen was collected at Rock Creek, near the Pit River and modern Lake Britton. The second fisher was collected at Burney Mountain, south of the town of Burney.

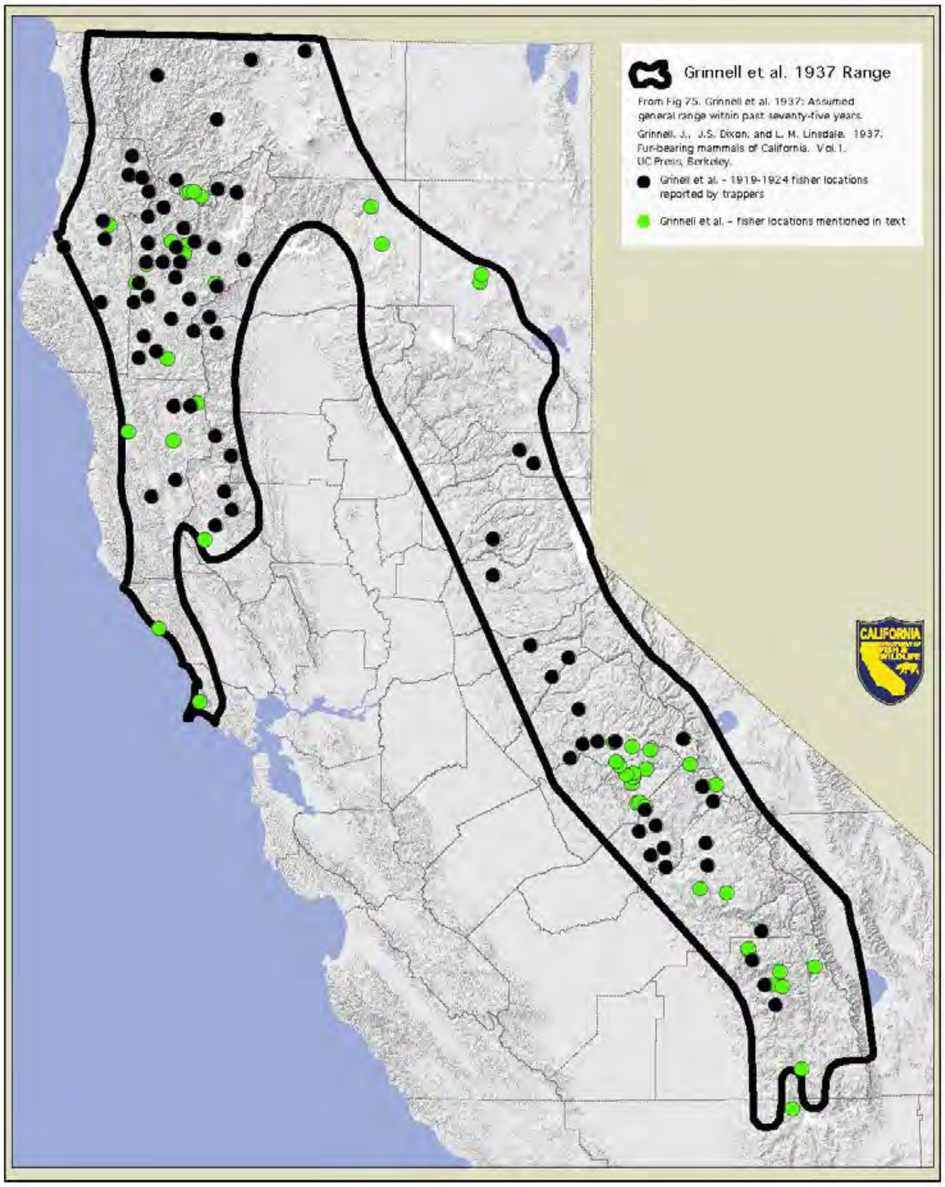


Figure 2. Assumed general range of the fisher in California from ~1850 -1925 from Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Anecdotal evidence of fishers in the northern Sierra is provided in an 1894 publication describing the efforts of William Price to collect mammals in the Sierra Nevada (primarily in Placer and El Dorado counties) and in Carson Valley, Nevada [31]. Price included notes on species that he did not collect but were “commonly known to the

Comment [JT13]: I think the caption for this figure is confusing – it took me a while to figure out what it meant.

I think what it means is:

Grinnel et al- 1919-1924 fisher locations reported by trappers (map only)

Grinnel et al.– fisher locations mentioned in the text (map and text description)

Also the font of the legend needs to be increased – it is hard to read at its current size trappers." His notes for fisher were: "One individual was seen near the resort on Mt. Tallac[20] shortly before my arrival. Mr. Dent informed me they were the most valuable animals to trappers, and that he frequently secured several dozen during the winter. They prefer the high wooded ridges of the west slope of the Sierras above 4000 feet." Although Mr. Dent's specific fisher trapping locations are unclear, it seems likely the fishers were taken within the general area of the publication's focus: the Sierra Nevada between the current routes of Interstate 80 and Highway 50, as well as the adjacent Carson Valley. Mr. Dent is mentioned elsewhere in the paper as having trapped river otter in winter along the South Fork of the American River. Additionally, when relevant, Price discusses more distant geographic localities for some species and their close relatives. If the fishers referenced were trapped at distant locations (e.g., the southern Sierra) it is likely those locations would have been mentioned. Price also noted that martens were reported by Mr. Dent as "common in the higher forests" and "associated with the fisher". Therefore, it is unlikely that Mr. Dent was confusing fishers with martens. Price's paper indicates that trapping pressure on fishers was likely significant prior to 1900. Mr. Dent is described as having trapped for ten years. If his claim of frequently trapping "several dozen" fishers annually was accurate, it is possible that he alone may have harvested several hundred animals.

Current Range and Distribution in California

Our understanding of the contemporary distribution of fisher in California is based on observations of the species through opportunistic and systematic surveys, chance encounters by experienced observers, and scientific study. Fishers are secretive and elusive animals; observing one in the wild, even where they are relatively abundant, is rare. Individuals encountering fishers in the wild often see them only briefly and under conditions that are not ideal for observation. Therefore, it is likely that animals identified as fishers may be mistakenly identified. This likelihood decreases with more experienced observers.

Considerable information about the locations of fishers in the state has been collected by the Department and housed in its California Natural Diversity Database and its Biogeographic Information and Observation System. The U.S. Fish and Wildlife Service (USFWS) also compiled information about sightings of fishers for its own evaluation of

[20] This site is likely the historic Glen Alpine Springs resort south of Lake Tahoe and southwest of Fallen Leaf Lake. It was located near the base of Mt. Tallac.

the status of the species in California, Oregon, and Washington. This information includes data from published and unpublished literature, submissions from the public during the USFWS's information collection period, information from fisher researchers, private companies, and agency databases (S. Yaeger, USFWS, pers. comm). This combined dataset represents the most complete single database documenting the contemporary distribution of fishers in California.

Aubry and Jagger [32] noted that anecdotal occurrence records such as sightings and descriptions of tracks cannot be independently verified and thus are inherently unreliable. They and others have promoted the use of standardized techniques that produce verifiable evidence of species presence (remote cameras and track-plate boxes) [33]. In its compilation of sightings of fishers, the USFWS assigned a numerical reliability rating *sensu amplo* [34] to each fisher occurrence record as follows:

1. Specimens, photographs, video footage, or sooted track-plate impressions (records of high reliability that are associated with physical evidence);
2. Reports of fishers captured and released by trappers or treed by hunters using dogs (records of high reliability that are not associated with physical evidence);
3. Visual observations from experienced observers or from individuals who provided detailed descriptions that supported their identification (records of moderate reliability);
4. Observations of tracks by experienced individuals (records of moderate reliability);
5. Visual observations of fishers by individuals of unknown qualifications or that lacked detailed descriptions (records of low reliability);
6. Observations of any kind with inadequate or questionable description or locality data (unreliable records).

The Department adopted this rating system to estimate and map the current distribution of fishers in California and, as a conservative approach, considered only those locations assigned ratings of 1 and 2 to be "verified" records (Figure 3). Undoubtedly, reports of

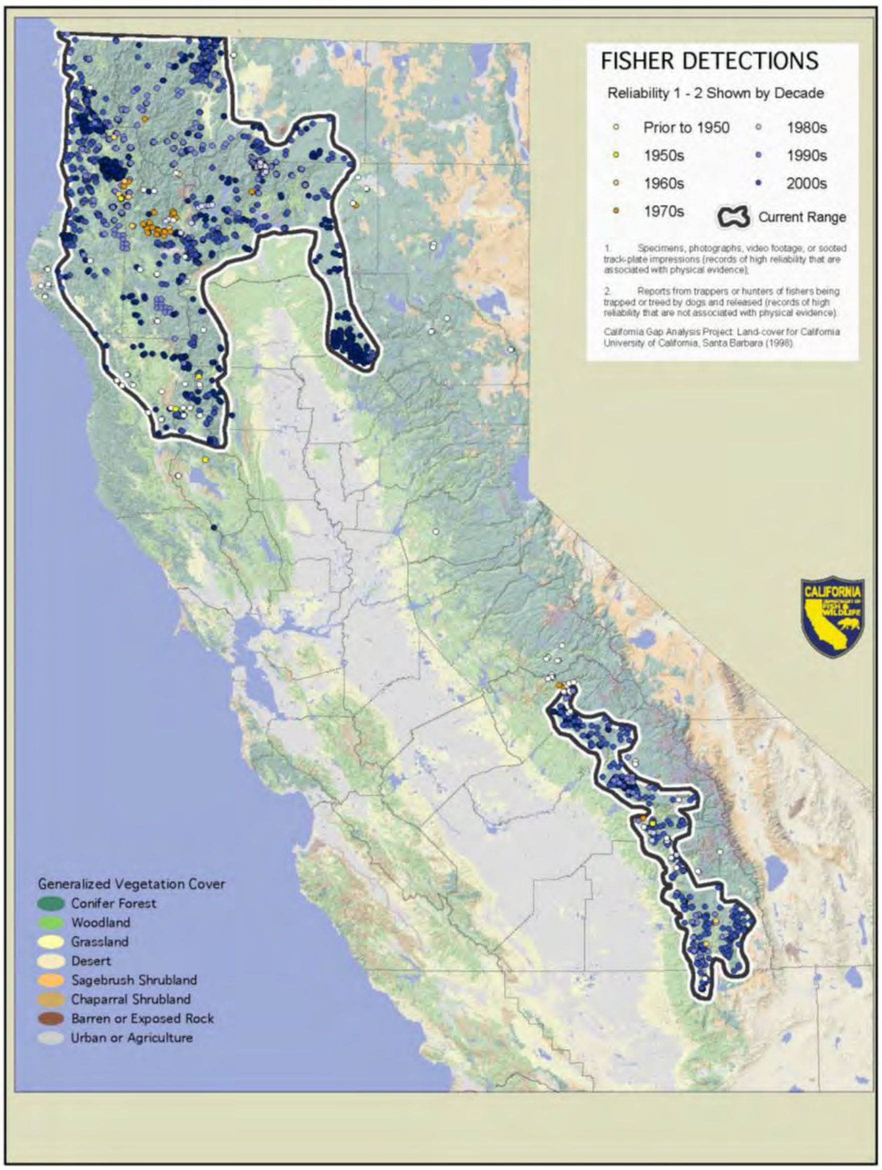


Figure 3. Locations of fishers detected in California by decade from 1950 through 2010 and estimated current range. Observations of fishers were compiled by the USFWS using information from the California Department of Fish and Wildlife's California Natural Diversity Database, federal agencies, private timberland owners, and others. Only observations assigned a reliability rating of 1 or 2 after Aubrey and Lewis [34] were included. California Department of Fish and Wildlife, 2014.

Comment [JT14]: The legend and colors of the map are difficult to read – many of the colors look similar so it is hard to discern which time period they were from. Recommend changing color palette to be more distinct. The font in the legend is again too small and difficult toread.

fishers assigned to other categories represent accurate observations, but when taken as a whole do not substantially change our understanding of the contemporary distribution of fisher populations in the state.

A number of broad scale, systematic surveys for fisher and other forest carnivores in the Sierra Nevada Mountains were conducted from 1989-1994 [35], from 1996-2002 [35], and from 2002-~~2009~~ 2014 (USDA 2006, USDA 2008, Truex et al. 2009, Zielinksi et al. 2013). At that time, fishers were not detected across an approximately 430 km (270 mi) region; from the southern Cascades (eastern Shasta County) to the southern Sierra Nevada (Mariposa County). Zielinski et al. [35] expressed concern about this gap in their distribution primarily because it represented more than 4 times the maximum dispersal distance reported for fishers and put fishers in the southern Sierra Nevada at a greater risk of extinction due to isolation than if they were connected to other populations. They offered several explanations to account for the lack of fishers in the region including trapping and elimination of habitat through railroad logging.

Comment [JT15]: The carnivore monitoring program in the Sierras is still ongoing and has collected data annually from 2002-2014.

2002-2009 is the correct date range for the trend analysis conducted by Zielinski et al. 2013, but does not cover the full duration of the broad scale systematic surveys that have been completed.

Zielinski et al. [35] could find no reason to suspect that fisher at one time did not occur where habitat was suitable throughout the Sierra Nevada and thought it likely that the fisher population had already been reduced by the time Grinnell [3] and his colleagues assessed its distribution. Price [31] supports this assertion by providing evidence that fishers were sought after by Sierra Nevada trappers several decades prior to the assessment of Grinnell [3].

Despite a number of extensive surveys using infrared-triggered cameras conducted by the Department, the USDA Forest Service (USFS), private timber companies, and others, since the 1950s no verifiable detections of fishers have occurred in that portion of the Sierra Nevada bounded approximately by the North Fork of the Merced River and the North Fork of the Feather River [35,36].

To approximate the current range of fishers in California, observations of fishers with high reliability were mapped from 1993 to the present. Those locations were overlaid using GIS on layers of forest cover and layers of potential habitat (US Fish and Wildlife Service - Conservation Biology Institute habitat model) and buffered by 4 km to approximate the home range size of a male fisher. Polygons were drawn to incorporate most, but not all, of the buffered detections of fishers (Figure 3). This estimate of

Comment [JT16]: Is this radius? Diameter? – makes a big difference and needs to be specified

current range is approximately 48% of the assumed historical range estimated by Grinnell et al. [3].

Genetics

Paleontological evidence indicates that fishers evolved in eastern North America and expanded westward relatively recently (<5,000 years ago) during the late Holocene, entering western North America as forests developed following the retreat of ice sheets [23]. By the late Holocene, records of fishers on the Pacific coast were common [37]. Wisely et al. [37] hypothesized that fishers then expanded from Canada southward through mountain forests of the Pacific Coast, eventually colonizing the Sierra Nevada in a stepping-stone fashion from north to south.

Currently, fishers in California occur in the northwestern portions of the state, the northern Sierra Nevada, and in the southern Sierra Nevada. Mitochondrial DNA (mtDNA) has been used in several studies to describe the genetic structure of fishers in the state [29,37,38]. Mitochondria are small maternally inherited structures in most cells that produce energy. Portions of the DNA contained within mitochondria known as D-loop regions contain nonfunctional genes and have been widely used in studies of ancestry because they are rich in mutations which are inherited. Early genetic studies of fishers by Drew et al. [38] identified three haplotypes[21] in California (haplotypes 1, 2, and 4) by sequencing mtDNA. Haplotype 1 was found in northern and southern California populations, the Rocky Mountains, and in British Columbia. Haplotype 2 was limited to fishers in northern California. Haplotype 4 was only found in museum specimens from California; however, it was present in extant fisher populations in British Columbia. Based on these findings, Drew et al. [38] suggested that gene flow between fishers in British Columbia and California must have occurred historically, but that these populations were now isolated.

Comment [JT17]: While this haplotype definition is technically correct I don't think it is the most useful definition for helping readers understand what exactly it is.

Suggestions to clarify include text like …

A haplotype is a contraction for 'haploid genotype' and is a group of genes within an organism that was inherited together from a single parent.

Subsequent genetic investigations using nuclear microsatellite DNA and based on sequencing the entire mtDNA genome, reported high genetic divergence between fishers in northern California and the southern Sierra Nevada [29,37]. Knaus et al. [29] identified three distinct haplotypes unique to fishers in California; one geographically

[21] A haplotype is a set of DNA variations (allele), or polymorphisms, that tend to be inherited together [39].

restricted to the southern Sierra Nevada Mountains and two restricted to the Siskiyou and Klamath mountain ranges. The magnitude of the differentiation between haplotypes of fishers in northern and southern California populations was substantial and considered comparable to differences exhibited among subspecies [29].

Advances in genetic techniques have made it possible to estimate the length of time fishers in the southern Sierra Nevada have been isolated from other populations. This may indicate how long fishers have been absent or at low numbers within some portion or portions of the southern Cascades and northern Sierra Nevada and point to a long-standing gap in their distribution in California. Knaus et al. [29] concluded that the absence of a shared haplotype between populations of fishers in northern and southern California and the degree of differentiation between haplotypes indicates they have been isolated for a considerable period. They hypothesized that this divergence could have occurred approximately 16,700 years ago, but acknowledged that absolute dates based on assumptions of mutation rates used in their study contain substantial and unknown error. Despite this uncertainty, Knaus et al. [29] concluded that three genetically distinct maternal lineages of fishers occur in California and their divergence likely predated modern land management practices.

Tucker et al. [40] used nuclear DNA from contemporary and historical samples from fishers in California and found evidence that fisher in northwestern California and the southern Sierra Nevada became isolated long before European settlement and estimated that the population declined substantially over a thousand years ago. This ~~generally~~ supports the conclusion of Knaus et al. [29] that fishers in northern and southern portions of the state became isolated prior to European settlement.

Comment [JT18]: I think it more appropriate to cite my PLOS One paper (ref #28) from a peer reviewed journal and not my dissertation chapter here.

Tucker et al. [40] also found evidence of a more recent population bottleneck in the northern and central portions of the southern Sierra Nevada and hypothesized that the southern tip of the range acted as a refuge for fisher from disturbance beginning with the Gold Rush through the first half of the twentieth century. That portion of the range appeared to have maintained a stable population while the remainder of the southern Sierra Nevada occupied by fisher was in decline.

Comment [JT19]: Same comment - use plos one paper for citation

Reproduction and Development

Powell [2] suggested that fishers are polygynous (one male may mate with more than one female) and that males do not assist with rearing young. The fisher breeding season may vary by latitude, but generally occurs from February into April [2,6,41,42]. Females can breed at one year of age, but do not give birth until their second year [2,43,44]. They produce, at most, one litter annually and may not breed every year [8,45]. Reproductive frequency and success depend on a variety of factors including prey availability, male presence or abundance, and age and health of the female. Reproductive frequency likely peaks when females are 4-5 years old [2,8,45,46].

Female fishers follow a typical mustelid reproductive pattern of delayed implantation of fertilized eggs after copulation [8,47,48]. Implantation is delayed approximately 10 months [41] and occurs shortly before giving birth (parturition) [48]. Arthur and Krohn [46] considered the most likely functions of delayed implantation are to allow mating to occur during a favorable time for adults and to maximize the time available for kits to grow before their first winter.

Active pregnancy follows implantation in late February for an average period of 30 to 36 days [2,48]. Females give birth from about mid-March to early April [49–53] and breed approximately 6-10 days after giving birth [2,47,54]. Ovulation is presumed to be induced by copulation [2], with estrus lasting 2-8 days [54]. Therefore, adult female fishers are pregnant almost year round, except for the brief period after parturition [2]. Lofroth et al. [24] developed an excellent diagram that illustrates the reproductive cycle of fishers in western North America (Figure 4).

Studies of wild fishers have reported litter sizes to range from 1-4 kits and average 1.8-2.8 [49,55–57]. Based on laboratory examination of corpora lutea[22] observed in harvested fishers, average litter size ranged from 2.3-3.7 kits [8,41–43,59–61]. These averages may be high and counts of placental scars may provide a more accurate estimate of births than the number of corpora lutea [2]. Crowley et al. [60] found that on average, 97% of females they sampled had corpora lutea, but only 58% had placental scars.

[22] The corpus luteum is a transient endocrine gland that produces essentially progesterone required for the establishment and maintenance of early pregnancy [58].

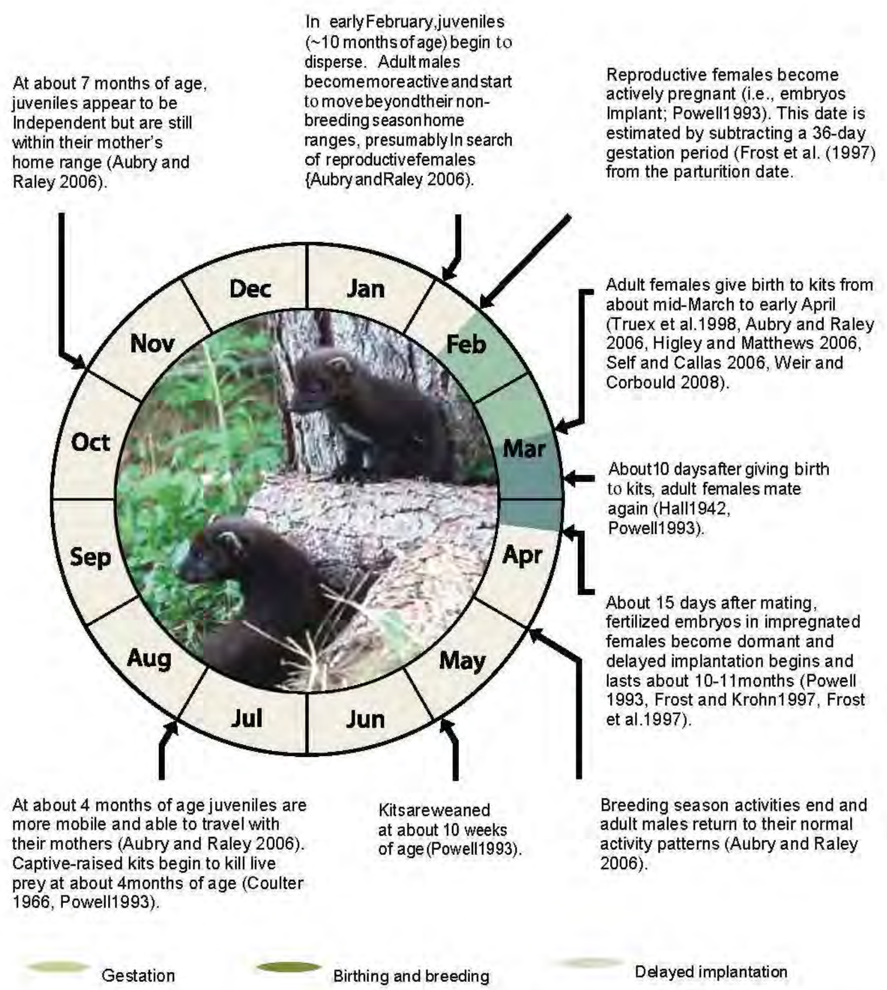


Figure 4. Reproductive cycle, growth, and development of fishers in western North America. From Lofroth et al. [22].

Raised in dens entirely by the female, young are born with their with eyes and ears closed, only partially covered with sparse growth of fine gray hair, and weigh about 40 g [6,25,54]. The kits' eyes open at 7-8 weeks old. They remain dependent on milk until 8-10 weeks of age, and are capable of killing their own prey at around 4 months [2,25]. Juvenile females and males become sexually mature and establish their own home

ranges at one year of age [41,62]. Some have speculated that juvenile males may not be effective breeders at one year due to incomplete formation of the baculum [25]. Fishers have a relatively low annual reproductive capacity [5]. Due to delayed implantation, females must reach the age of two before being capable of giving birth and adult females may not produce young every year. The proportion of adult females that reproduce annually reported from several studies in western North America was 64% (range = 39 – 89%) [24]. However, the methods used to determine reproductive rates (e.g., denning rates) varied among these studies and may not be directly comparable.

A recent study in the Hoopa Valley of California reported that 62% (29 of 47) of denning opportunities were successful in weaning at least one kit from 2005-2008 [63]. Of the female fishers of reproductive age translocated to private timberland in the southern Cascades and northern Sierra Nevada, most ($\bar{x}$ = 78%, range = 63-90%) produced young annually from 2010-2013 and 66% successfully weaned at least 1 kit (Facka, unpublished data). Reproductive rates may be related to age, with a greater proportion of older female fishers producing kits annually than younger female fishers [24].

Many kits die immediately following birth. Frost and Krohn [48] found in a captive population that average litter size decreased from 2.7 to 2.0 within a week of birth. Similarly, during a 3-year study of fishers born in captivity, 26% died within a week after birth [44]. In wild populations, kits have been found dead near den sites and reproductive females have been documented abandoning their dens indicating their young had died [49,50,56]. The number of fishers an individual female is able to raise until they are independent depends primarily upon food resources available to them [64]. Paragi [65] reported that fall recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.

Survival

Comment [JT20]: There is a significant amount of data and estimates of survival rates for the SNAMP and Kings River study areas in the southern Sierrras. I was surprised to not see this data cited here

Seems highly relevant to include that information here.

There are few studies of longevity of fishers in the wild. Powell [2] believed their life expectancy to be about 10 years, based on how long some individuals have lived in captivity and from field studies. Older individuals have been captured, but they likely represent a small proportion of populations. In British Columbia, Weir [61] captured a fisher that was 12 years of age and, in California, a female fisher live-trapped and radio-collared in Shasta County gave birth to at least one kit at 10 years of age [66]). Of

14,502 fishers aged by Matson's Laboratory using cementum annuli, the oldest individual reported was 9 years of age [67].

In the wild, most fishers likely live far less than their potential life span. Of 62 fishers captured in northern California, only 4 (6%) were older than 6 years of age and no individuals were older than 8 years, although one of those animals lived to at least 10 years of age [66,68]. From 2009-2011, a total of 67 fishers were live-trapped in northern California as part of an effort to translocate the species to the southern Cascades and northern Sierra. The median age of those individuals was 2 years (range = 0.6 – 6). The true age structures of fisher populations are not known because estimates are typically derived from harvested populations or limited studies, both of which have inherent biases due to differences in capture probabilities of fishers by age and sex class.

Estimated survival rates of fishers vary throughout their range [24]. Factors affecting survival include commercial trapping intensity, density of predators, prey availability, rates of disease, and road density. Indirect effects include habitat quality and exposure to toxicants that may increase a fisher's vulnerability to other sources of mortality (e.g., predation). Lofroth et al. [24] summarized annual survival rates reported for radio-collared fishers in North America. They reported that anthropogenic sources of mortality accounted for an average of 21% of fisher deaths in western North America documented by 8 studies, and averaged 68% for 3 studies in eastern Northern America. This difference was presumably due, in part, to the take of fisher by commercial trapping which is more widespread in eastern North America (e.g., Ontario, Maine, and Massachusetts). In western North America, the overall average annual survival rate reported for three untrapped fisher populations was 0.74 (range = 0.61-0.84) for adult females and 0.82 (range = 0.73-0.86) for adult males [24].

Comment [JT21]: What about climatic factors (precipitation, winter snowpack, etc…)

Comment [JT22]: This is where it seems like it would be very useful to cite CA specific survival estimates from the 2 southern Sierra demography studies, especially since as stated a few sentences before that survival rates vary throughout their range

Food Habits

Fishers are generalist predators and consume a wide variety of prey, as well as carrion, plant matter, and fungi [2]. Since fishers hunt alone, the size of their prey is limited to what they are able to overpower unaided [2]. Understanding the food habits of fishers typically involves examination of feces (scats) found at den or rest sites, scats collected from traps when fishers are live-captured, or gastrointestinal tracts of fisher carcasses. Remains of prey often found at den sites can provide detailed information about prey

species that may be otherwise impossible to determine by more traditional techniques [24].

In a review of 13 studies of fisher diets in North America by Martin [69], five foods were repeatedly reported as important in almost all studies: snowshoe hare (*Lepus americanus*), porcupine (*Erethizon dorsatum*), deer, passerine birds, and vegetation. In western North America, fishers consume a variety of small and medium-sized mammals and birds, insects, and reptiles, with amphibians rarely consumed [24]. The proportion of different food items in the diets of fishers differs presumably as a function of their experience and the abundance, catch-ability, and palatability of their prey [2].

In California, studies indicate fishers appear to consume a greater diversity of prey than elsewhere in western North America [24,70,71]. This difference may reflect an opportunistic foraging strategy or greater diversity of potential prey [70]. In northwestern California and the southern Sierra Nevada, mammals represent the dominant component of fisher diets, exceeding 78% frequency of occurrence in scats [71,72]. Diets reported in these studies differed somewhat in the frequency of occurrence of specific prey items, but included insectivores (shrews, moles), lagomorphs (rabbits, hares), rodents (squirrels, mice, voles), carnivores (mustelids, canids), ungulates as carrion (deer and elk), birds, reptiles, and insects. Amphibian prey were only reported for northwestern California [71], where they were found infrequently (<3%) in the diet. Fishers also appear to frequently consume fungi and other plant material [72,73].

In the Klamath/North Coast Bioregion of northern California, as defined by the California Biodiversity Council [74], Golightly et al. [71] found mammals, particularly gray squirrels (*Sciurus griseus*), Douglas squirrel (*Tamiasciurus douglasii*), chipmunks (*Eutamias* sp.), and ground squirrels (*Spermophilus* sp.), to be the most frequently consumed prey by fishers. Other taxonomic groups found at high frequencies included birds, reptiles, and insects. Studies in both the Klamath/North Coast Bioregion and the southern Sierra Nevada have shown low occurrences of lagomorphs and porcupine in the diet [70–72]. This is likely due to the comparatively low densities of these species in ranges occupied by fishers in California compared to other parts of their range [72].

In the southern Sierra Nevada, Zielinski et al. [72] reported that small mammals comprised the majority of the diet of fishers. However, insects and lizards were also

frequently consumed. No animal family or plant group occurred in more than 22% of feces. In the southern Sierra Nevada, Zielinski et al. [72] also noted that consumption of deer carrion increased from less than 5% in other seasons to 25% during winter months and the consumption of plant material increased with its availability in summer and autumn.

Fishers also adapt their diet by switching prey when their primary prey is less available; consequently their diets vary based on what is seasonally available [71,72,75,76]. Differences in the size and diversity of prey consumed by fishers among regions may reflect differences in the average body sizes of fishers their ability to capture and handle larger versus smaller prey [24]. The pronounced sexual dimorphism characteristic of fishers may also influence the types of prey they are able to capture and kill. This has been hypothesized as a mechanism that reduces competition between the sexes for food [2]. Males, being substantially larger than females, may be more successful at killing larger prey (e.g., porcupines and skunks) whereas females may avoid larger prey or be more efficient at catching smaller prey [24].

Comment [JT23]: General comment about diet. I just saw a presentation on new research from Pennsylvania fisher diet analysis that found that ~10% of their diet in the study area included other fishers (cannibalism). First time that cannibalism in fishers has been reported.

Diets of Fishers Reintroduced to the Central Appalachian Mountains:
A Generalist Predator Exploiting a Diverse Prey Base (Wildlife Society Annual Conference)
Darin J. McNeil, Indiana University of Pennsylvania,

In a study of fisher diets in southern Sierra Nevada, Zielinski et al. [72] found that during summer, the diet of female fishers compared to the diet of male fishers contained a greater proportion of small mammals. Deer remains in the feces of male fishers occurred much more frequently (11.4%) than in the feces of female fishers (1.9%). Weir et al. [77] reported that the stomachs of female fishers contained a significantly greater proportion of small mammals compared to male fishers. Aubry and Raley [49] found that female fishers consumed squirrels, rabbits and hares more frequently than male fishers and did not prey, or preyed infrequently, on some species found in the diets of male fishers (i.e., skunk, porcupine, and muskrat). However, since most scats from female fishers were collected at dens, the sample may have been biased towards smaller prey that could more easily be transported by females to dens and consumed by kits [49]. In some areas, male fishers have been found with significantly ($P<0.1$) more porcupine quills in their heads, chests, shoulders, and legs than female fishers [59,78]. It is not known whether this difference reflects greater predation on porcupines by male fishers, female fishers being more adept at killing porcupines, or female fishers experiencing higher rates of mortality when preying on porcupines than male fishers [2].

Movements

Home Range and Territoriality: A home range is commonly described as an area which is familiar to an animal and used in its day-to-day activities [79]. These areas have been described for fisher and vary greatly in size throughout the species' range and between the sexes.

Fishers are largely solitary animals throughout the year, except for the periods when males accompany females during the breeding season or when females are caring for their young [2]. The home ranges of male and female fishers may overlap, however, the home ranges of adults of the same sex typically do not [2]. Although the home range of a female generally only overlaps the home range of a single male, a male's home range may overlap those of multiple females with the potential benefit of increased reproductive success [2].

Lofroth et al. [24] summarized 14 studies that provided estimates of the home range sizes of fishers in western North America. On average across those studies, home range sizes were 18.8 km^2 (7.3 mi^2) for females and 53.4 km^2 (20.6 mi^2) for males. This difference in home range size, with male fishers using substantially larger areas than females, has been consistently reported [49,52,56,59,80–87]. In 9 studies in western North America the home range sizes of male fishers were 3 times larger than the home range sizes of female fishers [24]. Lofroth et al. [24] noted that home range sizes of fishers generally increase from southern to northern latitudes. Some factors that may influence the suitability of home ranges include landscape scale fragmentation, heterogeneity, and edge ecotones, but these attributes have not been well studied [88].

Comment [JT24]: I did not see any mention of the Popescu 2014 paper that shows significant difference in home range size between the sexes and seasons (spring/summer vs fall/winter) in this documents.

Popescu, Viorel D., Perry Valpine, and Rick A. Sweitzer. "Testing the consistency of wildlife data types before combining them: the case of camera traps and telemetry." *Ecology and evolution* 4.7 (2014): 933-943.

Comment [JT25]: This is a pretty incomplete list of factors that influence suitability of home ranges – prey availability, inter and intra-specific competition, disturbance

either need to expand or cut it

Dispersal: Dispersal describes the movements of animals away from the site where they are born. These movements are typically made by juvenile animals and have been pointed out by Mabry et al. [89] as increasingly recognized to occur in three phases: 1) departing from the natal[23] area; 2) searching for a new place to live; and 3) settling in the location where the animal will breed. The length of time and distance a juvenile fisher travels to establish its home range is influenced by a number of factors including its sex, the availability of suitable but unoccupied habitat of sufficient size, ability to

[23] Natal refers to the place of birth.

move through the landscape, prey resources, turnover rates of adults [52,56,62] and perhaps competition with other juveniles seeking to establish their own home ranges.

Dispersing juvenile fishers are capable of moving long distances and traversing rivers, roads, and rural communities [49,52,56]. During dispersal, juveniles likely experience relatively high rates of mortality compared to adult fishers from predation, starvation, accident, and disease due to traveling through unfamiliar and potentially unsuitable habitat [2,8,52,90]. Dispersal in mammals is often sex-biased, with males dispersing farther or more often than females [89]. This pattern appears to hold true for fishers [49,57,91]. It may result from the willingness of established males to allow juvenile females, but not other males, to establish home ranges within their territories [91]. Because females generally establish territories closer to their natal areas, the risks associated with dispersal through unknown areas are minimized and their territories are closer to those areas where resources have proven sufficient [92,93].

Juvenile fishers generally depart from their natal area in the fall or winter (November through February) when they exceed 7 months of age [24]. In some studies, juvenile male fishers departed from their home ranges earlier than females [57]. Where suitable, unoccupied habitat is unavailable, juveniles may be forced into longer periods of transiency before establishing home ranges. This behavior is characterized by higher mortality risk [52].

Understanding dispersal in fishers and many other species of mammals is challenging due to the difficulty of capturing and marking young at or near the site where they were born, concerns over equipping juvenile animals with telemetry collars or implants, difficulties associated with locating actively dispersing animals, and the comparatively high rates of juvenile mortality. Studies that have been able to follow dispersing juvenile fishers until they establish home ranges are relatively rare. Direct comparison of the results of these studies is difficult because various methods have been used to calculate dispersal distances. In eastern North America, Arthur et al. [62], reported mean maximum dispersal distances for male fishers [$\bar{x}$ =17.3 km (10.7 mi), range=10.9-23.0 km (6.8-14.3 mi), n=8] and for females [$\bar{x}$ =14.9 km (9.3 mi), range=7.5-22.6 km (4.7-14.0 mi), n=5]. York [56] reported mean maximum dispersal distances for males [$\bar{x}$ =25 km (15.5 mi), range=10-60 km (6.2-37.3 mi), n=10]) and for females [$\bar{x}$ =37 km (23 mi), range=12-107 km (7.5-66.5 mi), n=19]. The greater dispersal distance for

Field Code Changed

Field Code Changed

Comment [JT26]: Add citation to Tucker 2013 (dissertation). There is a chapter about sex-biased dispersal in fisher

Field Code Changed

Field Code Changed

juvenile females compared to males reported by York is unusual as, in other studies, males dispersed farther than females.

In the interior of British Columbia, Weir and Corbould [52], reported a mean dispersal distance from the centers of natal and established home ranges of 24.9 km (9.6 mi) for two females and 41.3 km (15.9 mi) for one male. In the southern Oregon Cascade Range, Aubry and Raley [49] reported mean dispersal distances from capture locations to the nearest point of post-dispersal home ranges for male fishers [$\bar{x}$ = 29 km (18 mi), range 7-55 km (4.4-34.2 mi), n = 3] and female fishers [$\bar{x}$ = 6 km (3.7 mi), range 0-17 km (0-10.6 mi, n = 4]. In northern California on the Hoopa Valley Indian Reservation, Matthews et al. [57], reported that the mean maximum distance from natal dens to the most distant locations documented for juvenile fishers was greater for males [$\bar{x}$ = 8.1 km (5.0 mi), range = 5.9–10.3 km (3.7-6.4 mi), n = 2) than females [$\bar{x}$ = 6.7 km (4.2 mi), range = 2.1–~~20.l~~20.1 km (1.3-12.5 mi), n = 12]. They also reported the distance between natal dens and the centroids (geometric center) of home ranges established by a single male [1.3 km (0.82 mi)] and 7 females [$\bar{x}$ = 4.0 km (2.5 mi), range 0.8-18 km (0.5-11.2 mi)].

Habitat Use

Fishers use a variety of habitats throughout their range to meet their needs for food, reproduction, shelter, and protection from predation. Many studies have described habitats used by fishers, but most have focused on aspects of their life history related to resting and denning. This is due, in part, to the challenges of obtaining information about the activities of fishers when they are moving about compared to being in a fixed location such as a rest site or den. Some researchers [3,94–96] have gained insight into the habitat use and movements of fishers by following their tracks in the snow.

In their comprehensive synthesis of the habitat ecology of fishers in North America, Raley et al. [88] used a hierarchical ordering process proposed by Johnson [97] to assess habitat associations of fishers at multiple scales (Table 1). They described the fisher's geographical distribution (first-order selection) as the ecological niche occupied by the species, which is further refined at the home range scale (second-order selection). Ultimately, the selection of different environments (third-order) and of resources (fourth-order) is constrained by landscape scale processes and conditions

Comment [JT27]: typo

Comment [JT28]: Discussion of the dispersal data from the SNAMP and Kings River studies needs to be included here.

Table 1. Summary of habitats used by fishers categorized by hierarchical order (Johnson 1980) and a synthesis of fisher habitat studies by Raley et al. [88].

.

First-order	Geographic distribution	Fisher distribution has consistently been associated with expanses of low- to mid-elevation mixed conifer or conifer-hardwood forests with relative dense canopies.
Second-order	Selection or composition of home ranges with the geographic distribution	Characterized by a mosaic of forest types and seral stages, with relatively high proportions of mid- to late-seral conditions, but low proportions of open or non-forested habitats.
Third-order	Selection or use of different environments within home ranges	Rest Sites: Fisher consistently selected sites for resting that have larger diameter conifer and hardwood trees, larger diameter snags, more abundant large trees and snags, and more abundant logs than at random sites. Sites used for foraging, traveling, seeking mates: Although results indicate complex vertical and horizontal structure is important to fishers, strong patterns of use or habitat selection were not found.
Fourth-order	Selection or use of specific resources within home ranges	Rest Structures: Fishers primarily used deformed or deteriorating live trees and snags for resting. The species of tree used appeared less important than the presence of a suitable microstructure (e.g., mistletoe brooms, cavities, nests of other species) for resting. Dens: Female fishers use cavities in trees to give birth and shelter their young. Den trees used for reproduction were old and were always among the largest diameter trees in the vicinity.

[88]. We have adopted this hierarchical approach to describe habitats selected by fishers.

Some researchers have hypothesized that fishers require old-growth conifer forests for survival [98]. However, habitat studies during the past 20 years demonstrate that fishers are not dependent on old-growth forests *per se*, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. Raley et al. [88] suggested that the most consistent characteristic of fisher home ranges is that they contain a mixture of forest plant communities and seral stages which often include high proportions of mid- to late-seral forests.

Fishers in western North America have been consistently associated with low- to mid-elevation forested environments [24]. The Department calculated the mean elevation of each Public Land Survey [99] section in which fishers were detected in California from 1993-2013. The grand mean of elevations at those locations was 1127 m (3698 ft) with 90% of the elevation means occurring between 275 m and 2197 m (902 ft and 7208 ft) (Figure 5). Habitats at higher elevations may be less favorable for fishers due to the

Comment [JT29]: What is the size of these public survey sections? It does not make a lot of sense to me to average elevation over a section when you may be averaging Mountain peaks with river canyons…. Why not use the elevation of each location or of a smaller neighborhood surrounding the detection? I think this would more accurately represent elevation.

Comment [JT30]: Considering the size of the NW CA population is much larger than the Sierras it seems that the data in this figure over represents elevations of the NWCA population and hides significant differences between the NW and SSN.

The mean elevation of detections in the SSN is considerably higher, especially at the far south on the Sequoia NF. The mean elevation of fisher detections in the USFS SSN monitoring program from 2002-2012 was 1880m (6170 ft)

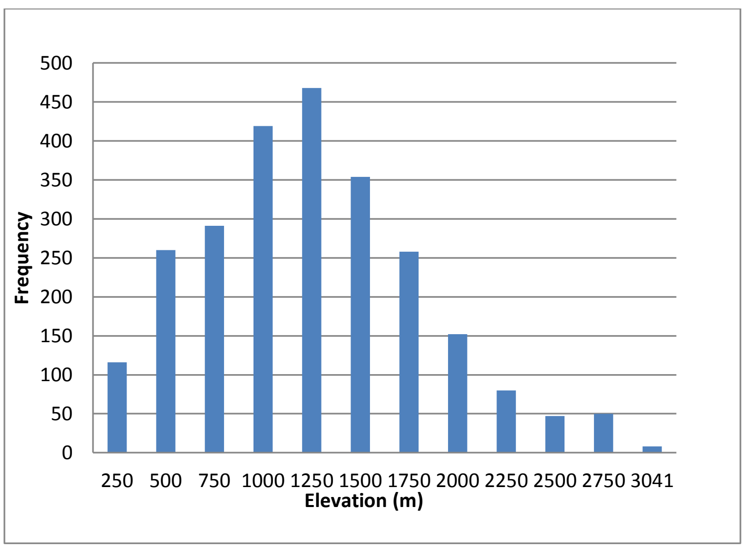


Figure 5. Mean elevations of Sections where fishers were observed (reliability ratings 1 and 2) in California from 1993-2013. California Department of Fish and Wildlife, 2014.

depth of the winter snowpack that may constrain their movements [100], because the abundance of den, structure, rest structures, and prey may be limited [88], or for other unknown reasons.

Fishers use a variety of forest types in California, including redwood, Douglas-fir, Douglas-fir - tanoak, white fir, mixed conifer, mixed conifer-hardwood, and ponderosa pine [53,85,101]. Tree species' composition may be less important to fishers than components of forest structure that affect foraging success and provide resting and denning sites [98]. Forest canopy appears to be one of these components, as moderate and dense canopy is an important predictor of fisher occurrence at the landscape scale ([53,85,102,103].

Hardwoods were more common in fisher home ranges in California compared elsewhere in western North America, [24]. This may be related to the use of hardwoods for resting and their importance as habitat for prey. In general, based on a number of studies in eastern North America and in California, high canopy closure is an important component of fisher habitat, especially at the rest site and den site level [25,53,85,102]. At the stand and site scale, forest structural attributes considered beneficial to fishers include a diversity of tree sizes and shapes, canopy gaps and associated under-story vegetation, decadent structures (snags, cavities, fallen trees and limbs, etc.), and limbs close to the ground [25].

Studies of habitats used by fishers when they are away from den or rest sites in western North America are rare and most methods employed have not allowed researchers to distinguish among behaviors such as foraging, traveling, or seeking mates. Where these studies have occurred, active fishers were associated with complex forest structures [88]. Raley et al. ([88]) reviewed several studies ([102,104–106]) and reported that active fishers were generally associated with the presence, abundance, or greater size of one or more of the following: logs, snags, live hardwood trees, and shrubs. Although complex vertical and horizontal structures appear to be important to active fishers, overarching patterns of habitat use or selection have not been demonstrated [88]. The lack of strong habitat associations for active fishers may be influenced by the limitations of most methods used to study fishers to distinguish among behaviors such as foraging, traveling, or seeking mates that may be linked to different forest conditions [88].

During periods when fishers are not actively hunting or traveling, they use structures for resting which may serve multiple functions including thermoregulation, protection from predators, and as a site to consume prey [24,107]. Fishers typically rest in large deformed or deteriorating live trees, snags, and logs and the forest conditions surrounding these sites frequently include structural elements of late-seral forests [88]. The characteristics of rest structures used by fishers are extremely consistent in western North America, based on an extensive review by Raley et al. [88]. They summarized the results of studies from 12 different geographic regions of more than 2,260 rest structures in western North America and reported that secondarily, fishers rested in snags and logs. The species of tree or log used for resting appeared to be less important than the presence of a suitable microstructure in which to rest (e.g., cavity, platform) [88]. Microstructures used by fishers for resting include: platforms formed as a result of fungal infections, nests, or woody debris; cavities in trees or snags; and logs or debris piles created during timber harvest operations [49,52,86,108,109][49]. Rest structures appear to be reused infrequently by the same fisher. In southern Oregon, Aubry and Raley [49] located 641 resting structures used by 19 fishers and only 14% were reused by the same animal on more than one occasion.

Comment [JT31]: This is awkward wording… if snags and logs are secondary, what is primary?

A meta-analysis conducted by Aubry et al. [107] of 8 study areas from central British Columbia to the southern Sierra Nevada found that fishers selected rest sites in stands that had steeper slopes, cooler microclimates, denser overhead cover, a greater volume of logs, and a greater abundance of large trees and snags than random sites. Live trees and snags used by fishers are, on average, larger in diameter than available structures (see review by Raley et al. [88]). Fishers frequently rest in cavities in large trees or snags and it may require considerable time (> 100 years) for suitable microstructures to develop [88].

The types of den structures used by fishers have been extensively studied. Female fishers have been reported to be obligate cavity users for birthing and rearing their kits [88]. However, hollow logs are used for reproduction (i.e., maternal dens) occasionally [49] and Grinnell et al. [3] reported observations of a fisher with young that denned under a large rocky slab in Blue Canyon in Fresno County. Both conifers and hardwood trees are used for denning and the frequency of their use varies by region; the available evidence indicates that the incidence of heartwood decay and development of cavities is more important to fishers than the species of tree [88]. Dens used by fishers must shelter kits from temperature extremes and potential predators. Females may choose

Comment [JT32]: Again, it seems that discussion of the large amounts of data on den sites from Kings River and SNAMP should be included here – seems more relevant than relying on studies from other populations – what about Rebecca Green's work on den sites on the Sierra NF?

dens with openings small enough to exclude potential predators and aggressive male fishers [88].

Measurements of the diameter of trees used by fishers for reproduction indicate they were consistently among the largest available in the vicinity and were 1.7-2.8 times larger in diameter on average than other trees in the vicinity of the den [52,65,104] as cited by Raley et al. [88]. Depending on the growing conditions, considerable time may be needed for trees to attain sufficient size to contain a cavity large enough for a female fisher and her kits. Information collected from more than 330 dens used by fishers for reproduction indicates that most cavities used were created by decay caused by heart-rot fungi [52,66,110]. Infection by heart-rot fungi is only initiated in living trees [111,112] and must occur for a sufficient period of time in a tree of adequate size to create microstructures suitable for use by fishers. This process is important for fisher populations as female fishers use cavities exclusively for dens [88]. Although we are not aware of data on the ages of trees used for denning by fishers in California, Douglas-fir trees used for dens in British Columbia averaged 372 years in age [110].

A number of habitat models have been developed to rank and depict the distribution of habitats potentially used by fisher in California [102,103,113,114]. The newest model was developed by the Conservation Biology Institute and the USFWS (FWS-CBI model) to characterize fisher habitat suitability throughout California, Oregon, and Washington. In California, the FWS-CBI model consists of 3 different sub-models by region. Where these regions overlapped the models were blended together using a distance-weighted average.

The FWS-CBI models predict the probability of fisher occurrence (or potential habitat quality) using Maxent (version 3.3.3k) [109], 456 localities of verified fisher detections since 1970, and an array of 22 environmental data layers including vegetation, climate, elevation, terrain, and Landsat-derived reflectance variables at 30-m and 1-km resolutions (W. Spencer and H. Romsos, pers. comm.). The majority of the fisher localities utilized was from California, and included points from northwestern California and the southern Sierra Nevada. The environmental variables were systematically removed to create final models with the fewest independent predictors.

For the southern Sierra Nevada and where it blended into the northern Sierra Nevada, the variables used in the FWS-CBI model were basal-area-weighted canopy height,

minimum temperature of the coldest month, tassel-cap greenness[24], and dense forest (percent in forest with 60% or more canopy cover). In the Klamath Mountains and Southern Cascades and where the model blended into the northern Sierra Nevada, the model variables used were tassel-cap greenness, percent conifer forest, latitude-adjusted elevation, and percent slope. Within the Coast Range and where the model blended into the Klamath Mountains, model variables used were biomass, mean temperature of the coldest quarter, isothermality, maximum temperature of the warmest month, and percent slope.

The FWS-CBI model is emphasized here because of its explicit emphasis on modeling habitat throughout California, its use of a large number of detections from throughout occupied areas in California, and a large number of environmental variables. Other recent models [96, 106] have primarily been focused on predicting habitat in the northwestern part of California or have been derived from far fewer fisher detections [97].

The final FWS-CBI model provides a spatial representation of probability of fisher occurrence or potential habitat suitability using 3 categories. Habitat considered to be preferentially used by fishers was rated as “high quality”, model values associated with habitats avoided by fishers were designated as “low quality”, and habitats that were neither avoided nor selected were considered “intermediate”. The “low quality” habitat category may include non-habitat (not used) as well as areas used infrequently by fishers relative to its availability. This FWS-CBI model was considered to be the best information available depicting the amount and distribution of habitats potentially suitable for fisher within the historical range depicted by Grinnell et al. [3] and the species’ current range in California (Figures 6 and 7).

---

[24] Tassel-cap greenness is a measure from LANDSAT data generally related to primary productivity (i.e. the amount of photosynthesis occurring at the time the image was captured) (K. Fitzgerald, pers. comm.).

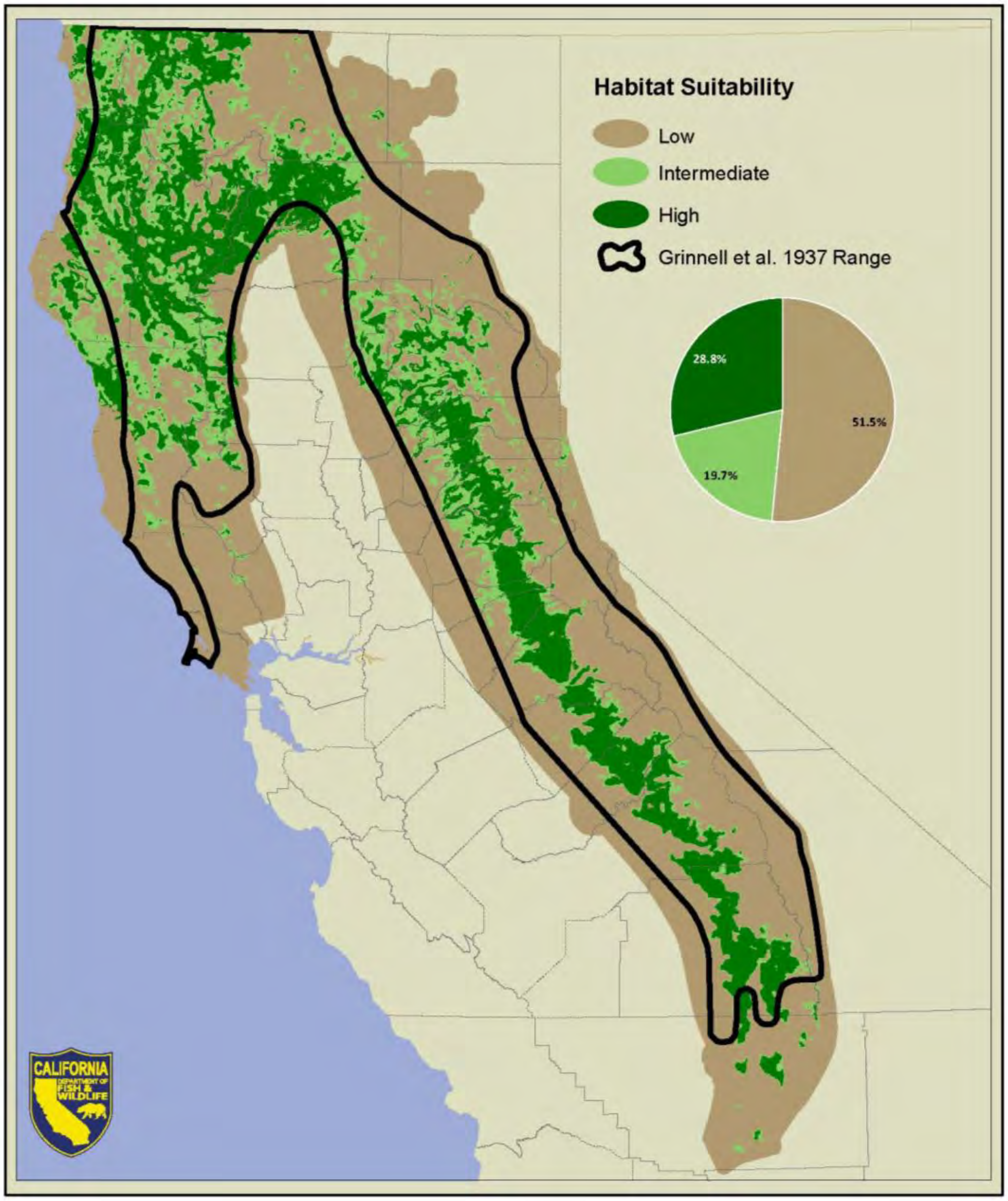


Figure 6. Summary of predicted habitat suitability within the historical range depicted by Grinnell et al. (1937). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

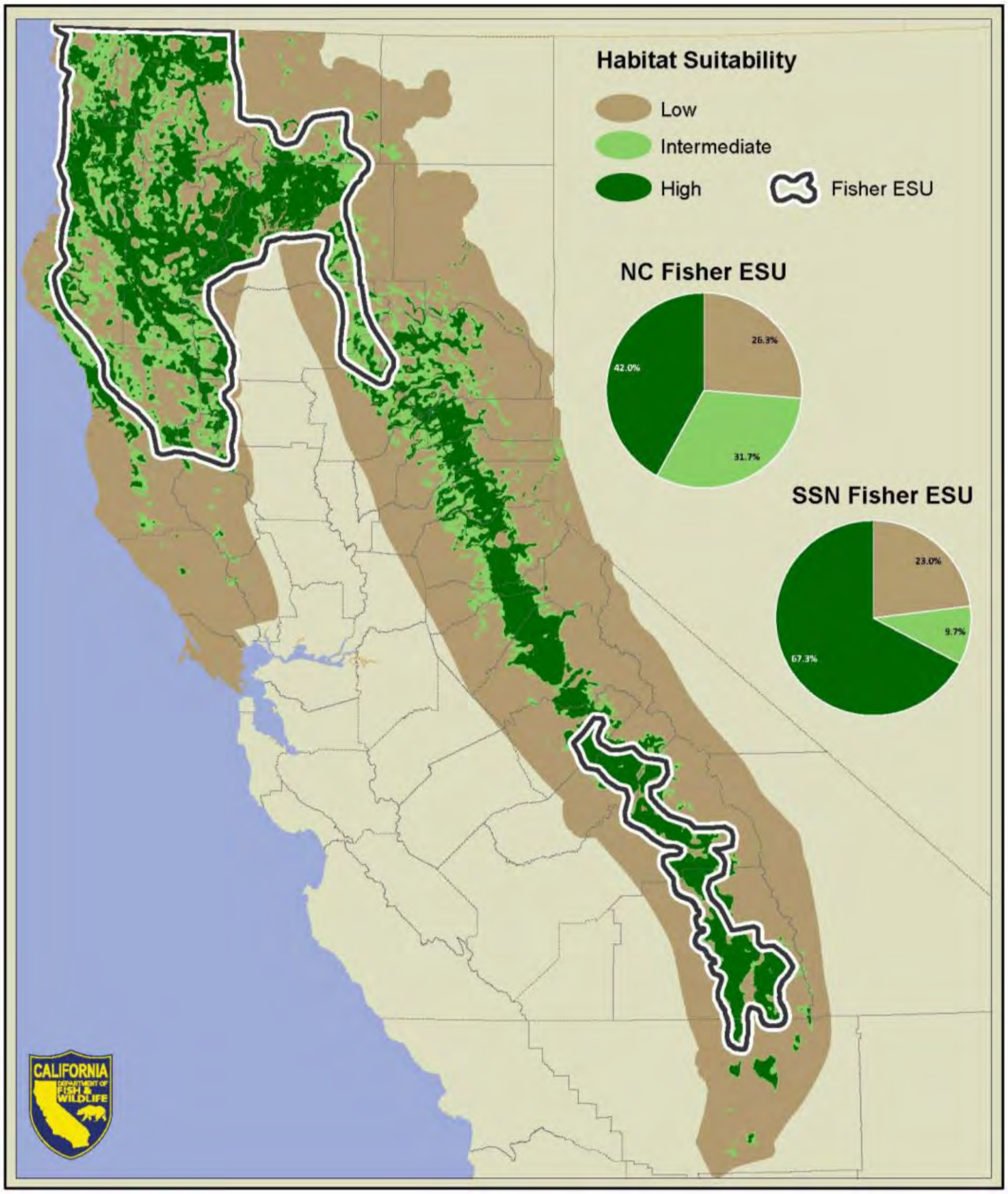


Figure 7. Summary of predicted habitat suitability within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU). Habitat suitability was predicted using a model developed by the Conservation Biology Institute and the US Fish and Wildlife Service, 2014.

Conservation Status

Regulatory Status

The fisher is currently designated by the Department as a Species of Special Concern[25] and as a candidate species at both the state[26] and federal[27] levels. Fishers are considered a sensitive species by the USFS and the Bureau of Land Management.

Habitat Essential for the Continued Existence of the Species

Fishers have generally been associated with forested environments throughout their range by early trappers and naturalists [3,31] and researchers in modern times [2,25,115–118]. However, the size, age, structure, and scale of forests essential for fisher are less clear. Fishers have been considered to be among the most habitat specialized mammals in North America and were hypothesized to require particular

[25] Generally, a Species of Special Concern is a species, subspecies, or distinct population of an animal native to California that satisfies one or more of the following criteria: 1) is extirpated from the State; 2) is Federally listed as threatened or endangered; 3) has undergone serious population declines that, if continued or resumed, could qualify it for State listing as threatened or endangered; and/or 4) occurs in small populations at high risk that, if realized, could qualify it for State listing as threatened or endangered. However, "Species of Special Concern" is an administrative designation and carries no formal legal status.

[26] A species becomes a state candidate upon the Fish and Game Commission's determination that a petition to list the species as threatened or endangered provides sufficient information to indicate that listing may be warranted [California Code of Regulations (Cal. Code Regs), tit. 14, § 670.1(e)(2)]. During the period of candidacy, candidate species are protected as if they were listed as threatened or endangered under the California Endangered Species Act (Fish & G. Code, § 2085).

[27] Federal candidate species are plants and animals for which the USFWS has sufficient information on their biological status and threats to propose them as endangered or threatened under the Endangered Species Act (ESA), but for which development of a proposed listing regulation is precluded by other higher priority listing activities. Federal candidate species receive no statutory protection under the ESA.

forest types (e.g., old-growth conifers) habitat for survival [98]. However, studies of fisher habitat use over the past two decades demonstrate that they are not dependent on old-growth forests *per se*, nor are they associated with any particular forest type [88]. Fishers are found in a variety of low- to mid-elevation forest types [105,119–122] that typically are characterized by a mixture of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. These landscapes are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Despite considerable research on the characteristics of habitats used by fishers, quantitative information is lacking regarding the number and spatial distribution of suitable den and rest structures needed by fishers and their relationship to measures of fitness such as reproductive success.

Most studies of habitat use and selection by fishers have focused on structures used for denning and resting, in part because those aspects of fisher ecology are more easily studied than habitat selection for foraging. Trees with suitable cavities are important to female fishers for reproduction. These trees must be of sufficient size to contain cavities large enough to house a female with young [52]. Aubry and Raley [49], reported that the sizes of den entrances used by female fishers were typically just large enough to for them to fit through and hypothesized that size of the opening may exclude potential predators and perhaps male fishers. In contrast, Weir [52], found that female fishers did not appear to select den entrances of a size to exclude potentially antagonistic male fishers. Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110].

Habitats used by fishers in western North America are linked to complex ecological processes including natural disturbances that create and influence the distribution and abundance of microstructures for resting and denning [88]. These include wind, fire, tree pathogens, and primary excavators important to the formation of cavities or platforms used by fishers. Trees used by fishers for denning or resting are typically large and considerable time (>100 years) may be required for suitable cavities to develop [88].

Comparatively little is known of the foraging ecology of fishers, in part, due to the difficulty of obtaining this information. However, forest structure important for fishers

should support high prey diversity, high prey populations, and provide conditions where prey are vulnerable to fishers [28] .

Distribution Trend

Comparing the historical range of fishers in California estimated by Grinnell et al. [3] to the distribution of more recent detections of fishers, it appears that their range has contracted by approximately 48%. This is largely based on contemporary surveys indicating that fishers are absent in the central and northern portions of the Sierra Nevada and rare or absent from portions of Lake and Marin counties. However, recent genetic analyses indicate some of the area considered to be a modern gap [35,36] in the historical distribution of fishers in the northern and central Sierra Nevada may have been long standing and pre-dated European settlement [29,40]. Yet, Grinnell et al. [3] and Price [31] suggest that fishers were present in this region post European settlement. This indicates that the gap was narrower historically than during contemporary times.

Comment [JT33]: Add ref #28

Despite extensive surveys from 1989-1995 [36] and 1996-2002 [35] for fishers from the southern Cascades (eastern Shasta County) to the central Sierra Nevada (Mariposa County), none were detected. However, these surveys were conducted at a broad scale and the authors point out that the species targeted were not always detected when present and that some areas that may have been occupied were not sampled.

Since the 1990s, detections of fishers have increased along the western portions of Del Norte and Humboldt counties, in Mendocino County, and in southeastern Shasta County (Figure 3). It is unknown if these relatively recent detections represent range expansions due to habitat changes, the recolonization of areas where local populations of fishers were extirpated by trapping, or if they were present, but undetected by earlier surveys. Some fishers, or their progeny, released in Butte County as part of a reintroduction effort have also been documented in eastern Shasta, Tehama, and western Plumas counties.

Population Abundance in California

There are no historical studies of fisher population size, abundance, or density in California. Concern over what was perceived to be an alarming decrease in the number

of fishers trapped in California led Joseph Dixon, in 1924, to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [3]. In that year, only 14 fishers were reported taken by trappers in the state, with the pelt of one animal reportedly selling for $100 (valued at $1,366 today, US Bureau of Labor Statistics). Grinnell et al. [3] concluded that the high value of fisher pelts at that time caused trappers to make special efforts to harvest them. From 1919 to 1946, a total of 462 fishers were reported to have been harvested by trappers in California and the annual harvest averaged 18.5 fishers [123]. Most animals were taken in a single trapping season (1920) when 120 fishers were harvested [124]. Despite concerns about the scarcity of fishers in the state, trapping of fisher was not prohibited until 1946 [125].

Grinnell et al. [3] noted that "Fishers are nowhere abundant in California. Even in good fisher country it is unusual to find more than one or two to the township." They roughly estimated the fisher population in California at fewer than 300 animals statewide with a density of 1 or 2 animals per township [93 km^2 (36 mi^2)] in good fisher range. For perspective, substantially higher numbers of fisher are captured for radio-collaring/study purposes in various studies in the present day: over a two month period beginning in November 2009, the Department-led translocation project live-trapped 19 fishers from donor sites in northwestern California. A total of 67 fishers were captured as part of an effort to translocate the species to the Southern Cascades and northern Sierra Nevada from 2009-2012 from widely distributed locations in northern California. Over a period of 28 days in 2012, 19 fishers were captured in vicinity of the translocation release site in the northern Sierra Nevada that were likely the offspring of animals translocated to the area [126]. Although using trapping results to describe the relative abundance of species can be misleading due to differences in catch-ability or trap placement, it is noteworthy that capture success for fishers during this effort was higher than for any other species of carnivore trapped (A. Facka, pers. comm.). Other species captured included raccoon (*Procyon lotor*), ringtail (*Bassariscus astutus*), gray fox (*Urocyon cinereoargenteus*), spotted skunk (*Spilogale gracilis*), and opossum (*Didelphis virginiana*).

Despite the paucity of empirical data, there are several estimates of fisher population size in northern California. In April 2008, Carlos Carroll indicated that his analysis of fisher data sets from the Hoopa Reservation and the Six Rivers National Forest in northwestern California suggested a regional (northern California and a small portion of

adjacent Oregon) fisher population of 1,000-3,000 animals (C. Carroll, pers. comm.). This estimate represented the rounded outermost bounds of the 95% confidence intervals from the analysis. Carroll acknowledged a lack of certainty regarding the population size, as evidenced by the broad range of the estimate. However, he believed the estimate to be useful for general planning and risk assessment.

Self et al. (2008 SPI comment information) derived two separate "preliminary" estimates of the size of the fisher population in California. Using estimates of fisher densities from field studies, they used a "deterministic expert method" and an "analytic model based approach" to estimate regional population sizes. The deterministic expert method provided an estimate of 3,079 fishers in northern California, and the model-based regression method estimate was 3,199 (95% confidence interval [CI]: 1,848 - 4,550) fishers. Estimates for the southern Sierra Nevada population were 598 using the deterministic expert method and 548 (95% CI: 247 – 849) fishers based on their regression model. While cautioning that their estimates were preliminary, the authors emphasized the similarities between the separate estimates.

Estimates of the number of fishers in the southern Sierra Nevada indicate that despite using different approaches, the population is quite small. Lamberson et al. [127], using an expert opinion approach, estimated the southern Sierra Nevada fisher population to range from 100-500 animals. Spencer et al. [128] estimated the size of the fisher population in the southern Sierra Nevada by extrapolating previous density estimates of Jordan [129], using data from the USFS regional population monitoring program (USDA Forest Service 2006), and linking a regional habitat suitability model to life history attributes. Using these data, they estimated 160-350 fishers in the southern Sierra Nevada population, of which 55-120 were estimated to be adult females. More recent work by Spencer et al. [119] estimated the southern Sierra Nevada fisher population at 300 individuals. Estimates of the number of fishers in California vary depending on the source, but range from 1,000 to approximately 4,500 fishers statewide.

Population Trend in California

No data are available that document long-term trends in fisher populations statewide in California. Despite genetic evidence indicating a long-standing historical separation of fishers in northern California from those in the southern Sierra Nevada [28], fishers reportedly occurred in the central and northern Sierra Nevada post-European settlement

Comment [JT34]: These estimates are very high when compared to other population estimates from the SSN. I would not devote and entire paragraph to these estimates which have not been peer reviewed or published – there is no basis to judge the merit of their estimation methods. Just because they have two similar estimates does not mean that they are accurate, especially considering they are quite dissimilar from other population size estimates in the SSN (Spencer et al.2011, Jordan et al. 2007…)

Comment [JT35]: I think this entire section needs reorganized as it jumps all over the place and is hard to follow. A suggested outline:

Population Trend in CA:
1)Historical distribution and trend
2)Large Scale Monitoring:
a. SSN (USFS)
b. NWCA (CADFW)
3) Local monitoring (smaller areas within pops)
a. Hoopa
b.Green Diamond
c. Sweirs
d. SNAMP??
e. Kings River??

Comment [JT36]: I would like to point out again that all we have are unverified locations in the central and northern Sierras, there are no physical specimens from the gap.

Formatted: Underline

[3,31], but were likely not abundant based on the scarcity of records from this region. By the late 1800s, habitat changes and harvest by trappers may have reduced the abundance of fishers in this region to low levels. The apparent scarcity of fishers in the central and northern Sierra Nevada by the early 1900s is supported by the work of Grinnell et al. [3] and the lack of specimens from that region.

In northern California, Matthews et al. [130] reported substantial declines in the density of fishers on Hoopa Valley Tribal lands from about 52 individuals/100 km^2 (52 individuals/38.6 mi^2) in 1998 to about 14 individuals/100 km^2 (14 individuals/38.6 mi^2) in 2005. However, continued monitoring of this population indicates that overall the population density has increased by 2012-2013, but only to about half of that estimated in 1998.

To assess changes in fisher populations on their lands in coastal northwestern California, Green Diamond Resource Company repeated fisher surveys using track plates in 1994, 1995, 2004, and 2006 [131]. Detection rates at segments increased slightly from 1994 to 2006. At individual stations, detection rates were higher in 1995, lower in 2004, and higher in 2006. However, there was insufficient statistical power to detect a trend in these detection ratios (L. Diller, pers. comm.).

More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed.

Swiers et al. [132], collected hair samples from fishers from 2006-2011 in northern Siskiyou County to examine the potential effects of removing animals from the population for translocation. Their study area included lands managed by two private timber companies and the USFS. Using non-invasive mark-recapture techniques, Swiers et. al. found the population of approximately 50 fishers to be stable, despite the removal of nine fishers that were translocated to Butte County. Estimates of abundance and population growth indicated that the population size was stable, although estimates of survival and recruitment suggested high population turnover [132].

Comment [JT37]: This statement is illogical. The lack of specimens from the central and northern Sierras does not support that they were scarce, it supports that they were absent…

Comment [JT38]: This paragraph seems extremely dismissive of the evidence of long term genetic isolation in Knaus et al. 2011, and my 2012 paper.

The magnitude of genetic differentiation between NW and SSN detected was striking. and would have taken a lot longer than the last 150 years to accumulate, yet here it is dismissed in one sentence in favor of the Grinnel historical range and theory of more recent extirpation from the central and northern Sierra, which I will reiterate has no physical evidence to support it.

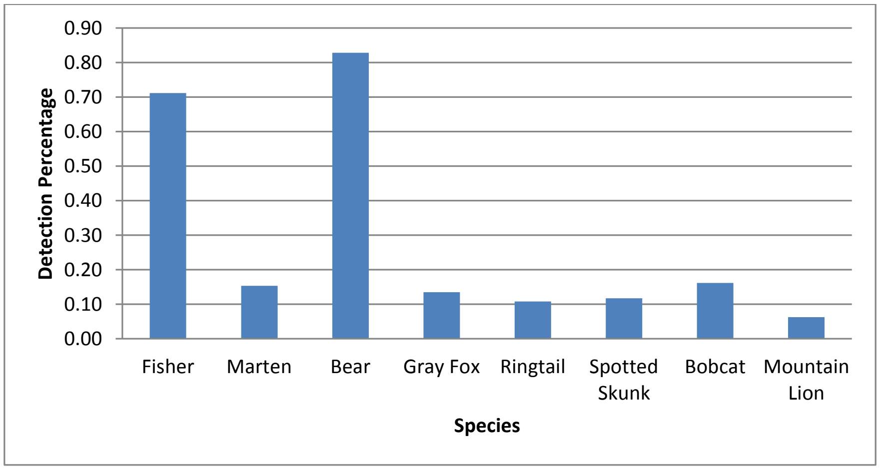


Figure 8. Detections of carnivores at 111 remote camera stations on lands managed by Green Diamond Resource Company in Del Norte and northern Humboldt counties, from 2011-2013. California Department of Fish and Wildlife, 2014.

Tucker et al. [28] concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago. They hypothesized that as a result, fishers in California contracted into the two current populations (i.e., northern California and southern Sierra Nevada). If correct, the spatial gap between the fisher populations in northern California and the southern Sierra Nevada long pre-dated European settlement. Tucker et al. [28] also detected a bottleneck signal (i.e., reduction in population size) in the northern half of the southern Sierra Nevada population, indicating that portions of that population experienced a second decline post-European settlement. They hypothesized that the southern tip of the Sierra Nevada may have served as a refugium in the late 19th and 20th centuries. The southern extent of fisher habitat in the southern Sierra may have contained sufficient high quality habitat to serve as a refugium supporting enough fishers to constitute a founding population (J. Tucker, pers. comm.). Tucker et al. [28] using genetic techniques estimated that the total current population size of fishers in northwestern California could range from 258-2850 and the southern Sierra Nevada population could range from 334-3380.

~~Monitoring of fisher populations in northern California has been limited, but S~~several ~~studies~~ large scale monitoring programs are providing insight into the distribution and trends in occupancy rates of fishers in the state. Estimates of trends in occupancy have been used as surrogates for trends in abundance for some species of wildlife [133], in

Comment [JT39]: If you are going to include this I think you need to include a vicinity map showing where these surveys were conducted within the NW population for reference

Comment [JT40]: You need to add discussion of the Knaus 2011 paper as well, as the two papers support each other's conclusions.

I would move this up to the beginning of the section as it deals with historical context and seems out of order here

Comment [JT41]: This is incorrect. These estimates were for effective population size (Ne) not census population size (Nc)

Comment [JT42]: This paragraph seems out of place here and it is a rough transition from the previous paragraphs

Comment [JT43]: ?? The Southern Sierra population has had an extensive, systematic monitoring program in place since 2002, and there was a fairly long history of systematic surveys by Zieinski et al prior to this in the 1990s.

If you are just referring to the NWCA population then you should not follow with a sentence about SSN fisher monitoring.

part, because it is more cost effective and feasible than monitoring direct measures of abundance. The U.S. Forest Service has conducted a large-scale systematic monitoring program for fisher in the Sierra Nevada since 2002. Zielinski et al. [134] ~~implemented~~analyzed 8 years of data (2002-2009) from this~~ a~~ monitoring program ~~for fishers in the southern Sierra Nevada over an 8 year period (2002-2009)~~ ~~and modeled trends in occupancy by combining the effects of detection probability and occupancy~~. They estimated the overall probability of occupancy, adjusted to account for uncertain detection, to be 0.367 (SE = 0.033). Probabilities of occupancy were lowest in the southeastern portion of their study area (0.261) and highest in the southwestern portion~~s~~ of their study area (~~southwestern zone = ~~0.583) [134]. They found no statistically significant trend in occupancy during the sampling period and concluded that the small population of fishers in the southern Sierra did not appear to be declining.

Comment [JT44]: I think you are underselling the SSN fisher monitoring program in comparison to the EBM monitoring in the subsequent paragraph. Why is there a ton of detail about that monitoring program (FIA hexagons, site selection, etc…) for the EBM monitoring in NWCA but not the SSN fisher monitoring? I can provide additional details if you want to add this or many are available in the trend analysis paper (Zielinski et al.2013)

Either provide the same level of detail for both or cut details from the EBM description to balance.

Comment [JT45]: Unnecessary – this is by definition what occupancy modeling is

The Department has conducted a large-scale monitoring project for forest carnivores, including fishers, as part of its Ecoregion Biodiversity Monitoring (EBM) program in the Klamath and East Franciscan ecoregions of northern California since 2011. EBM surveys for carnivores were conducted using camera traps within hexagons established by the Forest and Inventory Assessment system [135]. All the sites selected for survey occurred in forested habitats and were selected randomly (although land ownership, road access, and safety issues occasionally precluded completely random placement of plots). A Bayesian hierarchical model was used to estimate occupancy and detection probabilities for fisher across stations nested within plots within ecoregions (Furnas et al. unpublished manuscript). A total of 85 plots containing 169 stations were surveyed across the entire 2.8 million-ha study area during 2011 and 2012. The overall occupancy estimate for fisher was 0.438 [90% CI: 0.390-0.493] for stations, and 0.622 [90% CI: 0.569-0.685] for station pairs. The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.

Threats (Factors Affecting the Ability of Fishers to Survive and Reproduce)

Evolutionarily Significant Units

For the purposes of this Status Review, the Department designated fishers inhabiting portions of northern California and the southern Sierra Nevada as separate Evolutionarily Significant Units (ESUs). These units will be evaluated for listing separately where the information available warrants independent treatment and are hereafter referred to as the NC (northern California) Fisher ESU and SSN (southern Sierra Nevada) Fisher ESU. The use of ESUs by the Department to evaluate the status of species pursuant to CESA is supported by the determination by the Third District Court of Appeal that the term “species or subspecies” as used in sections 2062 and 2067 of the CESA includes Evolutionarily Significant Units[28]. To be considered an ESU, a population must meet two criteria: 1) it must be reproductively isolated from other conspecific (i.e., same species) population units, and 2) it must represent an important component of the evolutionary legacy of the species [136].

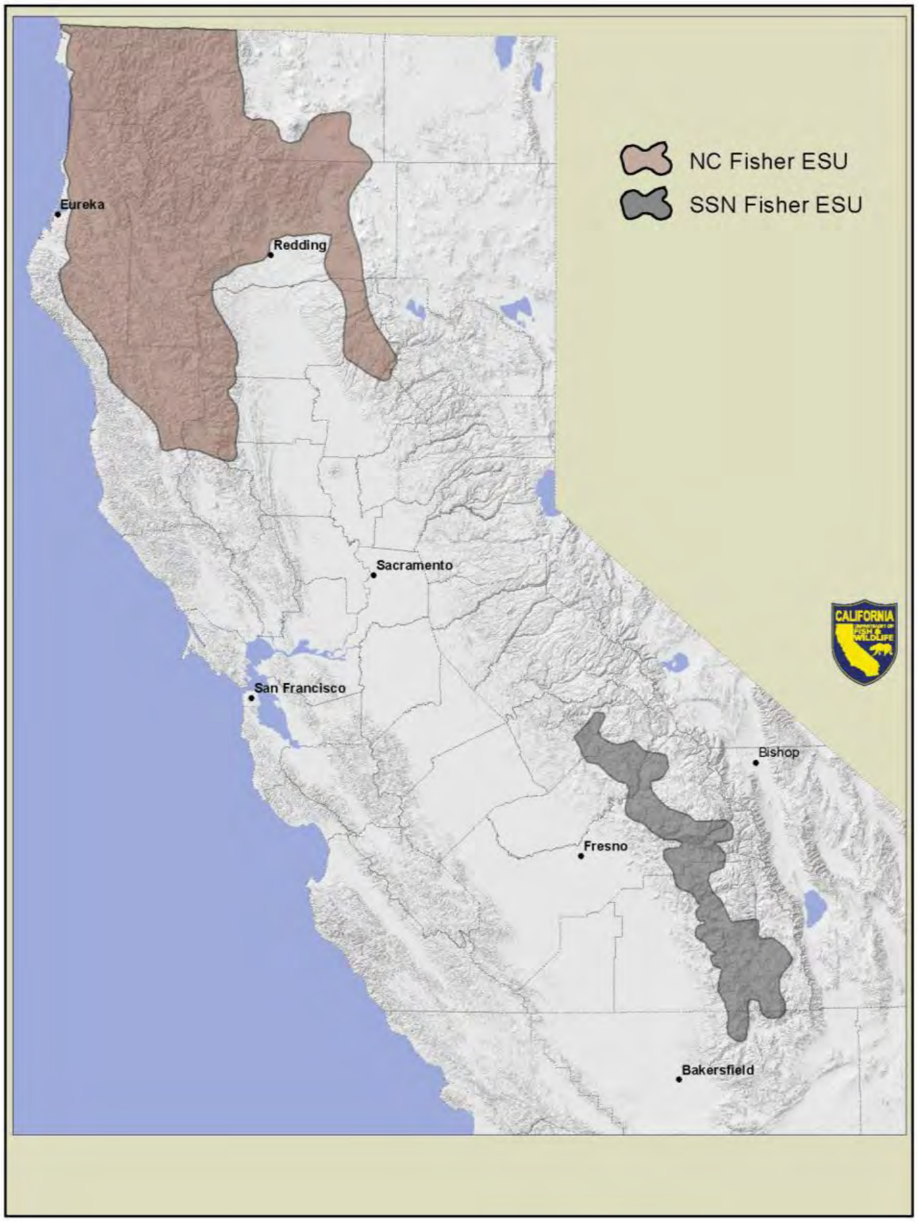
ESU boundaries for fisher represent the Department’s assessment of the current range of the species in the state, considering the reproductive isolation of fishers in the southern Sierra Nevada from fishers in northern California and the degree of genetic differentiation between them (Figure 9). Maintenance of populations that are geographically widespread and genetically diverse is important because they may consist of individuals capable of exploiting a broader range of habitats and resources than less spatially or genetically diverse populations. Therefore, they may be more likely to adapt to long-term environmental change and also to be more resilient to detrimental stochastic events.

Habitat Loss and Degradation

Fishers have consistently been associated with expanses of low- to mid-elevation mixed conifer forests characterized by relatively dense canopies. Although fishers occupy a variety of forest types and seral stages, the importance of large trees for denning and resting has been recognized by the majority of published work on this topic [24,52,98,108–110,117]. Life history characteristics of fishers, such as large home range, low fecundity (reproductive rate), and limited dispersal across large areas of open habitat are thought to make fishers particularly vulnerable to landscape-level habitat alteration, such as extensive logging or loss from large stand-replacing wildfires [5,25]. Buskirk and Powell [98] found that at the landscape scale, the abundance and

[28] 156 Cal.App.4th 1535, 68 Cal.Rptr.3d 391

distribution of fishers depended on size and suitability of patches of preferred habitat, and the location of open areas in relation to those patches.



1373 Figure 9. Fisher Evolutionarily Significant Units (ESUs) in California. California Department of Fish and
1374 Wildlife, 2014.

Fishers have frequently been associated with old-growth forests and some researchers have hypothesized that they require those forests for survival. Habitat studies in recent decades demonstrate that fishers are not entirely dependent on old-growth forests, provided adequate canopy cover, large structures for reproduction and resting, vertical and horizontal escape cover, and sufficient prey are available [88]. However, the home ranges of fishers often include high proportions of mid- to late-seral forests [88].

Most forest landscapes occupied by fishers have been substantially altered by human settlement and land management activities, including timber harvest. These activities have significantly modified the age and structural features of many forests in California. Most of the old growth and late seral forest in California outside of National Parks and Wilderness Areas has been subject to timber harvesting in some form since the 19th century. Besides the direct removal of trees through timber harvest, management practices and policies have had many indirect effects on forested landscapes [24]. Silvicultural methods, harvest frequency, and post-harvest treatments have influenced the suitability of habitats for fisher. Generally, timber harvest has substantially simplified the species composition and structure of forests [137,138]. Habitat elements used by fishers such as microstructures for denning can take decades to develop and a substantial reduction in the density of these elements from landscapes supporting fisher would likely reduce the distribution and abundance of fisher in the state.

Of the historical range of the fisher in California estimated by Grinnell et al. [3], nearly 61% is in public ownership and about 37% is privately owned (Figure 10). Within the current estimated range of fishers in the state, greater than 50% of the land within each ESU is in public ownership and is primarily administered by the USFS or the National Park Service (NPS) (Figure 11). Private lands within the NC Fisher ESU and the SSN ESU represent about 41% and 10% of the total area within each ESU, respectively.

The volume of timber harvested on public and private lands in California has generally declined since late 1980s (Figure 12). On USFS lands the number of acres harvested annually in California within the range of the fisher also declined substantially in recent decades [139]. Sawtimber volume (net volume in board feet of sawlogs harvested from commercial tree species containing at least one 12-foot sawlog or two noncontiguous 8 foot sawlogs) harvested from the National Forests in both the NC and SSN ESUs declined substantially in the early 1990s and has remained at relatively low levels (Figures 13 and 14).

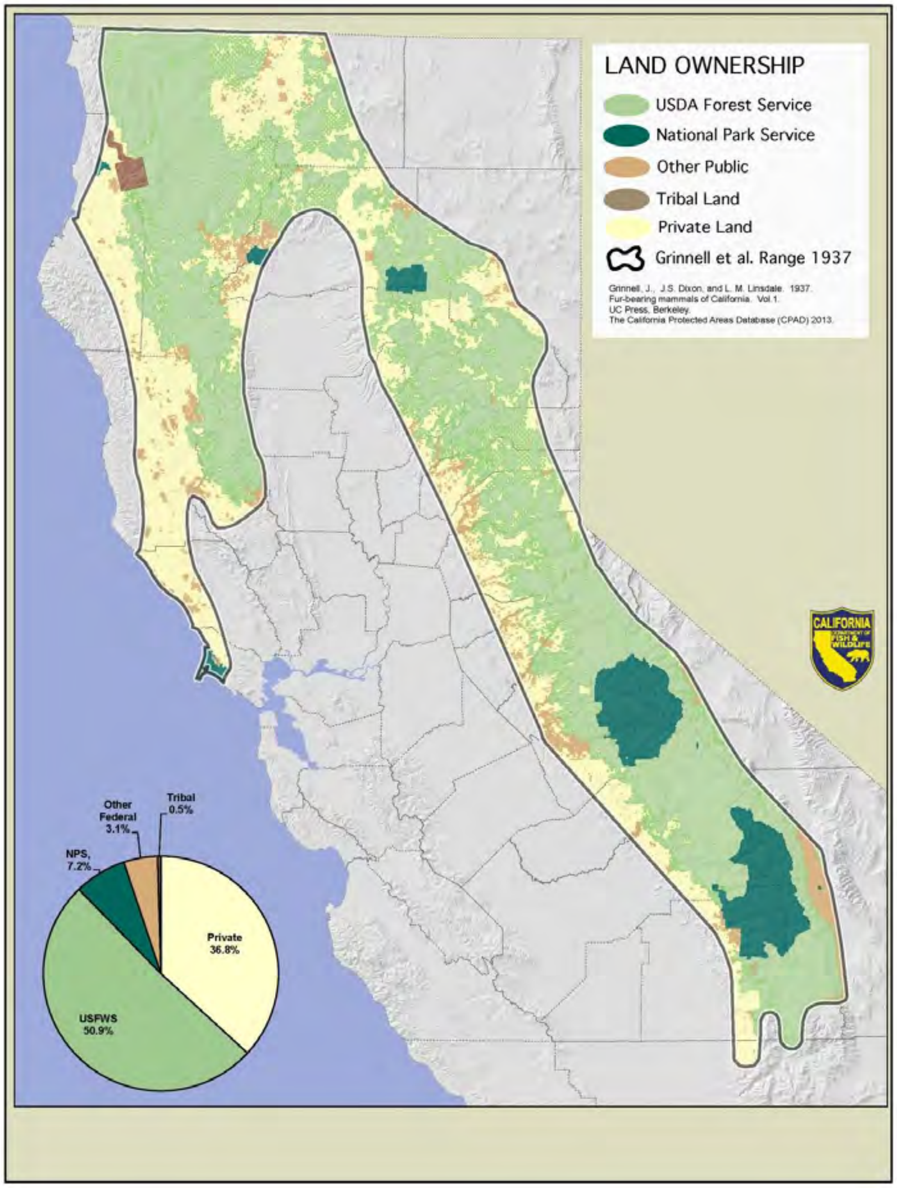


Figure 10. Landownership within the historical range of fisher depicted by Grinnell et al. [3]. California Department of Fish and Wildlife, 2014.

Comment [JT46]: This figure is missing depiction of tribal lands with the Tule River Indian Reservation near the Sequoia NF

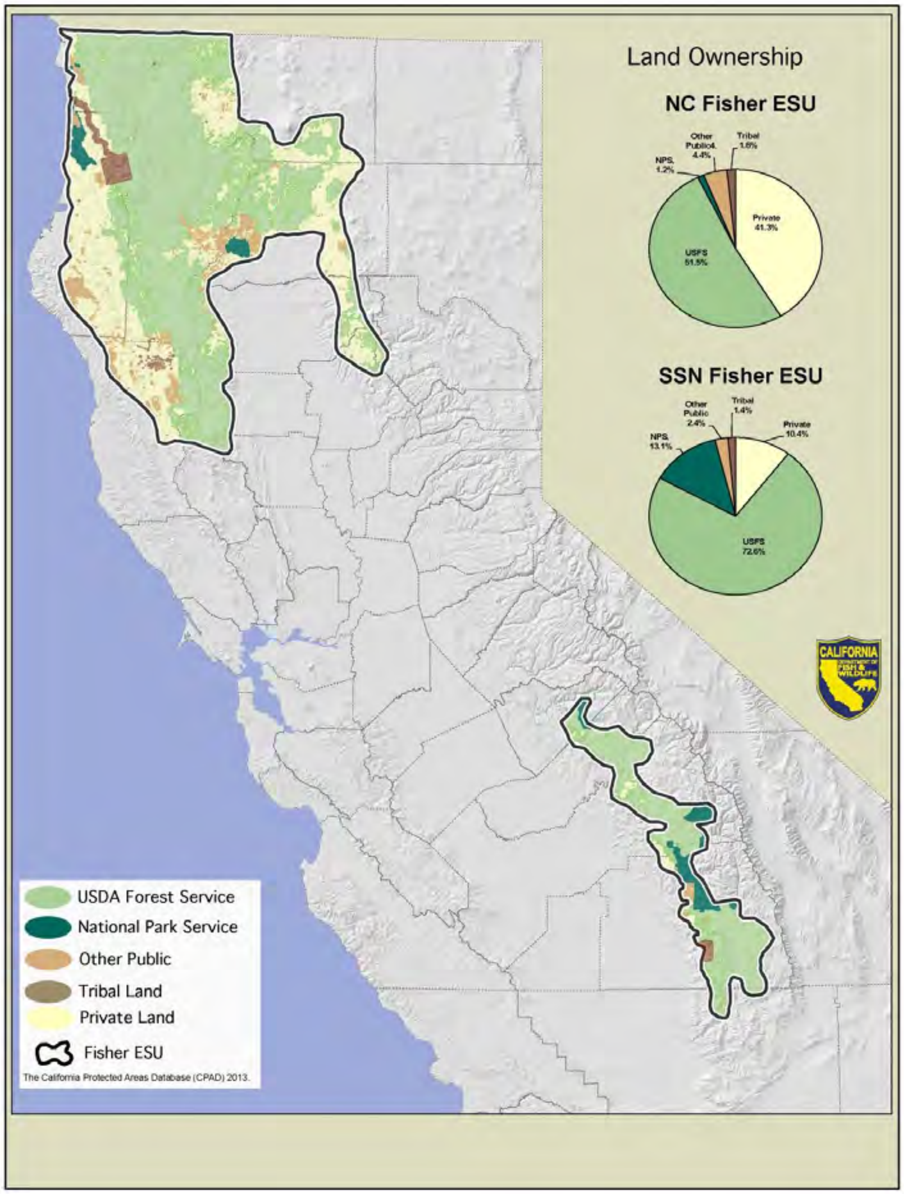


Figure 11. Landownership within the Northern California Fisher Evolutionarily Significant Unit (NC Fisher ESU) and the Southern Sierra Nevada Evolutionarily Significant Unit (SSN Fisher ESU) (CDFW, unpublished data, USFWS, unpublished data), 2014.

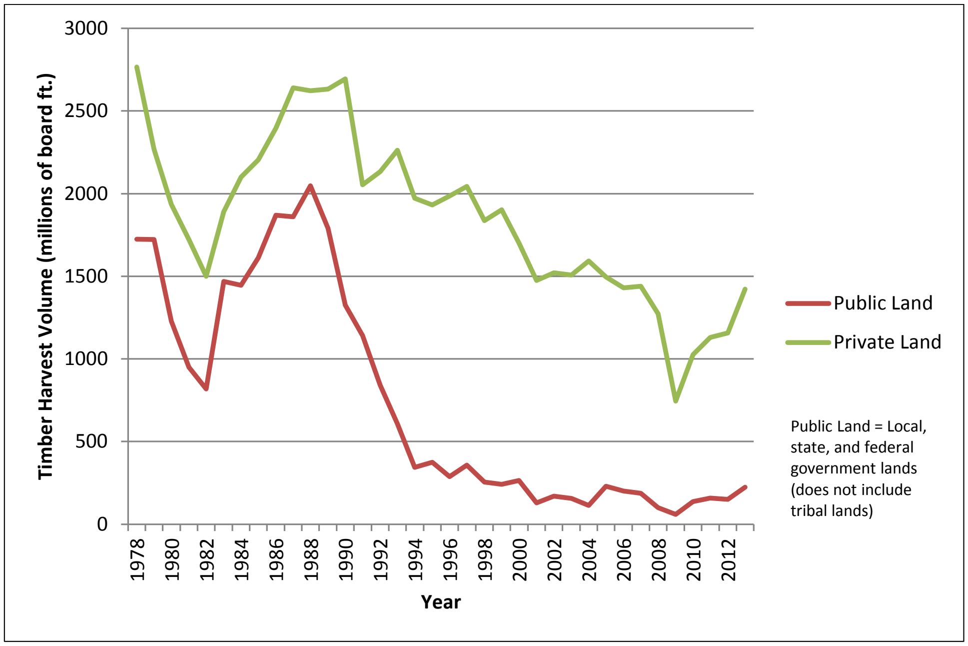


Figure 12. Volume of timber harvested on public and private lands in California (1978-2013) [140].

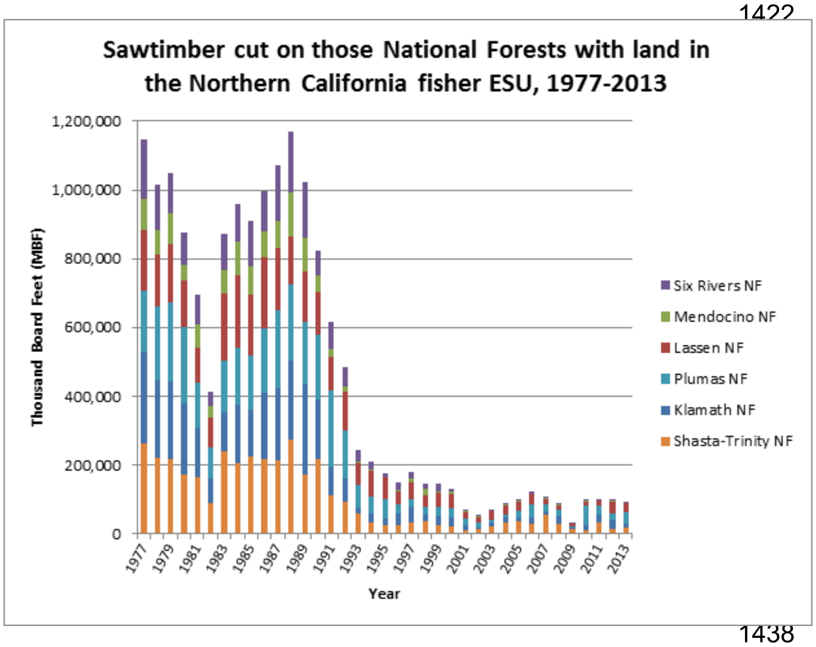


Figure 13. Sawtimber cut on National Forests within the Northern California Fisher ESU from 1977-2013 [139].

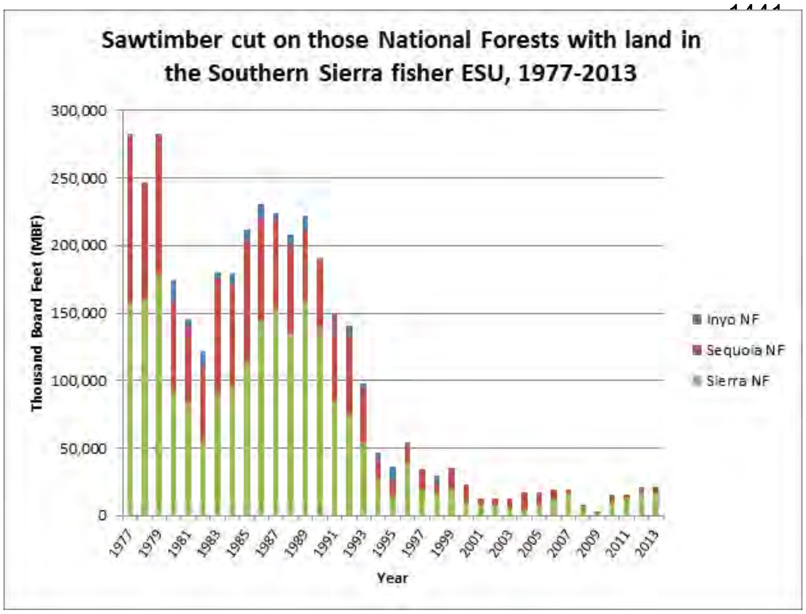


Figure 14. Sawtimber cut on National Forests within the Southern Sierra Fisher ESU from 1977-2013 [139].

Timber harvest is the principal large-scale management activity taking place on public and private forest lands that has the potential to degrade habitats used by fishers. This could occur through extensive fragmentation of forested landscapes where patches of remaining suitable habitat are small and disconnected. However, fishers are known to establish home ranges and successfully reproduce within forested landscapes that have been intensively managed for timber production (Figure 15).

A more proximal concern for the long-term viability of fishers across their range in California is the presence of suitable denning and resting sites and habitats capable of supporting foraging activities. However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California.

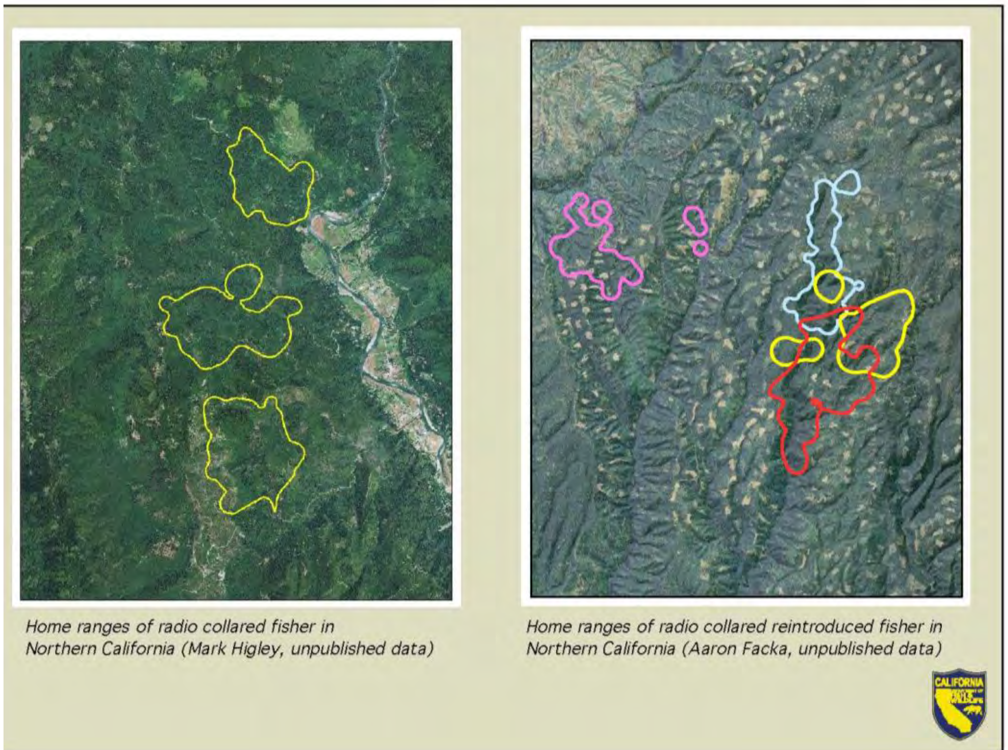


Figure 15. Home ranges of female fishers on managed landscapes in northern California and the northern Sierra Nevada, 2014.

Comment [JT47]: Needs a more informative caption- what exactly am I looking at here?

Population Size and Isolation

Grinnell et al. [3], considered the range of fishers in California to extend south from the Oregon border to Lake and Marin counties, eastward to Mount Shasta and the Southern Cascades, and to include the southern Cascades south of Mount Shasta through the Sierra Nevada Mountains to Greenhorn Mountain in Kern County. However, few records of fishers inhabiting the central and northern Sierra Nevada exist, creating a gap in the species' distribution that has been frequently described in the literature. A number of studies have commented on this gap and considered fishers to have been extirpated from this region during the 20th century [36,38]. However, recent genetic work by Knaus et al. [29] and Tucker et al. [28] indicates fishers in the southern Sierra Nevada became isolated from northern California populations long before European settlement.

Based on Tucker et al. [28], the fisher population in California experienced a significant decline of approximately 90% long before European Settlement, resulting in the isolation of fisher populations in northern California from fishers in the Sierra Nevada. Tucker et al. [28] pointed out that mass extinctions and shifts in the distribution of species occurred at the end of the Pleistocene [141] and would be consistent with the divergence dates of fisher populations in California reported by Knaus et al. [29]. However, in California there were two “mega-droughts” during the Medieval Warm Period (MWP) that lasted over 200 and 140 years each from 832-1074 and 1122-1299 AD, respectively. These droughts may have caused fisher populations to contract isolating the population in the Sierra Nevada from fishers elsewhere in the state [28].

Comment [JT48]: Again, I think the Knaus paper needs more description here than this brief reference

In addition to this early population contraction, a more recent bottleneck may have occurred that was likely associated with the impact of human development in the late 19^{th} century and early 20^{th} century [28]. Tucker et al. [40] suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20^{th} century while fisher in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable based on estimates of occupancy from 2002-2009 [134].

Comment [JT49]: Use PLOS one paper – ref # 28

Intensive trapping of fishers for fur from the mid-1800s through the mid-1900s likely reduced the statewide fisher population and may have extirpated local populations. In the Sierra Nevada, trapping pressure combined with unfavorable habitat changes during this period may have caused the fisher population to contract to refugia in the southern Sierra Nevada. Fishers in the southern Sierra Nevada are geographically isolated from breeding populations of fishers elsewhere in the state and do not appear to be expanding their range northward. Should fishers in the southern Sierra Nevada expand their range northward, or fishers currently occupying the northern Sierra expand to the south, contact would most likely first occur with the progeny of animals translocated to the northern Sierra Nevada near Stirling in Butte County. However, fishers in either location do not appear to be dispersing towards each other and natural contact in the near-term (50 years) is unlikely.

Although fishers in northern California are ~~effectively~~ isolated from fishers in the southern Sierra Nevada, they are part of a regional population that extends into southern Oregon. A fisher that was marked by researchers in Oregon was

subsequently live-trapped and released in upper Horse Creek in northern Siskiyou County (R. Swiers, pers. comm.). There is no evidence that the progeny of non-native fishers introduced to the vicinity of Crater Lake, Oregon from British Columbia in 1961 and from Minnesota in 1981, have dispersed to California [38,91,142,143].

Although fishers do not fully occupy their assumed historical distribution, their population is likely higher than when densities of fishers were estimated by Grinnell et al. [3] at 1-2 per township in good habitat.

Predation and Disease

Predation and disease (including toxins) appear to be the most significant causes of mortality for California fishers. Since 2007, the causes of mortality for radio-collared and opportunistically found fishers from one area in northern California (Hoopa) and the southern Sierra Nevada have been analyzed through gross necropsies, histology, toxicology, and molecular methods. In a sample of 128 fishers from these two populations that died between 2007-2012, predation was the most common cause of mortality (52%), followed by disease/toxins (24%), and vehicular strikes (8%) (M. Gabriel, unpublished data). The proportion of fishers dying from each cause did not differ among these monitored populations, or by sex, which suggests that the relative impact of each source of mortality is similar for both male and female fishers and throughout fisher range in California (M. Gabriel, unpublished data). Preliminary assessment of mortality data from 2010-2013 for the northern Sierra Nevada population recently established through translocation is also consistent with these findings (D. Clifford, M. Gabriel and C. Wengert, unpublished data).

Predation: DNA amplified from 50 predated fisher carcasses from Hoopa, Sierra Nevada Adaptive Management Project (SNAMP) and King's River projects identified bobcats (*Lynx rufus*) as the predator of 25 sampled fishers (50%), mountain lions (*Puma concolor*) as the predator of 20 sampled fishers (40%) and coyotes (*Canis latrans*) as the predator of 4 fishers (8%). The single remaining carcass had both bobcat and mountain lion DNA present [144].

The relative frequencies of mountain lion and bobcat predation did not differ among the three populations studied but did differ by sex. Bobcats killed only female fishers, whereas mountain lions more frequently preyed upon male than female fishers. Coyotes

killed an equal number of male and female fishers [144]. This finding suggests that female fishers suffer greater predation from smaller predators than male fishers, and that predation risk overall is higher for female fishers. Predation risk for females also varied seasonally: over 70% (19/25) of female predation deaths by bobcats occurred late March through July, the period when fisher kits are still dependent on their mothers for survival [144].

The proportion of fisher mortalities caused by predation found by Wengert [144] is higher than previously reported in California [145] and British Columbia [52]. Powell and Zielinski [25] suspected that significant rates of predation of healthy adults would occur mainly in translocated fisher populations, but the findings in Wengert [144] indicate that predation is a significant mortality factor for native fisher populations in California. Whether or not some forest management practices favor the existence of more generalist predators (like bobcats) over specialist predators like fishers is not known. However, Wengert [146] found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.

Disease: A number of viral, bacterial, and parasitic diseases have been documented in fisher. Canine distemper virus (CDV) infection, a cause of significant morbidity and mortality in other carnivore populations [147], was associated with the death of four radio-collared fishers from the southern Sierra Nevada population in 2009 [148]. Three of these animals died within a 2-week period from April 22-May 5 and were found within 20 km (12.4 mi) of each other, while the fourth fisher died during an immobilization event 4 months later approximately 70 km (43.5 mi) away from the initial cases. Infection with CDV decreases immune function, thus vital capacity co-infections with other pathogens are common [147].

Canine distemper virus causes lethargy (weakness), disorientation, pneumonia and other neurologic signs (tremors, seizures, circling) which could predispose an animal to predation or compromise an animal's ability to survive a capture and immobilization event. The source of the infections in these fishers, as well as pertinent transmission routes remain unclear, but the temporal and spatial distribution of the fisher CDV mortalities, as well as the similarity of the virus isolates, suggest two spillover events from one or multiple other sympatric carnivore species.

In California, CDV mortalities in gray foxes and raccoons are common (D. Clifford, CDFW; UC Davis, unpublished data). Both of these species frequently occur in habitats used by fishers. Although the solitary nature of the fisher may lower disease transmission (and thus large-scale outbreak) risk, CDV has been responsible for the near extirpation of other small carnivore populations including black-footed ferrets (*Mustela nigripes*) [149] and Santa Catalina Island foxes (*Urocyon littoralis catalinae*) [150]. Furthermore, highly virulent biotypes of CDV can be transmitted and cause high mortalities in multiple carnivore species [151] . This scenario was evident by a 2009 CDV outbreak in Switzerland that killed red foxes (*Vulpes vulpes*), Eurasian badgers (*Meles meles*), stone (*Martes foina*) and pine (*Martes martes*) martens, a Eurasian lynx (*Lynx lynx*) and a domestic dog [151].

Although CDV can cause mortalities in fishers, antibodies against this disease have been detected in a small number of apparently healthy live-captured individuals in California, indicating that some fishers can survive infection (Table 3). Of 98 fishers sampled from the Hoopa Valley Indian Reservation population, five animals (5%) had antibodies to CDV [152]. From 2007 to 2009 in the southern Sierra Nevada, 14% (five out of 36) of sampled fishers on the Kings River Fisher Project and 3% (one out of 36) of sampled fishers in the SNAMP area were exposed to CDV [152]. Evidence to date and experiences with other species underscore the fact that CDV has potential to be a pathogen of conservation concern for fishers in California, and that risk is increased in populations that are small and fragmented.

Deaths due to rabies and canine parvovirus (CPV), both potentially significant pathogens for *Martes* species [153], have not been documented in fishers in California. However, virus shedding[29] of CPV has been documented in fisher [152], and clinically significant illness due to CPV was observed in a fisher (D. Clifford, CDFW unpublished data). Fishers inhabiting lands on the Hoopa Valley Tribal Reservation in northwestern California are commonly exposed to and infected with CPV: 28 of 90 (31%) fishers tested in 2004-2007 had antibodies to the virus present in their plasma (Table 2).

Fishers in California are commonly exposed to *Toxoplasma gondii,* an obligate intracellular parasite that has caused mortality in captive black-footed ferrets (*Mustela nigripes*) [154], American minks (*Mustela vision*) [155], and free-ranging southern sea

[29] Viral release following reproduction in a host-cell.

otters (*Enhydra lutris*) [156]. Exposure prevalence for fishers sampled in California ranged from 11-58%, and both the northern California and southern Sierra fisher populations were exposed (Table 3). Exposure to *T. gondii* was also common in fishers in Pennsylvania [157].

Table 2~~3~~. Prevalence of exposure to canine distemper, canine parvo virus, and toxoplasmosis in fishers in California based on samples collected in various study areas from 2006 to 2009 [140].

	Canine Distemper Percent (No. sampled)	Canine Parvo Virus Percent (No. sampled)	*Toxoplasma gondii* Percent (No. sampled)
Hoopa	5% (98)	31% (90)	58% (77)
North Coast Interior	--	11% (19)	46% (13)
Sierra Nevada Adaptive Management Project	3% (36)	4% (24)	66% (33)
USFS (southern Sierra Nevada)	14% (36)	47% (19)	55% (39)

California fishers have been exposed to two vector-borne pathogens, *Anaplasma phagocytophilum* and *Borrelia burgdorferi sensu lato* (bacteria that causes lyme disease) [158], but mortalities of fishers from these diseases have not been reported. Fishers are likely susceptible to *Yersinia pestis*, the agent of plague, but no cases have been documented as causing mortality in fishers [153]. Plague is known to cause mortality in other mustelids, is a serious zoonotic[30] risk [159] and is endemic in many parts of California.

Other documented disease-caused fisher mortalities included: bacterial infections causing pneumonia, some of which were associated with the presence of an unknown helminth parasite; concurrent infection with the protozoal parasite *Toxoplasma gondii* and urinary tract blockage, and a case of cancer which caused organ failure (M. Gabriel, unpublished data).

Fishers and other *Pekania* and *Martes* species harbor numerous ecto- and endoparasites. Although some parasites can serve as vectors for other diseases,

[30]Zoonotic diseases are contagious diseases that can spread between animals and humans.

infections and infestations are usually associated with minimal morbidity and mortality [153]. Banci [121] noted fisher susceptibility to sarcoptic mange, and endo- and ectoparasites of fishers have been described by Powell [2].

Two parasitic infections have only recently been documented in California fishers. The eyeworm, *Thelazia californiensis,* was first found under the eyelids of multiple individuals from northern California in 2009 (D. Clifford, CDFW unpublished data). Although these worms may cause some irritation and eye damage, there were no vision deficits or eye damage noted in affected fishers. *T. californiensis* most often infects livestock and is transmitted by flies that mechanically transport eyeworm eggs among animals while feeding on eye secretions [160]. In 2010, trematode flukes and eggs were recovered from five fishers from Humboldt County that were noted to have severe peri-anal swellings and subcutaneous abscesses during their immobilization examination [161]. Retrospective analysis of field observations revealed that similar peri-anal swelling and abscesses were occasionally noted on fishers immobilized as part of the Hoopa Fisher Project (Higley, unpublished data). No mortalities have been attributed to this novel trematode infection (L. Woods, unpublished data), but it is not known if fishers with severe disease suffer morbidity or reduced long term survival.

Although a number of viral, bacterial, and parasitic diseases are known to cause morbidity and mortality in fisher and may have been responsible for local declines in fishers, the Department is not aware of studies indicating that disease is significantly limiting fisher populations in California.

Human Population Growth and Development

The human population in California has increased substantially in recent decades. Based on population estimates by the California Department of Finance from 1970 to 2010 [162,163], the state's population increased by approximately 46% and population growth is expected to continue. Estimates indicate nearly 38 million people currently reside in the state [164] and those numbers are expected to reach approximately 53 million by 2060 [165], an increase of about 27%. Human population growth rate in the Sierra Nevada is expected to continue to exceed the state average [166].

The California Department of Forestry and Fire Protection (CAL FIRE) estimated that statewide, between 2000 and 2040, about 2.6 million acres of private forests and

rangelands will be impacted by new development [167]. New development was defined as a housing density of one or more units per 8 ha (20 ac). Hardwood forest, Woodland Shrub, Grassland, and Desert land cover types were predicted to experience the most development, encompassing about 890,000 ha (2.2 million acres). Development projected to occur between 2000 and 2040 in habitats potentially suitable for fisher was comparatively low (6%).

Within the NC and SSN Fisher ESUs, future human development (structures) on parcels less than 16.2 ha (40 ac) is projected to occur primarily on private lands and will encompass 4% and 5% of the total area of each ESU, respectively (Figure 16, Table 4). This represents an increase of about 1% in the acres developed on parcels of that size within each ESU. Development that may occur within suitable fisher habitat on parcels greater than 16.2 ha (40 ac) was excluded from this assessment because parcels of that size likely provide some fisher habitat post-development. In the NC Fisher ESU, slightly more than half of development as of 2010 occurred in habitats predicted to be of intermediate or high value to fishers (Table 5). That percentage is not expected to change substantially by 2030. Within the SSN Fisher ESU, about 60% of past development occurred in habitats predicted to be of intermediate or high value to fishers and that proportion is also not predicted to change substantially by 2030.

Duane [168] identified at least five ways land conversion can directly affect vegetation and wildlife including loss of habitat, fragmentation and isolation of habitat, harassment by domestic dogs and cats, and impacts from the introduction of invasive plants. Additional threats to wildlife include increased risk of exposure to diseases shared with domestic animals, mortality from vehicles, disturbance, impediments to movement, and increased fire frequency and severity. Fishers are known to occur near human residences, interact with domestic animals, and consume food or water left outside for pets or to specifically feed wildlife (Figure 17, CDFW unpublished data). It is likely that this exposure increases the risk of fishers contracting diseases, some of which can be fatal to them (e.g., canine distemper). However, the effects of future development on fishers are uncertain. Although about half of the development on parcels less than 16.2 ha (40 ac) is predicted to occur within intermediate and high value habitat, the area involved is relatively small.

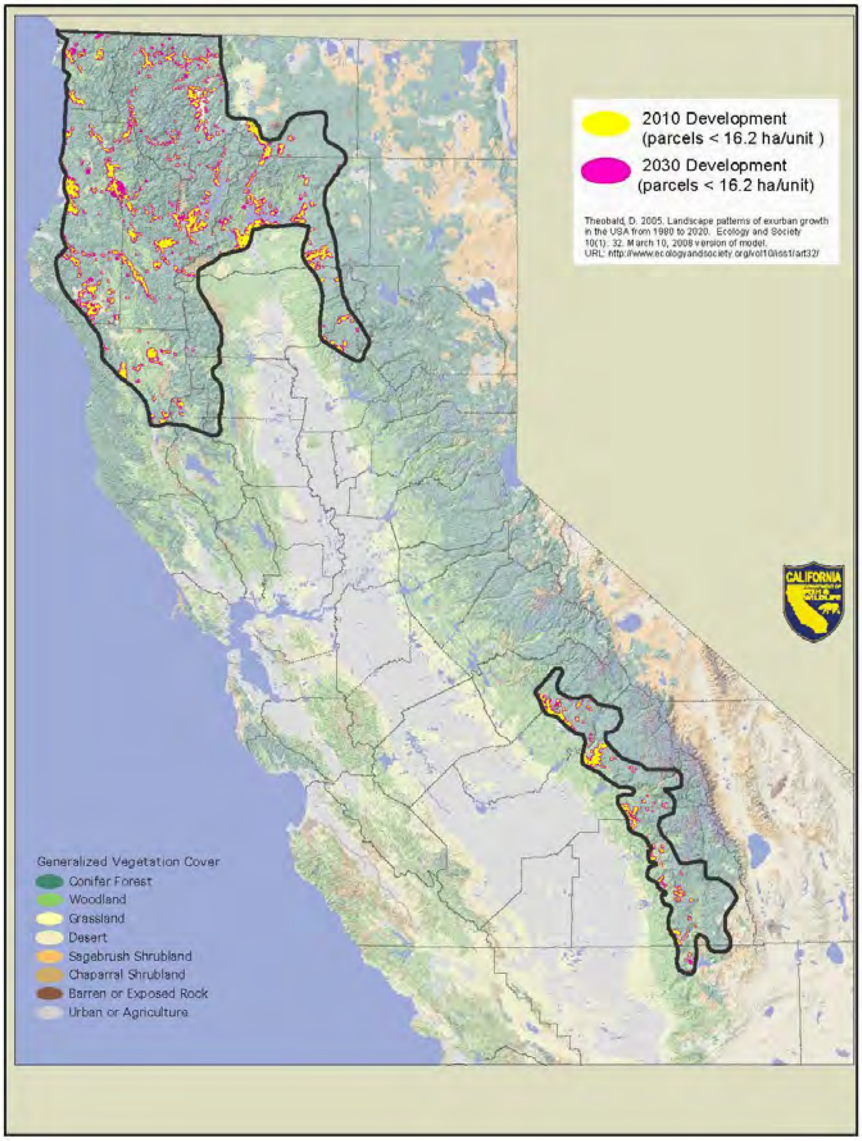


Figure 16. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected to occur by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169]. California Department of Fish and Wildlife, 2014.

Comment [JT50]: The detail on development is very hard to see here. Maybe just use two maps zoomed in to each of the ESUs and leave the central sierra gap out. I think by this point readers are familiar with the overall distribution in the state

Table 3~~4~~. Area encompassed by human development (structures) on parcels less than 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)				
Evolutionarily Significant Unit	Total Area	Contemporary Development (2010)	Percent of Total	Projected Development (2030)	Percent of Total
NC Fisher	4,103,639 (10,140,312)	129,764 (320,654)	3%	160,757 (397,240)	4%
SSN Fisher	778,273 (1,923,155)	32,361 (79,966)	4%	35,845 (88,576)	5%

Table 4~~5~~. Potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Fisher habitat suitability (low, intermediate, and high) was predicted using a habitat model developed by the US Fish and Wildlife Service and the Conservation Biology Institute. Areas of contemporary and projected development were based on Theobald [169].

	Hectares (Acres)					
Evolutionarily Significant Unit	Low	Percent of Total	Intermediate	Percent of Total	High	Percent of Total
NC Fisher (2010)	55,954 (138,264)	43%	33,065 (81,706)	26%	39,831 (98,425)	31%
NC Fisher (2030)	69,856 (172,617)	44%	41,952 (103,666)	26%	48,030 (118,684)	30%
SSN Fisher (2010)	11,942 (29,510)	37%	4,213 (10,411)	13%	16,205 (40,044)	50%
SSN Fisher (2030)	14,158 (34,986)	39%	4,758 (11,758)	13%	16,929 (41,832	47%

Figure 17. Fisher obtaining food near human residences in Shasta County on June 16, 2012. Photo credit: Jim Sartain.

Disturbance

Although fishers may be active throughout the day and night, they are seldom seen. This is due, in part, to the relatively remote forested habitats the species typically occupies. Human-caused disturbance to fishers may occur due to noise or actions that alter habitats occupied by fisher. Fishers occupy a relatively wide elevational range in California and many forms of human activity occur in these areas (e.g., logging, fire management, mining, hiking, hunting, horseback riding, and off road vehicles).

Reproductive female fishers with dependent young are potentially more susceptible to disturbance than adult male fishers or juvenile fishers because they must shelter and provision their kits in dens. Although female fishers readily move their kits to alternate dens, this requires energy and the risk of predation may be comparatively high. Before the kits are old enough to be able to follow their mother independently, she must carry them in her mouth out of their den and for some distance to a new den site. Kits are typically carried singly; therefore this may require multiple trips to shift den locations.

The effects of disturbance to fishers using dens have not been well studied, however, monitoring radio-collared females with young provides some insight into their sensitivity

to some human activity. Researchers frequently monitor the activities of female fishers at dens. This may include multiple visits to den sites to set infrared cameras to document reproduction, listen for the presence of kits, and in some cases temporarily remove kits from their dens to be counted and marked for later identification. These relatively invasive activities have become increasingly common since the 1990s as interest in fishers has grown and monitoring techniques have improved. Although researchers exercise care to minimize disturbance, it is likely that their presence at the den is recognized by female fishers. Despite the potential for these activities to result in abandonment of kits, it has rarely been documented.

Timber management activities may disturb fisher foraging, resting, or reproductive activities. This may include disturbance due to noise associated with logging, or the cutting of den or rest trees occupied by fishers. However, timber management activities generally occur infrequently and stands are left largely undisturbed between harvest entries. Most watersheds on private timberlands are harvested at a rate of 1-3% annually (J. Croteau, pers. comm.). Fishers have been known to occupy habitats in the immediate vicinity of active logging operations, suggesting that the noises associated with these activities or their perceived threat did not result in either displacement or territory abandonment (CDFW, unpublished data).

Comment [JT51]: This seems a very incomplete discussion of a very complex issue.

I am surprised to see no peer reviewed science discussed here. There have been a number of recent papers looks at the effects of fuels treatments on fisher - including thinning and timber harvest. Also I imagine data from the SNAMP project might directly speak to this issue, but that study was not referenced.

Zienlinski et al. 2013 (see below) is one example, as well as perhaps Garner 2013.

Zielinski, William J., et al. "An assessment of fisher (Pekania pennanti) tolerance to forest management intensity on the landscape." *Forest Ecology and Management* 310 (2013): 821-826.

Garner, J.D., 2013. Selection of disturbed habitat by fishers (*Martes pennanti*) in the Sierra National Forest. MS thesis, Humboldt State University. Arcata, California.

Recreational use of habitats occupied by fisher in California is likely higher on public lands than private lands managed for timber production. Despite the intense use some public lands receive, the majority of recreational human activity occurs near roads, trails, and specific points of interest (e.g., lakes). Fisher home ranges are typically large and are generally characterized by steep, heavily vegetated, rugged terrain and the likelihood that recreation by humans would occur for sufficient duration to substantially disrupt essential behaviors of fishers (e.g., breeding, feeding) is low.

Comment [JT52]: Pot farms are not near these features, but I do not think that is the type of human activity you are referring to here.

Roads

Fishers occupying habitats containing roads occasionally are struck by vehicles and killed [53,56,100,126]. Researchers following radio-collared fishers have reported the loss of some study animals due to collisions with vehicles and road-killed fishers are occasionally reported to the Department as incidental observations (CDFW unpublished data).

The probability of a fisher being struck by a vehicle increases as a function of road density within its home range, vehicle speeds, and traffic levels. Mortalities are likely to be lowest on rural roads because the traffic is relatively light and traffic speeds are comparatively low. In contrast, the probability of fishers being killed on highways is likely higher because of speed and higher levels of traffic. Although roads are a source of mortality for fisher in California and have been hypothesized to be a potential barrier to dispersal [24,91,170], they have not been demonstrated to limit fisher populations. Roads have not shown to be barriers to dispersal or movement of fishers in areas where they have been reintroduced to the northern Sierra Nevada or studied in northern Siskiyou County [126].

Comment [JT53]: Tucker 2013 (dissertation) found that genetic connectivity for female fisher (but not males) was impeded by roads. Ref #40.

Fire

Wildfires are a natural part of California's forest ecology and most frequently start as a result of lightning strikes. Wildfires affect habitats used by fisher and can directly affect individual animals. At the landscape level, the impact of fires on fishers is likely related to fire frequency, fire severity, and the extent of individual fires. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. High intensity fires that involve large areas of forest (stand replacing fires) can have long-term adverse effects on local populations of fishers by the elimination of expanses of forest cover used by fishers, the loss of habitat elements such as dens and rest sites that take decades to form, reductions in prey, and creation of potential barriers to dispersal. Safford et al. [171], believed that overall the most significant outcome of potential losses in canopy cover and/or surface wood debris resulting from increased frequencies of mixed and high severity fires would be changes or reductions in densities of fisher prey.

Federal fire policy formally began with the establishment of forest reserves in the 1800s and early 1900s [172]. In 1905, the U.S. Forest Service was established as a separate agency to manage the reserves (ultimately National forests). Concern that these reserves would be destroyed by fire led to the development of a national policy of fire suppression [172]. In the 1920s, the USFS' view of fire suppression was strongly influenced by Show and Kotok [173] who concluded that fire, particularly repeated burnings, discouraged regeneration of mixed conifer forests and created unnatural forests that favored mature pines. In 1924, Congress passed the Clarke-McNary Act

that established fire exclusion as a national policy and formed the basis for USFS and NPS policies of absolute suppression of fires until those policies were reconsidered in the 1960s [174].

Fire suppression efforts proved very successful. In California from 1950-1999, wildfires burned on average 102,000 ha/year (252,047 ac/year) representing only 5.6% of the area estimated to have burned in a similar period of time prior to 1800 [174]. This was based on an estimate of the high fire return interval and was assumed to be similar to the fire rotation [174]. Prior to European settlement, fires deliberately set by Native Americans were designed to manage vegetation for food and improve hunting [175] and to reduce catastrophic fires [176]. Fires set by indigenous people and fires started by lightning have been estimated to have burned from 2.3 to greater than 5.3 million ha (5.6 to > 13 million acres) annually in California [177].

Effective fire suppression efforts have dramatically altered the structure of some forests in California by enabling increases in tree density, increases in forest canopy cover, changes in tree species composition, and forest encroachment into meadows. These efforts have also contributed to the potential for fires to be larger in extent and more severe. Forest wildfires in the western United States have become larger and more frequent [178]. Westerling et al. [179] found a nearly four-fold increase in the frequency of large (>400 ha [988 ac]) wildfires in western forests in the period of 1987-2003 compared to 1970-1986, and found that the total area burned increased more than six and a half times its previous level. This includes regions occupied by fisher in California.

In the Sierra Nevada, the severity and the area burned annually increased substantially since the beginning of the 1980s, equaling or exceeding levels from decades prior to the 1940s when fire suppression became national policy [178]. Miller et al. [180] examined trends and patterns in the size and frequency of fires from 1910 to 2008, and the percentage of high-severity fires from 1987 to 2008 on four national forests in northwestern California. From 1910 to 2008, the mean and maximum size of fires greater than 40 ha (99 ac) and total annual area burned increased.

In 1992, the Fountain Fire in eastern Shasta County burned approximately 25,900 ha (64,000 ac) near the southern extent of the fisher range in the southern Cascades. This was a severe fire and likely created a temporary barrier to fisher movements across the

largely barren landscape that remained for several years post-burn. Most of the land within the fire's perimeter was privately owned and commercial timberland owners salvaged post-fire and replanted trees rapidly after the burn [181]. In recent years, fishers have been detected south of the Fountain Fire in areas where previous surveys failed to detect their presence (CDFW unpublished data, SPI unpublished data), indicating that some animals may have dispersed through areas of young forest or chaparral (although it is possible that these animals were already present in these areas prior to the burn). From December 2013 through March 2014, Roseburg Resources conducted surveys for fisher using remotely triggered cameras within the boundary of the Fountain Fire and adjacent to its southern boundary. Fishers were detected at 6 of 13 (46%) sample units that were totally within or mostly comprised of areas burned by the Fountain Fire. Fishers were also detected at 4 of 7 (57%) units surveyed on property adjacent to the southern boundary of the fire (R. Klug, pers. comm).

The Rim Fire burned approximately 104,000 ha (257,000 ac) in Tuolumne County in August 2013. This fire was situated just north of the SSN ESU. The loss of forest and shrub canopy due to the fire has likely created a barrier to the potential expansion of fishers northward from the southern Sierra population until the vegetation recovers sufficiently to facilitate its use by fishers.

While the frequency and extent of wildfires in the California have increased in recent years, the area burned annually is substantially smaller than in pre-historic (pre-1800) times when 1.8 – 4.8 million ha (4.4 – 11.9 million ac) of the state burned annually [174]. Historically, the return interval for most fires in California within fisher range was 0-35 years and these fires were of low and mixed severity [182] (Figures 18 and 19).

Lawler et al. [183] predicted that fires will be more frequent but less intense by the end of the 21^{st} century due to changes in climate in both the Klamath and the Sierra Nevada mountains. However, others have predicted an increase in large, more intense fires in the Sierra Nevada, but negligible change in fire patterns in the coastal redwoods [184]. Westerling et al. [185], modeled large [> 200 ha and > 8,500 ha (> 494 ac and > 21,004 ac)] wildfire occurrence as a product of projected climate, human population, and development scenarios. The majority of scenarios modeled indicated significant increases in large wildfires are likely by the middle of this century. The area burned by wildfires was predicted to increase dramatically throughout mountain forested areas in northern California, and potential increases in burned area in the Sierra Nevada

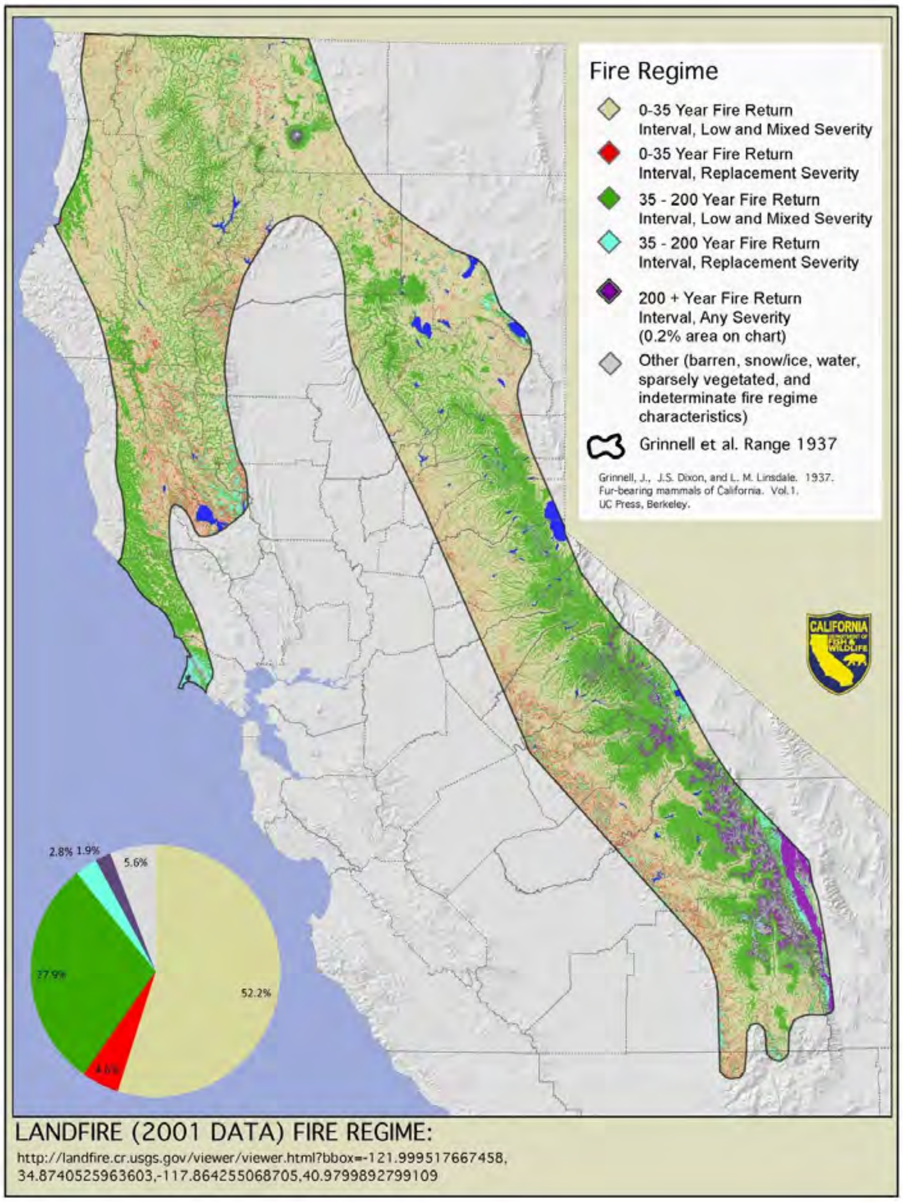


Figure 18. Presumed historical fire regimes within the historical range of fisher in California described by Grinnell et al. [3]. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

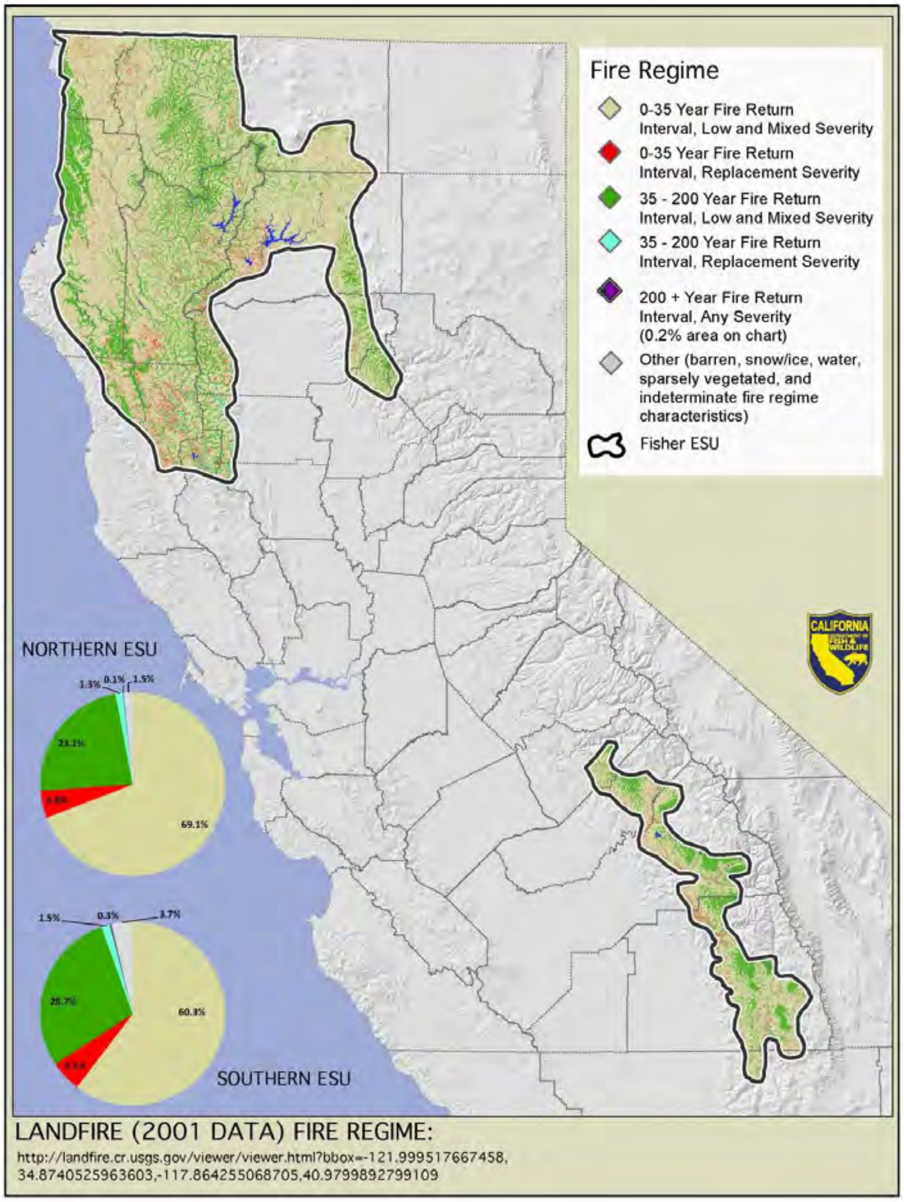


Figure 19. Presumed historical fire regimes within the Northern California Fisher Evolutionarily Significant Unit and the Southern California Fisher Evolutionarily Significant Unit. Depictions of fire return intervals and severity were produced using Landscape Fire and Resource Management Tools [182]. California Department of Fish and Wildlife, 2014.

Comment [JT54]: Again, I would recommend zooming in to just the two ESUs and cutting out the gap (perhaps make it Figure 19a (Northern CA) and 19b (SSN). At this scale its hard to see sufficient detail within the ESUs.

appeared greatest in mid-elevation sites on the west side of the range [185]. However, the authors cautioned that their results reflect the use of illustrative models and underlying assumptions; such that predications for a particular time and location cannot be considered reliable and that the models used were based on fixed effects (i.e., no future changes in management strategies to mitigate or adapt to the effects on climate and development on wildfire). Should these changes in fire regime occur, over the long term they will likely decrease habitat features important to fishers such as large or decadent trees, snags, woody debris, and canopy cover [171,186,187].

Toxicants

Recent research documenting exposure to and mortalities from anticoagulant rodenticides (ARs) in California fisher populations has raised concerns regarding both individual and population level impacts of toxicants within the fisher's range [153]. Although the source of toxicants to fishers has not been conclusively determined, numerous reports from remediation operations of illegal marijuana cultivation sites (MJCSs) on public, private, and tribal forest lands indicate the presence of a large amount of pesticides, including ARs, at these sites.[31] The presence of a large number of MJCSs within habitat occupied by fisher populations and the lack of other probable sources of ARs suggest that the AR exposure is largely occurring on the cultivation sites.

Fishers are opportunistic generalist predators and can be exposed to toxicants through several routes. They can be exposed directly through consumption of flavored baits. Rodenticide baits flavorized to be more attractive to rodents (with such tastes as sucrose, bacon, cheese, peanut butter and apple) would also likely appeal to fishers [189]. Furthermore, there have been reports of intentional wildlife poisoning by adding

[31] Marijuana cultivation has increased since the 1990s on both private and public lands. Cultivation on private lands appears to be increasing, in part, in response to Proposition 215, the Compassionate Use Act of 1996 which allowed for legal use of medical marijuana in California. As growth sites are largely unregulated, compliance with environmental regulations regarding land use, water use, and pesticide use is frequently lacking. The High Sierras Trail Crew, a volunteer organization that maintains Sierra Nevada national forests, reports remediating more than 600 large-scale MJCSs on just two of California's 17 national forests [188].

pesticides to food items such as canned tuna or sardines [188]. Many of the pesticides found at MJCSs are liquid formulations that can easily be mixed into food.

As carnivores, fishers could also be exposed to toxicants secondarily through prey. This is likely the primary means of AR exposure because of the toxin's persistence in the body tissue of poisoned prey items; secondary exposure of mustelids to ARs has occurred in rodent control operations [190]. Tertiary AR exposure to wildlife that consume carnivores (such as mountain lions) has also been proposed [191] and may be possible in fishers that eat smaller carnivores. Lastly, AR exposure has been documented in both pre-weaned fishers and mountain lions, indicating either placental or milk transfer has occurred [189,191].

Anticoagulant Rodenticides: ARs cause mortality by binding to enzymes responsible for recycling Vitamin K and thus impair an animal's ability to produce several key clotting factors. ARs fall into two categories (generations) based on toxicological characteristics and use patterns: first and second generation anticoagulant rodenticides (FGARs and SGARs, respectively). FGARs, developed in the 1940s, are less toxic than SGARs, and require consecutive days of intake by a rodent to achieve a lethal dose. FGARs have a lower ability to accumulate in biological tissue and are metabolized more rapidly [192,193]. There are 60 FGAR products registered in California. Labeled uses of FGARs are commensal rodent (house mice, Norway rats, and roof rats) control and agricultural field rodent control.

Development of SGARs began in the 1970s as resistance to FGARs began to appear in some rodent populations. SGARs have the same mechanism of action as FGARs but have a higher affinity for the target enzymes, leading to greater toxicity and more persistence in biological tissues (half-life of 113 to 350 days) [192,193]. A lethal dose may be consumed at a single feeding. The several days' lag time between ingestion and death allows the rodent to continue feeding, which leads to a higher concentration in body tissue. There are 79 SGAR products registered in California containing the active ingredients brodifacoum, bromadiolone, difethialone, and difenacoum. Labeled uses are for the control of commensal rodents in and around residences, agricultural buildings, and industrial facilities, such as food processing facilities and commercial facilities. SGAR products must be placed within 100 feet of man-made structures and may not be used for control of field rodents.

The unexpected discovery of AR residues in a fisher being studied by the UC Berkeley Sierra Nevada Adaptive Management Project research team prompted monitoring of AR exposure in carcasses of fishers submitted for necropsy from research projects located throughout the fisher's range in California. The livers of 58 fishers that died from 2006-2011 were tested; 79% were positive for AR exposure. Four of these fishers died from AR poisoning. The number of different AR compounds found in a single individual ranged from 0 to 4, with the average being 1.6, indicating that multiple compounds are used in environments inhabited by fishers [189]. Of the fishers testing positive for AR exposure~~ed~~, 96% were exposed to SGARs and the exposure of fishers to ARs was geographically widespread [189].

Gabriel et al. [189] documented the amount of toxicants found at one illegal MJCS in Humboldt County. Among other toxicants, 0.68 kg (1.5 lbs) of brodifacoum, as well as 2.9 kg (6.5 lbs) worth of empty AR bait containers were found. Based on the LD50 value for a domestic dog, it was estimated that this amount of material could kill between 4 and 21 fishers through direct consumption.

The sublethal impacts of AR exposure to fishers are not fully known. Sublethal effects may include increased susceptibility to disease [194], behavioral changes such as lethargy and slower reaction time which may increase vulnerability to predation and vehicle strikes [195], and reduced reproductive success. The contribution of AR (and other pesticides found on MJCSs) exposure to mortality from other sources in fishers may be supported by the greater survival rate in female fishers that had fewer MJCSs located within their home ranges [196]. Studies have suggested that embryos are more sensitive to anticoagulants than are adults [197–199]. AR-related fisher mortalities were concentrated temporally in mid-April and mid-May which is the denning period for fisher females [189]. This raises concerns that mothers could expose their kits to ARs through lactation and that mortalities of females would lead to abandonment and mortality of their kits. Higher AR-related mortalities in spring may be a consequence of more ARs being used at this time to protect young marijuana plants from rodent damage than at other times of the year.

On July 1, 2014, SGARs products containing brodifacoum, bromadiolone, difenacoum, and difethialone were designated as restricted materials and their legal use was limited to certified private applicators, certified commercial applicators, or those under their direct supervision. The placement of SGAR bait will generally be prohibited more than

15 m (50 ft) from man-made structures. These new regulations may limit the availability of SGARs, but how effective they will be at reducing the use of SGARs at MJCSs is unknown.

Other Potential Toxicants: Other pesticides deployed at MGCSs have likely caused fisher mortalities: 3 fishers in northern California were suspected to have died as a result of exposure to the carbamate toxin-methomyl cholecalciferol and bromethalin (Gabriel, unpublished data). Pests include many species of insects and mites, as well as rodents, deer, rabbits, and birds (California Research Bureau 2012); a number of pesticides have been found at MJCSs that were presumably used to combat them (Table 6). Some of the organophosphates and carbamates used on MJCSs are not legal for use in the U.S. because of mammalian and avian toxicity. Secondary exposure of carnivores and scavengers to carbofuran has also been reported worldwide and has been the result of both intentional poisoning and legal use [200,201]. Volunteer reclamation crews reported that AR and other toxicants were found and removed from 80% of 36 reclaimed sites in National Forests in California in 2010 and 2011 [196]. Sixty-eight kilograms of AR and other pesticides were removed from Mendocino National Forest during a removal of 630,000 plants in three weeks during 2011. In addition to being placed around young marijuana plants, pesticides are also often placed along plastic irrigation lines which often extend outside the perimeter of grow sites, increasing the area of toxicant use. An eradication effort in public lands involving multiple grow sites yielded irrigation lines extending greater than 40 km [189].

ARs are persistent in liver tissue, thus the compounds can be detected in liver tissue of sublethally exposed animals for several months following the exposure. Other pesticides such as carbofuran and methamidophos, which are present at the same sites, are more likely to cause immediate mortality, but are much less likely to be detected in fishers because carcasses would need to be recovered at MJCSs to confirm exposure.

Population-level Impacts: Although it is well documented that anticoagulant rodenticides (ARs) used both legally and illegally have caused mortalities of non-target wildlife species, including fishers [189,192,202–204], the question of whether or not lethal and sublethal exposure to ARs or other pesticides has the ability to impact fishers at the population-level has just begun to be assessed.

To estimate the extent of the current fisher range potentially impacted by MJCSs, the area surrounding illegal grow sites in 2010 and 2011 was buffered by 4 km (2.5 mi) and that total area was compared to the area represented by the assumed current range of fishers in California. The area potentially affected by these sites over a 2-year period represented about 32% of the fisher range in the state (Figure 20) (M. Higley, unpublished data). Furthermore, a high proportion of grow sites are not eradicated and most sites discovered in the past were not remediated and hence may continue to be a source of contaminants.

Table 5~~6~~. Classes of toxicants and toxicity ranges of products found at marijuana cultivation sites (MJCSs) (CDFW, IERC, HSVTC unpublished data). Some classes contain multiple compounds with many consumer products manufactured from them.

Class	Mammalian Toxicity Range	Relative Frequency of Occurrence at MJCSs[1]	Evidence of Exposure or Toxicity (Gabriel et al. unpublished)
Organophosphate Insecticides	Slight to Extreme	Common	Detected
Carbamate Insecticides	Moderate to Extreme	Common	Detected
Anticoagulant Rodenticides	Extreme	Common	Detected
Acute Rodenticides	High to Extreme	Occasional	Not Detected
Pyrethroid Insecticides	Slight	Common	Not Detected
Organochlorine Insecticide	Moderate	Occasional	Not Detected
Other Insecticides	Slight to Moderate	Occasional	Not Detected
Fungicide	Slight	Common	Not Detected
Molluscicide	Moderate	Common	Not Detected

[1]Relative frequency of occurrence was rated as “occasional” or “common” based on the highest occurrence for any product in each class.

Although AR poisoning resulting in mortality has been documented in four fishers from two geographically separated populations and AR exposure is highly prevalent and geographically widespread [189], the cumulative impact of individual toxicity and exposure is hard to quantify at the population level. Determination of poisoning and exposure usually requires collection of carcasses, and therefore data are only available

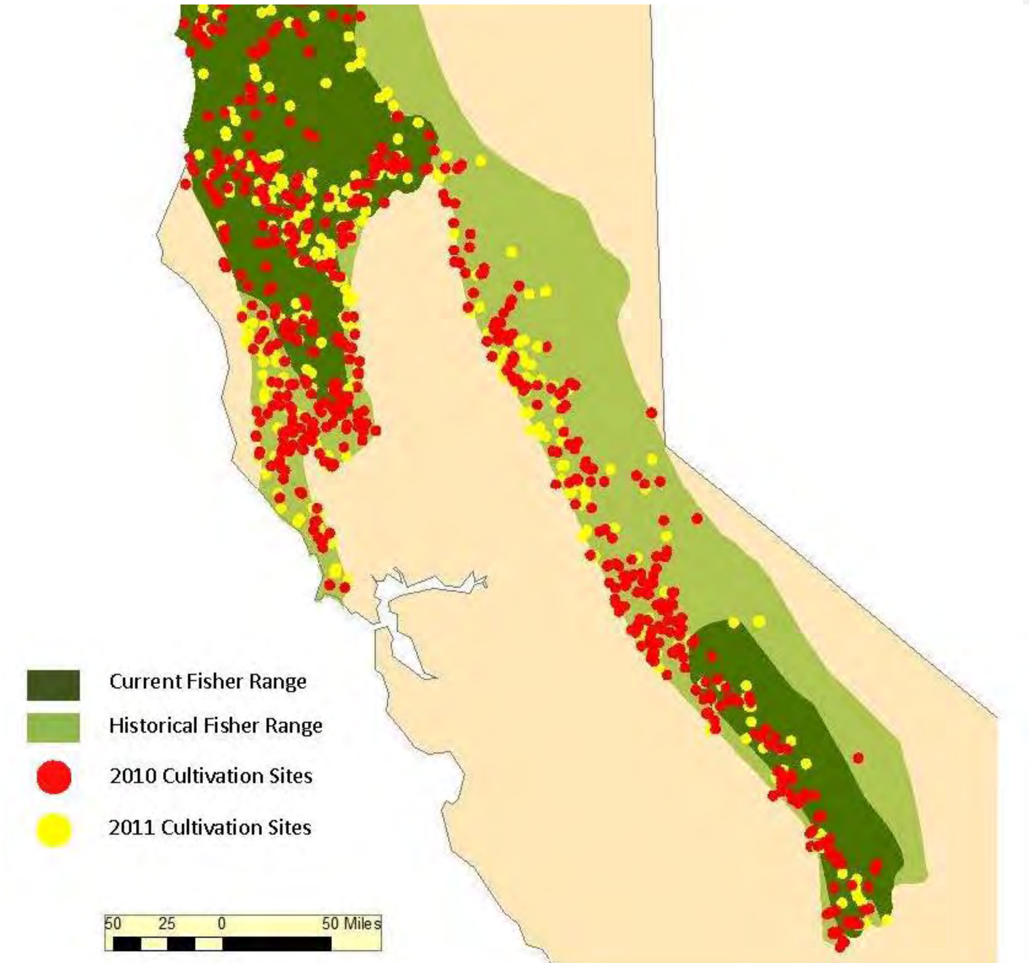


Figure 20. Cultivation sites eradicated on public, tribal or private lands during 2010 and 2011 within both historical and estimated current ranges of the fisher in California. Adapted from Higley, J.M., M.W. Gabriel, and G.M. Wengert (2013).

for fisher populations where ongoing intensive research (often involving a substantial number of radio collared animals) is conducted. Accordingly, pesticide-caused mortality and exposure prevalence should be considered minimum estimates because poisoning cases and sublethal exposures in unmonitored populations are unlikely to be detected.

Despite these limitations, recent research from the well-monitored southern Sierra Nevada fisher population in California has revealed that female fishers with more MJCSs in their home ranges had higher rates of mortality and a higher likelihood of being exposed to one or more AR compounds [196]. Despite this association, further study is needed to demonstrate that chronic or sublethal AR or other pesticide exposure could predispose a fisher to death from another cause (aka indirect effect). These data do not currently exist for fishers, but evidence from laboratory and field studies in other species supports the premise that pesticide exposure can indirectly affect survival [194,205–212].

Exposure to AR through either milk or placental routes was identified in a dependent fisher kit that died after its mother was killed [189]. Additionally, Gabriel and colleagues observed that AR mortalities occurred in the spring (April-May), a time when adult females are rearing dependent young. Low birth weight, stillbirth, abortion, and bleeding, inappetance and lethargy of neonates have all been documented in other species as a result of exposure to ARs, but it is not known if any of these effects have occurred in fisher, nor does it appear that specific populations are experiencing noticeably poor reproductive success. Further investigation to determine if neonatal litter size and weaning success for females varies by the number of MJCSs located within an individual's home range may start to address this question.

Reductions in prey availability due to pesticide use at MJCSs could potentially impact fisher population vital rates through declines in fecundity or survivorship, or both. Because pesticides are often flavorized with an attractant [192], there is potential that MJCSs could be localized population sinks for small mammals. Prey depletion has been associated with predator home range expansion and resultant increase in energetic demands, prey shifting, impaired reproduction, starvation, physiologic (hematologic, biochemical and endocrine) changes and population declines in other species [213–216]. However, the level of small mammal mortality at MJCSs remains largely unknown, thus, evidence for prey depletion or sink effects, as well as secondary impacts to carnivore populations dependent upon those prey remain speculative.

Multiple studies have demonstrated that sublethal exposure to ARs or organophosphates (OPs) may impair an animal's ability to recover from physical injury. A sublethal dose of AR can produce significant clotting abnormalities and some hemorrhaging (Eason and Murphy 2001). Predators with liver concentrations of ARs as low as 0.03ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey [192]. Accordingly, fishers exposed to ARs may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted during mating), or from minor wounds inflicted by prey or during hunting.

Challenges to investigating toxicant threats from MJCSs within fisher range include the illegal nature of growing operations, lack of resources to conduct field studies, and difficulties in distinguishing toxicant-related effects from those resulting from other environmental factors [217].

The high prevalence of AR exposure in fishers and other species throughout California indicates the potential for additive and synergistic associations with pesticide exposure at MJCSs and consequently increased mortality from other causes. Small, isolated fisher populations, such as occurs in the SSN Fisher ESU, are of concern because they are more vulnerable to stochastic events than larger populations and a reduction in survivorship may cause a decline or inhibit growth.

Climate Change

Extensive research on global climate has revealed that temperature and precipitation have been changing at an accelerated pace since the 1950s [218,219]. Average global temperatures over the last 50 years have risen twice as rapidly as during the prior 50 years [183]. Although the global average temperature is expected to continue increasing over the next century, changes in temperature, precipitation, and other climate variables will not occur uniformly across the globe [218].

In California, temperatures have increased, precipitation patterns have shifted, and spring snowpack has declined relative to conditions 50 to 100 years ago [220,221]. Current modeling suggests these trends will continue. Annual average temperatures are predicted to increase in California by approximately 2.4 C in California by the 2060s (Pierce et al. [222]) and by 2 to 5 C by 2100 (Cayan et al. [223]). Projections of

precipitation patterns in California vary, but most models predict an overall drying trend with a substantial decrease in summer precipitation [224–226]. However, the Mt. Shasta region may experience more variable patterns and a possible increase in precipitation [227]. Extremes in precipitation are predicted to occur more frequently, particularly on the north coast where precipitation may increase and in other regions where the duration of dry periods may increase [222,228]. Warming temperatures have caused a greater proportion of precipitation to fall as rain rather than snow, earlier snowmelt, and reduced snowpack [229]. These patterns are expected to continue [223–225,230] and Sierra Nevada snowpack is predicted to decline by 50% or more by 2100 [231]. Forests throughout the state will likely become more dry [223,224,229].

The changing climate may affect fishers directly, indirectly, or synergistically with other factors. Fishers may be directly impacted by climate changes as a warmer and drier environment may cause thermal stress. Fishers in California often rest in tree cavities, and in the southern Sierra, rest sites are often located near water [108]. Zielinski et al. [108] suggested fishers may frequent such structures and settings in order to minimize exposure to heat and limit water loss, particularly during the long hot and dry seasons in California. The effect of increasing temperatures, shifting precipitation patterns, and reduced snowpack on fisher fitness may depend, in part, on their ability to behaviorally thermoregulate by seeking out cooler microclimates, altering daily activity patterns, or relocating to cooler areas (potentially at higher elevations) during warmer periods. Warming is predicted throughout the range of the fisher in California [183]. Pierce et al. [222] projected warmer conditions (2.6 C increase) for inland portions of California compared to coastal regions (1.9 C increase) in the state by 2060. Therefore, fishers inhabiting the SSN Fisher ESU may experience greater warming than those occupying portions of the NC Fisher ESU.

Bioclimatic models (models developed by correlating the current distribution of the fisher with current climate) applied to projected future climate (using a medium-high greenhouse-gas emissions scenario) suggest that fishers may lose most of their “climatically suitable” range within California by the year 2100 [183]. However, the distribution and climate data for those models was assessed at a 50 x 50 km grid; at that scale the projections are influenced by topographic features such as large mountain ranges, but they are not substantially affected by fine-scale topographic diversity (e.g., slope, aspect, and elevation diversity within each grid cell). Because of the topographic diversity in California’s montane environments, temperature and other climatic variables

can change considerably over relatively small distances [232]. Thus, the diversity of the physical environment within areas occupied by fisher may buffer some of the projected effects of a changing climate [233].

Climate change is likely to indirectly affect fishers by altering the species composition and structural components of habitats used by fishers in California [183,234]. Climate change may also interact synergistically with other potential threats such as fire; it is likely that fires will become more frequent and potentially more intense as the California climate warms and precipitation patterns change [179,183,184]. To evaluate potential future climate-driven changes to habitats used by fisher in the state, Lawler et al. [183] combined model projections of fire regimes and vegetation response in California by Lenihan et al. [234] with stand-scale fire and forest-growth models. Interactions between climate and fire were projected to cause significant changes in vegetation cover in both fisher ESUs by 2071-2100, as compared to mean cover from 1961-1990 (Table 7).

In the Klamath Mountains, the primary predicted change is an increase in hardwood cover and a likely decrease in canopy cover (exemplified by reduced conifer forest cover and increased mixed forest and mixed woodland cover). In the southern Sierra Nevada, the predicted changes are similar (more hardwood cover and less canopy cover) but also include substantial reduction in the amount of forested habitats and a concomitant increase in the amount of grasslands [183]. If woodlands and grasslands within the fisher ESUs expand considerably in the future as a result of climate change, the loss of overstory cover may reduce suitability of some areas and render others unsuitable. However, Lawler et al. [183] also suggested that projected increases in mixed-evergreen forests resulting from a warming climate could enhance the "floristic conditions" for fisher survival (as long as other factors do not cause fishers and their prey to migrate from these areas), presumably due to the frequent use of hardwood trees for denning and resting. Lastly, Lawler et al. [183] cautioned that their habitat modeling was based on a 10 x 10 km grid, which was a "high resolution for this type of model" and that fisher habitat quality depends primarily on vegetation and landscape features occurring at finer spatial scales. They further noted that the modeled changes are broad, landscape-scale patterns that will be "filtered" by variability in topography, vegetation and other factors.

Table 6~~7~~. Approximate current (1961-1990) and predicted future (2071-2100) vegetation cover in the Klamath Mountains and southern Sierra Nevada, as modeled by Lawler et al. [183].

Klamath Mountains - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	66	30	26	14	23
Mixed forest	23	51	51	51	51
Mixed woodland	8	16	20	30	22
Shrubland	0	1	1	3	2
Grassland	3	2	2	2	2
TOTAL	100	100	100	100	100

Southern Sierra Nevada - land cover percentages					
	Current	**Future**			
		Model 1	Model 2	Model 3	Average
Evergreen conifer forest	40	31	21	10	21
Mixed forest	2	15	5	2	7
Mixed woodland	25	34	36	37	36
Shrubland	16.5	2	3	8	4
Grassland	16.5	18	35	44	32
TOTAL	100	100	100	101	100

Hayoe et al. [225] modeled California vegetation over the same period as Lawler et al. [183] and also concluded that widespread displacement of conifer forest by mixed evergreen forest is likely by 2100. Shaw et al. [235] predicted substantial losses of California conifer forest and woodlands and, in general, increases in hardwood forest, hardwood woodlands, and shrublands by 2100. In the southern Sierra, Koopman et al. [236] modeled vegetation and predicted that although species composition would change, needleleaf forests would still be widespread in 2085. Koopman et al. [236] also stressed that decades or centuries may be required for substantial vegetation changes to occur, particularly in forested areas.

Burns et al. [237] assessed potential changes in mammal species within several National Parks resulting from a doubling of the baseline atmospheric CO_2 concentration. Although the results indicated that fishers were among the most sensitive of the modeled carnivores to climate change, they were predicted to continue to Yosemite

National Park. Burns et al. [237] suggested that the most noticeable effects of climate change on wildlife communities may be a fundamental change in community structure as some species emigrate from particular areas and other species immigrate to those same areas. Such "reshuffling" of communities would likely result in modifications to competitive interactions, predator-prey interactions, and trophic dynamics.

Warmer temperatures may also result in greater insect infestations and disease, further influencing habitat structure and ecosystem health [229,238,239]. Winter insect mortality may decline and some insects, such as bark beetles, may expand their range northward [240–242]. Invasive plant species may find advantages over native species in competition for soils, water, favorable growing locations, pollinators, etc. in a warmer environment. Plant invasions can be enhanced by warmer temperatures, earlier springs and earlier snowmelt, reduced snowpack, and changes in fire regimes [243]. Changes in forest vegetation due to invasive plant species may impact fisher prey species composition and abundance. Although the available evidence indicates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state.

Existing Management, Monitoring, and Research Activities

U.S. Forest Service

The majority of land within the current range of the fisher in California is public (approximately 55%) and the majority of these lands are managed by the USFS. The historical range of fishers described by Grinnell et al. [3], encompassed all or portions of 13 National Forests including the Mendocino, Six Rivers, Klamath, Shasta-Trinity, Lassen, Plumas, Tahoe, Eldorado, Stanislaus, Sierra, Inyo, Humboldt-Toyiabe, and Sequoia as well as the Tahoe Basin Management Unit.

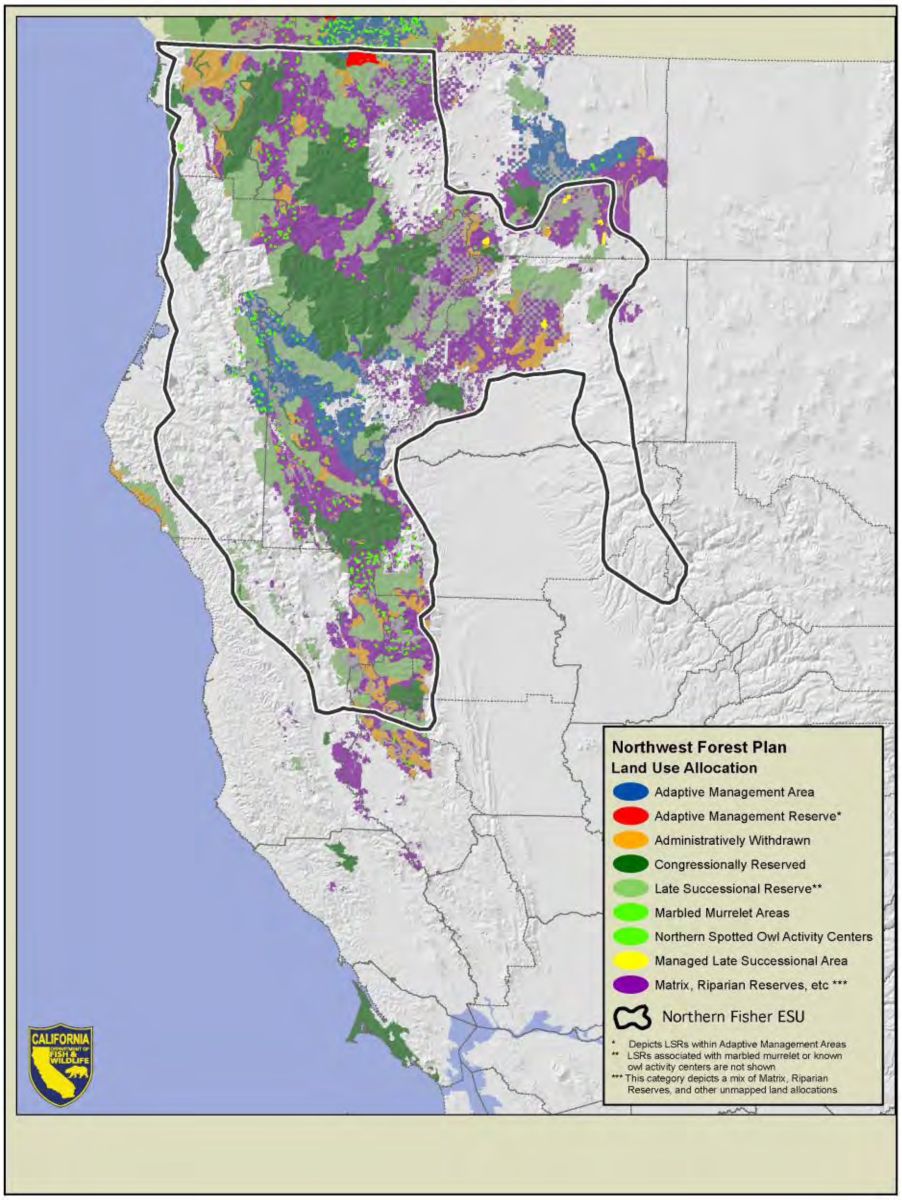
USFS sensitive species, such as fisher, are plant and animal species identified by the Regional Forester for which population viability is a concern due to a number of factors including declining population trend or diminished habitat capacity. The goal of sensitive species designation is to develop and implement management practices so that these species do not become threatened or endangered. Sensitive species within the USFS Pacific Southwest Region are treated as though they were federally listed as threatened or endangered (USDA 1990).

Current USFS policy requires biological evaluations for sensitive species for projects considered by National Forests (USDA FSM 2672.42). Pursuant to the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) (NEPA), USFS analyzes the direct, indirect, and cumulative effects of the actions on federally listed, proposed, or sensitive species. The fisher is designated as a sensitive species on 11 National Forests in California: Eldorado, Inyo, Klamath, Mendocino, Plumas, San Bernardino, Shasta-Trinity, Sierra, Six Rivers, Stanislaus, and Tahoe.

U.S. Forest Service – Specially Designated Lands, Management, and Research

Northwest Forest Plan: In 1994, the Northwest Forest Plan (NWFP) was adopted to guide the management of over 24 million acres of federal lands in portions of northwestern California, Oregon, and Washington within the range of the northern spotted owl (NSO) [244]. Adoption of the NWFP resulted in amendment of USFS and the Bureau of Land Management (BLM) management plans to include measures to conserve the NSO and other species, including the fisher, on federal lands.

The NWFP created an extensive and large network of late-successional and old-growth forest (Figure 21). These lands are designated as Congressionally Reserved Areas and Late Successional Reserves and are managed to retain existing natural features or to protect and enhance late-successional and old-growth forest ecosystems. Timber harvesting is permitted under Matrix lands designed in the plan; however, the area available for harvest is constrained to protect sites occupied by marbled murrelets, NSOs, and sites occupied by other species. Riparian Reserves apply to all land allocations to protect riparian dependent resources. With the exception of silvicultural activities that are consistent with Aquatic Conservation Strategy objectives, timber harvest is not permitted within Riparian Reserves, which can vary in width from 30 to 91 m (100 to 300 feet) on either side of streams, depending on the classification of the stream or waterbody ([245]).



2330 Figure 21. Northwest Forest Plan land use allocations [246]. California Department of Fish and Wildlife,
2331 2014.

Northern Spotted Owl Critical Habitat: In developing its designation of critical habitat for the NSO, the US Fish and Wildlife Service recognized the importance of implementation of the NWFP to the conservation of native species associated with old-growth and late-successional forests. The designation of critical habitat for the NSO did not alter land use allocations or change the Standards and Guidelines for management under the NWFP, nor did the rule establish any management plan or prescriptions for the management of critical habitat. However, it encourages federal land managers to implement forest management practices recommended in the Revised Recovery Plan for the NSO. Those include conservation of older forest, high-value habitat, areas occupied by NSOs, and active management of forests to restore ecosystem health in many parts of the NSO's range. These actions are intended to restore natural ecological processes where they have been disrupted or suppressed. By this rule, the USFWS encourages the conservation of existing high-quality NSO habitat, restoration of ecosystem health, and implementation of ecological forestry management practices recommended in the Revised NSO Recovery Plan. NSO critical habitat comprises substantial habitat within the range of fishers in northern California (Figure 22).

Sierra Nevada Forest Plan Amendment (SNFPA): The USFS adopted this amendment in 2001 to direct the management of National Forests within the Sierra Nevada. A Supplemental Environmental Impact Statement was subsequently adopted in 2004, to better achieve the goals of the SNFPA by refining management direction for old forest ecosystems and associated species, aquatic ecosystems and associated species, and fire and fuels management (USDA 2004). It also amended Land Management Plans for National Forests within the Sierra Nevada.

The Record of Decision for the SNFPA contains broad management goals and strategies to address old forest ecosystems, describe desired land allocations across the Sierra Nevada, outline management intents and objectives, and establish management standards and guidelines. Broad goals of the SNFPA conservation strategy for old forest and associated species are as follows:

- Protect, increase, and perpetuate desired conditions of old forest ecosystems and conserve species associated with these ecosystems while meeting people's needs for commodities and outdoor recreation activities;

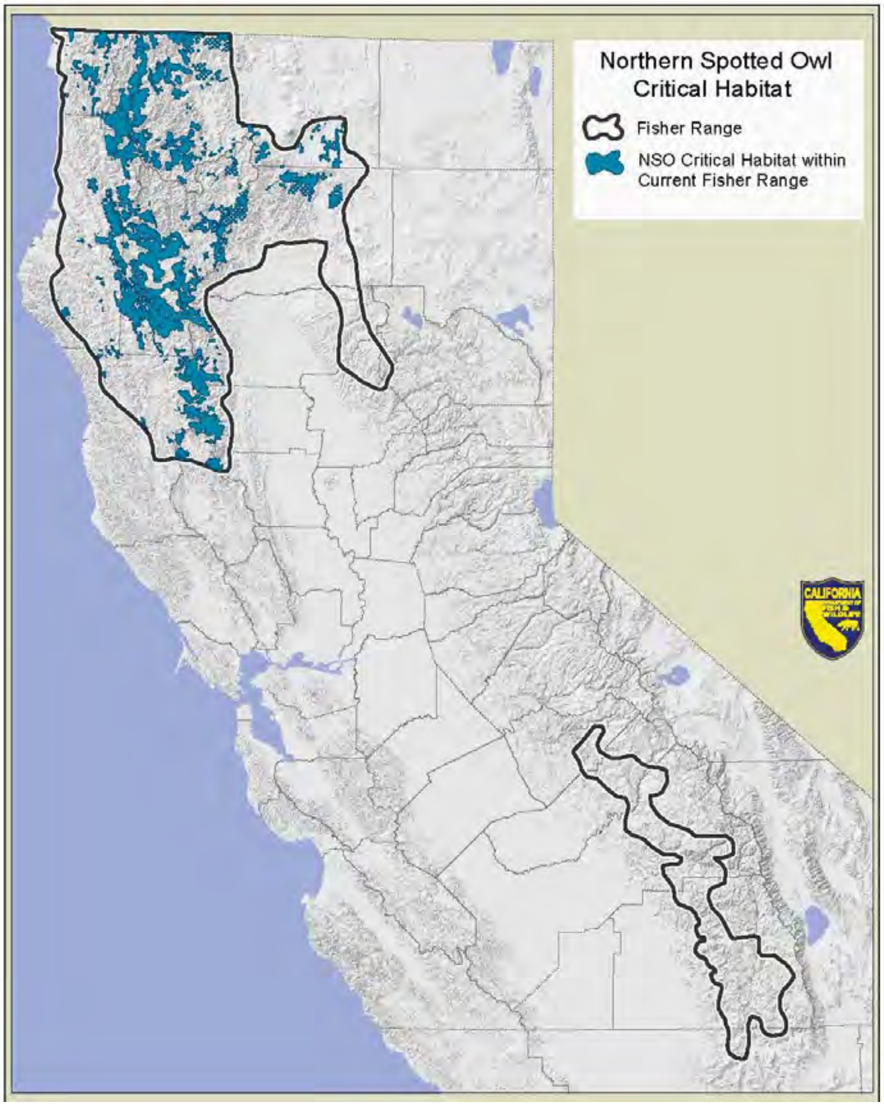


Figure 22. Distribution of northern spotted owl critical habitat within the current estimated range of the fisher in California.

- Increase the frequency of large trees, increase structural diversity of vegetation, and improve the continuity and distribution of old forests across the landscape; and

- Restore forest species composition and structure following large scale, stand-replacing disturbance events.

The SNFPA established a network of land allocations to provide direction to land managers designing fuels and vegetation management projects. A number of these land allocations contain specific measures to conserve habitat for fishers or will likely benefit them by conserving habitat for other species or resources. These include land allocations for:

- Wilderness areas and wild and scenic rivers
- California spotted owl protected activity centers
- Northern goshawk protected activity centers
- Great gray owl protected activity centers
- Forest carnivore den site buffers
- California spotted owl home range core areas
- Southern Sierra fisher conservation area
- Old forest emphasis areas
- General forest
- Riparian conservation areas

Wilderness Areas: In California, there are 40 designated Wilderness areas administered by the USFS totaling approximately 4.9 million acres within the historical range of the fisher described by Grinnell et al. [3]. Within the current range of the fisher, there are 16 wilderness areas encompassed by the northern population totaling approximately 3.5 million acres and 10 wilderness areas encompassing the southern Sierra population totaling about 416,000 acres. Wilderness areas within the historical and current range of fishers in the state are managed by the USFS to preserve their natural conditions; activities are coordinated under the National Wilderness Preservation System. Although many wilderness areas in California include lands at elevations and habitats not typically occupied by fishers, considerable suitable habitat is predicted to occur within their boundaries.

Giant Sequoia National Monument: The 328,315 acre Giant Sequoia National Monument (Monument) is located in the southern Sierra Nevada and is administered by the USFS, Sequoia National Forest. Presidential proclamation established the Monument in 2000 for the purpose of protecting specific objects of interest and directed that a Management Plan be developed to provide for those objects' proper care (Giant Sequoia Management Plan, 2012). Fisher, as well as a number of other species such as American marten, great gray owl, northern goshawk, California spotted owl, peregrine falcon, and the California condor were identified as objects to be protected. Habitats within the Monument are intended to be managed to support viable populations of these species. Three categories of land allocations within the Monument have been established that include, but are not limited to, designated wilderness, wild and scenic river corridors, the Kings River Special Management Area, and the Sierra Fisher Conservation Area (311,150 acres). The current Management Plan for the Monument lists specific objectives to study and adaptively manage fisher and fisher habitat and a strategy to protect high quality fisher habitat from any adverse effects of management activities.

Sierra Nevada Adaptive Management Project (SNAMP): The SNAMP was initiated in 2005 to evaluate the impacts of fuel thinning treatments designed to reduce the hazard of fire on wildlife, watersheds, and forest health [247]. A primary intent was to test adaptive management processes through testing the efficacy of Strategically Placed Landscape Treatments (SPLATs) and focused on four response variables, including fishers. Researchers are studying factors that may limit the fisher population within SNAMP's study site in the southern Sierra Nevada. As of March 2014, a total of 113 fishers (48 males and 65 females) have been captured and radio-collared as part of this investigation [248].

Kings River Fisher Project: The Pacific Southwest Research Station initiated the Kings River Fisher Project in 2007, in response to concerns about the effects of fuel reduction efforts on fishers in the southern Sierra Nevada [249]. The project area encompasses about 53,200 ha (131,460 ac) and is located southeast of Shaver Lake on the Sierra National Forest. The primary objectives of the study include better understanding fisher ecology and addressing uncertainty surrounding the effects of timber harvest and fuels treatments on fishers and their habitat. Over 100 fishers have been captured and radio collared, 153 dens were located, and more than 500 resting structures have been identified [249]. Predation has been the primary cause of death of the fishers studied.

Comment [JT55]: Add size estimate for SNAMP in previous paragraph

Bureau of Land Management

Management of Bureau of Land Management (BLM) lands are authorized under approved Resource Management Plans (RMPs) prepared in accordance with the Federal Land Policy and Management Act, NEPA, and various other regulations and policies. Some Plans (e.g., Sierra RMP) include conservation strategies for fishers and other special status species. The Sierra RMP contains objectives to sustain and manage mixed evergreen forest ecosystems in to support viable populations of fisher by conserving denning, resting, and foraging habitats [250]. This plan contains provisions to manage lands within the RMP to support large trees and snags, to provide habitat connectivity among federal lands, and making acquisition of fisher habitat a priority when evaluating private lands for purchase [250].

Management of BLM lands within NSO range are also subject to provisions of the NWFP. Its mandate is to take an ecosystem approach to managing forests based on science to maintain healthy forests capable of supporting populations of species such as fisher associated with late-successional and old-growth forests [245].

National Park Service

Compared to other public lands which are primarily administered for multiple uses, national parks are among the most protected lands in the nation [251]. The National Park Service (NPS) does not classify species as sensitive, but considers special designations by other agencies (e.g., sensitive, species of special concern, candidate, threatened, and endangered) in planning and implementing projects. Forested lands within National Parks are not managed for timber production and salvage logging post-wildfires is limited to the removal of trees for public safety. Fires occurring in parks in the Sierra Nevada are either managed as natural fires or as prescribed burns (Yosemite National Park 2004).

State Lands

State lands comprise only about one percent of fisher range in California. State agencies are subject to the California Environmental Quality Act (CEQA). During CEQA review for proposed projects on state lands within fisher range and where suitable habitat is present, potential impacts to fishers are specifically evaluated because the

species is a Department of Fish and Wildlife Species of Special Concern. Recreation is diverse and widespread on state lands but, as is the case with federal lands, the impacts of public use of state lands on fishers are expected to be low. Public use may result in temporary disturbance to individual fishers, but the adverse impacts are unlikely due to the small area involved and relatively low level of public use of dense forested habitat. Some state lands are harvested for timber. Commercial harvest of timber on state lands is regulated under the California Forest Practice Rules (CCR, Title 14, Chapters 4, 4.5, and 10, hereafter generally referred to as the FPRs) that require the preparation and approval of Timber Harvesting Plans (THPs) prior to harvesting trees on California timberlands.

Private Timberlands

The Department estimates that approximately 39% of current fisher range in California is comprised of private or State lands regulated under the Z'berg-Nejedly Forest Practice Act and associated FPRs promulgated by the State Board of Forestry and Fire Protection (BOF). The FPRs are enforced by CAL FIRE and are the primary set of regulations for commercial timber harvesting on private and State lands in California. Timber harvest plans (THPs) prepared by Registered Professional Foresters provide: (1) information the CAL FIRE Director needs to determine if the proposed timber operation conforms to BOF's rules; and (2) information and direction to timber operators so they comply with BOF's rules (CCR, Title 14, § 1034). The preparation and approval of THPs is intended to ensure that impacts from proposed operations that are potentially significant to the environment are considered and, when feasible, mitigated.

Under the FPRs (CCR, Title 14, § 897(b)(1)(B)), forest management shall "maintain functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within the planning watershed." Although the FPRs do not require measures specifically designed to protect fishers, elements of these rules provide for the retention of habitat and habitat elements important to the species. Trees potentially suitable for denning or resting by fisher may be voluntarily retained to achieve post-harvest stocking requirements under the FPR subsection relating to "decadent or deformed trees of value to wildlife" (FPR 912.7(b)(3), 932.7(b)(3), 952.7(b)(3)). Additional habitat suitable for fishers may be retained within Watercourse and Lake Protection Zones (WLPZs).

WLPZs are defined areas along streams where the FPRs restrict timber harvest in order to protect instream habitat quality for fish and other resources. Harvest restrictions and retention standards differ across the range of the fisher, but WLPZs may encompass 15 – 45 m (50-150 ft) on each side of a watercourse 30-91m (100-300 ft) in total width depending on side slope, location in the state, and the watercourse's classification. In some locations, WLPZs may constitute 15% or more of a watershed (J. Croteau, pers. comm.). Drier regions of the state with lower stream densities have a much lower proportion of the landscape in WLPZs. Where WLPZs allow large trees with cavities and other den structures to develop, they may provide fishers a network of older forest structure within managed forest landscapes.

Timberland owners with relatively small acreages [<1,012 ha (2,500 acres)] may prepare Non-Industrial Timber Management Plans (NTMPs) designed to provide long-term forest cover on enrolled ownerships which may provide habitat suitable for use by fishers.

For ownerships encompassing at least 50,000 acres, the FPRs require a balance between timber growth and yield over 100-year planning periods. Sustained Yield Plans and Option A plans (CCR, Title 14, § 1091.1, § 913.11, § 933.11, and § 959.11) are two options for landowners with large holdings that meet this requirement. Consideration of other resource values, including wildlife, is also given in these plans, which are reviewed by specific review team agencies and the public and approved by CAL FIRE. Implementation of either option is likely to provide forested habitat that is suitable for fishers. However, the plans are inherently flexible, making their long-term effectiveness in providing functional habitat for fishers uncertain.

Landowners harvesting dead, dying, and diseased conifers and hardwood trees may file for an exemption from the FPR's requirements to prepare THPs and stocking reports (CCR, Title 14, § 1038(b)). Timber harvesting under exemptions is limited to removal of 10% or less of the average volume per acre. Exemptions may be submitted by ownerships of any size and can be filed annually. The FPRs impose a number of restrictions related to exemptions including generally prohibiting the harvest of old trees [trees that existed before 1800 AD and are greater than 152.4 cm (60 in) at the stump for Sierra or Coastal Redwoods and trees; greater than 121.9 cm (48 in) for all other species]. Exceptions to this rule are provided under CCR, Title 14, § 1038(h).

Portions of the FPRs (CCR, Title 14, §§ 919.16, 939.16, and 959.16) relate to late succession forest stands[32] on private lands. Proposals to harvest late successional stands where the stands' amount, distribution, or functional wildlife habitat value will be reduced and result in a significant adverse impact on the environment must include a discussion of how the species primarily associated with late successional stands will be affected. When long-term significant adverse effects on fish, wildlife, and listed species associated primarily with late successional forests are identified, feasible mitigation measures to mitigate or avoid adverse effects must be incorporated into THPs, Sustained Yield Plans, or NTMPs. Where these impacts cannot be avoided or mitigated, measures taken to reduce them and justification for overriding concerns must be provided.

Some private companies, including large industrial timberland owners and non-industrial timber owners, have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These may include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Private Timberlands – Conservation, Management, and Research

Forest Stewardship Council Certification: In 1992, the Forest Stewardship Council (FSC) was formed to create a voluntary, market-based approach to improve forest practices worldwide [252]. FSC's mission is to promote environmentally sound, socially beneficial, and economically prosperous forest management founded on a number of principles including the conservation of biological diversity, maintenance of ecological functions, and forest integrity [253]. In California, approximately 1.6 million acres of forest lands are FSC certified [254].

Habitat Conservation Plans: Habitat Conservation Plans authorize non-federal entities to "take," as that term is defined in the federal Endangered Species Act (16 U.S.C., § 1531 *et seq.*)(ESA), threatened and endangered species. Applicants for incidental take

[32] Late Succession Forest Stands refers to stands of dominant and predominant trees that meet the criteria of WHR class 5M, 5D, or 6 with an open, moderate or dense canopy closure classification, often with multiple canopy layers, and are at least 20 acres in size. Functional characteristics of late succession forests include large decadent trees, snags, and large down logs (Cal. Code Regs, tit. 14, § 895.1).

permits under Section 10 of the ESA must submit an HCP that specifies, among other things, impacts that are likely to result from the taking and measures to minimize and mitigate those impacts. An HCP may include conservation measures for candidate species, proposed species, and other species not listed under the ESA at the time an HCP is developed or a permit application is submitted. This process is intended to ensure that the effects of the incidental take that may be authorized will be adequately minimized and mitigated to the maximum extent practicable. There are six HCPs in California within the range of the fisher (Table 8). Of those, only the Humboldt Redwoods HCP specifically addresses fisher, although other HCPs contain provisions intended to benefit species such as NSO (e.g., Green Diamond Resources Company and Fruit Growers Supply Company) that may also benefit fishers.

Fisher Translocation: From 2009-2012, the Department translocated[33] individual fishers from northwestern California to private timberlands in Butte County owned by Sierra-Pacific Industries (SPI). This effort, the first of its kind in California, was undertaken in cooperation with SPI, USFWS, and North Carolina State University. A primary conservation concern for fisher has been the apparent reduction in overall distribution in the state. Fishers have been successfully translocated many times to reestablish the species in North America [26], and reestablishing a population in formerly occupied range was believed to be an important step towards strengthening the statewide population in California [256].

Prior to translocating fishers to the northern Sierra Nevada, the Department assessed the suitability of five areas as possible release sites [256]. Those lands represented most of the large, relatively contiguous tracts of SPI land within the southern Cascades and northern Sierra Nevada. The Department considered a variety of factors in its evaluation of the feasibility of translocating fishers onto SPI's property, including habitat suitability of candidate release sites, prey availability, genetics, potential impacts to other species with special status, disease, predation, and the effects of removing animals on donor populations.

[33] Translocation refers to the human-mediated movement of living organisms from one area for release in another area [255].

Table 7~~8~~. Approved Habitat Conservation Plans within the range of the fisher in California.

HCP Name	**Location**	**Area (acres)**	**Permit Period**	**Covered Species**
Green Diamond Resources Company	Del Norte & Humboldt counties	407,000	1992-2022 (30 years)	• northern spotted owl
Humboldt Redwood Company (PALCO)	Humboldt County	211,000	1999-2049 (50 years)	• American peregrine falcon • marbled murrelet • northern spotted owl • bald eagle • western snowy plover • bank swallow • red tree vole • pacific fisher • foothill yellow-legged frog • southern torrent salamander • northwestern pond turtle • northern red-legged frog
Fruit Growers Supply Company	Siskiyou County	152,000	2012-2062 (50 years)	• coho salmon (Southern Oregon/Northern California Coasts ESU) • steelhead (Klamath Mountains Province ESU) • Chinook salmon (Upper Klamath and Trinity Rivers ESU) • northern spotted owl • Yreka phlox
Green Diamond Resources Company	Humboldt and Del Norte counties	417,000	2007-2057 (50 years)	• chinook salmon (California Coastal, Southern Oregon and Northern California Coastal, and Upper Klamath/Trinity Rivers ESUs) • coho salmon (Southern Oregon/Northern California Coast ESU) • steelhead (Northern California DPS, Klamath Mountains Province ESU). • resident rainbow trout • coastal cutthroat trout • tailed frog • southern torrent salamander
Fisher Family	Mendocino County	24	2007-2057 50 years	• Behren's silverspot butterfly • Point Arena mountain beaver
AT&T	Mendocino County	11	2002-2012 10 years	• Point Arena mountain beaver

From late 2009 through late 2011, 40 fishers (24F, 16M) were released onto the Stirling Management Area. All released fishers were equipped with radio-transmitters to allow monitoring of their survival, reproduction, dispersal, and home range establishment. The released fishers experienced high survival rates during both the initial post-release period (4 months) and for up to 2 years after release [126]. A total of 11 of the fishers released onto Stirling died by the spring of 2013. Twelve female fishers known to have denned at Stirling produced a minimum of 31 young [126].

In October of 2012, field personnel conducted a large scale trapping effort on Stirling to recapture previously released fishers and their progeny. Twenty-nine fishers were captured and, of those, 19 were born on Stirling [126]. On average, female fishers recaptured during this trapping effort had increased in weight by 0.1 kg and males had increased in weight by 0.4 kg. Juvenile fishers captured on Stirling weighed more than juveniles of similar age from other parts of California [126]. Based on the results of trapping at Stirling, to the extent that those captured are representative of the population, most females (70%) were less than 2 years of age and males in that age group comprised 47% of the population, suggesting relatively high levels of reproduction and recruitment [126].

Candidate Conservation Agreement with Assurances: A "Candidate Conservation Agreement with Assurances for Fisher" (CCAA) between the USFWS and SPI regarding translocation of fisher to a portion of SPI's lands in the northern Sierra Nevada was approved on May 15, 2008. CCAAs are intended to enhance the future survival of a federal candidate species, and in this instance provides incidental take authorization to SPI should USFWS eventually list fisher under the federal ESA. This 20-year permit covers timber management activities on SPI's Stirling Management Area, an approximately 160,000-acre tract of second-growth forest in the Sierra Nevada foothills of Butte, Tehama, and Plumas counties. This tract is in the northern portion of the gap in the fisher distribution and was believed to be unoccupied by fishers prior to the translocation.

Tribal Lands

Comment [JT56]: No mention here of the Tule River Indian Reservation??

Hoopa Valley Tribe: The Hoopa Valley Tribe has been active in fisher research, focusing on den site characteristics, juvenile dispersal, and fisher demography, for nearly 2 decades. The tribal lands are in a unique location near the northwestern edge

of the Klamath Province. The fisher is culturally significant to the Hoopa (Hupa) people, and forest management activities are conducted with sensitivity to potential impacts to fisher. Since 2004, the Hoopa Valley Tribe has collaborated with the Wildlife Conservation Society to study the ecology of fishers. Information gained from fisher research conducted at Hoopa has contributed significantly to the understanding of the species in California.

Management and Monitoring Recommendations

The Department has implemented a number of actions designed to better understand fisher in California and to improve its conservation status. These include collaborating with various governmental agencies and other entities including the BOF, CAL FIRE, USFS, BLM, USFWS, private timberland owners/companies, and university researchers, to evaluate land management actions, facilitate research, and contribute to the development of effective conservation strategies. In addition, the Department recommends the following:

1. Support independent research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California.

2. Expand collaboration with timberland owners/managers to encourage conservation of fishers. This includes cooperating in studies of fishers to provide a better understanding of their use of managed landscapes in California.

3. Continue efforts to encourage private landowners to retain and recruit forest structural elements important to fishers during the review of timber management planning documents on private lands.

4. Design, secure funding, and collaboratively implement large-scale, long-term, multi-species surveys of forest carnivores in the state with private and federal partners. Monitoring of occupancy rates is a comparatively cost effective method that should be considered for long-term monitoring. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.

Comment [JT57]: What does this mean? Kind of vague

5. Develop and implement a range-wide health monitoring and disease surveillance program for forest carnivores to better understand the disease relationships among species and the implications of disease to fisher populations, potential effects of toxicants and their potential effects on fisher and fisher prey. It may be possible to partner with existing studies and surveys to collect some of the data needed.

6. Continue monitoring fishers and their progeny reintroduced to the northern Sierra Nevada and southern Cascades. This includes collecting, analyzing, and publishing information about reproduction, survival, dispersal, habitat use, movements, and trends. Fishers translocated elsewhere in North America have rarely been monitored and this translocation is the first effort of its kind in the state. Continued monitoring is critical to answer questions about how fishers use managed landscapes and to determine if the project is successful in the long-term and, if not, why it failed.

7. In the southern Sierra Nevada, collaborate with land management agencies and researchers to expand connectivity between core habitats and to facilitate population expansion.

8. Assess the potential for assisted dispersal of juvenile fishers or translocation of adults from the southern Sierra population to nearby suitable, but unoccupied, habitat north of the Merced River as a means to strengthen the fisher population in the region.

Summary of Listing Factors

CESA directs the Department to prepare this report regarding the status of the fisher in California based upon the best scientific information. Key to the Department's analyses are six relevant factors highlighted in regulation. Under the California Code of Regulations, Title 14, § 670.1, subd. (i)(1)(A), a "species shall be listed as endangered or threatened...if the Commission determines that its continued existence is in serious danger or is threatened by any one or any combination of the following factors:"

(1) present or threatened modification or destruction of its habitat;
(2) overexploitation;

(3) predation;
(4) competition;
(5) disease; or
(6) other natural occurrences or human-related activities

Also key are the definitions of endangered and threatened species, respectively, in the Fish and Game Code. CESA defines endangered species as one "which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, over exploitation, predation, competition, or disease." (Fish & G. Code, § 2062.) A threatened species under CESA is one "that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts required by [CESA]." (*Id.*, § 2067.)

Fishers in California occur in two separate and isolated populations that differ genetically. Due in part to the distance separating these populations and differences in habitat, climate, and stressors potentially affecting them, the Department has considered them as independent Evolutionarily Significant Units where appropriate in its analysis of listing factors.

Present or Threatened Modification or Destruction of its Habitat

Comment [JT58]: I am not sure what the guidelines are for references in this part of the document (here until 'Listing Recommendation header…) but in reading through it there is very inconsistent referencing with extensive citations in some sections but many areas of the text that have few or no references listed.

I have pointed out a few areas that need additional citations, but there are probably many others.

Considerable research has been conducted to understand the habitat associations of fisher throughout its range. Studies during the past 20 years indicate fishers are found in a variety of low- and mid-elevation forest types [105,119–122]. Perhaps the most consistent, and generalizable attribute of home ranges used by fishers is that they are composed of a mosaic of forest plant communities and seral stages, often including relatively high proportions of mid- to late-seral forests [88]. Forested landscapes with these characteristics are suitable for fisher if they contain adequate canopy cover, den and rest structures of sufficient size and number, vertical and horizontal escape cover, and prey [88]. Thresholds for these attributes for fishers are not well understood and further research is needed to understand how forest structure and the distribution and abundance of micro-structures used for denning and resting affect fisher populations.

Management of Federal Lands: Federal land management agencies are guided by regulations and policies that consider the effects of their actions on wildlife. The

majority of federal actions must comply with NEPA. This Act requires Federal agencies to document, consider, and disclose to the public the impacts of major Federal actions and decisions that may significantly impact the environment.

The status of fisher as a sensitive species on USFS and BLM lands in California provides consideration for the species as guided by land management plans adopted by these agencies. As a result, substantial federal lands currently occupied by fishers in the state are managed to provide habitat for fishers, although specific guidelines are frequently lacking. Federal lands designated as wilderness areas or as National Parks are likely to provide long-term protection of fisher habitat. However, some portions of those lands are unlikely to be occupied by fishers due to the habitats they support or the elevations at which they occur.

Management of Private Lands: Timber harvest activities on private lands are regulated by various provisions of the Z'Berg Nejedly Forest Practice Act of 1973 and additional rules promulgated by the State Board of Forestry and Fire Protection. These rules are enforced by CAL FIRE and, although some timber harvest activities are exempt from these rules, they apply to all commercial harvesting activities on private lands.

The FPRs promulgated under the act specify that an objective of forest management is the maintenance of functional wildlife habitat in sufficient condition for continued use by the existing wildlife community within planning watersheds. This language may result in actions on private lands beneficial to fishers. However, information about what constitutes the "existing wildlife community" is frequently lacking in THPs, and specific guidelines to retain habitat for fishers and other terrestrial mammals are not incorporated into the FPRs.

Timber management activities subject to the FPRs can reduce the suitability of habitats used by fishers or render some areas unsuitable. These changes may be short-term or long-term, depending on a number of factors including the type of silviculture used, intermediate treatments conducted while forests regrow, timber site growing potential, and the time between timber rotations.

Fishers are able to utilize a diversity of forest types and seral stages. An aspect of forest management important to the suitability and long-term viability of fishers is the retention and recruitment of habitat elements for denning, resting, and to support prey

populations in sufficient number and in locations where they can be successfully captured by fisher. The FPRs require the retention of unmerchantable snags unless they are considered merchantable or pose a safety, fire, insect, or disease hazard. However, live trees of various species as well as merchantable snags are not required to be retained, even if potentially used as den or rest sites. No provision is provided in the rules to specifically recruit snags.

The demand for and uses of forest products have increased over time and some trees historically considered unmerchantable and left on forest lands when the majority of old-growth timber was logged are merchantable in today's markets. The time interval between harvests may also affect the distribution and abundance of habitat structures used by fishers. Trees used for denning, in particular, may take decades to reach adequate size, for stress factors to weaken its vigor, and for heartwood decay to advance sufficiently to form a suitable cavity [88]. Frequent harvest entries to salvage dead, dying, and diseased trees likely reduce the availability of these habitat elements. Retention of forest cover and large trees is a requirement of the FPRs along streams (i.e., WLPZs), with the width of these areas determined by stream class, slope, and the presence of anadromous salmonids.

The FPRs do not specifically require the retention or recruitment of hardwoods and, in some cases, their harvest may be required to meet stocking standards. Hardwoods may also be intentionally killed ("hack-and-squirt" herbicide application or felled) individually or in clusters to recruit conifers. Throughout much of the occupied range of fishers in California, hardwoods appear to be an important element of habitats used by the species. Various hardwood species provide potential den and rest trees and habitat used by fisher prey. Although the FPRs do not require retention of hardwoods, the Department is not aware of data indicating that their removal on commercial timberlands has substantially affected the distribution or abundance of fishers in California.

Depending on their location, WLPZs may comprise up to 15 percent of private ownerships managed for timber production. Drier regions of the state with lower stream densities have a much lower proportion of the landscape designated as WLPZs. Where they are managed to retain or recruit trees suitable for denning and resting, WLPZs may provide a network of older forest structure within managed forest landscapes beneficial to fishers and provide denning, resting, and foraging habitat for fishers. Outside of WLPZs, trees suitable for denning or resting by fishers are not required to be retained;

however they may be intentionally left by landowners to meet post-harvest stocking requirements.

The effects of future timber harvest activities on habitats used by fishers cannot be accurately predicted as changes in regulations, policies, and market conditions influence management intensity. Independent of the FPRs, trees of value to fishers may remain on landscapes through timber rotations because they are unmerchantable, are located in areas where access is infeasible, or because of company policies. Some private companies have instituted voluntary management policies that may contribute to conservation of fishers and their habitat. These include measures to retain snags, green trees (including trees with structures of value to wildlife), hardwoods, and downed logs.

Fire: In recent decades the frequency, severity, and extent of fires has increased in California. This has varied statewide, with the greatest increases in fires severe enough to eliminate forest stands occurring in the Sierra Nevada, southern Cascades, and Klamath Mountains. Increased fire frequency, size, and severity within occupied fisher range in California could result in mortality of fishers during fire events, diminish habitat carrying capacity, inhibit dispersal, and isolate local populations of fisher. However, the contemporary extent of wildfires burning annually in California is considerably less than the estimated 1.8 million ha (4.5 million ac) that burned annually in the state prehistorically (pre 1800) [174].

Comment [JT59]: This is not a fair comparison The pre-1800 acreage was of much higher proportion of low-moderate severity – you cannot directly compare this to the current fire conditions because the fire serverity, and its potential impact on fisher,is so different.

The fisher population in the SSN Fisher ESU is at greater risk of being adversely affected by wildfire than fishers in northern California, due its small size, the comparatively linear distribution of the habitat available, and predicted future climate changes. Timber harvest activities in portions of the southern Sierra Nevada occupied by fisher are largely under federal management. These National Forests in the SSN ESU have adopted specific guidelines to protect habitats used by fishers.

Within the NC Fisher ESU, fishers are comparatively widespread across a matrix of public and private forest lands. With the exceptions of Lake, Sonoma, and Marin counties, fishers currently occur throughout much of the historical range assumed by Grinnell et al. [3].

Overexploitation

Fishers are relatively easy to capture and, when legally trapped as furbearers in California, their pelts were valuable ([123]. The first regulated trapping season occurred in 1917, and the annual fee for a trapping license from 1917-1946 was $1.00. Due to their high commercial value, fishers were specifically targeted by trappers [3] and were also likely harvested by trappers seeking other furbearers [123].

Since the mid-1800s, the distribution of fisher in North America contracted substantially, in part, due to over-trapping and mortality from predator control programs [26]. Over-trapping of fisher has been considered a significant cause of its decline in California [3]. By the early 1900s, relatively few fisher pelts were sold in California. Only 28 fishers were reported trapped during the 1917-1918 license year when nearly 4,000 licenses were sold. Interestingly, even as late as 1919-1920, rangers in Yosemite trapped 12 fishers and 102 were reported to have been taken statewide that season [3]. Although not all trappers sought fishers, those trapping in areas where they occurred likely considered fisher a prize catch.

Despite being the most valuable furbearer in California at the time, the reported take by trappers during a 5-year period from 1920-1924 was only 46 animals [3]. Fishers were considered to be rare in California by the early 1920s [124]. Grinnell et al. [3] considered the complete closure of the trapping season for fishers or the establishment of local protection through State Game Refuges necessary to ensure the future of fisher in California [3]. He and his colleagues were optimistic that trappers would be among the first to favor protection for fishers if presented with factual information fairly, and believed that fur buyers would support any conservation measure that would ensure a future supply of revenue.

The high value trappers obtained for the pelts of fisher in the early 1900s, the species' vulnerability to trapping [8], and the lack of harvest regulations resulted in unsustainable exploitation of fisher populations [26]. Concern over the decrease in the number of fishers trapped in California led Joseph Dixon in 1924 to recommend a 3-year closed season to the legislative committee of the State Fish and Game Commission [124]. However, despite concerns about the scarcity of fishers in the state by Dixon and others, trapping of fisher was not prohibited until 1946 [125]. Although commercial

trapping of fishers was prohibited, commercial trapping of other furbearers with body gripping traps in California continued.

The incidental capture of fishers in traps set for other species has been well described in the literature. Captured fishers frequently died as a result (see Lewis et al. [123]). Fishers held by body gripping style traps may die from exposure to weather and stress, be killed by other animals including other fishers [8], or may be injured attempting to escape. In addition, fishers are quick and powerful animals, and releasing one held in a leg-hold trap unharmed would be challenging. Some trappers may have simply killed and discarded fishers when their pelts could not be sold, or injured animals in the process of releasing them to avoid being bitten (R. Callas, unpublished data). The level of mortality of fishers incidentally captured by trappers using body gripping traps has been considered to be a potential factor that may have negatively affected populations [8] and slowed the recovery of fisher numbers in California after legal trapping was prohibited.

With the passage of Proposition 4 in 1998, body-gripping traps (including snares and leg-hold traps) were banned in California for commercial and recreational trappers (Fish & G. Code, § 3003.1). Licensed individuals trapping for purposes of commercial fur or recreation in California are now limited to the use of live-traps. Licensed trappers are also required to pass a Department examination demonstrating their skills and knowledge of laws and regulations prior to obtaining a license (Fish & G. Code, § 4005). Fishers incidentally captured by trappers must be immediately released *(Id*, § 465.5(f)(1)).

The owners of traps or their designee are required by regulation to visit all traps at least once daily. When confined to cage traps, fishers may scratch and bite at the trap housing (typically made of wire or wood) in an effort to escape. In some cases, this has resulted in broken canines or damage to other teeth, but injuries of this nature, although undesirable, are likely not life-threatening (CDFW, unpublished data). Older adult fishers are frequently missing one or more canines, molars, or both and otherwise appear in good physical condition (CDFW, unpublished data).

The sale of trapping licenses in California has declined since the 1970s (Figure 23), indicating a decline in the number of traps in the field during the trapping season for other furbearers. The harvest, value of furs, and number of licenses sold varied greatly

over the years. In 1927, license sales reached 5,243, but with the Depression and World War II, sales declined dramatically until about 1970 when the price of fur began to

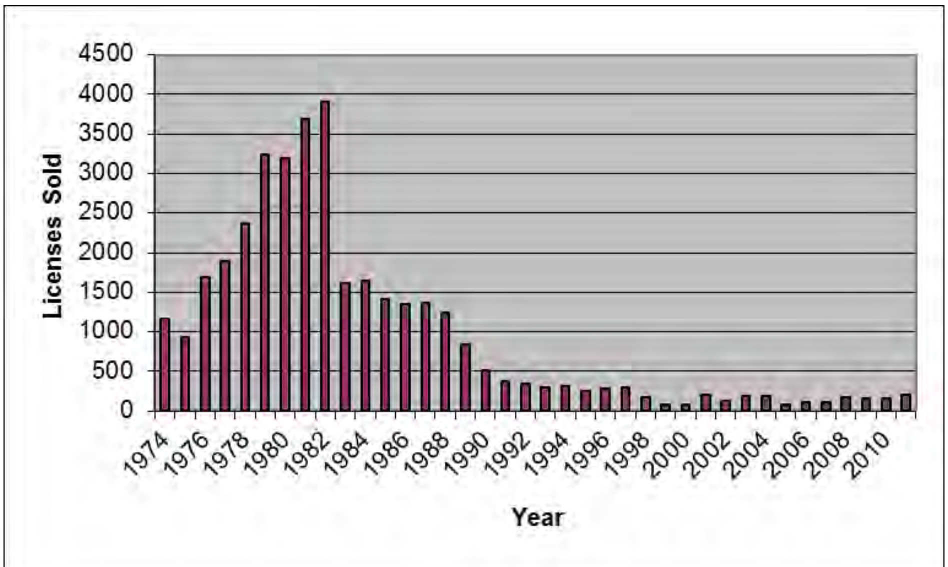


Figure 23. Trapping license sales in California from 1974 through 2011(CDFW Licensed Fur Trapper's and Dealer's Reports, http://www.dfg.ca.gov/wildlife/hunting/uplandgame/reports/trapper.html).

increase [257]. From the early 1980s through the present, license sales have continued to decrease with average sales from 2000-2011 equaling about 150 per year.

Licensed nuisance/pest control operators are permitted to use body-gripping traps (conibear and snare) in California. However, throughout most of the Sierra Nevada and a substantial part of the southern Cascades, such traps must be fully submerged in water. Where above-water body-gripping traps are used in fisher range, incidental capture and take could occur. However, licensed nuisance/pest control operators typically work in close proximity to homes and residential areas and their likelihood of capturing fishers is low. The USDA Wildlife Services uses a variety of traps to assist landowners whose property (typically livestock) has been damaged by certain species of wildlife. However, fishers are not permitted to be taken under these circumstances and are not commonly associated with causing damage to property (CDFW, unpublished data).

Currently and in the foreseeable future, the likelihood of fishers being overexploited in California is low, based on the prohibition against commercial or recreational take of fishers, low level of commercial and recreational trapping and prohibition of body-gripping traps. The Department is not aware of any data indicating that the potential risk to fisher populations from incidental take due to trapping differs significantly for populations in NC or SSN Fisher ESUs.

Predation

Recent research indicates predation is a substantial cause of mortality for fishers in California [144]. This research, using DNA amplified from fisher carcasses, identified bobcat, mountain lion, and coyote as predators of fishers, with predation attributed to bobcat being the most frequent (50%).

The risk of predation is likely heightened when fishers occupy habitats in close proximity to open and brushy habitats (G. Wengert, pers. comm.), both habitats used extensively by bobcats. Female fishers are more likely to be predated by bobcats and this occurs most frequently during the breeding season when young fishers are dependent on their mothers for survival. ~~Fragmentation~~ home of forested landscapes may increase the abundance of some small mammal species used by fishers as prey, but it may also favor potential predators adapted to early successional habitats. However, fishers have co-evolved with the suite of predators naturally occurring within their range and adverse population level effects on fishers due to predation have not been documented.

Currently, there is no information indicating differential risk of predation to fisher in the NC or SSN Fisher ESUs. Based on a sample of 50 fisher carcasses from these regions, no difference in the relative frequencies of predation by bobcat or mountain lion was found. Fishers in the SSN Fisher ESU are likely at greater risk of population level effects of predation due to the small size of their population compared to northern California. However, fishers in the southern Sierra Nevada have apparently been isolated in that region ~~for decades or longer~~ for hundreds to thousands of years and, at times, their numbers may have been smaller than they are today. The abundance of potential predators of fishers during those periods is unknown, but they likely co-occurred with fisher populations in the region.

Comment [JT60]: Reference?

Comment [JT61]: Reference?

Comment [JT62]: Reference?

Comment [JT63]: … Definitely not just decades…

Comment [JT64]: Reference?

Competition

The relationships between fishers and other carnivores where their ranges overlap are not well understood [24]. Throughout their range, fishers potentially compete with a variety of other carnivores including coyotes, foxes, bobcats, lynx, American martens, weasels (*Mustela* spp.), and wolverines [24,25,106]. Fishers likely compete for resources most intensely with other species of forest carnivores of similar size (e.g., bobcats, gray fox). Also, the relative similarities in body size, body shape, and prey between fisher and martens suggest the potential for competition between these species [24]. However, in California, martens typically occur at higher elevations than fisher and thus may have evolved strategies to minimize competition by separation and by exploiting somewhat different habitats. Where fishers and martens are sympatric, fishers likely dominate interactions between the species because of their larger body size.

Comment [JT65]: Reference?

Comment [JT66]: Reference?

Little is known regarding the potential risks to fisher populations from competition with other carnivores. Fisher have evolved with other carnivores and, with the exception of the wolverine, these potential competitors remain within habitats occupied by fishers in California. There is no evidence that fisher populations in either NC or SSN Fisher ESUs are adversely affected by competition with other species. However, landscape level habitat changes that favor population increases in competitors may intensify interspecific competition.

Comment [JT67]: Reference (Zielinski et al. 2005?)

Disease

Considerable research into the health of fisher populations in California has been conducted in recent years [152,158,161,258]. Fishers are known to die from a number of infectious diseases that appear to cycle within fisher populations or spill over from other species of carnivores.

Canine distemper virus (CDV) is common in gray fox and raccoon populations in California and both species occur in habitats occupied by fishers. Although studies have shown that fisher may survive CDV infections, outbreaks of highly virulent biotypes have been responsible for the near extirpation of other carnivore species including other mustelids. Deaths caused by other pathogens potentially significant for *Martes* (i.e., rabies, canine parvo virus), have not been documented for fisher in California. Although

Comment [JT68]: No references provided for the text in the next 3 paragraphs

canine parvo virus has been documented to cause clinical disease in fishers, testing to date indicates that the disease is circulating in California fishers without causing population level impacts.

Exposure of fishers to *Toxoplasma gondii* in both northern California and the southern Sierra Nevada has been documented. Although this parasite has caused mortality in other mustelids, it has not been documented as a source of mortality in fisher. This is also the case for known vector borne pathogens. Fisher harbor numerous ecto- and endoparasites and, although some can serve as vectors for other diseases, they are usually associated with minimal morbidity and mortality.

There is no evidence indicating that the prevalence of pathogens potentially affecting fishers in the state differs significantly between populations within the NC and SSN Fisher ESUs. The fisher population in the southern Sierra Nevada is likely at a higher risk of diseases that cause significant morbidity or mortality due to the population's isolation and comparatively small size. Although there is no evidence that CDV has caused substantial population declines in fisher, it is a pathogen of conservation concern for fisher and health surveillance of populations is prudent to detect and intervene to the extent possible, if needed.

Other natural occurrences or human-related activities

Population Size and Isolation: The distribution of fisher in California appears to have changed substantially before and after European Settlement. Although its precise distribution prior to the 1800s is unknown, based on recent genetic evidence, the fisher population in the state declined dramatically and contracted into two separate populations long before that time. Further reductions in range and abundance were likely post-European Settlement due to over trapping, predator control programs, and habitat changes that rendered areas unsuitable, or less suitable, for fishers. Since trapping of fishers was prohibited in 1946 and the use of body-gripping traps was banned in 1998, the number of fishers in California has increased to levels likely higher than existed during the period of unregulated trapping in the mid-1800s to early 1900s.

Comment [JT69]: Reference?

Comment [JT70]: Reference?

Comment [JT71]: Reference?

The fisher population within the SSN Fisher ESU is likely at greater risk of extirpation due to its small size (recently estimated at <250 individuals [134]), limited geographic range, and isolation compared to fishers in northern California. Small, isolated

populations are subject to an increased risk of extinction from stochastic (random) environmental or demographic events. Small populations are also at greater risk of adverse impacts resulting from the loss of genetic diversity, including inbreeding depression. The probability of this occurring in fisher occupying either the NC Fisher ESU or the SSN Fisher ESU is unknown. Events such as drought, high intensity fires, and disease, should they occur, have a higher probability of adversely affecting the fisher population in the southern Sierra Nevada. Currently, fishers nearest to the southern Sierra Nevada population are those translocated to the northern Sierra Nevada near Stirling City, a distance of approximately 285 km (177 mi). Fishers within the SSN Fisher ESU are likely to remain isolated in the foreseeable future due to that distance and potential barriers to movement.

Comment [JT72]: References?

Some researchers have expressed concern that restoring connectivity between the California fisher ESUs may result in the loss of local adaptations that have evolved in each population [40]. Fishers within the NC Fisher ESU are also largely isolated from other populations of fishers, although their population is contiguous with a small population in southern Oregon. Despite its isolation, the fisher population in northern California is comparatively large, distributed over a large geographic area, and its distribution has apparently not contracted, and may have slightly expanded, in recent decades. Over the last 8 years, occupancy rates of fishers in the southern Sierra have been stable [134]. Although long-term monitoring of population abundance and trends is lacking for fishers within the NC Fisher ESU, surveys from this region and recent estimates of relatively high rates of occupancy indicate that the population has not declined substantially in recent decades.

Comment [JT73]: Also, cite ref #28

Comment [JT74]: Reference?

Comment [JT75]: Overreaching in your conclusions here - Just because you have high occupancy rates from some studies of limited extent within the NWCA population does not mean that the population has not declined. You simply do not have the data to draw this inference.

Toxicants

Fishers in California are frequently exposed to anticoagulant rodenticides (ARs) and potentially to other toxicants. ARs have caused the deaths of some fishers, and within the SSN Fisher ESU there is a correlation between the presence of MJCSs within a fisher's home range and reduced survival. Those working to dismantle and remediate these sites report large numbers of pesticide containers (empty and full), but no organized data have been collected to quantify usage. In addition, use practices are largely unknown. Food containers that appear to have been spiked with pesticides and piles of bait have been found on MJCSs indicating intended poisoning of wildlife. However, containers are often found onsite without signs of where the material was

Comment [JT76]: Reference?

Comment [JT77]: Reference?

applied. In addition, it is important that MJCSs be searched for fisher and other wildlife carcasses, that these be quantified, and that the appropriate body tissues be analyzed for residues of contaminants.

There is incomplete understanding of effects of contaminants on fishers. Also unknown is the effect of multiple exposures of the same contaminant, similar contaminants, and contaminants with different modes of action. It is also unknown if there are potentially additive effects of contaminants with other stressors on individual fishers. ARs may also have indirect effects by predisposing fishers to other sources of mortality such as predation or accidents. AR toxicants were found at MJCSs in the 1980s and 1990s (M. Gabriel, pers. comm.), but the extent and distribution of their use was not documented.

Although limited population level monitoring of fishers has occurred, the species' distribution in California does not appear to have changed appreciably in decades. If toxicant use has been widespread, long-term, and caused substantial mortality, it is likely that new gaps in the range of fishers or declines in capture rates would have been observed due to the extensive efforts conducted since the early 1990s to detect and study the species. However, evidence of exposure in fishers and the documented deaths of a number of animals indicate this is a potentially significant threat that should be closely monitored and evaluated. Exposure to toxicants at MJCSs has been documented in both the NC and SSN Fisher ESU, but there is insufficient information to determine the relative risk to either population. However, the potential risk to fishers within the SSN Fisher ESU may be greater due to its comparatively small population size.

Comment [JT78]: I do not agree with this statement – as stated in the previous paragraph the extent and distribution of toxicants in the 1980's and 1990's was not documented.

From personal experience running a field project in the southern Sierras our encounters with grow sites seemed to increase substantially over time since 2002.

Also, currently long term monitoring methods are designed with statistical power to detect a 20% decline in occupancy and more gradual declines would not necessarily have been detected.

Comment [JT79]: In my opinion to say that toxicant exposure 'has been documented' really understates the magnitude of exposure that has been observed – this makes it sounds like it has been found occasionally versus the reality that it has been detected in the vast majority of fishers in these populations.

Climate Change

Climate research predicts continued climate change through 2100, at rates faster than occurred during the previous century. These changes are not expected to be uniform, and considerable uncertainty exists regarding the location, extent, and types of changes that may occur within the range of the fisher in California. Overall, warmer temperatures are expected across the range of fishers in the state, with warmer winters, earlier warming in the spring, and warmer summers.

Projected climatic trends will likely create drier forest conditions, increase fire frequency, and cause shifts in the composition of plant communities. The effect of warming

temperatures on mountain ecosystems will most likely be complex and predicting how ecosystems will be affected in particular areas is difficult. Some bioclimatic modeling (Lawler et al. [183]) broadly predicts that the climate in much of California may be unsuitable for fishers by 2100. Several papers that have modeled vegetation change suggest that within those portions of California currently occupied by fishers, conifer forests will decline in distribution, mixed or hardwood forests and woodlands will increase in distribution, and canopy cover in many areas will likely decline (with the shift from forest to woodland vegetation) [183,225,235]. These predictions notwithstanding, they are based on long-term models that utilize broad climate and vegetation parameters that largely do not reflect the fine-scale variation (in both climate and vegetation diversity) typically found in the topographically and ecologically diverse montane habitats of California.

Fishers within the SSN Fisher ESU are likely more vulnerable to the potentially adverse effects of warming climate than fishers in northern California. The comparatively small size of the population in the southern Sierra, its linear distribution, and potential barriers to dispersal (the 2013 Rim Fire area, river canyons, etc.) increase the likelihood that it will become fragmented and decline in size during this century. The fisher population within the NC Fisher ESU is comparatively large and well distributed geographically, increasing the probability that should some of the predicted effects of climate change be realized, areas of suitable habitat will remain.

While evidence demonstrates that climate change is progressing, its effects on fisher populations are unknown, will likely vary throughout its range in the state, and its severity will likely depend on the extent and speed with which warming occurs. Fishers are already experiencing the effects of climate change as temperatures have increased during the last century. As the 21^{st} century progresses and population data continue to be compiled, scientists will become better informed as to effects of a warming environment on California's fisher population. Continued monitoring of fisher distribution and survival over the ensuing decades will provide information about the immediacy of this threat.

Listing Recommendation

“Endangered species” means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease (FGC §2062). "Threatened species" means a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by this chapter” (FGC §2067).

The Department recommends that designation of the fisher in California as threatened/endangered is _______.

Protection Afforded by Listing

CESA defines “take” to mean “hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.” (Fish & G. Code, § 86.). If the fisher is listed as threatened or endangered under CESA, take would be unlawful absent take authorization from the Department (FGC §§ 2080 et seq. and 2835). Take can be authorized by the Department pursuant to FGC §§ 2081.1, 2081, 2086, 2087 and 2835 (NCCP).

Take under Fish and Game Code Section 2081(a) is authorized by the Department via permits or memoranda of understanding for individuals, public agencies, universities, zoological gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

Fish and Game Code Section 2086 authorizes locally designed voluntary programs for routine and ongoing agricultural activities on farms or ranches that encourage habitat for candidate, threatened, and endangered species, and wildlife generally. Agricultural commissioners, extension agents, farmers, ranchers, or other agricultural experts, in cooperation with conservation groups, may propose such programs to the Department. Take of candidate, threatened, or endangered species, incidental to routine and

ongoing agricultural activities that occur consistent with the management practices identified in the code section, is authorized.

Fish and Game Code Section 2087 authorizes accidental take of candidate, threatened, or endangered species resulting from acts that occur on a farm or a ranch in the course of otherwise lawful routine and ongoing agricultural activities.

As a CESA-listed species, fisher would be more likely to be included in Natural Community Conservation Plans (Fish & G. Code, § 2800 *et seq*.) and benefit from large-scale planning. Further, the full mitigation standard and funding assurances required by CESA would result in mitigation for the species. Actions subject to CESA may result in an improvement of available information about fisher because information on fisher occurrence and habitat characteristics must be provided to the Department in order to analyze potential impacts from projects.

Economic Considerations

The Department is not required to prepare an analysis of economic impacts (Fish & G. Code, § 2074.6).

Literature Cited

1. Douglas CW, Strickland MA (1999) Fisher. Wild Furbearer Management and Conservation in North America. Species Biology, Management, and Conservation. Chapter 40.

2. Powell RA (1993) The fisher: life history, ecology, and behavior. University of Minnesota Press Minneapolis.

3. Grinnell J, Dixon JS, Linsdale JM, University of California B, Museum of Vertebrate Zoology (1937) Fur-bearing mammals of California: their natural history, systematic status, and relations to man,. Berkeley, Calif.: University of California press.

4. Buskirk SW, Ruggiero LF (1994) American Marten. The Scientific Basis for Conserving Forest Carnivores - American Marten, Fisher, Lynx, and Wolverine in the Western United States. US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. p. 186.

5. Lewis JC, Stinson DW (1998) Washington State status report for the fisher. Washington Department of Fish and Wildlife, Wildlife Management Program.

6. Coulter M. (1966) The ecology and management of fishers in Maine Syracuse, New York, USA: University, Syracuse.

7. Pittaway RJ (1978) Observations on the behaviour of the fisher (Martes pennanti) in Algonquin Park, Ontario. Nat Can 105: 487–489.

8. Douglas CW, Strickland MA (1987) Fisher. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. Ontario, Canada: Ontario Ministry of Natural Resources.

9. Erxleben JCP (1777) Systema regni animalis per classes, ordines, genera, species, varietates cum synonymia et historia animalium: Classis I. Mammalia. Impensis Weygandianis.

10. Goldman FA (1935) New American mustelids of the genera Martes, Gulo, and Lutra. Proc Biol Soc Wash 48: 175–186.

11. Rhoads SN (1898) Contributions to a revision of the North American beavers, otters and fishers. Trans Am Philos Soc 19: 417–439.

12. Hagmeier EM (1959) A reevaluation of the subspecies of fisher. Can Field Nat 73: 185–197.

13. Hosoda T, Suzuki H, Harada M, Tsuchiya K, Han S-H, et al. (2000) Evolutionary trends of the mitochondrial lineage differentiation in species of genera Martes and Mustela. Genes Genet Syst 75: 259–267.

14. Stone KD, Cook JA (2002) Molecular evolution of Holarctic martens (genus Martes, Mammalia: Carnivora: Mustelidae). Mol Phylogenet Evol 24: 169–179.

15. Koepfli K-P, Deere K, Slater G, Begg C, Begg K, et al. (2008) Multigene phylogeny of the Mustelidae: resolving relationships, tempo and biogeographic history of a mammalian adaptive radiation. BMC Biol 6: 10.

16. Sato JJ, Wolsan M, Minami S, Hosoda T, Sinaga MH, et al. (2009) Deciphering and dating the red panda's ancestry and early adaptive radiation of Musteloidea. Mol Phylogenet Evol 53: 907–922.

17. Wolsan M, Sato JJ (2010) Effects of data incompleteness on the relative performance of parsimony and Bayesian approaches in a supermatrix phylogenetic reconstruction of Mustelidae and Procyonidae (Carnivora). Cladistics 26: 168–194.

18. Nyakatura K, Bininda-Emonds OR (2012) Updating the evolutionary history of Carnivora (Mammalia): a new species-level supertree complete with divergence time estimates. BMC Biol 10: 12.

19. Sato JJ, Wolsan M, Prevosti FJ, D'Elía G, Begg C, et al. (2012) Evolutionary and biogeographic history of weasel-like carnivorans (Musteloidea). Mol Phylogenet Evol 63: 745–757.

20. Baldy R, Beck R, Carpenter C, Carpenter W, Golla V, et al. (1996) Hupa language dictionary. Second. Hoopa, CA: Hoopa Valley Tribal Council. 131 p.

21. Samuels JX, Cavin J (2013) The earliest known fisher (Mustelidae), a new species from the Rattlesnake Formation of Oregon. J Vertebr Paleontol 33: 448–454. doi:10.1080/02724634.2013.722155.

22. Eshelman R, Grady F (1984) Quaternary vertebrate localities of Virginia and their avian and mammalian fauna. In: McDonald JN, Bird SO, editors. The Quaternary of Virginia - A symposium volume. Charlottsville, Virginia: VIRGINIA DIVISION OF MINERAL RESOURCES PUBLICATION 75, Vol. 75. pp. 43–70.

23. Graham RW, Graham MA (1994) The late Quaternary distribution of Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates.

24. Lofroth EC, Raley CM, Finley LL, Naney RH (2010) Conservation of fishers (Martes pennanti) in south-central British Columbia, western Washington, western Oregon, and California. US Government Printing Office.

25. Powell RA, Zielinski WJ (1994) Fisher. General Technical Report. Fort Collins, CO: USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. Available: http://treesearch.fs.fed.us/pubs/27328. Accessed 11 October 2013.

26. Lewis JC, Powell RA, Zielinski WJ (2012) Carnivore Translocations and Conservation: Insights from Population Models and Field Data for Fishers (Martes pennanti): e32726. PLoS One 7: n/a. doi:http://dx.doi.org/10.1371/journal.pone.0032726.

27. Gibilisco CJ (1994) Distributional dynamics of modern Martes in North America. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables,

and fishers: biology and conservation. , Ithaca, New York, USA: Cornell University Press.

28. Tucker JM, Schwartz MK, Truex RL, Pilgrim KL, Allendorf FW (2012) Historical and contemporary DNA indicate Fisher decline and isolation occurred prior to the European settlement of California. PloS One 7.

29. Knaus BJ, Cronn R, Liston A, Pilgrim K, Schwartz MK (2011) Mitochondrial genome sequences illuminate maternal lineages of conservation concern in a rare carnivore. BMC Ecol 11: 10.

30. Grinnell, J, Dixon J, Linsdale M (1930) Vertebrate natural history of a section of northern California through the Lassen Peak region. University of California Publications in Zoology. 594 p.

31. Price WW (1894) Notes on a Collection of Mammals from the Sierra Nevada Mountains. ZOE Biol J 4: 315–332.

32. Aubry KB, Jagger LA (2006) The importance of obtaining verifiable occurrence data on forest carnivores and an interactive website for archiving results from standardized surveys. In: Santos-Reis M, Birks JDS, O'Doherty EC, Proulx G, editors. Martes in Carnivore Communities. Alberta, Canada: Alpha Wildl. Publ.

33. McKelvey KS, Aubry KB, Schwartz MK (2008) Using Anecdotal Occurrence Data for Rare or Elusive Species: The Illusion of Reality and a Call for Evidentiary Standards. Bioscience 58: 549–555.

34. Aubry KB, Lewis JC (2003) Extirpation and reintroduction of fishers (Martes pennanti) in Oregon: implications for their conservation in the Pacific states. Biol Conserv 114: 79–90. doi:http://dx.doi.org/10.1016/S0006-3207(03)00003-X.

35. Zielinski WJ, Truex RL, Schlexer FV, Campbell LA, Carroll C (2005) Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. J Biogeogr 32: 1385–1407.

36. Zielinski WJ, Kucera TE, Barrett RH (1995) Current distribution of the fisher, Martes pennanti, in California. Calif Fish Game 81: 104–112.

37. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

38. Drew RE, Hallett JG, Aubry KB, Cullings KW, Koepf SM, et al. (2003) Conservation genetics of the fisher (Martes pennanti) based on mitochondrial DNA sequencing. Mol Ecol 12: 51–62.

39. Talking Glossary: "Haplotype" (n.d.). Available: http://www.genome.gov/glossary/index.cfm?id=99. Accessed 4 September 2014.

40. ~~Tucker~~ 40 JM (2013) Assessing changes in connectivity and abundance through time for fisher in the southern Sierra Nevada. Dissertation The University of Montana.

41. Wright PL, Coulter MW (1967) Reproduction and growth in Maine fishers. J Wildl Manag: 70–87.

42. Leonard RD (1986) Aspects of reproduction of the fisher, Martes pennanti in Manitoba. Can Field-Nat Ott ON 100: 32–44.

43. Eadie WR, Hamilton WJ (1958) Reproduction in the fisher in New York. N Y Fish Game J 5: 77–83.

44. Frost HC, Krohn WB (1997) Factors affecting the reproductive success of captive female fishers. In: Proulx G, Bryant HN, Woodward PM, editors. Martes: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB. pp. 100–109.

45. Paragi TF, Arthur SM, Krohn WB (1994) Seasonal and circadian activity patterns of female fishers, Martes pennanti, with kits. Can Field-Nat Ott ON 108: 52–57.

46. Arthur SM, Krohn WB (1991) Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J Mammal: 72–2.

47. Mead RA (1994) Reproduction in Martes. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 404–422.

48. Frost HC, Krohn WB, Wallace CR (1997) Age-specific reproductive characteristics in fishers. J Mammal 78: 598–612.

49. Aubry KB, Raley CM (2006) Ecological characteristics of fishers (Martes pennanti) in the Southen Oregon Cascade Range Update: July 2006. Unpubl. report. Olympia, WA: USDA Forest Service, Pacific Northwest Research Station Olympia Fortestry Sciences Laboratory.

50. Higley JM, Matthews S (2006) Demographic rates and denning ecology of female Pacific fishers (Martes pennanti) in northwestern California: Preliminary report October 2004-July 2006. Unpubl. report. Hoopa Valley Tribe and Wildlife Conservation Society.

51. Self S, Callas R (2006) Pacific fisher natal and maternal den study: Progress Report No. 1. Sierra Pac Ind Calif Dep Fish Game.

52. Weir RD, Corbould FB (2008) Ecology of fishers in the sub-boreal forests of north-central British Columbia, final report. Prince George, British Columbia, Canada: Peace/Williston Fish & Wildlife Compensation Program.

53. Truex RL, Zielinski WJ, Golightly RT, Barrett RH, Wisely SM (1998) A meta-analysis of regional variation in fisher morphology, demography, and habitat ecology in California. Draft Rep Submitt Calif Dep Fish Game U S For Serv Pac Southwest Res Stn Arcata Calif.

54. Hall ER (1942) Gestation period in the fisher with recommendations for the animal$\backslash$’s protection in California. Calif Fish Game 28: 143–147.

55. Paragi TF, Krohn WB, Arthur SM (1994) Using estimates of fisher recruitment and survival to evaluate population trend. Northeast Wildl 51: 1–11.

56. York EC (1996) Fisher population dynamics in north-central Massachusetts University of Massachusetts at Amherst.

57. Matthews SM, Higley JM, Rennie KM, Green RE, Goddard CA, et al. (2013) Reproduction, recruitment, and dispersal of fishers (Martes pennanti) in a managed Douglas-fir forest in California. J Mammal 94: 100–108.

58. Bachelot A, Binart N (2005) Corpus luteum development: lessons from genetic models in mice. Curr Top Dev Biol 68: 49–84. doi:10.1016/S0070-2153(05)68003-9.

59. Kelly GM (1977) Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas University of Massachusetts. Available: http://agris.fao.org/agris-search/search/display.do?f=2013/US/US2013054260005426.xml;US201300542658. Accessed 11 October 2013.

60. Crowley SK, Krohn WB, Paragi TF (n.d.) A comparison of fisher reproductive estimates. Trans Northeast Sect Wildl Soc 47: 36–42.

61. Weir RD (2003) Status of the fisher in British Columbia. BC Minist Sustain Resour Manage Conserv Data Cent BC Minist Water Land Air Prot Biodivers Branch Vic BC Wildl Bull No B-105 38pp: 3.

62. Arthur SM, Paragi TF, Krohn WB (1993) Dispersal of juvenile fishers in Maine. J Wildl Manag 57: 868.

63. Higley JM, Matthews S (2009) Fisher habitat use and population monitoring on the Hoopa Valley Reservation, California Final Report USFWS TWG U-12-NA-1. Hoopa Val Tribe Hoopa Calif USA.

64. King CM, Powell RA, Powell C (2007) The natural history of weasels and stoats: ecology, behavior, and management. Oxford University Press New York.

65. Paragi TF (1990) Reproductive biology of female fishers in southcentral Maine University of Maine at Orono. Available: http://www.library.umaine.edu/theses/theses.asp?Cmd=abstract&ID=MARC1647. Accessed 11 October 2013.

66. Reno MA, Rulon K, James C (2008) Fisher (Martes Pennanti) Presence, Physical Attributes and Condition Within Two Industrially Managed Forests of Northern California. 2008 Annual Conference of the Western Section of the Wildlife Society.

67. Aging Experience, Accuracy and Precision (n.d.). Available: http://www.matsonslab.com/aging-experience-accuracy-and-precision.html. Accessed 6 September 2014.

68. Brown RN, Gabriel MW, Wengert G, Matthews S, Higley JM, et al. (2006) Fecally transmitted viruses associated with Pacific fishers (Martes pennanti) in northwestern California. Trans West Sect Wildl Soc 42: 40–46.

69. Sandra Martin (1994) Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael RA, Powell RA, editors. Martens, sables and

fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 297–315.

70. Zielinski WJ, Duncan NP (2004) Diets of Sympatric Populations of American Martens (martes Americana) and Fishers (martes Pennanti) in California. J Mammal 85: 470–477.

71. Golightly RT, Penland TF, Zielinski WJ, Higley JM (2006) Fisher diet in the Klamath/north coast bioregion. Final Rep US Fish Wildl Serv Scotia Pac Humboldt State Spons Programs Found Arcata Calif.

72. Zielinski WJ, Duncan NP, Farmer EC, Truex RL, Clevenger, et al. (1999) Diet of fishers (Martes pennanti) at the southernmost extent of their range. J Mammal 80: 961–971.

73. Grenfell WE, Fasenfest M (1979) Winter food habits of fisher (Martes pennanti) in northwestern California. Calif Fish Game 65: 186–189.

74. Bioregions of California (n.d.). Available: http://biodiversity.ca.gov/bioregions.html. Accessed 5 September 2014.

75. Powell RA, Brander RB (1977) Adaptations of fishers and porcupines to their predator prey system. Proceedings of the 1975 Predator Symposium (RL Phillips and C. Jonkel, eds.). University of Montana, Missoula. pp. 45–53.

76. Powell SM, York EC, Fuller TK (1997) Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodard PM, editors. Martes: taxonomy, ecology, techniques, and management. Alberta, Canada: Provincial Museum of Alberta, Edmonton. pp. 279–305.

77. Weir RD, Harestad AS, Wright RC (2005) Winter Diet Of Fishers In British Columbia. Northwest Nat 86: 12–19. doi:http://dx.doi.org/10.1898/1051-1733(2005)086[0012:WDOFIB]2.0.CO;2.

78. Kuehn DW (1989) Winter foods of fishers during a snowshoe hare decline. J Wildl Manag: 688–692.

79. Burt WH (1943) Territoriality and home range concepts as applied to mammals. J Mammal 24: 346–352.

80. Buck S, Mullis C, Mossman AS (1983) Corral Bottom-Hayfork Bally Fisher Study: final report. Arcata, CA: Humboldt State University and USDA Forest Service.

81. Johnson SA (1984) Home range, movements, and habitat use of fishers in Wisconsin University of Wisconsin–Stevens Point.

82. Arthur SM, Krohn WB, Gilbert JR (1989) Home range characteristics of adult fishers. J Wildl Manag 53: 674–679.

83. Jones JL (1991) Habitat use of fisher in northcentral Idaho University of Idaho.

84. Garant Y, Crete M (1997) Fisher, Martes pennanti, home range characteristics in a high density untrapped population in southern Quebec. Can Field-Nat Ott ON 111: 359–364.

85. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Home Range Characteristics Of Fishers in California. J Mammal 85: 649–657.

86. Yaeger JS (2005) Habitat at fisher resting sites in the Klamath Province of northern California [Master's Thesis]. Arcata, CA: Humboldt State University. Available: http://www.fws.gov/yreka/fisher/Literature/Yaeger%202005.pdf. Accessed 11 October 2013.

87. Koen EL, Bowman J, Findlay CS, Zheng L (2007) Home Range and Population Density of Fishers in Eastern Ontario. J Wildl Manag 71: 1484–1493. doi:http://dx.doi.org/10.2193/2006-133.

88. Raley CM, Lofroth EC, Truex RL, Yaeger JS, Higley JM (2012) Habitat ecology of fishers in western North America. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press.

89. Mabry KE, Shelley EL, Davis KE, Blumstein DT, Vuren DHv (2013) Social Mating System and Sex-Biased Dispersal in Mammals and Birds: A Phylogenetic Analysis: e57980. PLoS One 8.

90. Strickland MA (1994) Harvest management of fishers and American martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 149–164.

91. Aubry K, Wisely S, Raley C, Buskirk S (2004) Zoogeography, Spacing Patterns, and Dispersal in Fishers. In: Harrison DJ, Fuller AK, editors. Martens and Fishers (Martes) in Human-Altered Environments: an international perspective. New York, NY: Springer. pp. 201–220.

92. Greenwood PJ (1980) Mating systems, philopatry and dispersal in birds and mammals. Anim Behav 28: 1140–1162.

93. Stephen Dobson F (1982) Competition for mates and predominant juvenile male dispersal in mammals. Anim Behav 30: 1183–1192.

94. De Vos A (1951) Overflow and dispersal of marten and fisher from wildlife refuges. J Wildl Manag 15: 164–175.

95. Hamilton WJ, Cook AH, Hamilton WF (1955) The biology and management of the fisher in New York. N Y Fish Game J 2: 13–35.

96. Powell RA (1979) Ecological energetics and foraging strategies of the fisher (Martes pennanti). J Anim Ecol: 195–212.

97. Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61: 65–71.

98. Buskirk SW, Powell RA (1994) Habitat Ecology of Fishers and American Martens. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 283–296. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

99. The Public Land Survey System (PLSS) (n.d.). Available: http://nationalatlas.gov/articles/boundaries/a_plss.html. Accessed 4 September 2014.

100. Krohn WB, Arthur SM, Paragi TF (1994) Mortality and vulnerability of a heavily trapped fisher population. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Comstock Publishing Associates. Available: http://www.cabdirect.org/abstracts/19950611063.html. Accessed 9 October 2013.

101. Klug Jr RR (1997) Occurrence of Pacific fisher (Martes pennanti pacifica) in the redwood zone of northern California and the habitat attributes associated with their detections Humboldt State University.

102. Carroll C, Zielinski WJ, Noss RF (1999) Using Presence-Absence Data to Build and Test Spatial Habitat Models for the Fisher in the Klamath Region, U.S.A. Conserv Biol 13: 1344–1359.

103. Davis FW, Seo C, Zielinski WJ (2007) Regional variation in home-range-scale habitat models for fisher (Martes pennanti) in california. Ecol Appl 17: 2195–2213.

104. Slauson KM, Zielinski WJ, Holm GW (2003) Distribution and Habitat Associations of the Humboldt marten (Martes americana humboldtensis), and Pacific fisher (Martes pennanti pacifica) in Redwood National and State Parks. Final Rep USDA For Serv Pac Southwest Res Stn Arcata Calif USA.

105. Weir RD, Harestad AS (2003) Scale-dependent habitat selectivity by fishers in south-central British Columbia. J Wildl Manag 67: 73–82.

106. Campbell LA (2004) Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada University of California. Available: http://www.fs.fed.us/psw/programs/snrc/staff/campbell/campbell_dissertation.pdf. Accessed 11 October 2013.

107. Aubry KB, Raley CM, Buskirk SW, Zielinski WJ, Schwartz MK, et al. (2013) Meta-analyses of habitat selection by fishers at resting sites in the pacific coastal region. J Wildl Manag 77: 965–974.

108. Zielinski WJ, Truex RL, Schmidt GA, Schlexer FV, Schmidt KN, et al. (2004) Resting habitat selection by fishers in California. J Wildl Manag 68: 475–492.

109. Purcell KL, Mazzoni AK, Mori SR, Boroski BB (2009) Resting structures and resting habitat of fishers in the southern Sierra Nevada, California. For Ecol Manag 258: 2696–2706.

110. Davis LR (2009) Denning ecology and habitat use by fisher (Martes pennanti) in pine dominated ecosystems of the Chilcotin Plateau Dept. of Biological Sciences-Simon Fraser University. Available: http://summit.sfu.ca/item/9870. Accessed 10 October 2013.

111. Bull EL, Parks CG, Torgersen TR (1997) Trees and logs important to wildlife in the Interior Columbia River Basin. General Technical Report. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.

112. Manion PD (n.d.) Tree disease concepts. Second. New Jersey, USA: Prentice Hall Career and Technology.

113. Zielinski WJ, Dunk JR, Yaeger JS, LaPlante DW (2010) Developing and testing a landscape-scale habitat suitability model for fisher (Martes pennanti) in forests of interior northern California. For Ecol Manag 260: 1579–1591.

114. California Wildlife Habitat Relationships System (2008). Sacramento, California: California Department of Fish and Wildlife: California Interagency Wildlife Task Group.

115. Weir RD, Corbould FB (2010) Factors Affecting Landscape Occupancy by Fishers in North-Central British Columbia. J Wildl Manag 74: 405–410.

116. Buck SG, Mullis C, Mossman AS, Coolahan C (1994) Habitat use by fishers in adjoining heavily and lightly harvested forest. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, New York: Cornell University Press. pp. 368–376.

117. Jones JL, Garton EO (1994) Selection of successional stages by fishers in north-central Idaho. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. pp. 377–387.

118. De Vos A (1952) The ecology and management of fisher and marten in Ontario. Available: http://www.citeulike.org/group/15497/article/9675279. Accessed 21 August 2014.

119. Spencer W, Rustigian-Romsos H, Strittholt J, Scheller R, Zielinski W, et al. (2011) Using occupancy and population models to assess habitat conservation opportunities for an isolated carnivore population. Biol Conserv 144: 788–803.

120. Hagmeier EM (1956) Distribution of marten and fisher in North America. Can Field Nat 70: 149–168.

121. Banci V (1989) A fisher management strategy for British Columbia. Victoria, British Columbia, Canada: Ministry of Environment.

122. Powell RA (1994) Structure and spacing of Martes populations. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA. pp. 101–121.

123. Lewis JC, Zielinski WJ (1996) Historical harvest and incidental capture of fishers in California. Northwest Sci 70: 291–297.

124. Dixon JS (1925) A closed season needed for fisher, marten, and wolverine. Calif Fish Game 11: 23–25.

125. Gould GI Jr (1987) Forest Mammal Survey and Inventory. Calif. Dept. of Fish and Game.

126. Powell RA, Facka AN, Clifford DL, Beach C, Smith K (2013) Reintroduction of fishers into the northern Sierra Nevada of California: Annual Report for 2012. North Carolina State University, California Department of Fish and Wildlife.

127. Lamberson RH, Truex RL, Zielinski WJ, Macfarlane D (2000) Preliminary analysis of fisher population viability in the southern Sierra Nevada. Arcata CA Humboldt State Univ.

128. Spencer WD, Rustigian H, Strittholt JR, Scheller R, Syphard A (2008) Coupling Habitat, Population, and Landscape-Change Models for Fishers (Martes Pennanti) in the Sierra Nevada, California. 22nd Annual Meeting of the Society for Conservation Biology (SCB 2008).

129. Jordan MJ (2007) Fisher ecology in the Sierra National Forest, California Berkeley, Calif.: University of California, Berkeley. Available: http://www.carnivoreconservation.org/files/thesis/jordan_2007_phd.pdf. Accessed 11 October 2013.

130. Matthews SM, Mark Higley J, Scott Yaeger J, Fuller TK (2011) Density of fishers and the efficacy of relative abundance indices and small-scale occupancy estimation to detect a population decline on the Hoopa Valley Indian Reservation, California. Wildl Soc Bull 35: 69–75.

131. Diller L, Hamm K, Lamphear D, Thompson J (2008) Summary of fisher (Martes pennanti) studies on Green Diamond Resource Company timberlands, north coastal California. Korbel, CA: Green Diamond Resource Company.

132. Swiers RC (2013) Non-Invasive Genetic Sampling and Mark-Recapture Analysis of a Fisher (Martes pennanti) Population in Northern California used as a Reintroduction Source. [Raleigh, North Carolina]: North Carolina State University,.

133. Noon BR, Bailey LL, Sisk TD, McKelvey KS (2012) Efficient Species-Level Monitoring at the Landscape Scale. Conserv Biol 26: 432–441.

134. Zielinski WJ, Baldwin JA, Truex RL, Tucker JM, Flebbe PA (2013) Estimating Trend in Occupancy for the Southern Sierra Fisher Martes pennanti Population. J Fish Wildl Manag 4: 3–19.

135. Bechtold WA, Patterson PL (2005) The enhanced forest inventory and analysis program: national sampling design and estimation procedures. General Technical Report. Asheville, North Carolina: US Department of Agriculture Forest Service, Southern Research Station.

136. Waples R (1991) Definition of a “species” under teh Endangered Species Act: Application to Pacific salmon. Technical menorandum. NOAA.

137. Franklin JF, Spies TA, Pelt RV, Carey AB, Thornburgh DA, et al. (2002) Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. For Ecol Manag 155: 399–423.

138. Thompson ID, Baker JA, Ter-Mikaelian M (2003) A review of the long-term effects of post-harvest silviculture on vertebrate wildlife, and predictive models, with an emphasis on boreal forests in Ontario, Canada. For Ecol Manag 177: 441–469.

139. USDA Forest Service (2014) Forest Management: Cut and sold reports. Available: http://www.fs.fed.us/forestmanagement/products/sold-harvest/cut-sold.shtml. Accessed 22 August 2014.

140. California Timber Harvest Statistics - harvyr2.pdf (n.d.). Available: http://www.boe.ca.gov/proptaxes/pdf/harvyr2.pdf. Accessed 6 September 2014.

141. Barnosky AD, Koch PL, Feranec RS, Wing SL, Shabel AB (2004) Assessing the causes of Late Pleistocene extinctions on the continents. Science 306: 70–75.

142. Wisely SM, Buskirk SW, Russell GA, Aubry KB, Zielinski WJ (2004) Genetic Diversity And Structure Of The Fisher (Martes Pennanti) In A Peninsular And Peripheral Metapopulation. J Mammal 85: 640–648. doi:http://dx.doi.org/10.1043/0022-2372(2004)085.

143. Farber S, Callas RL, Yaeger JS, Schwartz MK, Pilgrim K, et al. (2010) Cooperative mesocarnivore genetic surveys to estimate the number of individuals and preliminary sub-population trend in northern Siskiyou County, California: Draft 15 April 2010. Unpublished Report. Yreka Fish and Wildlife Office, Yreka, California: USDI Fish and Wildlife Service.

144. Wengert GW, Gabriel MW, Matthews SM, Higley JM, Sweitzer R, et al. (2013) Intraguild Predation on Fishers in California: Patterns of Predation by Three Larger Carnivores. Rev J Wildl Manag.

145. Buck SG (1982) Habitat utilization by fisher (Martes pennanti) near Big Bar, California [Master’s Thesis]. Arcata, CA: Humboldt State University.

146. Wengert GM (2013) Ecology of intraguild predation on fishers (Martes pennanti) in California UNIVERSITY OF CALIFORNIA, DAVIS. Available: http://gradworks.umi.com/36/14/3614292.html. Accessed 4 September 2014.

147. Williams ES (2001) Canine distemper. In: Williams ES, Barker RICK, editors. Infectious diseases of wild mammals. Ames, Iowa: Iowa State University Press. p. 50.

148. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

149. Williams ES, Thorne ET, Appel MJ, Belitsky DW (1988) Canine distemper in black-footed ferrets (Mustela nigripes) from Wyoming. J Wildl Dis 24: 385–398.

150. Timm SF, Munson L, Summers BA, Terio KA, Dubovi EJ, et al. (2009) A suspected canine distemper epidemic as the cause of a catastrophic decline in Santa Catalina Island foxes (Urocyon littoralis catalinae). J Wildl Dis 45: 333–343.

151. Origgi FC, Plattet P, Sattler U, Robert N, Casaubon J, et al. (2012) Emergence of canine distemper virus strains with modified molecular signature and enhanced neuronal tropism leading to high mortality in wild carnivores. Vet Pathol Online 49: 913–929.

152. Gabriel MW, Wengert GM, Matthews SM, Higley JM, Foley JE, et al. (2010) Effectiveness of rapid diagnostic tests to assess pathogens of fishers (Martes pennanti) and gray foxes (Urocyon cinereoargenteus). J Wildl Dis 46: 966–970.

153. Gabriel MW, Wengert GW, Brown RN (2012) Pathogens and parasites of Martes species: Management and conservation implications. In: Aubry KB, Zielinski WJ,

Raphael MG, Proulx G, Buskirk SW, editors. Biology and conservation of martens, sables, and fishers: a new synthesis. Ithaca, New York: Cornell University Press. pp. 138–185.

154. Burns R, O'Toole ESWD, 2003 JPD (n.d.) Toxoplasma gondii infections in captive black-footed ferrets (Mustela nigripes), 1992–1998: clinical signs, serology, pathology, and prevention. J Wildl Dis 39: 787–797.

155. Pridham TJ, Belcher J (1958) Toxoplasmosis in mink. Can J Comp Med Vet Sci 22: 99–106.

156. Cole RA, Lindsay DS, Howe DK, Roderick CL, Dubey JP, et al. (2000) Biological and molecular characterizations of Toxoplasma gondii strains obtained from southern sea otters (Enhydra lutris nereis). J Parasitol 86: 526–530.

157. Larkin JL, Gabriel M, Gerhold RW, Yabsley MJ, Wester JC, et al. (2011) Prevalence to Toxoplasma gondii and Sarcocystis spp. in a Reintroduced Fisher (Martes pennanti) Population in Pennsylvania. J Parasitol 97: 425–429. doi:http://dx.doi.org/10.1645/GE-2623.1.

158. Brown RN, Gabriel MW, Wengert GW, Matthews S, Higley JM, et al. (2008) Pathogens associated with fishers. Final Report USFWS-813335G021. Yreka, CA.

159. Williams ES, Mills K, Kwiatkowski DR, Thorne ET, Boerger-Fields A (1994) Plague in a black-footed ferret (Mustela nigripes). J Wildl Dis 30: 581–585.

160. Weinmann R, Raskas HJ, Roeder RG (1974) Role of DNA-dependent RNA polymerases II and III in transcription of the adenovirus genome late in productive infection. Proc Natl Acad Sci 71: 3426–3430.

161. Clifford DL, Woods L, Gabriel MW, Tkach V, Hoberg E, et al. (2012) Assessing disease risk from a novel parasite infection in Pacific fisher (Martes pennanti). Sacramento, California.

162. CDOF (2011) E-6. Revised Population Estimates and Components of Change by County — July 1, 2000–2010. Sacramento, California: State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-6/2000-10/.

163. CDOF (1991) E-6 County Population Estimates and Components of Change— July 1, 1970–1990. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/view.php#objCollapsiblePanelEstimatesAnchor.

164. CDOF (2013) E-1 Cities, Counties, and the State Population Estimates with Annual Percent Change— January 1, 2012 and 2013. State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php.

165. CDOF (2013) Report P-1 (Age): State and County Population Projections by Major Age Groups, 2010-2060 (by decade). State of California, Department of Finance. Available: http://www.dof.ca.gov/research/demographic/reports/projections/P-1/.

166. Bunn D, Mummert A, Hoshovsky M, Gilardi K, Shanks S (2007) California wildlife: Conservation challenges (California's Wildlife Action Plan). California Department of Fish and Game and the Wildlife Health Center, University of California, Davis.

167. FRAP (2003) The changing California: Forest and range 2003 assessment. CalFire. Available: http://frap.fire.ca.gov/data/assessment2003/index.html.

168. Duane TP (1996) Human Settlement 1850-2040. In: Center WR, editor. Ecosystem Project, Final Report to Congress, vol. II, Assessments and Scientific Basis for Management Options. Davis, CA, USA.: University of California.

169. Theobald D (2005) Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecol Soc 10.

170. Garroway CJ, Bowman J, Wilson PJ (2011) Using a genetic network to parameterize a landscape resistance surface for fishers, Martes pennanti. Mol Ecol 20: 3978–3988.

171. Safford HD (2006) Potential Impacts of climate change to fisher habitat in California: a preliminary assessment. Unpubl. report. Vallejo, California: USDA Forest Service, Pacific Southwest Region.

172. Stephens SL, Sugihara NG (2006) Fire management and policy since European settlement. Fire in California's Ecosystems. Berkeley, California: University of California Press. pp. 431–443.

173. Show SB, Kotok EI (1923) Forest fires in California, 1911-1920: an analytical study. Washington D.C., USA: US Department of Agriculture. Available: http://scholarsarchive.library.oregonstate.edu/jspui/handle/1957/11024. Accessed 11 October 2013.

174. Stephens SL, Martin RE, Clinton NE (2007) Prehistoric fire area and emissions from California's forests, woodlands, shrublands, and grasslands. For Ecol Manag 251: 205–216. doi:http://dx.doi.org/10.1016/j.foreco.2007.06.005.

175. Taylor AH, Skinner CN (1998) Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. For Ecol Manag 111: 285–301.

176. Anderson MK (2006) The use of fire by Native Americans in California. In: Sugihara NG, Van Wagtendonk JW, Shaffer KE, Fites-Kaufman J, Thode AE, editors. Fire in California's Ecosystems. University of California Press. p. 596.

177. Martin RE, Sapsis DB (1992) Fires as agents of biodiversity: pyrodiversity promotes biodiversity. Proceedings of the conference on biodiversity of northwest California ecosystems. Cooperative Extension, University of California, Berkeley.

178. Miller JD, Safford HD, Crimmins M, Thode AE (2009) Quantitative evidence for increasing forest fire severity in the Sierra Nevada and southern Cascade Mountains, California and Nevada, USA. Ecosystems 12: 16–32.

179. Westerling AL, Hidalgo HG, Cayan DR, Swetnam TW (2006) Warming and earlier spring increase western US forest wildfire activity. Science 313: 940–943.

180. Miller JD, Skinner CN, Safford HD, Knapp EE, Ramirez CM (2012) Trends and causes of severity, size, and number of fires in northwestern California, USA. Ecol Appl 22: 184–203.

181. Zhang J, Webster J, Powers RF, Mills J (2008) Reforestation after the Fountain Fire in Northern California: An Untold Success Story. J For 106: 425–430.

182. LANDFIRE-Fire Regime Product Descriptions (n.d.). Available: http://www.landfire.gov/NationalProductDescriptions13.php. Accessed 4 September 2014.

183. Lawler JJ, Safford HD, Girvetz EH (2012) Martens and fishers in a changing climate. In: Aubry KB, Zielinski WJ, Raphael MG, Proulx G, Buskirk SW, editors. Martens, Sables, and Fishers: A New Synthesis. Ithaca, NY: Cornell University Press. pp. 371–397.

184. Fried JS, Torn, Mills E (2004) The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California. Clim Change 64: 169–191. doi:http://dx.doi.org/10.1023/B:CLIM.0000024667.89579.ed.

185. Westerling AL, Bryant BP, Preisler HK, Holmes TP, Hidalgo HG, et al. (2011) Climate change and growth scenarios for California wildfire. Clim Change 109: 445–463.

186. Mckenzie D, Gedalof Z, Peterson DL, Mote P (2004) Climatic Change, Wildfire, and Conservation. Conserv Biol 18: 890–902.

187. Krawchuk MA, Moritz MA (2012) Fire and Climate Change in California. Calif Energy Comm Publ Number CEC-500-2012-026.

188. Gabriel MW, Wengert GW, Higley JM, Krogan S (2013) Silent forests? Rodenticides on illegal marijuana crops harm wildlife. Wildl Prof Spring.

189. Gabriel MW, Woods LW, Poppenga R, Sweitzer RA, Thompson C, et al. (2012) Anticoagulant Rodenticides on our Public and Community Lands: Spatial Distribution of Exposure and Poisoning of a Rare Forest Carnivore: e40163. PLoS One 7.

190. Alterio N (1996) Secondary poisoning of stoats (Mustela erminea), feral ferrets (Mustela furo), and feral house cats (Felis catus) by the anticoagulant poison, brodifacoum. N Z J Zool 23: 331–338.

191. Moriarty JG, Riley PD, Sureiys LE, Sikich JA (2013) Exposure of wildlife to anticoagulant rodenticides at Santa Monica Mountains National Recreation Area: from mountain lions to rodents. Proceedings of the 25th Vertebrate Pest Conference. Vol. 25. pp. 144–148.

192. Erickson WA, Urban DJ (2004) Potential risks of nine rodenticides to birds and nontarget mammals: a comparative approach. US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances.

193. Fisher P, O'Connor C, Wright G, Easton CT (2003) Persistence of four anticoagulant rodenticides in livers of laboratory rats. New Zealand Department of Conservation.

194. Riley SPD, Bromley C, Poppenga RH, Uzal FA, al et (2007) Anticoagulant Exposure and Notoedric Mange in Bobcats and Mountain Lions in Urban Southern California. J Wildl Manag 71: 1874–1884.

195. Cox P, Smith R. (n.d.) Rodenticide ecotoxicology: pre-lethal effects of anticoagulants on rat behaviour. 15th Vertebrate Pest Conference. Davis, CA, USA.: University of California.

196. Thompson C, Sweitzer R, Gabriel M, Purcell K, Barrett R, et al. (2013) Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California. Conserv Lett.

197. Laas FJ, Forss DA, Godfreyi MER (1985) Retention of brodifacoum in sheep tissues and excretion in faeces. N Z J Agric Res 28: 357–359.

198. Godfrey MER, Lyman CP (1980) Preliminary dosing trials of a new anticoagulant, brodifacoum, as a toxicant for the rabbit, Oryctolagus cuniculus (L.). N Z J Exp Agric 8: 1–5.

199. Munday JS, Thompson LJ (2003) Brodifacoum toxicosis in two neonatal puppies. Vet Pathol Online 40: 216–219.

200. Jansman H, van Tulden P (2012) Persecution and poisoning of birds of prey in the Netherlands. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 139–142.

201. Mineau P, Lyon L, McMillin S (2012) Impacts of carbofuran on birds in Canada and the United States. In: Richards N, editor. Carbofuran and wildlife poisoning: global perspectives and forensic approaches. John Wiley & Sons. pp. 219–222.

202. Anderson B, Borges S, Graber K, Hartless C, Housenger J, et al. (2011) Risks of non-compliant rodenticides to nontarget wildlife. Washington D.C., USA: United States Environmental Protection Agency, O.o.C.S.a.P.P., Office of Pesticides Programs, Environmental Fate and Effect Division.

203. Berny PJ, Buronfosse T, Buronfosse F, Lamarque F, Lorgue G (1997) Field evidence of secondary poisoning of foxes (Vulpes vulpes) and buzzards (Buteo buteo) by bromadiolone, a 4-year survey. Chemosphere 35: 1817–1829.

204. Ruder MG, Poppenga RH, Bryan JA, Bain M, Pitman J, et al. (2011) Intoxication of nontarget wildlife with rodenticides in northwestern Kansas. J Wildl Dis 47: 212–216.

205. Janeway CA, Travers P, Walport M (2007) Immunobiology. 7th ed. New York, New York, USA: Garland Science.

206. Li Q, Kawada T (2006) The mechanism of organophosphorus pesticide-induced inhibition of cytolytic activity of killer cells. Cell Mol Immunol 3: 171–178.

207. Zabrodskii PF, Lim VG, Strel'tsova EV (2012) Disturbances of immune status and cytokine profile caused by chronic intoxication with organophosphorus compounds and their correction by administration of imunofan. Eksp Klin Farmakol 75: 35.

208. Vidal D, Alzaga V, Luque-Larena JJ, Mateo R, Arroyo L, et al. (2009) Possible interaction between a rodenticide treatment and a pathogen in common vole (Microtus arvalis) during a population peak. Sci Total Environ 408: 267–271. doi:http://dx.doi.org/10.1016/j.scitotenv.2009.10.001.

209. Gordon CJ (1994) Thermoregulation in laboratory mammals and humans exposed to anticholinesterase agents. Neurotoxicol Teratol 16: 427–453.

210. Grue CE, Hart ADM, Mineau P (1991) Biological consequences of depressed brain cholinesterase activity in wildlife. In: Mineau P, editor. Cholinesterase-inhibiting insecticides. Their Impact on wildlife and the environment. Amsterdam, Netherlands: Elsevier Science Publishers. pp. 151–209.

211. Ahdaya SM, Shah PV, Guthrie FE (1976) Thermoregulation in mice treated with parathion, carbaryl, or DDT. Toxicol Appl Pharmacol 35: 575–580.

212. Martin PA, Solomon KR (1991) Acute carbofuran exposure and cold stress: Interactive effects in mallard ducklings. Pestic Biochem Physiol 40: 117–127.

213. Hayward MW, Jedrzejewski W, Jedrzewska B (2012) Prey preferences of the tiger Panthera tigris. J Zool 286: 221–231. doi:http://dx.doi.org/10.1111/j.1469-7998.2011.00871.x.

214. Karanth KU, Nichols JD, Kumar NS, Link WA, Hines JE (2004) Tigers and their prey: predicting carnivore densities from prey abundance. Proc Natl Acad Sci U S A 101: 4854–4858.

215. Knick ST (1990) Ecology of bobcats relative to exploitation and a prey decline in southeastern Idaho. Wildl Monogr: 3–42.

216. Knick ST, Hellgren EC, Seal US (1993) Hematologic, biochemical, and endocrine characteristics of bobcats during a prey decline in southeastern Idaho. Can J Zool Can Zool 71: 1448–1453.

217. Colvin, B., Jackson W. (1991) Secondary poisoning hazards associated with rodenticide use. In: Magallona E., editor. 11th International Congress Plant Protection. Manila, Phillipines.

218. Pachauri RK, Reisinger A (2007) Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Intergov Panel Clim Change 1.

219. Solomon S, Qin D, Manning M, ALLEY R, BERNTSEN T, et al. (2007) Technical Summary. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate Change 2007: the physical science basis. Contribution of working group 1 to the fourth assessment report of the Intergovernmental Panel on Climate Change. Cambridge, UK and New York, USA: Cambridge University Press. pp. 19–91.

220. Bonfils C, Duffy PB, Santer BD, Wigley TML, Lobell DB, et al. (2008) Identification of external influences on temperatures in California. Clim Change 87: 43–55. doi:10.1007/s10584-007-9374-9.

221. Tingley MW, Koo MS, Moritz C, Rush AC, Beissinger SR (2012) The push and pull of climate change causes heterogeneous shifts in avian elevational ranges. Glob Change Biol 18: 3279–3290.

222. Pierce DW, Das T, Cayan DR, Maurer EP, Miller NL, et al. (2013) Probabilistic estimates of future changes in California temperature and precipitation using statistical and dynamical downscaling. Clim Dyn 40: 839–856. doi:http://dx.doi.org/10.1007/s00382-012-1337-9.

223. Cayan D, Tyree M, Pierce D, Das T (2012) Climate Change and Sea Level Rise Scenarios for California Vulnerability and Adaptation Assessment. California Energy Commission.

224. Littell JS, Elsner MM, Mauger G, Lutz E, Hamlet AF, et al. (2011) Regional climate and hydrologic change in the northern US Rockies and Pacific Northwest: internally consistent projections of future climate for resource management. University of Washington, College of the Environment.

225. Hayhoe K, Cayan D, Field CB, Frumhoff PC, Maurer EP, et al. (2004) Emissions pathways, climate change, and impacts on California. Proc Natl Acad Sci U S A 101: 12422–12427.

226. Christensen JH, Hewitson B, Busuioc A, Chen A, Gao X, et al. (2007) Regional climate projections. In: Susan S, Qin D, Manning M, Chen Z, Marquis M, et al., editors. Climate change 2007-the physical science basis: Working group I contribution to the fourth assessment report of the IPCC. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, Vol. 4.

227. Cayan D, Tyree M, Dettinger M, Hidalgo H, Das T, et al. (2009) Climate change scenarios and sea level rise estimates for the California 2008 climate change scenarios assessment. Calif Clim Change Cent CEC-500-2009-014-D.

228. Pierce DW, Cayan DR, Das T, Maurer EP, Miller NL, et al. (2013) The key role of heavy precipitation events in climate model disagreements of future annual precipitation changes in California. J Clim. Available: http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-12-00766.1. Accessed 14 October 2013.

229. Halofsky JE, Peterson DL, O'Halloran KA, Hawkins-Hoffman C (2011) Adapting to climate change at Olympic National Forest and Olympic National Park. General Technical Report. US Department of Agriculture, Forest Service, Pacific Northwest Research Station. Available: http://www.treesearch.fs.fed.us/pubs/38702. Accessed 14 October 2013.

230. Salathe EP, Leung Lr, Qian Y, Zhang Y (2010) Regional climate model projections for the State of Washington. Clim Change 102: 51–75. doi:http://dx.doi.org/10.1007/s10584-010-9849-y.

231. Ralph M (2011) Water supply and flooding. In: Pierce DW, editor. California Climate Extremes Workshop Report. La Jolla, CA: Scripps Institution of Oceanography.

232. Loarie SR, Duffy PB, Hamilton H, Asner GP, Field CB, et al. (2009) The velocity of climate change. Nature 462: 1052–1055. doi:10.1038/nature08649.

233. Moritz C, Agudo R (2013) The Future of Species Under Climate Change: Resilience or Decline? Science 341: 504–508. doi:10.1126/science.1237190.

234. Lenihan JM, Drapek R, Bachelet D, Neilson RP (2003) Climate change effects on vegetation distribution, carbon, and fire in California. Ecol Appl 13: 1667–1681.

235. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al. (2011) The impact of climate change on California's ecosystem services. Clim Change 109: 465–484. doi:10.1007/s10584-011-0313-4.

236. Koopman ME, Nauman RS, Leonard JL (2010) Future climate conditions in Fresno County and surrounding counties. The National Center for Conservation Science and Policy.

237. Burns CE, Johnston KM, Schmitz OJ (2003) Global climate change and mammalian species diversity in U.S. national parks. Proc Natl Acad Sci 100: 11474–11477.

238. Littell JS, Oneil EE, McKenzie D, Hicke JA, Lutz JA, et al. (2010) Forest ecosystems, disturbance, and climatic change in Washington State, USA. Clim Change 102: 129–158. doi:http://dx.doi.org/10.1007/s10584-010-9858-x.

239. Spies TA, Giesen TW, Swanson FJ, Franklin JF, Lach D, et al. (2010) Climate change adaptation strategies for federal forests of the Pacific Northwest, USA: ecological, policy, and socio-economic perspectives. Landsc Ecol 25: 1185–1199. doi:http://dx.doi.org/10.1007/s10980-010-9483-0.

240. Paradis A, Elkinton J, Hayhoe K, Buonaccorsi J (2008) Role of winter temperature and climate change on the survival and future range expansion of the hemlock woolly adelgid (Adelges tsugae) in eastern North America. Mitig Adapt Strateg Glob Change 13: 541–554.

241. Safranyik L, Carroll AL, Regniere J, Langor DW, Riel WG, et al. (2010) Potential for Range Expansion of Mountain Pine Beetle into the Boreal Forest of North America. Can Entomol 142: 415–442.

242. Trần JK, Ylioja T, Billings RF, Régnière J, Ayres MP (2007) Impact of minimum winter temperatures on the population dynamics of Dendroctonus frontalis. Ecol Appl 17: 882–899.

243. Vose JM, Peterson DL, Patel-Weynand T (2012) Effects of Climatic Variability and Change on Forest Ecosystems: A Comprehensive Science Synthesis for the US Forest Sector. US Department of Agriculture, Forest Service, Pacific Northwest Research Station.

244. USDA Forest Service, USDI Bureau of Land Management (1994) Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. [Portland, Or. : Interagency SEIS Team]. 569 p. Available: http://archive.org/details/finalsupplementa03v1unit. Accessed 2 September 2014.

245. USDA Forest Service, USDI Bureau of Land Management (1994) Standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl (Attachment A).

246. The Pacific Northwest Interagency Monitoring Program - Northwest Forest Plan Monitoring - Map Data (n.d.). Available: http://www.reo.gov/monitoring/reports/10yr-report/map-graphics/index.shtml. Accessed 5 September 2014.

247. Sulak A, Huntsinger L (2012) Perceptions of Forest Health among Stakeholders in an Adaptive Management Project in the Sierra Nevada of California. J For 110: 312–317.

248. Smith T (2014) What we're working on now: Pacific Southwest Research Station (PSW) Sugar Pine Fisher Project Update. Available: http://snamp.cnr.berkeley.edu/teams/fisher. Accessed 1 September 2014.

249. Kings River Fisher Project | Mammals | Wildlife & Fish | Research Topics (n.d.). Available: http://www.fs.fed.us/psw/topics/wildlife/mammals/fisher_krfp/. Accessed 1 September 2014.

250. USDI Bureau of Land Management (2008) Sierra Resource Management Plan and Record of Decision. Folsom, CA: Bureau of Land Management.

251. Hannibal ME (2012) America's Next Best Idea: The National Park System Looks to the Future. George Wright Forum 29: 380–384.

252. FSC Forest Stewardship Council U.S. (FSC-US) · Our History (n.d.). Available: https://us.fsc.org/our-history.180.htm. Accessed 2 September 2014.

253. FSC Forest Stewardship Council U.S. (FSC-US) · Mission and Vision (n.d.). Available: https://us.fsc.org/mission-and-vision.187.htm. Accessed 2 September 2014.

254. preview.fsc-certified-acres-by-state.a-204.pdf (n.d.). Available: https://us.fsc.org/preview.fsc-certified-acres-by-state.a-204.pdf. Accessed 2 September 2014.

255. IUCN, SSC (2013) Guidelines for Reintroductions and Other Conservation Translocations. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission.

256. Callas RL, Figura P (2008) Translocation plan for the reintroduction of fishers (Martes pennanti) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. Sacramento, California: California Department of Fish and Game.

257. Gould GI, Escallier J (1989) Licensed trapper's and dealer's report. Sacramento, California: California Department of Fish and Game.

258. Keller SM, Gabriel M, Terio KA, Dubovi EJ, VanWormer E, et al. (2012) Canine distemper in an isolated population of fishers (Martes pennanti) from California. J Wildl Dis 48: 1035–1041.

Review Comments: Fisher Status Report

W. Zielinski - 03 November 2014

General Comments:

1. **<u>Excellent review of the literature</u>**. This is a very comprehensive review, summarizing the relevant literature in a way that is easily consumed and understood. I really respect the amount of work involved in summarizing fisher and related literature; this is a mammoth undertaking. I wanted to note this first, because it is the most impressive aspect of the document. I will be using this review as a source of fisher information for some time to come! Very few sources of published literature are excluded, primarily those that appeared recently. I've listed these at the end of this review.
2. **<u>The gap</u>**. The review represents a nuanced and, in my opinion, appropriate consideration of the historical and current gap in the fisher distribution in the Sierra. This is a critical element of the review because of the implications. If one assumes the gap was large prior to human influence, then the current distribution may not be interpreted as very different than the historical distribution. If, on the other hand, one views the historical gap as small – which seems to be the way the review is leaning – then the current distribution is significantly smaller than the historical distribution. The evidence pits sophisticated molecular genetic data against old fashioned accounts by naturalists and trappers; evidence that is difficult to reconcile. I think the document puts the matter in proper perspective, bringing the full weight of historical evidence, from scientists and naturalists, to bear on the issue. I agree with the estimate that the current distribution is only 48% of the historical distribution (line 519-520). The conclusion, however, that the current distribution is half of the historical distribution suggests that the NC and SN ESUs may be at greater risk than the review seems to suggest.
3. **<u>An apparent bias when data are lacking</u>**. I noted a number of examples where, when data on a particular topic were lacking, the authors assumed the best rather than the worst, or something in-between. Ideally, when the conservation of a species is a stake and a document is written by the agency responsible for that species, the precautionary principle is applied. There are a number of cases where this does not seem to be the case. Examples are listed below:
    a. Pg. 3, lines 90-91. That there is "no substantial evidence" isn't the same as no effect; no evidence can also mean that there may be effects that haven't yet been revealed.
    b. Pg. 3, line 108. "Insufficient information" is used here to imply that when little is known there is probably no effect, but the precautionary principle would have us err on the side of assuming a negative effect when we know the potential direct and indirect risks from rodenticides.
    c. Pg. 47, line 1399 – 1406. Yes, the timber harvest has decreased since the 1980s, but what is not mentioned here is that the historical high in the 1980s took many of the saw logs that would have been resting habitat, had they not been harvested. The fact that harvest is at low levels now is no protection for fishers if in the preceding century a significant number of large trees were removed. To be fair we should have data on the saw logs that <u>remain</u> in the forest in the form of large trees, compared to what would have been

available if the heavy harvest decades of the previous century had not occurred. This section seems written to downplay the effect of timber harvest on fisher habitat.

d. Pg. 51, lines 1466-1467. This is an optimistic, but unsubstantiated conclusion. It is hard to believe this in light of the decades of saw log harvest in the late 20th century. But, here again, is a conclusion that assumes the best when it would be equally likely to conclude – in the absence of data and with the history of selective harvest in the mid-elevations of the Sierra – that availability may indeed be limiting fisher populations.

e. Bobcats and mountain lions are key predators on fishers and are also species that favor more disturbed and early seral habitats. Thus, many fisher scientists have assumed that timber harvest and other factors that fragment overhead cover will provide and advantage to the fisher's predators. Yet, on page 55 (lines 1571-1573) - despite evidence from Wengert (and from Slader Buck's thesis) and a strong basis in conventional wisdom based on habitat relations – the authors are equivocal about whether forest management practices could affect the abundance/distribution of fisher predators ("*Whether or not some forest management practices favor.. generalist predators (like bobcats)… is not known*"). Stating that it is not known, in this case gives the impression that it is not likely to be a factor, which is contrary to conventional wisdom.

f. Pg. 64, lines 1821-1823. Indeed, "…*roads.. have not been demonstrated to limit fisher populations*", but nor has that possibility been eliminated. One has to ask, what type of data would be necessary, and how expensive would it be to collect, to demonstrate that roads limit fisher populations? This is asking a lot; instead the review assumes no effect when the data do not exist to demonstrate an effect. This is another example of a subtle and likely unintentional, bias against fisher conservation.

g. Pg. 73, line 2085-86. Yes, any cumulative impact – esp. of an illegal activity – is "*hard to quantify at the population level*" but the widespread and ubiquitous nature of the threat should be a major concern, even if hard to quantify. Stating how difficult it is to quantify suggests to the reader that it doesn't have a significant negative effect.

4. **Discounting the cumulative risks facing the SN ESU**. There were a number of locations in the document where risk factors/threats were described for each ESU but those risks were presumed to affect the SN ESU – which is smaller and more vulnerable - more negatively than the NC ESU. Viewed collectively, the following factors may interact to put the SN ESU at greater risk than the NC ESU: (1) ARs, (2) climate change, (3) fire severity, (4) susceptibility to fragmentation, (5) small existing population size and (6) fewer state and fed land allocations that may indirectly benefit fishers. The generally low reproductive capacity of fishers (line 659) compound these risks. The review states, on page 53, that "*Fishers in the southern SN are geographically isolated….and do not appear to be expanding their range northward*." Moreover, lines 3085-3087 state that "*Events such as drought, high intensity fires and disease, should they occur… have a higher probability of adversely affecting the fisher(s).. in the southern Sierra*". I would argue that these factor factors are occurring and thus, they are having a disproportionate effect on the SN ESU. The totality of evidence, in my opinion, would lead one to conclude that the SN ESU will require more protection than the NC ESU, yet the apparent conclusion the

Department is poised to make, renders the same conclusion for both ESUs, i.e., that neither requires the protection of listing.

5. **<u>Uncertain implementation of purported protections by land management agencies</u>**. In the section entitled "*Existing Management…Activities*" the review cites rules/regs on federal, state and private lands as though they have been implemented and have been demonstrated to be effective at protecting fishers or their habitat. However, many of these policies are protection in words only. The tone of some of the writing is decidedly optimistic, in terms of fisher habitat outcomes. In a number of cases, I believe this tone is not justified given how little evidence exists that rules/regs have been implemented and have resulted in benefits. Examples include the following:
   - **a.** Pg. 81, line 2298. I have reviewed many such "cumulative effects" analyses by the USFS and they are superficial at best and, at worst, give the reader a false sense of security about the effects of projects. Direct and indirect cumulative effects analyses boil down to simple descriptions of existing conditions. Limited faith should be placed on NEPA as a policy tool that will help maintain fisher populations on FS land.
   - **b.** Pg. 81, line 2318. This implies that the NWFP protects sites important to fishers, but fishers are not one of the species individually identified for such protections. This is another instance where the regulations have not been demonstrated to address fisher conservation.
   - **c.** Pg. 85, line 2403-04. Where is the analysis that suggests that wilderness areas provide considerable suitable habitat? Is it optimism that fuels the statement referred to here? Our work, in the Klamath province (Zielinski et al. 2010) found that little predicted fisher habitat occurred in wilderness**.**
   - **d.** Pg. 86, line 2414. Certainly there is the "intention" to manage the monument for viable populations of fishers. But having reviewed that document, and seeing what has occurred on the ground since its signing, it is faith alone that would lead one to conclude that the GSNM has a plan that will assure viable fisher populations. The GSNM is not monitoring or managing for the conservation of fishers that I am aware of, at least in any accountable fashion. Similarly, text on lines 2418 – 2421, gives the reader a false sense of comfort when these objectives are listed, but in reality there is nothing to guarantee that these steps are, or will be taken.
   - **e.** Pg. 87. The contributions that BLM and NPS are making to fisher conservation are treated very superficially and, in the case of the BLM account, give a false sense of responsible management intended to protect fishers. Yes, the BLM has regs and objectives to "support viable populations" of fishers, but they have neither comprehensive management plan nor monitoring plan to tell us whether they have (or will) succeed or not. The statements here seem to be provided only to add to a list of other good intentions that, if examined carefully will reveal that "the emperor has no clothes". On the other hand, the NPS in the Sierra ESU is providing real habitat management in the form of low intensity Rx fire, restoring conditions that many believe the fisher used prior to the era of fire suppression; something positive should be said about this in the NPS section.

f. Pg. 88, line 2484-86. Again, yes these regs are "on the books" but where is the evidence that they have, or will, protect fisher habitat? The assumption throughout this section is that stuff that is on paper will manifest in conservation actions. But this paints a rosier view than exists, in my opinion. We need to know more than what the FPRs say, we need to know how they were implemented and whether they contribute to well-being of fishers and their habitat. That, itself, may be hard to demonstrate, but the reader should be made aware of these shortcomings so as to not develop a false sense of assurance.

g. Pg. 89, line 2517. Yes WLPZs <u>may</u> constitute 15% or more of a watershed, but where is the analysis that represents what they <u>do</u> constitute. Here again, the max value is cited (via pers. comm.), presumably to curry favor with a skeptical reader (?). Same thing on line 2520, where the author states that WLPZs "<u>may</u>" provide a network of older forest (rather than a likely alternative that they "may not"). Each outcome is as likely when there is no evidence presented to confirm or deny. Moreover, the WLPZs feature riparian areas; shouldn't something be stated about the protections, or lack thereof, in upland areas?

h. Pg. 89, lines 2535-36. Here, on the contrary, is an example appropriate wording when there is no evidence. The author states "*However, the plans are…flexible, making their… effectiveness in providing… habitat uncertain*." This states the case fairly, not biasing the reader one way or the other.

i. Pg. 90, lines 2554 – 2558. What are the "*feasible mitigation measures*" (a table listing them would be helpful)? And, what are the "measures taken" when impacts cannot be avoided? Stating what is in the FPRs is just lip service if it can't be demonstrated what the measures are, and importantly, how they compensate for impacts.

j. Pg. 90, lines 2560. It is not enough to say that "*some companies.. have instituted voluntary management policies….*" What are they, and as a Department, what is your opinion of their efficacy?

k. Pg. 98, lines 2822-2823. Yes, the Dept. may not be "*aware of data indicating that the removal of hardwoods…. Has substantially affected … fishers*" but, again, this should not console those concerned about fishers. The absence of data is no reason for optimism. Instead, economic forces suggest that hardwoods will be discriminated against and that this will likely to have negative effects on fishers.

l. Pg. 99, lines 2859-2860. That the "National Forests in the SSN ESU have adopted specific guidelines to protect habitats" means nothing unless it can be demonstrated that they have been acted on and that they have benefited fishers. I know of no such data that would suggest they have. For example, the review states (pg. 38, lines 1121 – 1123) that "*Trees used by fishers for denning and resting are typically large and considerable time (> 100 years) may be required for suitable cavities to develop*" and (on pg. 32, line 985) that "*Rest structures appear to be reused infrequently*…". If the agency directives do not need to be adhered to, or have no "teeth", what actions - short of state or federal listing - will protect the future provision of adequate amounts of large trees for a species like the fisher that may require hundreds of these slowly-renewing habitat resources within their home range and over their lifetime? Thus, the Department is taking, at face value, the wishful thinking on the part of federal and state agencies. It would be preferable to focus on what *has actually been done* to protect habitat, than what these documents describe as goals or intentions. If the agencies cannot demonstrate that their intentions have resulted in positive outcomes for fishers then the conservative position would be to assume that there is no material benefit to fishers.

6. **Inadequate consideration of the effects of fuels management**. The document covers well the threat and history of timber harvest on fishers, and the potential impact of fire, but does not do justice to one of the foremost new threats to fisher habitat in California: fuels management via forest thinning. There is huge momentum to treat an increasing number of acres in the fisher range, particularly in the SN ESU, to simplify forest structure. There are few published studies that have evaluated the effects of these activities on fisher habitat, but they should be highlighted and their collective results summarized. These papers include: Scheller et al. 2011, Thompson et al. 2011, Truex and Zielinski 2013, Garner 2013 and Zielinski et al. 2013. And, it appears that Sweitzer et al. have something in the works that may be available by request (I'll send a subsequent email with this information).
7. **Listing Factors**. The only factors that I believe are negligible or not significant to warrant serious concern are overexploitation, predation, competition and disease. Predation is, indeed, the leading cause of mortality but fishers have to die of something. I do, however, view this as a potential listing factor only insofar as land management has changed to favor the abundance of habitat-generalist predators such as bobcats and lions. The science and predictions about climate change are ambiguous. It is very hard to link climate change to bleak future outcomes for fishers since there are some negatives (increased fire) and some positives (potential expansion of hardwoods and mixed hardwood/conifer forests). The authors have not made, in my opinion, an effective case that "modification of habitat" or "toxicants" are not significant listing factors. Regarding "modification of habitat" there are a growing number of pieces of research that can assist in evaluating habitat modification at the landscape level (i.e., Thompson et al. (2011), Garner (2013), Zielinski et al. (2013)). However, relying on federal land policy (line 2759) that only "*considers the effects on wildlife*" is not a guarantee that significant habitat alteration will not occur, nor is the fact that USFS and BLM have "*consideration for species guided by management plans*"(line 2765). As noted earlier (see # 3, above) many of these policies are intention statements with little or no teeth to guarantee their implementation. Nor are the FPRs much protection since they include "*language [that] may result in actions that …are beneficial*". Salvage logging, the likely loss of snags that were once considered unmerchantable but are now merchantable, persecution of hardwoods (hack n squirt) all conspire to the conclusion (together with lackluster existing regulations) that lack of enforcement of existing rules and the lack of proactive protections will lead to significant "modification of habitat".

8. **Contributions of fisher working groups**. I was surprised that the document did not reference the activities of the 2 fisher working groups: the *California Fisher Working Group* and the *Southern Sierra Nevada Working Group*. The latter, in particular, has committees focused on

various threats and research needs which, collectively, represent hope for the future. These efforts represent human capital and social solutions to the plight of fishers and should be recognized in this document. Kathryn Purcell organized and manages these groups and I'm sure could offer a brief summary of their activities (kpurcell@fs.fed.us).

Specific Comments:

1. Pg. 3, line 86-87. This may be true in the NC ESU but certainly not in the SN ESU. Only 10% of the existing SN ESU may be privately owned, but using Grinnell's view of the historical distribution would lead one to conclude that a much larger percent of the SN is in fisher range and many of these private lands are absent fishers. And, this statement needs to be tempered by the absence of information as to whether private vs. public lands are serving as sources vs. sinks.
2. Pg. 22, line 682. A weasel reference [64] is used here to support a statement about fishers.
3. Pg. 23. The material here on survival should be augmented with the work by Sweitzer and colleagues: "*Reproductive parameters, population size, density and indications of negative population growth for a fisher population*." This paper in review in the *J. Mammalogy* (I'll send it in a separate email, with permission from the senior author). The estimate of lambda reported in this paper is arithmetically < 1.0, but the CI overlaps 1.0. This is important work and one of the few papers on demographic rates of fishers in California.
4. Pg. 24. If gray literature is ok, somewhere on this page it may be useful to cite the abstract by Slauson and Zielinski (2012) that found that fisher home range size is inversely related to the abundance of prey items > 200g in the diet ("*Effects of diet composition on home range size by fishers in California*"). I can make details available if necessary.
5. Pg. 33. Rebecca Green and coauthors have created a wonderful photographic guide to fisher resting structures (digital only, available by request, but cited below). Somewhere on this page would be a good place to refer to it.
6. Pg. 34, lines 1052-1054. Suspect references in these sentences. Reference 96 is not "recent" (published in 1979) and is not really a model in the sense referred to here. Also reference 97 does not apply to the topic referenced; it is on an entirely different topic.
7. Pg. 38, lines 1100 -1103. Yes, "*quantitative information is lacking… to measures of fitness*.." (which is a very high standard) but missing in this section are the recent developments to understand management effects on fisher habitat (the "female fisher home range template" of Thompson et al. (2011)), the effects of fuels management on fisher habitat and fisher tolerance of disturbance work (Truex and Zielinski 2013, Zielinski et al. 2013), and the recent work on estimating fisher population growth rates by Sweitzer et al. (*in review*, *J. Mammal*). These recent pieces of work have much to add to the discussion in this section.
8. Pg. 39, line 1150. Change to "*…fishers <u>appeared to have</u> increased*.." Wording change is necessary to acknowledge there are no quantitative data to support this assertion.
9. Pg. 40, line 1175 – 1176. Recall, however, that Grinnell's estimates of density occurred shortly after the railroad logging era and on the tail end of the fisher trapping era, so his guesses as density may be lower than might have occurred previous to the impacts of these

factors. This logic also challenges the optimistic conclusion, on pg. 54 (lines 1528 -1530) that fisher's "*population is likely higher then when densities.. were estimated by Grinnell et al. to be 1-2 per township in good habitat*". Grinnell's estimates, coming on the heels of significant trapping pressure and timber harvest in California, may not be good proxies for a historical baseline.

10. Pg. 63, lines 1795-1796. This is too important a number to cite only via pers. comm. and to represent by a single sentence. I suggest that these data be presented in a figure – as was done for other timber harvest data -- together with estimates of variation. This is critical information, and could be related to the results in Zielinski et al. (2013) which linked and index of fisher density to the rate and extent of timber harvest and fuels management. I suggest that the review seek to amplify this information and do more to relate it to what is known about fisher home range characteristics.
11. Pg. 64, Roads. The Roads subcommittee of the Southern Sierra Nevada Fisher Working Group has good data on road mortalities and the use of crossings, including culverts, by fishers. A woman with the first name of "Linzey" is the lead; Kathryn Purcell (kpurcell@fs.fed.us) should be able to put you in touch with her.
12. Pg.66, regarding fire, see also Hanson (2013). This new work attempts to shed light on the question about how fishers use post-fire landscapes.
13. Pg. 72, lines 2031-32. Call a spade a spade, change to: "*These new regulations are not likely to reduce use of SGARs at MJCSs*". This is just common sense, given the circumstances.
14. Pg. 72. I note here the subheading "*Population-level Impacts*", which makes sense but why does this only appear for the Toxicant threat and not the other threats, where population level impacts are just as relevant?
15. Pg. 80, top half. Somewhere around here it should be stated that the reduced snowpack expected in the future may be a benefit to fishers, which do more poorly in deep snow than do martens and other carnivores (see Krohn et al. refs).
16. Pg. 92. Conspicuous by its absence in the "covered species" column in this table is the fisher, esp. for GD and Fruit Growers. This absence should be noted, as well as its implications to fisher conservation.
17. Pg. 94. This is an impressive, and very expensive, wish list: each of which – I would assume – would be easier to achieve if the species were listed. I could add to this list, but given the reality of achieving these objectives, the list seems long enough already.
18. Pg. 99, lines 2850 – 2853. Yes, the extent of wildfire is less than that which burned prehistorically. However, the per acre severity has increased, leading to loss of overstory which has much greater implications to fisher habitat then the relatively mild, ground fires that were thought to characterize the prehistoric fire regimes.
19. Pg. 103, line 2994-96. Yes, they have co-evolved but the production of more edge and disturbed habitat via timber management, fuel management and fire may have shifted the balance to favor bobcats and lions.
20. Pg. 104. Competition. It is not published, but you overlooked here Lori Campbell's dissertation where she looked at factors affecting the distributions of coexisting carnivores in the Sierra (see references, below). For example, she found a negative association

between gray fox/spotted skunk and fishers in the Sierra and suggested that "*elevated densities of generalist species may hinder the return of fishers to portions of their range*…" Importantly, Lori also did an analysis that many have overlooked whereby she sought to understand the environmental features that differed between the area occupied by fishers in the Sierra and areas that are no longer occupied. She found that the occupied area had more and larger trees (conifers and hardwoods), steeper slopes, more shrub cover and fewer roads than the unoccupied area (see her Table 5 and Fig. 10). This information may be useful to add to earlier sections and it suggests that the size of the gap may have been influenced by these features, some of which are affected by management and human uses.

21. Pg. 106, lines 3103-3104. This statement needs to be revisited in light of the data in the forthcoming paper by Sweitzer et al. (*in review, J. Mammal*.) where they report a lambda value for the southern Sierra fisher population < 1.0 (though not significantly less). There may be high occupancy but demographic rates do not appear as favorable.
22. Pg. 107, line 3134-3136. Yes, it is hard to know what the outcome will be of the widespread and unregulated use of toxicants. However, the threat is potentially very real and it would be nice to see some wording here that would suggest that the Dept. is willing to pursue an emergency listing should new evidence arise that it is a significant threat. Is emergency listing a possibility under these circumstances? If so, it would reassure many of us to read that this is an option.

Recent or Overlooked Sources of Information:

Campbell, L.A. 2004. Distribution and habitat associations of mammalian carnivores in the central and southern Sierra Nevada. PhD dissertation, UC Davis, Davis, CA.

Garner, J.D. 2013. Selection of disturbed habitat by fishers (*Martes pennanti*) in the Sierra National Forest. MS thesis, Humboldt State University, Arcata, CA.

Green, R., K. Purcell, and C. Thompson. 2013. Photographic field guide to fisher rest and den sites in the Sierra National Forest. Kings River Fisher Project, USDA Forest Service, PSW Research Station, Fresno, CA.

Hanson, C. 2013. Habitat use of Pacific fishers in a heterogeneous post-fire and unburned Forest Landscape on the Kern Plateau, Sierra Nevada, California. The Open Forest Science Journal 6:24-30.

Slauson, K.M. and W.J. Zielinski. 2012. Effects of diet composition on home range size by fishers in California. Abstract of talk presented at TWS Western Section meeting.

Sweitzer, R. et al. in review. Reproductive parameters, population size, density and indications of negative population growth for a fisher population. J. Mammal

Thompson, C. M., W. J. Zielinski, and K. L. Purcell. 2011. Evaluating management risks using landscape trajectory analysis: A case study of California fisher. Journal of Wildlife Management 75:1164-1176.

Truex, R. L. and W. J. Zielinski. 2013. Short-term effects of fire and fire surrogate treatments on fisher habitat in the Sierra Nevada. Forest Ecology and Management 293:85-91.

Zielinski, W.J. 2013. The Forest Carnivores: Fisher and Marten. Chapter 7.1 in: Long, J., C. Skinner, M. North, P. Winter, W. Zielinski, C. Hunsaker, B. Collins, J. Keane, F. Lake, J. Wright, E. Moghaddas, A. Jardine, K. Hubbert, K. Pope, A. Bytnerowicz, M. Fenn, M. Busse, S. Charnley, T. Patterson, L. Quinn-Davidson and H. Safford. 2013. Science Synthesis to Support Forest Plan Revision in the Sierra Nevada and Southern Cascades. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 504 p.

Zielinski, W. J., C. M. Thompson, K. L. Purcell and J.D. Garner. 2013. An assessment of fisher (*Pekania pennanti*) tolerance to forest management intensity on the landscape. Forest Ecology and Management 310:821-826.

Appendix 4

Department Response to Peer Review Comments

Note: Page and line references below may not line up with the above peer reviewer-edited version of the draft document due to shifts caused by their edits. Also the final document was reorganized in response to comments received. Therefore, comments are grouped by section and topic to help facilitate locating comments by the reader in both the draft and final documents.

*Reviewers: BZ = Bill Zielinski; CT= Craig Thompson; JMH= Mark Higley; JT= Jody Tucker; LD= Lowell Diller; MG= Mourad Gabriel; RP= Roger Powell; SM= Sean Matthews; and WS= Wayne Spencer.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Executive Summary				
	2:54-58	SM	The report states "Although a comprehensive survey to estimate the size of the fisher population in California has not been completed, the available evidence indicates that fishers are widespread and relatively common in northern California and that the population in the southern Sierra Nevada is comparatively small (< 250 individuals), but stable." The conclusion fishers are "widespread and relatively common" is subjective at best and misleading at worst. I used spatial data provided by Lewis et al. (2012; Jeff Lewis, Washington Department of Fish and Wildlife, personal communication) to estimate the spatial extent of historic and contemporary fisher distributions. As a conservative estimate, I considered the historic and	Noted. Review of the current distribution (vs. the 2012 dataset mentioned in comment; see Figure 3) suggests that fishers are well distributed throughout much of their "assumed" historic range. The conclusion that fishers are relatively common in northwestern CA is primarily based on CDFW occupancy estimates based on recent surveys (over 60% of sample units estimated to be occupied by fishers). The conclusion is also supported by additional surveys mentioned in the document. Regarding the southern Sierra, the text was updated to reference challenge of linking occupancy estimates to abundance and the findings of Sweitzer et al. (in press). Regarding the stability of the SSN ESU, statement has been revised. Sweitzer et al. *in review* was reviewed and cited by the Department.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			contemporary ranges to occur north of California Highway 299 and for regulatory considerations to occur south of the California/Oregon border. Within these bounds and accepting the caveats of historic distribution data present by Gibilisco (1994), Lofroth et al. (2010), and others, fishers occupied approximately 78,212 km^2. Currently fishers are estimated to occupy 56,844 km^2, representing a 27% decrease in occupied range in northwestern California. Alternatively, considering only the area of overlap between historic and contemporary distributions, fishers currently occupy 52,256 km^2, representing a 33% decrease in the historic distribution currently occupied. It's undisputed that fishers in northwestern California are more widely distributed than fishers in the southern Sierra Nevada, however, presented with the fisher range in northwest California having contracted at least 25% over the last century in northwestern California, I question the conclusion fishers are "widespread" in the region. The conclusion fishers are relatively common appears to be partially based on comparisons of species visitation rates to remote	

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			survey stations (e.g., remotely-triggered cameras) presented in the report (Line 1256-1262). These surveys are most often designed based on individual movement patterns of a target species. For example, remotely triggered cameras are placed within a study area based on estimated home range sizes of fishers. Provided the spatial component of the sampling design is species specific, it is not valid to make comparisons of visitation rates of target and non-target species outside of more elaborate spatially nested sampling approach to accommodate the movement patterns of species being compared. I'll address this point further where these comparisons are made in the report. Regarding fishers in the southern Sierra Nevada, the conclusion of population stability is likely from Zielinski et al. (2013), who concluded fisher occupancy to be stable between 2002-2009. Tucker (2013), however, investigated the link between occupancy and abundance, showing that a 43% decline in abundance over an 8-year period only resulted in a 23% decline in occupancy reported. The U.S. Fish and Wildlife Service (2014) correctly articulates, "This	

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			effort demonstrates the complexities in determining population trend and identifies important cautions in extrapolating the conclusion of no trend in occupancy to a conclusion of no trend in abundance over 8-years of monitoring of the Southern Sierra Nevada Population." More recently Sweitzer et al. (In review) report an estimated λ for a portion of the SSN population on the Bass Lake Ranger District in the Sierra National Forest, near Oakhurst, California between 2007-2013 was 0.91 (95% CI 0.71-1.13). Zielinski et al. (2013) concluded fisher occupancy to be stable between 2002-2009. Taken together, these results indicate fishers are not in spatial recovery and numerically may be in decline.	
	2:57-59	WS	Need a citation. If the high estimate is from the Self et al., analysis, it is highly dubious.	A reference for this unpublished report is included in the Literature Cited.
	2:62-64	WS	Characterization of fisher use of old growth forest is incomplete	More detailed comment from WS cover letter is addressed under Habitat Use section below.
	3:86-87	SM	The report states, "However, fishers are widespread on public and private lands harvested for timber." I would suggest it be more accurate to say fishers are known to occupy public and private lands	Additional text noting some of these findings was added to the "Habitat Loss and Degradation" section of the document.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			harvested for timber. Comparisons of fisher demographic or surrogate state variables and potential source-sink dynamics between areas of alternate timber management intensities in California have yet to be made. Further, Lewis and Aubry (2003) summarized, "In the western USA, fishers generally avoid clearcuts and forested stands with <40% canopy cover (Buck et al. 1994, Jones and Garton 1994), and occur at low densities in second-growth forests (Powell and Zielinski 1994) and landscapes that have been extensively fragmented by timber harvesting (Rosenberg and Raphael 1986, Carroll et al. 1999)." Most recently, Weir and Corbould (2010) concluded that a 5% increase in recent logging decreased the relative probability of occupancy of a potential home range by 50% in north-central British Columbia. Similar occupancy and demographic-based metrics on public and private lands harvested for timber in California are not yet available.	
	3:86-87	WS	Widespread [on public and private lands harvested for timber] doesn't necessarily imply healthy, thriving, or resilient.	Noted. No Change.
	3: 86-87	BZ	This may be true in the NC ESU but certainly not in the SN ESU. Only	Noted. The percentages of private and public lands referenced relate to the current occupied range of fishers in

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			10% of the existing SN ESU may be privately owned, but using Grinnell's view of the historical distribution would lead one to conclude that a much larger percent of the SN is in fisher range and many of these private lands are absent fishers. And, this statement needs to be tempered by the absence of information as to whether private vs. public lands are serving as sources vs. sinks.	California estimated by CDFW and not to the assumed general range of fishes made by Grinnell et al. (1937). We agree that outside of the current range, fishers are rare or absent. CDFW is not aware of information to support or refute whether private versus public lands are sources or sinks for fishers.
	3:89-91	WS	There is evidence that fisher populations would be larger/more resilient with increased habitat quality and quantity.	Change made to text.
	3:89-91	SM	The report states: "At this time, there is no substantial evidence to indicate that the availability of suitable habitats is adversely affecting fisher populations in California." An opposite interpretation of available data is made by the U.S. Fish and Wildlife Service (2014) in the Draft Species Report, Fisher (*Pekania pennanti*), West Coast Population. The Service identified a variety of stressors for fishers related to habitat. The Service defines a stressor as: *…the activities or processes that have caused, are causing, or may cause in the future*	Noted. The document recognizes and addresses multiple threats/stressors that may contribute to the decline of fisher populations.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			the destruction, degradation, or impairment of west coast fisher populations or their habitat. Stressors are primarily related to human activities, but can be natural events and act on fishers at various scales and intensities throughout the analysis area. Stressors may be observed, inferred, or projected to occur in the near term. (USDI Fish and Wildlife Service 2014:46) The Service summarizes their findings in stating, "Past and ongoing loss and fragmentation of fisher habitat may contribute to the decline of fisher populations (Aubry and Lewis 2003, p.82)" (USDI Fish and Wildlife Service 2014:54).	
	3: 90-91	BZ	That there is "no substantial evidence" isn't the same as no effect; no evidence can also mean	No Change. We found no evidence that a lack of suitable habitat within the current range of the fisher in California is limiting fisher populations where they occur.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			that there may be effects that haven't yet been revealed.	
	3:99-100	SM	The report states: "This apparent long-term contraction notwithstanding, the distribution of fishers in California has been stable and possibly increasing in recent years." There is some mixed empirical evidence for population expansion in the SSN (Tucker et al. 2014), however I did not see the work of Tucker et al. (2014) or other support for this conclusion outlined in the body of the Status Review.	Accepted. Body of document updated to include mention of Tucker et al. (2014) paper outlining genetic and survey data suggesting possible northward expansion of the SSN population in recent decades.
	3:100-101	WS	[In response to statement that the distributions of fishers in California is stable or increasing] Clarify: evidence of increase ~1990s-2000s, but no evidence of expansion in past 10 years in SSN. Any evidence for this in north?	Noted. Population Size and Isolation section states (p.61): "Tucker et al. (2012) suggested that the southern tip of the Sierra Nevada may have served as a refuge during the gold rush and into the first half of the 20th century while the fisher population in the rest of the southern Sierra Nevada was in decline. Fishers in the southern Sierra Nevada may have expanded somewhat since that time and the population appears to have been stable from 2002 to 2009 (Zielinski et al. 2013*a*:10).."
	3-106-108	SM	The report states: "Exposure to toxicants at illegal marijuana cultivation sites has been documented in both the NC and SSN Fisher ESUs, but there is insufficient information to determine the effects of such exposure on either population." Thompson et al. (2014) identify a population-level effect, concluding	Text in the Toxicants section updated to summarize the findings of Thompson et al. (2013).

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			that female fishers more likely to encounter cultivation sites suffered significantly higher rates of mortality.	
	3:108	WS	Disagree with this statement [regarding anticoagulant rodenticides]. Strong evidence that exposure reduces individual fitness and may be limiting population resilience/expansion (e.g., Thompson et al. 2013).	Text in the Toxicants section updated to summarize the findings of Thompson et al. (2013)
	3:108	BZ	"Insufficient information" is used here to imply that when little is known there is probably no effect, but the precautionary principle would have us err on the side of assuming a negative effect when we know the potential direct and indirect risks from rodenticides.	Noted. The referenced text does not imply "no effect", only that there is insufficient information to determine an effect on fisher populations. Assuming a population level effect as a precautionary measure because individual effects can be demonstrated is unjustified. That philosophy would require the assumption of a negative effect whenever a stressor directly or indirectly affected individual members of a species is demonstrated and its population level effects are unknown.
	4:109-110	WS	May be true [that wildfire frequency, severity, and extent are increasing in California], but there is conflicting analyses about historic conditions, etc.	Noted. Text does state "in recent decades", and preponderance of fire ecology literature is consistent with this statement.
Regulatory Framework				
	3:105	JT	I would recommend including percentages/rates of exposure in each study area to better summarize the nature of this issue	Noted. Detail suggested is not necessary for Executive Summary.
	3:105	JT	As written I think this summary paragraph significantly understates	Additional information regarding the potential threat of anticoagulant rodenticides and toxicants was included in

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			the magnitude of the threat of AR's/toxicants to these populations.	the document.
	3:108	JT	This statement is not accurate – Thompson et al.2014 documented that female fisher survival was related to the number of grow sites they encounter. Thompson, Craig, et al. "Impacts of rodenticide and insecticide toxicants from marijuana cultivation sites on fisher survival rates in the Sierra National Forest, California." Conservation Letters 7.2 (2014): 91-102.	Text in the Toxicants Section updated to summarize the findings of Thompson et al. (2013)
	4:130	JMH	Suggests section break/new page between Executive Summary and subsequent sections	Page break added as well as Section heading to help orient readers.
Biology and Ecology				
Species Description				
Systematics	9:276	RP	Skunks are no longer included within the Mustelidae but are in their own family, Mephitidae.	Text was modified to delete reference to skunks in the family Mustelidae.
Systematics	9:281-284	RP	These statements are wrong. The best molecular and DNA phylogenies that include samples from the most species and that use the most molecular material do not put fishers, tayras and wolverines into a clade of their own. Koepfli gave a good talk at the Musteloid	Text was modified to delete reference to fishers being more closely related to tayra and wolverine than to other species of *Martes*.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			Conference at Oxford last year, reviewing the phylogenetic research that has been done. His review showed that the result for fishers and martens reported in his 2008 paper is still the best understanding for the relationships among these species (reference 15 in the review). I have attached a pdf figure with a summary of the pertinent material. Note that the tayra, the fisher, the wolverine, and the house marten all fall in clades including no other species. Thus, according to rules of zoological nomenclature, if all the "true" martens are included within Martes, then the house marten might or might not be included in Martes as well. This inclusion has been accepted. Next, the wolverine might be included within Martes. If so, fine, but this inclusion has not generally been accepted. Consequently, the wolverine has its own genus, Gulo. And, therefore, the fisher and the tayra must each have its own genus as well. In addition, the fisher is no more closely related to the wolverine than it is to any other species in the clade that includes the wolverine and the martens. But, because the fisher is in a clade with the wolverine and the martens, it is more closely related to those	

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			species than to the tayra (but not more closely related to wolverines than martens). A legitimate systematic decision (legal according to the rules of zoological nomenclature) would be to include the fisher, the wolverine and all the martens within Martes but to exclude tayras from that genus. Such a decision would include in 1 genus species that are more distantly related than usual for being member of the same genus. I hope I have been clear. Get back to me if you are confused.	
Systematics	9:291	RP	Wild European polecats are not and have never been known as "fitch ferrets".	Modified text to indicate that the term "fitch ferrets" referred to domesticated polecats.
Geographic Range and Distribution		CT	The southern ESU occupies a landscape that is elongated, with 4-5 core habitat areas connected by narrow bottlenecks at river canyons. This type of habitat configuration is at high risk of fragmentation, for example the 2013 Aspen and 2014 French fires which burned on opposite sides of the San Joaquin drainage in subsequent years, effectively breaking connectivity between two core habitat areas. Because the southern ESU population is small and at high risk from stochastic	Added text to Current Range section describing current shape of distribution in the SSN ESU.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			events, the shape of the habitat and the risk of further fragmentation is a critical consideration.	
Historical Range and Distribution in California	11:fig 1	WS	Current range map does not show introduced populations on Olympic Peninsula, WA or Stirling City, CA.	Noted.
Historical Range and Distribution in California	12:363-366	WS	Clarify what is meant by "collections." Are there museum specimens to verify ID and location, or do these include trapper accounts without verifiable specimens? Also, these are not shown as green on Figure 2 (as "… mentioned in text").	Text modified to clarify details regarding historical specimens.
Historical Range and Distribution in California	12:369	JT	I think it is important to include that none of these reported locations north of the Merced River have physical specimens present in museum collections. See figure 2, tableS1 in Tucker et al 2012.	Text modified to clarify details of historic records
Historical Range and Distribution in California	13:fig2	WS	some observations discussed in text are not shown as green on this figure.	Text and map legend updated to clarify.
Historical Range and Distribution in California	14:387	JT	I think the caption for this figure is confusing – it took me a while to figure out what it meant. I think what it means is: Grinnel et al- 1919-1924 fisher locations reported by trappers (map only) Grinnel et al.– fisher locations	Legend and caption for this figure have been revised.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			mentioned in the text (map and text description) Also the font of the legend needs to be increased – it is hard to read at its current size	
Current Range and Distribution in California	14: 414	RP	No one has observed the species but lots of people have observed members of the species. Let me explain. Do not confuse a species with an animal or animals. Animals have flesh and fur. They hunt prey or escape from predators. They eat. They interact with each other.	Revised text to correct this error.
Current Range and Distribution in California	17:481 (16:479 WS)	JT, WS	The legend and colors of the map are difficult to read – many of the colors look similar so it is hard to discern which time period they were from. Recommend changing color palette to be more distinct. The font in the legend is again too small and difficult to read.	The legend and colors for this figure have been revised.
Current Range and Distribution in California	18:492	JT	The carnivore monitoring program in the Sierras is still ongoing and has collected data annually from 2002-2014. 2002-2009 is the correct date range for the trend analysis conducted by Zielinski et al. 2013, but does not cover the full duration of the broad scale systematic surveys that have been completed.	Text revised to reflect this information.
Current Range and	18:518	JT	Is this radius? Diameter? – makes a	Noted. The locations were buffered by 4 km in all directions

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Distribution in California			big difference and needs to be specified	(i.e., 4 km is the radius of the buffer).
Current Range and Distribution in California	Entire	BZ	The review represents a nuanced and, in my opinion, appropriate consideration of the historical and current gap in the fisher distribution in the Sierra. This is a critical element of the review because of the implications. If one assumes the gap was large prior to human influence, then the current distribution may not be interpreted as very different than the historical distribution. If, on the other hand, one views the historical gap as small – which seems to be the way the review is leaning – then the current distribution is significantly smaller than the historical distribution. The evidence pits sophisticated molecular genetic data against old fashioned accounts by naturalists and trappers; evidence that is difficult to reconcile. I think the document puts the matter in proper perspective, bringing the full weight of historical evidence, from scientists and naturalists, to bear on the issue. I agree with the estimate that the current distribution is only 48% of the historical distribution (line 519-520). The conclusion, however, that the current distribution is half	Noted. The risk to contemporary fisher populations in California was assessed in the Status Review and is independent of the extent of the historical distribution of fisher.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			of the historical distribution suggests that the NC and SN ESUs may be at greater risk than the review seems to suggest.	
Genetics	18:535-536	WS	Recast sentence: this makes it sound like mtDNA is only found "in cells that produce energy" rather than that mitochondria produce energy in cells.	Text revised.
Genetics	18-19: 525 and 565	RP	4) Lines 525 and 565 – The content of these 2 lines contradict each other. If fishers did not reach California until <5000 years ago, the north and south populations in California could not have diverged 16,700 years ago. The 2 populations did not exist 16700 years ago.	Noted. The results of these studies appear to contradict each other, but were based on difference sources of information. Regardless of when fishers reached California, recent genetic evidence indicates that populations in northern California and the southern Sierra Nevada were isolated from each other prior to European settlement.
Genetics	19:541	JT	While this haplotype definition is technically correct I don't think it is the most useful definition for helping readers understand what exactly it is. Suggestions to clarify include text like … A haplotype is a contraction for 'haploid genotype' and is a group of genes within an organism that was inherited together from a single parent.	Text modified to include the following: *The term haplotype is a contraction for 'haploid genotype'. A haplotype is a group of genes that tend to be inherited together.*
Genetics	19:565	JMH	Noted that it is interesting that fishers were thought to have	Footnote added to mention the divergence of these two estimates and text was modified to attempt to clarify the

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			"expanded westward" from eastern North America less than 5000 years ago, but that Knaus et al. suggested genetic divergence in California might have begun approximately 16,700 years ago	difference between these estimates.
Reproduction and development	21:613-615	LD	Typically an average litter size is reported as a single number – are these means from different studies?	Noted. Yes, the range reported (1.9-2.8) are average litter sizes reported from several studies.
Reproduction and development	21:619	CT	There is a noticeable decline in litter size along a rough northeast to southwest gradient, with the smallest litter sizes being reported in the Southern Sierra ESU population (SNAMP mean litter size 1.5 kits, n=48; Kings River 1.6, n=65). SEE FIGURE INCLUDED WITH COMMENTS	Noted.
Reproduction and development	22-667-669	SM	Require the following changes: A recent study in the Hoopa Valley of California reported that 65% (55 of 85) of denning opportunities were successful in weaning at least one kit from 2005-2011 [57]	Text revised to reflect updated information provided in comment.
Reproduction and development	22:673	JMH	Suggested adding an additional citation to the statement that a greater proportion of older female fishers than younger females annually produce kits	Additional reference added to support this statement.
Reproduction and development	22: 682	BZ	A weasel reference [64] is used here to support a statement about fishers.	Reference deleted.
Reproduction and development	22:683-684	SM	The report states: "Paragi (Paragi 1990) reported that fall	Additional data incorporated into text.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			recruitment of kits in Maine was between 0.7 and 1.3 kits per adult female.” Lofroth et al. (2010) state that looking at results on recruitment from fisher populations in eastern North America provides limited insights into the dynamics of western populations because legal harvest of fishers in the East directly affects recruitment rates. Weir and Corbould (2008) estimated an average fall recruitment rate of 0.58 juveniles/adult female; Matthews et al. (2013) estimated the recruitment rate of juveniles that successfully established a home range per adult female was 0.19 (0.16 for females and 0.02 for males).	
Survival	Entire	BZ	The material here on survival should be augmented with the work by Sweitzer and colleagues: “*Reproductive parameters, population size, density and indications of negative population growth for a fisher population*.” This paper in review in the *J. Mammalogy* (I’ll send it in a separate email, with permission from the senior author). The estimate of lambda reported in this paper is arithmetically < 1.0, but the CI overlaps 1.0. This is important work and one of the few papers on demographic rates of	Findings of this paper incorporated into document.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			fishers in California.	
Survival	23:687 and 24:713	JT	There is a significant amount of data and estimates of survival rates for the SNAMP and Kings River study areas in the southern Sierrras. I was surprised to not see this data cited here Seems highly relevant to include that information here. AND This is where it seems like it would be very useful to cite CA specific survival estimates from the 2 southern Sierra demography studies, especially since as stated a few sentences before that survival rates vary throughout their range	Survival rates of fishers from the KRFP and SNAMP sites were added to the document.
Survival	23:697	SM	see Higley et al. 2013. Bobcat ecology and relationship with and influence on fisher survival on the Hoopa Valley Indian Reservation, California. Final Report USFWS TWG CA U-29-NA-1. Hoopa Valley Tribe, Hoopa, California. Page 24: Forty-eight fishers were monitored via radio telemetry until they died (17M, 31F) between 2004 and 2013 on the Hoopa Valley Indian Reservation. Average age at death across all years and all ages was 4.1 and 4.8 years for males and	Text revised to reflect this data (and a similar suggestion by another reviewer).

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			females respectively. Comparing the mean age at time of death of females for the years 2005-2008 (n=19) and 2009 to 2012 (n =12) there has been an increase in age from 3.8 to 6.3 years. There were not enough males monitored prior to 2009 do make a similar comparison for males.	
Survival	23:702	JMH	Our final report (Bobcat Ecology and Relationship with and influence on Fisher survival on the Hoopa Valley Indian Reservation, California Final Report USFWS TWG CA U-29-NA-1) includes quite a bit of population age structure information for the Hoopa Study area, including a shift in mean age of females (increasing during the study). Not sure if you would have noticed that part of our report given that the thing is very long. The most important thing was that during our study, females died at a younger age during the first half of the study and over all female survival has trended upwards so reproductive potential has improved.	Age structure/survival information from this report was added to the final document.
Survival	23:709	JMH	Unfortunately our causes of mortality data has not been published yet other than in reports. Within the report mentioned above we indicated	Description of factors affecting fisher survival has been updated and reworded.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			that over 29% of all male mortality at Hoopa was a direct result (not indirect) of toxicosis. Currently that number stands at over 35%	
Survival	23:710-712	SM	The report states: “Indirect effects include habitat quality and exposure to toxicants that may increase a fisher’s vulnerability to other sources of mortality (e.g., predation).” This statement suggests toxicants are only an indirect source of mortality. Gabriel et al. (2012) diagnosed four fisher deaths, including a lactating female, that were directly attributed to AR toxicosis and documented the first neonatal or milk transfer of an AR to an altricial fisher kit. Other toxicosis deaths have since been diagnosed (likely a Gabriel pers.comm.)	Description of factors affecting fisher survival has been updated and reworded.
Survival	23:717	JMH	Our report mentioned above clearly shows males with lower and declining survival rates when compared to females with the top known fate models showing lower average monthly survival for both males and females in May and June compared to all the other months. Presumably due to the rat poisons being placed at grow sites in the spring.	Text updated to reflect recent survival estimates from the Hoopa area.
Survival	23:718	SM	Additional data on survival rates can be found in Sweitzer et al. (In revision), estimated survival: juvenile, 0.79 (95% C.I. 0.65-0.93),	Text updated to reflect current survival estimates from the southern Sierra Nevada.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			subadult, 0.72 (95% C.I. 0.59-0.86), and adult, 0.72 (95% C.I. 0.62-0.82).	
Food Habits	Entire	BZ	If gray literature is ok, somewhere on this page it may be useful to cite the abstract by Slauson and Zielinski (2012) that found that fisher home range size is inversely related to the abundance of prey items > 200g in the diet ("*Effects of diet composition on home range size by fishers in California*"). I can make details available if necessary.	Incorporated this information and reference into the document.
Food Habits	24: 740-742	RP	The diversity of prey eaten by fishers in California, especially southern California, actually suggests that fishers' preferred prey is not present or is found at such low abundances that low ranked prey must be eaten. Across their range, fishers prey predominantly on mammals that are the largest they can catch consistently: porcupines, snowshoe hares, grey squirrels (and of course carrion). When those prey are abundant, fishers prey on nothing else. This pattern is consistent with the predictions of Charnov's (1976) model of optimal foraging. That model predicts that a predator should prey exclusively on its top ranked prey if such prey are	Modified text to include this hypothesis.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			abundant enough. If such prey are not abundant enough to support the predator population, then the predators should include the next ranked prey, and so on down. When fishers eat diverse prey, especially small prey, the best explanation is that their preferred prey are rare (or absent).	
Food Habits	24:747	JMH	Golightly (71) mentions woodrats being more common than squirrels in the coastal zone, should at least include them here. We have a more recent un-published report from Hoopa where woodrats were the number one prey item. I can send a copy of that report if you would like.	Description of prey items consumed in northwestern California updated based on this comment
Food Habits	26:773	JT	General comment about diet. I just saw a presentation on new research from Pennsylvania fisher diet analysis that found that ~10% of their diet in the study area included other fishers (cannibalism). First time that cannibalism in fishers has been reported. Diets of Fishers Reintroduced to the Central Appalachian Mountains: A Generalist Predator Exploiting a Diverse Prey Base (Wildlife Society Annual Conference) Darin J. McNeil, Indiana University of Pennsylvania.	Noted. No Change.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Food Habits	25: 776-780	RP	You can not cite my book as a source of this hypothesis. I state pretty clearly that differences in diet between the sexes probably seldom exist and are probably not related to sexual dimorphism in body size. I cite, in my book, several other publications that have espoused that hypothesis. I did, in my book, document that females might prey on smaller porcupines than males. Thor Holmes did nice morphometric work showing that trophic structures (teeth, jaws) are more alike than body sizes, meaning that selection has acted on the tools used for predation to make them more similar between the sexes than body size. Holmes's work suggests that diets do not differ between the sexes (Holmes & Powell in the 1994 Martes book).	Reference to Powell (1993) was removed. Weir (2005) was referenced for the hypothesis that dietary differences between male and female fishers may reduce competition between the sexes.
Food Habits		WS	Observation that porcupines are uncommon diet items in California fisher diets compared to other regions deserves elaboration, since porcupines appear to have been extirpated from large areas of the Sierra Nevada, including within the SSN ESU. The department should investigate this in more detail and evaluate the causes, including whether rodenticide poisoning associated with marijuana grow sites may be contributing to the	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			loss of porcupines from large areas. Not only are porcupines an important prey species in other portions of the fisher's geographic range, they are also "ecosystem engineers" that help recruit essential habitat elements (deformed trees, platforms, cavities, etc.) for fishers and other wildlife.	
Movements	26:810-811	WS	Not sure it is true that female home range generally overlaps the home range of only one male.	Statement removed.
Movements	26:816	WS	See SSNFCA for home range sizes in SSN.	Adult home range sizes from Sierra Nevada studies added to text.
Movements	2:6: 815-824	RP	One cannot compare home range sizes estimated with kernel estimators unless they were calculated using the same software package, the same band width and the same kernel. Different software packages produce different utilization distributions for a single set of data. Using different band widths and different kernels will yield different utilization distributions for a single data set. Thus, comparisons of home ranges sizes can not be made legitimately. If you insist on making such comparisons, you MUST make a strong disclaimer that the results of such comparisons might yield false results.	Text was added to indicate that differences in home range sizes estimated for fisher among studies was due, in part, to differences in sampling effort and analytical methods as described by Lofroth et al. (2010).
Movements	27:821	JT	I did not see any mention of the Popescu 2014 paper that shows	Reference added.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			significant difference in home range size between the sexes and seasons (spring/summer vs fall/winter): . Popescu, Viorel D., Perry Valpine, and Rick A. Sweitzer. "Testing the consistency of wildlife data types before combining them: the case of camera traps and telemetry." Ecology and evolution 4.7 (2014): 933-943.	
Movements	26:822-824	WS	See Sauder and Rachlow (2014) for influence of landscape-scale fragmentation on home range suitability. Also, the SSNFCS team is currently analyzing home range composition of female fishers from 3 telemetry studies in the region. Female home ranges have very high proportion of mature, dense forest (e.g., CWHR classes 4D and above), low proportion of open habitats, and high cohesion of mature, dense forest. Male home ranges are far more variable. Females seem to be very constrained to living within contiguous areas of mature, dense forest, where essentially all natal and maternal dens are located.	Noted.
Movements	27:826	JT	This is a pretty incomplete list of factors that influence suitability of home ranges – prey availability,	Sentence deleted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			inter and intra-specific competition, disturbance - either need to expand or cut it	
Movements	27:836	WS	Dispersing juveniles - See SSNFCA for updated specific info for SSN population. Also, should cite appropriate findings from Tucker 2013 and Tucker et al. 2014.	SSNFCA information added to text. Tucker information included.
Movements	27:841	WS	Sex biased dispersal - See SSNFCA for updated specific info for SSN population. Also, should cite appropriate findings from Tucker 2013 and Tucker et al. 2014.	As above.
Movements	27:844	WS	Establishment of female home ranges - Female home ranges generally overlap home ranges of their mother, from SNAMP telemetry data.	Information added to text.
Movements	27:844	JT	Add citation to Tucker 2013 (dissertation). There is a chapter about sex-biased dispersal in fisher	Accepted. Reference included.
Movements	27:859-860	WS	There are abundant data for SSN on [distance juveniles travel to establish home ranges] from SNAMP and KRFP studies. Rick Sweitzer has been analyzing dispersal events. Most females settle in/adjacent to mother’s home range.	Information added to text.
Movements	28:871	WS	Mean dispersal distance from the centers of natal and established home ranges - Add information for SSN from SSNFCA and contact Rick Sweitzer for ongoing dispersal analyses.	Information from SSNFCA added to text.
Movements	884	CT	Dispersal data is available from the	Information from SSNFCA added to text.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			Sierra Nevada Adaptive Management Project in the Southern Sierras as well. Based on the Euclidian distance between the centroids of natal home ranges and subsequent established territories, dispersal distance was 5.76 ± 1.26 km for females and 9.81 ± 2.22 km for males (insignificant difference, p = 0.10). These values were calculated using aerial telemetry, following collared juveniles as they dispersed, N = 24 females and 19 males. When least cost path analysis is used as opposed to Euclidian distance, the values change to 8.76 ± 2.11 km for females and 13.48 ± 3.71 km for males (still an insignificant difference, p = 0.25).	
Movements	29:886	JT	Discussion of the dispersal data from the SNAMP and Kings River studies needs to be included here.	Text updated to reflect SNAMP dispersal data contained in Spencer et al. (2015)
Habitat Use	section	WS	Section could be shorter and clearer with better organization and reduction of redundancies. Consider breaking into subsections by scale after introducing the 4 scales?	The section was revised to minimize redundancy and increase clarity.
Habitat Use	section	WS	Section may focus too much on studies from outside California and omits a number of recent fisher habitat studies in California. See SSNFCA and citations therein.	Additional information from California incorporated in text (see below).
Habitat Use	29: table 1	WS	Ongoing (unpublished) analysis in SSN shows that females are even	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			more biased than males in having home ranges composed primarily of dense, mature forest conditions. Males appear to use a greater mosaic of vegetation types/conditions.	
Habitat Use	29: table 1	WS	See SSNFCA for resting and denning habitat models. Denning habitat (used only by females in spring) is most limiting and strongly associated with contiguous, dense, mature forest conditions (e.g., CWHR 4D and above).	Noted. Table referred to has been eliminated in the final document.
Habitat Use	30:924-926	WS	Mean elevations - This would be much more meaningful if broken out by geographic region. Fishers in NW California use habitats down to sea level; fishers in SN use a relatively narrow elevation range; fishers on Kern Plateau (southeastern-most part of Sierra Nevada) use higher elevations, probably due to less snow there than occurs on the west slope of the SN.	Additional sentences added mentioning use of higher-elevation habitats in the southern Sierra Nevada
Habitat Use	31:926	JT	What is the size of these public survey sections? It does not make a lot of sense to me to average elevation over a section when you may be averaging Mountain peaks with river canyons…. Why not use the elevation of each location or of a smaller neighborhood surrounding the detection? I think this would more accurately represent elevation.	Noted. Text not revised due to data constraints. The exact location (and thus elevation) of each of the detections used in the analysis was not known. Some detections were only known to the level of a PLS Section (one square mile).

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat Use	31:928	JT	Considering the size of the NW CA population is much larger than the Sierras it seems that the data in this figure over represents elevations of the NWCA population and hides significant differences between the NW and SSN. The mean elevation of detections in the SSN is considerably higher, especially at the far south on the Sequoia NF. The mean elevation of fisher detections in the USFS SSN monitoring program from 2002-2012 was 1880m (6170 ft)	Additional sentences added mentioning use of higher-elevation habitats in the southern Sierra Nevada
Habitat Use	31:935	WS	Snow depth - See SSNFCA for discussion of this.	Text added.
Habitat Use	31:941	WS	Forest types used - presence of black oaks seems to be a habitat indicator for fishers in SSN, especially denning habitat. Black oaks provide good cavities for resting/denning and acorns for prey. And tan oak may be an important component in north coastal areas: Scott Yaeger and Mark Higley, personal communications.	Text added.
Habitat Use	31:966	WS	Patterns [of habitat use] may also be partially obscured by gender differences. Females may restrict activities more to mature, dense forest than males, which appear to be more tolerant of more diverse habitat mosaics, although this has not yet been quantified.	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat Use	32:971-976	RP	Telemetry studies of rest sites of fishers have a seldom mentioned bias that could be important. Fishers resting in trees transmit strong signals, biasing studies of rest sites. Fishers down on or in the ground do not transmit strong signals and, therefore, researchers seldom walk in on fishers resting in logs or in piles of brush or down holes.	Modified text to include this potential bias.
Habitat Use	978-980	CT & WS	Confusing phrase. If fishers rest secondarily in logs and snags, what do they primarily rest in?	Text reworded.
Habitat Use	980	CT	A recent analysis of fisher habitat use in the Rocky Mountains indicates that mid-scale heterogeneity is a primary driver of home range placement (J. Sauder, IDFG, unpublished work).	Noted.
Habitat Use	32:986-987	WS	Rates of resting structure reuse should be available from the SNAMP and KRFP studies in SSN.	Specific information from SSN added to text.
Habitat Use	32:1000	WS	Hollow logs are cavities.	Noted.
Habitat Use	33:1000	JT	Again, it seems that discussion of the large amounts of data on den sites from Kings River and SNAMP should be included here – seems more relevant than relying on studies from other populations – what about Rebecca Green's work on den sites on the Sierra NF?	Text updated to include den structure data from the KRFP and SNAMP study areas.
Habitat Use	32:1020	WS	Statement about female use of	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			cavities for dens is redundant.	
Habitat Use	33: entire	BZ	Rebecca Green and coauthors have created a wonderful photographic guide to fisher resting structures (digital only, available by request, but cited below). Somewhere on this page would be a good place to refer to it.	Text modified to reference this excellent guide to fisher den and rest sites in the Sierra National Forest.
Habitat Use	33:1023	MG	Would be noteworthy to mention that the age of trees maybe less in CA due to the increased growth season and increased fire scaring etc…	Noted. Text not modified, as a variety of site-specific factors may result in trees in California becoming suitable for denning at either younger or older ages than trees in portions of British Columbia
Habitat Use	33:1025	WS	Newest model - Newest only for landscape-scale (1st order selection). We also have finer scale models for resting, denning, and dispersal habitat (see SSNFCA).	Text clarified.
Habitat Use	33:1039	WS	Insert words “central and” before northern California.	Text modified.
Habitat Use	33:1032	RP	Most models, including this one, are correlation models and, therefore, cannot be used to predict anything till they have been tested. If they are shown to be able to predict, one still does not know why they can predict because they do not show functional relationships between fisher use and habitat.	Noted.
Habitat Use	34:146-147	WS	Insert “total above-ground” before “biomass”.	Text modified.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat Use	34:1049-1053	WS	should note that the CBI model used some environmental variables not previously available for other efforts or updated since previous efforts.	Text modified.
Habitat Use	34: 1052-1054	BZ	Suspect references in these sentences. Reference 96 is not "recent" (published in 1979) and is not really a model in the sense referred to here. Also reference 97 does not apply to the topic referenced; it is on an entirely different topic.	Citations used were out of sequence and have been corrected.
Habitat Use	34:1056-1057	WS	Current thinking of the SSNFCS Fisher Technical Team is that this model basically represents foraging habitat (because nearly all data are from active fishers attracted to baited stations). We now also have resting habitat model and a denning habitat model, using locations of resting and denning observations from telemetry studies. Resting habitat is a subset of available foraging habitat, and denning habitat is a subset of resting habitat. Denning habitat is used only by adult females for a limited season. Females are much more constrained than males to siting home ranges in dense, mature forest (i.e., denning habitat) and within a much narrower elevation band. See SSNFCA.	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat Use	1094	WS	Statement that fishers "are not dependent on old-growth forests" and that fishers use a wide variety of forest types and seral stages is incomplete and ignores the large amount of scientific evidence suggesting that dense, late-seral forests provide superior habitat conditions for fishers, and may well be required to sustain a breeding population.	Text added to clarify point, see page 36.
Habitat Use		WS	Sections of the status review pertaining to habitat use and essential habitat elements could be improved by reducing reliance on the general, rangewide fisher literature and studies from outside California, and focusing more on recent habitat studies in California, some of which appear to be missing from these sections. See the SSNFCA for additional literature review.	California specific information added based on comments above.
Habitat Use		WS	The section on habitat use could be shorter and clearer if organized using the scalar hierarchy summarized in Table 1. Also, see the SSNFCA for updated habitat models, including separate models for fisher foraging, resting, denning, and dispersal habitats. The review should recognize the importance of these various functional habitat categories, and that female denning habitat is the most limiting and most important	Habitat selection hierarchy presented in table form was deleted and the section was reorganized to improve clarity.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			to sustaining a population. Also critical is maintaining and improving potential dispersal habitat between areas suitable for supporting breeding females.	
Habitat Use		WS	The SSNFCA also provides updated habitat models at various scales, including separate models for fisher foraging, resting, denning, and dispersal habitats. Fishers, especially males, will occasionally forage in or disperse through vegetation types that do not provide all their life requisites. However, female home ranges are closely associated with large areas of dense, mature forests; and natal and maternal dens are highly constrained to being in areas of very dense, often multi-storied, canopies in mature forest stands supporting very large trees and dead wood structures. On average, ~80% of the area of breeding female home ranges in the SSN consist of CWHR High Reproductive Fisher Habitat Value (CWHR classes 4D, 5M, 5D, and 6).	Noted.
Habitat Use		WS	The section on population trends in California should be reorganized to more clearly reflect what is known or not about trends in the two ESUs. Currently, the section switches inconsistently between discussions concerning different	This section was reorganized to present information on populations in northern California and the southern Sierra Nevada separately.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			general regions of the state (northern, southern, northwestern, etc.), specific ecoregions (Klamath, East Fransiscan, etc.), individual counties, or even local study areas without clearly contrasting or discussing their implications for the ESUs or the state as a whole. Because the environmental contexts and threats differ greatly between the two ESUs, they should be addressed in separate subsections for clarity. The review should start with the broadest scales for context and step down to finer-scale assessments or specific study areas that provide insights on the regional trends. For example, the discussion of trends for the SSN ESU should begin with an overview of information pertaining to historic range contraction and some re-expansion at the range scale, followed by recent occupancy trends within the current ESU area and in three recognized population subdivisions of the ESU (Zielinski et al. 2013), followed by discussions of more local or fine-grained patterns from field studies within the ESU.	
Conservation Status				
Regulatory Status	37:1081	WS	Update federal legal status. Fisher are now proposed for listing as threatened.	Text amended.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat Essential for the Continued Existence of the Species	Entire Section	WS	This section very weak. Need more review of fisher habitat selection in California and discussion of what the essential elements are. See SSNFCA and copious literature cited therein.	Additional, California-specific information added to Habitat Use section.
Habitat Essential for the Continued Existence of the Species	37:1089-1090	WS	We actually know a lot about fisher forest habitat requirements.	See Habitat Use section.
Habitat Essential for the Continued Existence of the Species	38:1093-1094	WS	Evidence strongly suggests that old-growth is likely most preferred, and particular tree species are beneficial regionally (e.g., black oak in SSN, tanoak in NC.	Noted. No references provided by the reviewer.
Habitat Essential for the Continued Existence of the Species	38:1100-1103	WS	True, but current (ongoing, not-yet-published) analyses are being used to characterize habitat in breeding female home ranges in the SSN. These strongly suggest that reproductive success is associated with a high proportion of dense, old, forest characteristics at the home range scale. The smallest female home ranges are associated with forests having old growth characteristics, including very high basal area, mostly dense (>70% canopy cover from above) and multilayered canopies, abundant large snags and logs, and high basal area of black oaks.	Section amended to address fine-scale habitat characteristics.
Habitat Essential for the Continued Existence of the	38: 1100-1103	BZ	Yes, "*quantitative information is lacking… to measures of fitness*.." (which is a very high standard) but	The recent work of Truex and Zielinski 2013 and Zielinski et al. 2013, was incorporated into the section on fuels management and information from Sweitzer et al. (2015)

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Species			missing in this section are the recent developments to understand management effects on fisher habitat (the “female fisher home range template” of Thompson et al. (2011)), the effects of fuels management on fisher habitat and fisher tolerance of disturbance work (Truex and Zielinski 2013, Zielinski et al. 2013), and the recent work on estimating fisher population growth rates by Sweitzer et al. (*in review*, *J. Mammal*). These recent pieces of work have much to add to the discussion in this section.	was added in other sections related to fisher population trend. The potential effects of fuels treatments and no action of habitats used by female fishers with and without fire simulated by Thompson (2011) was incorporated into the section on fuels treatments.
Habitat Essential for the Continued Existence of the Species	38:1105-1115	WS	Redundant with above information. Consider better organizing this section to reduce redundancies and deal with issues of scale.	This section was reorganized to minimize redundancies and to improve clarity.
Habitat Essential for the Continued Existence of the Species	38: 1105	JMH	It is true that it may be easier to study den and rest site selection, but I believe most of the research focused on that because earlier papers recommended that research be done and that resting and denning habitat would likely be most critical to fishers. The attitude seemed to be that they could forage just about anywhere but were limited in rest site selection and even more limited for dens. I do wish we could do better at teasing apart foraging from other active behaviors. That	Sentence modified based on this comment.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			is definitely a difficult task.	
Habitat Essential for the Continued Existence of the Species	38:1114-1115	LD	In response to the following sentence within the document: "Studies have shown that trees used by fishers for reproduction are among the largest available in the vicinity [52,66,110]." Dr. Diller commented that: "True, but it is my experience that this only holds if comparing conifer and hardwood species separately."	Noted. No Change. No data were provided to evaluate this hypothesis.
Habitat Essential for the Continued Existence of the Species	38:1117	WS	Why focus on western North America and cite literature from BC and Rockies? There are numerous publications on fisher habitat selection in California that are not cited in this section: Spencer et al. 2011, Zielinski et al. 2004a, 2004b, 2006,2010; Davis et al. 2007, Purcell et al. 2009, Thompson et al. 2011, Zhao et al. 2012, etc.	Additional information and a number of the papers mentioned by the reviewer were incorporated into the document.
Habitat Essential for the Continued Existence of the Species	38:1121-1122	WS	Redundant	Noted.
Habitat Essential for the Continued Existence of the Species	39: 1150	BZ	Change to "…*fishers* <u>*appeared to have*</u> *increased*.." Wording change is necessary to acknowledge there are no quantitative data to support this assertion.	Text modified.
Distribution Trend	39	WS	See discussion in SSNFCA with evidence that in the SN, range contracted during 19th-20th centuries to the southernmost portion of the region (exact extent	Text modified to incorporate Tucker et al. (2012) hypothesis of population expansion in the southern Sierra Nevada post-contraction in the late 19th and 20th centuries.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			unknown, but probably south of the Kings River) and then re-expanded in the late 20th-early 21st century as far north as the Merced River.	
Distribution and Trend	39:1186	WS	Some evidence of recent expansion in the southern population as well, but that this northward expansion has stalled at the Merced River (Yosemite Valley). See SSNFCA.	Noted. Text indicates that fishers within the SSN ESU are not known to occur north of the Merced River.
Distribution Trend	39:1136-1139	LD	If there are no genetic data inconsistent with this finding, why would it be stated as if there is uncertainty about the conclusion?	Noted. The level of uncertainty reflects that used by the literature referenced [i.e., Tucker et al. (2012)].
Distribution Trend	39: 1150-1152	LD	This is a bit misleading since there was a big jump in fisher surveys beginning in the early 1990's following the first petition to list the fisher.	Text revised to indicate that high detections of fishers in western portions of Del Norte and Humboldt counties followed a major increase in survey effort since the 1990s to avoid the potential misconception that increased detections necessarily indicated an increase in fisher population size.
Distribution Trend	39:1152-1155	LD	Grinnell's distribution for fisher's in northern Humboldt and Del Norte counties extends further west than any reported trapping locations. Furthermore, there are numerous trapping locations for marten in this area, which indicates there was trapping pressure in this region. Considering the value of fisher pelts, trappers would not have passed up fishers if they were present. This suggests that Grinnell drew the range map based on a presumption of where fishers should occur. This indicates that almost certainly fishers have	Noted. We agree that fishers have almost certainly extended their range westward in northern Humboldt and Del Norte counties, beyond the Grinnell et al. (1937) map of the assumed historical range of fishers in that region. Our estimated current range of fishers in northern Humboldt and Del Norte counties extends essentially to the coastline, based on verified contemporary detections of fishers in those counties.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			extended their range to the west in this portion of their range.	
Distribution Trend	40: 1175-1176	BZ	Recall, however, that Grinnell's estimates of density occurred shortly after the railroad logging era and on the tail end of the fisher trapping era, so his guesses as density may be lower than might have occurred previous to the impacts of these factors. This logic also challenges the optimistic conclusion, on pg. 54 (lines 1528 - 1530) that fisher's "*population is likely higher then when densities.. were estimated by Grinnell et al. to be 1-2 per township in good habitat*". Grinnell's estimates, coming on the heels of significant trapping pressure and timber harvest in California, may not be good proxies for a historical baseline.	Noted. Reference to Grinnell et al. (1937) estimates were meant to apply to the period of their assessment and were not intended to reflect a "historical baseline" prior to habitat changes or trapping pressure that occurred in California from the late 1800s and early 1900s.
Population abundance in California	40:1190	MG	Is this the case for trapping at other projects where other sympatric carnivores may constitute equal or higher numbers of trap success? Not camera data but trapping #'s?	Noted. Currently we do not have similar data from other study sites.
Population abundance in California	42:1210	JT	These estimates are very high when compared to other population estimates from the SSN. I would not devote and entire paragraph to these estimates which have not been peer reviewed or published – there is no	Noted. Text not modified, but order in which the different population estimates were presented was modified. Similar estimate (not published or peer-reviewed) by Carroll also was addressed in a paragraph.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			basis to judge the merit of their estimation methods. Just because they have two similar estimates does not mean that they are accurate, especially considering they are quite dissimilar from other population size estimates in the SSN (Spencer et al.2011, Jordan et al. 2007…)	
Population Abundance in California	41:1215	LD	Suggested inserting the following text: Thompson (2008) employed a capture-resight technique to quantify the abundance and density of fisher on two separate 100 km^2 study sites on Green Diamond's ownership in coastal northern California. The estimated population density of fishers on Green Diamond's ownership based on these two study areas and two estimation techniques was 0.23 fisher/km^2 (sexes combined). Applying this average across the ownership, Green Diamond estimated a population of 335 fishers within its 1,457 km^2 (360,000 acre) ownership assessment area. Using the same mean fisher density estimate with a 20 km buffer around its ownership to represent the area of likely fisher ingress and egress, Green Diamond estimated a regional fisher population of almost 2,000 fishers.	Noted. This density estimate was made by averaging two estimates (i.e., mark-resight and based on home range size). The reviewer subsequently suggested not using the estimate of 0.23 fisher/km^2, because a more conservative approach when considering the species status. Instead he recommended using the lower density estimates in Thompson (2008), if this information was incorporated into the document.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Population Trend in California	42:1231	JT	I think this entire section needs reorganized as it jumps all over the place and is hard to follow. A suggested outline: Population Trend in CA: 1) Historical distribution and trend 2) Large Scale Monitoring: a. SSN (USFS) b. NWCA (CADFW) 3) Local monitoring (smaller areas within pops) a. Hoopa b. Green Diamond c. Sweirs d. SNAMP?? e. Kings River??	Text in this and previous section significantly revised.
Population Trend in California	42:1236	JT	I would like to point out again that all we have are unverified locations in the central and northern Sierras, there are no physical specimens from the gap.	Noted.
Population Trend in California	43:1237	JT	This statement is illogical. The lack of specimens from the central and northern Sierras does not support that they were scarce, it supports that they were absent…	Text added to Distribution Trend addresses this issue.
Population Trend in California	43:1237	JT	This paragraph seems extremely dismissive of the evidence of long term genetic isolation in Knaus et al. 2011, and my 2012 paper.	Text added to Distribution Trend section addresses this issue.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			The magnitude of genetic differentiation between NW and SSN detected was striking. and would have taken a lot longer than the last 150 years to accumulate, yet here it is dismissed in one sentence in favor of the Grinnel historical range and theory of more recent extirpation from the central and northern Sierra, which I will reiterate has no physical evidence to support it.	
Population Abundance in California	41:1241-1250	WS	I disagree with emphasizing these estimates. Previous peer review showed how assumptions biased these toward high estimates, due, for example, to extrapolating densities over larger areas of potential habitat than warranted. If you retain this information , consider stating that these are likely biased high for reasons pointed out by previous peer reviews.	Noted. These estimates are presented without particular emphasis.
Population Abundance in California	41:1252	WS	Density and population size estimates are currently available for portions of the SSN from the SNAMP and KRFP studies. See SSNFCA for estimates of fisher population size in Core Areas 4 (between Kings and San Joaquin Rivers) and 5 (between San Joaquin and Merced Rivers). These new density estimates could help corroborate/refine the overall size estimates for the SNN population	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Population Trend in California	42:1256-1262	SM	The report states: "More recent surveys by Green Diamond Resource Company in Del Norte and northern Humboldt counties provide insight into the probability of detecting fishers relative to other carnivores using baited camera stations on its industrial timberlands. Remote camera surveys were conducted at 111 stations from 2011-2013. Of the 7 species documented at camera stations, only bears were more frequently detected (83%) at camera stations than fishers (71%) (Figure 8). These data suggest fishers are relatively common within the area surveyed." As I stated previously, these comparisons and conclusions are not valid. First and foremost, these conclusions are not supported by a citation or supporting documentation. I am assuming the remote camera stations were deployed using an occupancy or similar sampling design. These designs are most often species specific, based on individual movement data. Because the 8 species in figure 8 represent at least an order of magnitude difference in distances traveled, comparisons of their frequencies of detection are not valid and cannot be used to assess how common or	Text revised to include a citation that describes the surveys conducted on Green Diamond lands from 1994-2011 and also to note that camera detection rates may not be a reliable indicator of population trend (citing a Matthews publication)

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			rare a species is, even in a relative sense.	
Population Trend in California	Section	WS	Consider organizing section better, clearly separating statewide vs northern vs southern studies (see highlights). Also, should lead each subsection with the most general and scientifically defensible assessments, followed by other more localized or less certain pieces of evidence. For example, the current organization seems to give the Green Diamond studies undue emphasis, given how little they actually can say about pop status or trends, relative to more comprehensive or statistically valid studies, like Tucker et al., Zielinski et al., and Furnas et al.	This section was reorganized to incorporation need information and to improve clarity.
Population Trend in California	41:1231	WS	Insert bold text in this sentence to give section context: No data are available that document long-term trends in fisher populations statewide in California**, although recent occupancy trend estimates are available for the southern population and localized studies provide some insights concerning trends in portions of the northern population.**	Suggestion incorporated.
	43:1276	JT	If you are going to include this I think you need to include a vicinity map showing where these surveys were conducted within the NW	Noted. Additional map not included. Text already states that the surveys were conducted in Del Norte and southern Humboldt counties. We are not able to provide a map for every study mentioned in the document.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			population for reference	
	43:1280	JT	You need to add discussion of the Knaus 2011 paper as well, as the two papers support each other's conclusions. I would move this up to the beginning of the section as it deals with historical context and seems out of order here	Knaus et al. reference added, and part of paragraph relocated within section.
Population Trend in California	42:1253	WS	Should the <u>ratios</u> be <u>rates</u> in this sentence?: However, there was insufficient statistical power to detect a trend in these detection **ratios** (L. Diller, pers. comm)	Text changed to "rates".
Population Trend in California	42:1255-1270	WS	Information related to Green Diamond and Swiers studies (detectability, commonness) is not relevant to population *trend* section. Also, Disagree with using this as evidence of "commonness" of fishers. Detection rates also depend on how easily attracted species are to baited stations, how far they move, the range of habitat values sampled, sampling design, etc. Fishers could be at average or low densities but frequently detected at stations. The sampling design can also affect detection rates. Were stations spaced sufficiently to be independent, or could one fisher visit multiple stations?	Noted. The document acknowledges that fisher detection rates at camera stations may not be a reliable indicator of population trends.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Population Trend in California	42:1267-1268	WS	Was this based on modeled or empirically measured population size? 2006-11 is not a very long period for detecting trends in a long-lived carnivore like fisher.	Noted.
Population Trend	43:fig 8	WS	Although this information might be useful, I question whether it is appropriate to make any inferences about density or abundance (relative or otherwise) from them. Need much more context about sampling area and design, etc. For ;example higher fisher than marten detections probably reflects elevation and the extreme rarity of the Humboldt marten. I would bet that some of the species with relatively low rates (e.g., gray fox) were more abundant than fisher. ETC.	Noted. These data were described to provide insight into the probability of detecting fishers relative to other carnivores. Nevertheless, Hamm et al. (2012) based on surveys from 1994-2011, concluded that fishers were relatively abundant and well distributed throughout the majority of Green Diamond's ownership.
	43:1278-1279	WS	Was the 90% decline just for the SSN population, or statewide?	Noted. Tucker et al. (2012:2,7) concluded that fisher populations in California experienced a 90% decline in effective population size more than 1,000 years ago.
	44:1292	JT	This is incorrect. These estimates were for effective population size (Ne) not census population size (Nc)	Text modified to reflect comment.
Population Trend in California	43:1296-1298	WS	This approach has become a standard practice for numerous species as highly effective, scientifically valid, and cost effective.	Noted.
	44:1296	JT	?? The Southern Sierra population has had an extensive, systematic monitoring program in place since 2002, and there was a fairly long	Text in this section reorganized to improve clarity.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			history of systematic surveys by Zieinski et al prior to this in the 1990s. If you are just referring to the NWCA population then you should not follow with a sentence about SSN fisher monitoring.	
Population Trend in California	44:1298-1307	WS	1. Zielinski et al. is the most scientifically defensible study of pop trends in the SN, but almost seems buried down here. 2. Need a map or description of the Zielinski et al. study zones to make this info more useful. Southeastern zone = Kern Plateau, which has lower modeled habitat value than the western portions, and the southwestern zone is that southern refugium that received less human disturbance and has the highest habitat value in the SSN. In other words, the occupancy patterns seen by Zielinski et al. correspond with predicted habitat values and historic observations, etc. See SSNFCA description of fisher core areas.	1. Noted. 2. Text descriptions added to doc.
Population Trend in California	45:1301	JT	I think you are underselling the SSN fisher monitoring program in comparison to the EBM monitoring in the subsequent paragraph. Why is there a ton of detail about that	Text describing EBM fisher monitoring program simplified by removing unnecessary details.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			monitoring program (FIA hexagons, site selection, etc…) for the EBM monitoring in NWCA but not the SSN fisher monitoring? I can provide additional details if you want to add this or many are available in the trend analysis paper (Zielinski et al.2013) Either provide the same level of detail for both or cut details from the EBM description to balance.	
Population Trend in California	43:1278	JMH	I am in no way a genetics expert. This work is extremely interesting to me and I did re-read the paper yesterday to try and get a better grasp upon their conclusions. I have no problem believing that the 2 current populations have been isolated for 1000 years. The gap is quite large and it does sound like the SSN population likely retreated to the extreme south. At the north end of the Sierras there is a noticeable gap in the suitable habitat model on your figures above. Jody did not have any historical samples from the central/northern Sierras where Grinnell showed historical records. I could totally picture a now missing, third, genetically isolated population that disappeared post European settlement. It seems that we either have to believe that	Noted. No Change.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			none of the Grinnell records were real or that there were indeed fisher in the central-northern Sierras. If they were there, it seems plausible that they could have been genetically isolated from both the SSN and NC populations or at least isolated from 1 or the other.	
Population Trend in California	43:1290	JMH	This should say “current effective population size” rather than an estimate of the actual current population.	Text modified based on comment
Population Trend in California	44:1322-1324	SM	Commenting on the results of the Department’s EBM program, the report states: “The results suggest that fishers are common and widespread throughout the study area, but the confidence intervals surrounding these data are broad due to the relatively few plots surveyed.” The strength of an occupancy-based protocol is to elucidate occupancy trends over time. While the results from 2 years of the program present a snapshot of fisher occupancy in the region, I suggest a comparison to historic distribution is a more appropriate evaluation of “widespread” and the conclusion of “common” steps beyond the data provided an occupancy protocol without an occupancy-abundance link (see Tucker 2013).	Text modified to clarify what is meant by the terms “common” and “widespread”.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Threats				
Threats (General)		WS	The review is very uneven in its treatment of various threats and the listing factors, with lengthy reviews of some factors not considered by scientists to be very high threats, and more cursory reviews of other factors that are considered of greater concern. For example, the review has a lengthy description of historic trapping effects on fishers even though fisher trapping has long been banned in California and is no longer considered a threat in the state. Similarly, there is a lengthy review of fisher diseases, although diseases are not necessarily considered an imminent threat to fisher persistence, and monitoring for and attempting to counter disease outbreaks would be very difficult and costly (D. Clifford, personal communications). In contrast, the review of fire as a threat—while heavy on the history of fire and fire management in the state and with some discussion of possible effects of fire on fisher habitat elements—provides inadequate treatment of the biggest concern, which is loss and fragmentation of habitat over large areas by very large and severe fires (Scheller et al. 2011). A major focus of the SSN	This section was revised to incorporate new information and to improve its clarity. In particular, information was added regarding the historical and potential current effects of fire and fuels treatments in the Sierra Nevada on fisher habitat.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			Fisher Conservation Strategy is restoring more naturally heterogeneous habitat conditions that are less likely to support very large, severe fires. Similarly, the review provides a lot of information about historic and current logging patterns in California, with some treatment of possible effects on fishers, but it seems to ignore that commercial timber harvest is just one of many sorts of vegetation management actions that affect fisher habitat, many of which are more common and widespread than logging, at least in the SSN.	
Threats (General)		WS	Some sections provide lengthy historical reviews of information not directly germane to current and future threats to fishers (e.g., the history of federal fire policies and state trapping policies). Such information could be conveyed more briefly to establish context for what is really important: what are the current and future conditions as they pertain to fisher conservation or extirpation?	The text was reorganized to minimize redundancy and to streamline the document.
Evolutionarily Significant Units		CT	The decision to identify northern and southern Evolutionary Significant Units appears warranted based on the biology, behavior, physiology, and genetic history of the species.	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
ESUs	44:1331-1333	WS	I agree with this designation.	Noted.
Habitat Loss and Degradation	45:1354	WS	Content of this section too narrowly focused on commercial timber harvest. There is extensive information (and debate, and research) on the role of other management activities (thinning, prescribed fire, salvage logging, stand improvement, etc.) and other disturbances (severe fires, insect outbreaks, etc.) on fisher habitat loss and degradation. At least in the SSN, timber harvest is a minor factor compared with these factors. See SSNFCA, Scheller et al. 2011, etc.	Drought and Insect Tree Mortality section added to habitat loss section. Also, some info on potential increase in insect infestations in Climate Change section (p.107).
Habitat Loss and Degradation	47:1376-1390	WS	(1377) Yes, and adult female home ranges are even more biased toward these conditions. Note that saying fishers are not DEPENDENT ON old-growth forests is not the same as saying that old-growth forests aren't THE BEST for supporting fishers. Currently, old-growth is so limited that fishers may be "making do" with the best available, though not optimal, conditions. (1379-1380) Correct. See previous comment. Current habitat conditions do not represent historical or desired habitat conditions, and fishers might be more abundant if there was more	Text modified to more clearly describe the relationship between fisher and characteristics of old forests.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			old growth. (1381) This implies that National Parks were always protected from logging. Although they have been protected in recent decades, forests in Yosemite and other national parks were historically heavily impacted by humans, including timber harvest in large areas. Old growth is less abundant in parks than the historic condition.	
Habitat Loss and Degradation	47:1399-1406	BZ	Yes, the timber harvest has decreased since the 1980s, but what is not mentioned here is that the historical high in the 1980s took many of the saw logs that would have been resting habitat, had they not been harvested. The fact that harvest is at low levels now is no protection for fishers if in the preceding century a significant number of large trees were removed. To be fair we should have data on the saw logs that <u>remain</u> in the forest in the form of large trees, compared to what would have been available if the heavy harvest decades of the previous century had not occurred. This section seems written to downplay the effect of timber harvest on fisher habitat.	Noted. Timber harvest has the potential to remove trees used for resting and denning by fishers, unless they are unmerchantable or specific measures are in place to retain them. It is reasonable to conclude that during the historical high in timber harvesting, trees used for resting by fishers were removed and that some of those trees would remain today had they not been cut. Nevertheless, the harvest rate in recent years provides an indication of the potential for this activity to affect habitats used by fishers in areas that were partially cut in the past. Historically, with the exception of clear cutting, trees used by fishers may have been retained during timber harvests because they were considered unmerchantable (e.g., conifers with defects, hardwoods). In more recent times, trees formerly considered unmerchantable may have been cut because of a broader market for forest products and the comparative lack of high quality logs from old trees. Fishers currently use landscapes and occupy specific sites that were intensively harvested for timber in the past (e.g., coastal redwood region). We are not aware of evidence, nor did the reviewer provide any, indicating that current or past timber harvesting is adversely affecting fisher populations in California.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat Loss and Degradation	48:1409	JMH	Looks like Round Valley and Tule River Reservations are lumped in with public land on this figure but not on the next 1	Figure was modified.
	50:1411	JT	This figure is missing depiction of tribal lands with the Tule River Indian Reservation near the Sequoia NF	Figure was modified.
Habitat Loss and Degradation	51:fig 14	WS	Consider adding Stanislaus NF. Not currently occupied by fisher, but range expansion onto Stanislaus NF is a major goal of SSN Fisher Conservation Strategy.	Noted. Adding Stan NF would not change pattern of figure. There has been the same general pattern of steep decline in saw timber sales since the late 1980's.
Habitat Loss and Degradation	51:1457	JMH	Although fishers do occupy heavily managed areas throughout the NC ESU, occupancy even with reproduction, does not always mean good quality habitat. I make this case cautiously and with caveats each time. Yes, they occupy managed landscapes and sometimes reproduce, however, it doesn't necessarily equate to high fitness habitat. The landscape, even in higher quality habitat likely has a mix of source, sink and neutral territories. Figure 15 really shows a number of fisher home ranges with relatively few open clear cuts within them. I have scanned the northern and central Sierras using Google Earth and I can see large areas that are heavily impacted by clear cuts. Much of that area I would think would be capable of supporting fisher	Some text in this section revised, including a discussion of the effect of the creation of open areas on fisher occupancy.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			habitat but, due to management activities it may remain of low to un-suitable quality. I am hoping that the monitoring of the Stirling reintroduction can continue long term and we will get a better picture of how fisher populations respond to landscapes subjected to intensive regeneration timber management. I have often thought that fishers would do quite well in the northern and central Sierra's if they could make their way to the public lands there. If they can survive and expand on the Stirling tract then I would imagine they will do well on the adjacent public lands as well.	
Habitat Loss and Degradation	51:1460-1462	WS	Yes, but no evidence that they can be as abundant in these conditions. Fishers clearly avoid the most heavily managed areas and site home ranges in the areas of most contiguous, intact, dense forest available (as seen in the right side of Figure 15 and various scientific studies, like Sauder and Rachlow (2014). Also, I question characterizing management of the Hoopa Reservation (Fig 15, left) as "intensively managed for timber production." Statements like these are misleading in that they can be interpreted as "intensive timber management does not reduce fisher habitat value," with is clearly	Figure has been removed.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			untrue. Clearcutting (even-aged management) is clearly detrimental to fishers.	
Habitat Loss and Degradation	1457-1462	CT	In southern ESU timber harvest is not the primary land management activity with the potential to degrade habitat. Fuel reduction treatments are the primary management threat, specifically understory / ladder fuel removal which may degrade prey habitat and fragment fisher habitat.	Fuel Reduction Treatments section has been added to report.
	51:1462	SM	I would caution the use of “intensively” to describe Hoopa forest management practices reflected in figure 15. BIA management in the 1970’s and 80’s may have been classified as such, but structural diversity in managed stands across Hoopa are relatively high compared to other “intensively managed” ownerships. More quantitative measurements of board feet per acre would be useful.	Text modified to clarify the possible implication that forest management at Hoopa is particularly “intensive”.
Habitat Loss and Degradation	51:1466	JMH	I agree that this is probably true but again, tend to point out that we simply do not have the data to make this conclusion. There are probably large chunks of potentially capable habitat that have few if any denning structures due to past management or intense stand replacing fire. Does this hinder population expansion? We don’t really know.	Text revised.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
	51: 1466	BZ	This is an optimistic, but unsubstantiated conclusion. It is hard to believe this in light of the decades of saw log harvest in the late 20th century. But, here again, is a conclusion that assumes the best when it would be equally likely to conclude – in the absence of data and with the history of selective harvest in the mid-elevations of the Sierra – that availability may indeed be limiting fisher populations.	Text was modified to indicate that insufficient evidence exists to conclude that a lack of habitat due to timber harvesting is adversely affecting fisher populations in California.
Habitat Loss and Degradation	51:1464-1467	WS	(1464) How/why this determination? More proximal how? (1465-1466) There is no evidence that foraging habitat is limiting. Fishers will forage in a wider array of conditions than they will rest and den. Denning habitat is the limiting factor. (1466-1467) Evidence for this statement? We do not know if this is true, and I suspect that denning habitat is limiting.	Text has been revised to remove these statements.
	51:1467-1468	SM	The report suggests: "However, at this time, the availability of denning or resting structures does not appear to be limiting fisher populations in California." The report does not provide nor am I	Text revised to clarify original intent.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			aware of any reference supporting this claim.	
Habitat Loss and Degradation	52:fig 15	WS	Captions should be more geographically specific than "northern California" and need to have scales! Are the scales the same between the two areas? If so, one cannot compared home range sizes. The left area is on Hoopa (coastal) with a completely different management scheme than that of the SPI lands (right area). Also, it is clear from right area that fishers are selecting the least heavily impacted portions of the land (avoiding denser areas of recent clearcuts). This figure not useful without more context and explanation	Figure no longer included in report.
Habitat Loss and Degradation	54:1475	JT	Needs a more informative caption- what exactly am I looking at here? (Caption for Figure 15)	Figure deleted.
Population Size and Isolation	52:Population Size and Isolation - entire section	WS	This section just repeats information already provided in earlier sections. Instead it should focus on how pop size and isolation increase THREATS to the population (continued genetic degradation, stochastic events, etc.). None of the information here addresses a threat to the population. Either delete section, or rewrite to focus on how pop isolation and size might affect	Text in this section was reorganized and streamlined to improve clarity. Some additional information was included relative to potential threats to fisher populations.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			THREATS to the pop.	
Population Size and Isolation		CT	Due to the smaller mean litter sizes of southern ESU populations, coupled with the small size of the southern Sierra population and the diversity of risks currently faced, the southern ESU defined by the Department can be expected to be less resilient to population fluctuation than other subpopulations.	Noted.
Population Size and Isolation	55:1496	JT	Again, I think the Knaus paper needs more description here than this brief reference	Noted. Text not modified. Knaus et al. is also mentioned two sentences earlier.
Population Size and Isolation	53:1498	JMH	If there had been a third isolated population as I suggested in previous comment, then during this period when the second bottle neck occurred that population might have been lost completely. I wish that there had been historic samples for Tucker et al from the central-northern Sierras. I feel that unless we are willing to discount Grinnell's records, we need to assume that fishers had been present in the central to northern Sierras and they are now gone. I think that if they had been there, Turcker et al's work would indicate that there was not any gene flow to either current population for at least 1000 years or so.	Noted.
Population Size and Isolation	53:1503	JMH	Although it is very promising that the occupancy surveys are not indicating a downward trend, I am	Text modified to mention research indicating that occupancy estimates based on current monitoring techniques may imperfectly detect population changes.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			only cautiously optimistic for several reasons. First, the occupancy surveys are only expected to detect fairly significant declines of populations (20% or so). Second, it is quite possible that fisher home range size might be at least partially density dependent, thus as the population decreases, home ranges increase in size and as we all know fishers are fairly easily trapped/detected when they are present. Therefore, a declining population could still occupy essentially the same area as a previously high density population. I say this because that certainly appeared to be the case at Hoopa. I think that there is some evidence that the SSN population might actually be expanding northward a bit as you mention. I think that I would emphasis that aspect more.	
	53:1505	SM	The report suggests the SSN population appears to have been stable. Refer to my comments above for lines 54-58.	Text modified to mention research indicating that occupancy estimates based on current monitoring techniques may imperfectly detect population changes. Text also modified to include population growth rate from recent research.
Population Size and Isolation	53:1528	JMH	I was really struck by this when you mentioned it above. Not sure how strong a case can be made given the changes in access, technology, population estimation techniques etc. If you can give a bit more	Noted. We are not aware of any additional detail regarding how Grinnell et al. reached their conclusion regarding fisher abundance.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			detail as to how Grinnell arrived at his estimation it might help make this case stronger. I totally believe that at least in accessible portions of the range that the density at that time would have been far less than today and I have always believed that over exploitation led to local to even wide spread extirpation (OR and WA and possibly central-northern Sierra). Then landscape changes following that period may have kept them from rebounding.	
Predation and Disease	54:1532	WS	Why combine predation and disease? Both the nature of these threats and their effects on fisher populations are very different. Also, why include toxins under disease? That is a separate factor and section.	Predation and Disease are now treated in their own sections.
Predation and Disease	54:1539	MG	Cite Wengert et al 2014 in The Journal of Wildlife Management 78(4):603–611; 2014; DOI: 10.1002	Document cited.
Predation and Disease	54:1542	MG	The wengert et al 2014 paper should be mentioned too since it highlights predation as a significant contributor, up to 61% of all fisher mortalities.	Document cited.
Predation and Disease	55:1566	WS	Section should address that exposure to toxicants may elevate measured predation rates by compromising fisher health and behavior (see Thompson et al. (2014).	Noted. Potential indirect effects of toxicants are described in the Toxicants Section.
Predation and	55: 1571-	BZ	Bobcats and mountain lions are key	Modified text to indicate that some forest management

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Disease	1573		predators on fishers and are also species that favor more disturbed and early seral habitats. Thus, many fisher scientists have assumed that timber harvest and other factors that fragment overhead cover will provide and advantage to the fisher's predators. Yet, on page 55 (lines 1571-1573) - despite evidence from Wengert (and from Slader Buck's thesis) and a strong basis in conventional wisdom based on habitat relations – the authors are equivocal about whether forest management practices could affect the abundance/distribution of fisher predators ("*Whether or not some forest management practices favor.. generalist predators (like bobcats)… is not known*"). Stating that it is not known, in this case gives the impression that it is not likely to be a factor, which is contrary to conventional wisdom.	practices favor species adapted to disturbed and early seral habitats, some of which are known to prey on fishers.
Predation and Disease	58:1673-1676	WS	This section seems overly long relative to the threat to fisher populations. Lead section with a general statement like this, and then provide results of studies without the details.	Predation and Disease issues have been divided into separate sections and substantially revised based on peer comments.
Human Population Growth and Development	59:1720	JMH	However, increased risk and severity of wildfire could lead to significant loss of habitat, at least temporarily.	Comment noted – no modifications to text. Increased threat of fire frequency and severity as a result of development already mentioned in same paragraph

Section Heading	Page: Line	Reviewer*	Comment	Department Response
	61:table 5	WS	Consider reorganizing table to show what proportion of high/med/low habitat is affected by human development	Noted. This table depicts potential fisher habitat modified by human development (structures) on parcels < 16.2 ha (40 ac) as of 2010 and projected by 2030 within the Northern California Fisher Evolutionarily Significant Unit (NC ESU) and the Southern Sierra Nevada Fisher Evolutionarily Significant Unit (SSN ESU).
Human Population Growth and Development	62:1728	JT	The detail on development is very hard to see here. Maybe just use two maps zoomed in to each of the ESUs and leave the central sierra gap out. I think by this point readers are familiar with the overall distribution in the state (Figure 16 caption)	Map revised.
Disturbance	63:1788-1789	WS	Has abandonment of kits due to human disturbance EVER been documented? Needs a citation.	Noted. No change to text.
Disturbance	63:1791	WS	Why just timber management (which I assume refers to commercial harvest)? Concerns about thinning, prescribed fires, etc., as well.	Noted. Timber management in this context includes various forms of the management of vegetation including commercial harvesting of timber and thinning.
Disturbance	65:1795	JT	This seems a very incomplete discussion of a very complex issue. I am surprised to see no peer reviewed science discussed here. There have been a number of recent papers looks at the effects of fuels treatments on fisher - including thinning and timber harvest. Also I imagine data from the SNAMP project might directly speak to this issue, but that study was not referenced.	Noted. The section in question primarily deals with the behavioral response of fishers to disturbances such as noise, human activity, etc. But the comment seems to be addressing the effects of habitat disturbance (e.g. forest management) upon fishers. Therefore these two citations, while relevant to fisher ecology, do not seem relevant to this section of the document.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			Zienlinski et al. 2013 (see below) is one example, as well as perhaps Garner 2013. Zielinski, William J., et al. "An assessment of fisher (Pekania pennanti) tolerance to forest management intensity on the landscape." Forest Ecology and Management 310 (2013): 821-826. Garner, J.D., 2013. Selection of disturbed habitat by fishers (Martes pennanti) in the Sierra National Forest. MS thesis, Humboldt State University. Arcata, California.	
Disturbance	63: 1795-1796	BZ	This is too important a number to cite only via pers. comm. and to represent by a single sentence. I suggest that these data be presented in a figure – as was done for other timber harvest data -- together with estimates of variation. This is critical information, and could be related to the results in Zielinski et al. (2013) which linked and index of fisher density to the rate and extent of timber harvest and fuels management. I suggest that the review seek to amplify this information and do more to relate	Text added to demonstrate the rate of timber harvest on private lands in portions of northern California. The findings of Zielinski et al. (2013) were described in the section on fuels treatments.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			it to what is known about fisher home range characteristics.	
Disturbance	63:1796-1799	WS	C. Thompson (pers. comm.) reports a case of displacement probably due to noise of some management actions.	Noted.
Roads	1809 - 1826	CT	Highway 41 culvert project being managed by Anae Otto of the Sierra National Forest Bass Lake District and Pam Flick of Defenders of Wildlife has been documenting fisher use of culverts along a stretch of highway considered to be a significant threat to fishers in the northern region of the southern ESU, and retrofitting existing culverts in Yosemite National Park to facilitate wildlife use.	Noted.
Roads	64: entire	BZ	The Roads subcommittee of the Southern Sierra Nevada Fisher Working Group has good data on road mortalities and the use of crossings, including culverts, by fishers. A woman with the first name of "Linzey" is the lead; Kathryn Purcell (kpurcell@fs.fed.us) should be able to put you in touch with her.	Noted. Information contained in the recent Conservation Strategy by Spencer et al. (2015), was used to illustrate proportional loss of fishers due to roadkill.
Roads	63-64:1811-1826	WS	This section needs expansion. See SSNFCA for discussion of roadkill, potential population level effects due to roadkill in denning habitat, and use of culverts as road-	Section on the additive and synergistic combination of effects added to the document. Other points noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			crossing structures. (1811-1812) More updated and specific data exist. See SSNFCA and contact Anae Otto (head of SSN Fisher Working Group Roads Subcommittee). This committee has been collecting roadkill data, monitoring underpasses for fisher use, and installing roadcrossing improvements for fishers on Sierra NF and in Yosemite. (1817-1818) Citations for this? Sounds like logical speculation, but any data? Vegetation near road and availability of crossing structures (culverts, etc.) likely also influences. Also habitat conditions near the roads. Hwy 41/Wawona Rd is thru densely forested fisher denning habitat and thus may disproportionately kill mothers with dependent young. (1818-1821) Not sure I agree with this assessment, which needs more specifics. (1821-1823) Not on their own, but as one additive source of mortality in addition to others. See Spencer et al. (2011): human additive mortality, including roadkill, may be limiting population growth and expansion in the SSN.	

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			(1824) Needs more specifics. Major freeways (like I-8i0) would likely be barriers.	
Roads	64: 1821-1823	BZ	Indeed, "…*roads.. have not been demonstrated to limit fisher populations*", but nor has that possibility been eliminated. One has to ask, what type of data would be necessary, and how expensive would it be to collect, to demonstrate that roads limit fisher populations? This is asking a lot; instead the review assumes no effect when the data do not exist to demonstrate an effect. This is another example of a subtle and likely unintentional, bias against fisher conservation.	Noted. The review does not assume that roads have "no effect" on individual fishers. It does, however, indicate that fishers are struck and killed by vehicles. Also a number of researchers hypothesized that roads may be barriers to dispersal. This may be true in some areas, but not in others. The statement that "roads have not been demonstrated to limit fisher populations" reflects CDFW's lack of information supporting an effect on populations. This statement does not imply an assumption of no effect. The reviewer did not provide supporting documentation to help resolve this question.
Roads	66:1831	JT	Tucker 2013 (dissertation) found that genetic connectivity for female fisher (but not males) was impeded by roads. Ref #40.	Text modified to reflect this finding
Fire	66: lines not specified	BZ	Regarding fire, see also Hanson (2013). This new work attempts to shed light on the question about how fishers use post-fire landscapes.	Text modified to include Hanson's findings in the Summary of Listing Factors Section related to fire. He reported that moderate/higher-severity fire in mature/old forests with moderate to high pre-fire canopy cover was beneficial to fishers due to their high structural complexity and prey.
Fire	67:1876	LD	I think it should also be mentioned the potential beneficial effects of fire in terms of creating fisher den and rest site structure. In the coastal redwood region, the majority of den structures are the	Text revised to incorporate these points.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			result of fire scars that produce internal cavities. And in fact, I believe the lack of fire in this region will likely result in long term loss of fisher late seral habitat elements despite the fact that many thousands of acres are being set aside to allow trees to get large and old.	
Fire	64:1828-1836	WS	Section needs expansion and more comprehensive analysis. See Scheller et al. 2011 concerning fire and vegetation management effects on fishers. There is a lot of recent literature and ongoing research on this topic, which deserves more in-depth treatment in this assessment. (1830-1831) Source/citation for this? Many (most?) wildfires are started by humans over large areas (especially lower elevation areas, WUI). (1831) Effects can be positive or negative, depending on the nature of the fire (size, severity) and time since fire. (1833-1836) Overly simplistic. Large and severe fires can have negative effects; more frequent, less severe fires in pine and mixed-conifer forests may be beneficial. See SSNFCA and other literature on	Major revision of section to address these comments.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			the topic.	
Fire	64-65:1845-1865	WS	Seems like too much historical detail. Focus should be on science detailing how fire characteristics affect fishers	Noted.
Fire	65:1871-1872	WS	This gets restated a lot, but there is huge variability across the west in fire regimes, regime changes, and effects on habitat. Section should focus more on specifics in California.	Noted.
Fire	1903 – 1907	CT	2013 Aspen Fire and the 2014 French Fire may represent a more severe threat to the southern ESU. The fires burned on opposite sides of the San Joaquin drainage, below the Mammoth Pool Da in an area identified by both modelling and field data as an important corridor between two areas of higher quality habitat. Habitat modelling by the Conservation Biology Institute has identified approximately six such [habitat] bottlenecks, and all are at risk of destruction via natural or anthropogenic disturbance.	Information on Aspen Fire and French Fire now included in text (p.79).
	1903-1907	CT	Rim Fire was a human-caused event.	Text modified.
Fire	66:1904-1907	WS	See SSNFCA for maps showing modeled effects on likely movement corridor, shifting it upslope to unburned/less severely burned forests.	Text modified to indicate that large areas that burned at high severity during the Rim Fire, resulted in a shift in potential dispersal habitat eastward to higher-elevation forests that did not burn at high severity (Spencer et al. 2015:56).
Fire	67:figs 18 & 19	WS	Suggest combining figs into one (simply add ESUs to fig 18). Also,	Noted. Both historical and potential future effects of fire are discussed.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			the historical fire regime isn't the key factor (and most scientists agree that trying to restore historical conditions isn't an option in many areas). More pertinent are current and future trends that indicate that large, severe (canopy-replacing) fires are a threat to fisher habitat. See SSNFCA. Maps showing departure from historical fire return intervals (FRID), integrated fire hazard, etc., are more useful.	
Fire	70:1933	JT	Again, I would recommend zooming in to just the two ESUs and cutting out the gap (perhaps make it Figure 19a (Northern CA) and 19b (SSN). At this scale its hard to see sufficient detail within the ESUs.	Figures modified to improve scale within each ESU.
Toxicants	69:entire Toxicants section	WS	Section is long, redundant and poorly organized. Start with an intro overview of the issue, and then organize info into subsections on ARs and other toxicants. In each subsection, provide general conclusions first, followed by more detailed scientific justification. Currently, AR info is scattered throughout with no cohesive thread.	This section was revised to minimize redundancy and to improve clarity.
Toxicants	69:1947		This qualification seems unnecessary. Illegal marijuana grow sites are clearly the overwhelming source.	Text modified to indicate that some researchers have suggested that such grow sites are the likely source of fisher exposure to toxicants (Gabriel et al. 2013, Thompson et al. 2013)

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Toxicants	70:1953	MG	In addition to remediation, scientist visiting sites at Day 0 (day of raid) have documented toxicants at sites, in addition to finding remaining toxicants at abandoned sites that Law Enforcement were not aware of. There is both correlative and first-hand accounts that fisher territories encompass these sites and that these sites have significant quantities of toxicants present. No other sources of exposure are present in these territories, thus leaving the conclusion that these are most likely the source of exposure.	Noted. Text not modified, as comment is consistent with existing conclusion of paragraph (that AR exposure is most likely occurring at MJCSs).
Toxicants	70:1972	WS	The paragraphs above all focus on ARs. Suggest organizing so the intro paragraphs provide overview of ALL toxicants that may be affecting fishers and prey (including insecticides, etc.), and moving the AR-specific content in here.	This section was revised and reorganized to improve clarity.
Toxicants	71:1998-2004	WS	Update this info. Exposure rates now estimated over 90% (M. Gabriel and C. Thompson, pers. comm.)	Noted. The documented exposure of fishers to rodenticides is high and reflects the published literature.
Toxicants	71:2012-2015	WS	Also, since ARs prevent clotting, otherwise minor injuries can be debilitating or fatal.	Noted. The text indicates that predators with liver concentrations of anticoagulant rodenticides as low as 0.03 ppm (ug/g) have died as a result of excessive bleeding from minor wounds inflicted by prey (Erickson and Urban 2004). Also, fishers exposed to anticoagulant rodenticides may be at risk of experiencing prolonged bleeding after incurring a wound during a missed predation event, during physical encounters with conspecifics (e.g., bite wounds inflicted

Section Heading	Page: Line	Reviewer*	Comment	Department Response
				during mating), or from minor wounds inflicted by prey or during hunting.
Toxicants	72	BZ	I note here the subheading "*Population-level Impacts*", which makes sense but why does this only appear for the Toxicant threat and not the other threats, where population level impacts are just as relevant?	Noted. Assessments of impacts to fisher populations from other identified threats were made in other sections, but that specific heading was not believed to be necessary.
Toxicants	72:2012	MG	It would also be worthy to note the #of rodents impacted by this amount, since it was mentioned that secondary exposure is the most likely source. It also highlights the impact to fishers via prey availability.	Text modified to include estimates of potential mouse mortality.
Toxicants	72:2031	JMH	I do not disagree that the use at MJCS is unknown, however, they will be using something. We have documented restricted use chemicals at a number of sites as well as banned chemicals. Therefore, if they feel the need for it they will likely continue to use it or a similar product. One thing that we are concerned about is that some of the other rat poisons are much more difficult to detect in animals, such as bromethalin (Tomcat).	Noted. Comment supports existing text.
Toxicants	72:2031-2033	WS	Actually, it is clear this will have no effect on MJCSs, which are run by criminals with no respect for regulations. Only increased law enforcement and cleanups will	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			help.	
Toxicants	72:2031-2032		Call a spade a spade, change to: "*These new regulations are not likely to reduce use of SGARs at MJCSs*". This is just common sense, given the circumstances.	Text modified to indicate that the new regulations are likely to limit the availability of SGARs, but that they may still be obtained outside of California.
Toxicants	72:2049	JMH	In an effort to remain undetected by law enforcement growers are spreading out their plants much further, planting multiple patches and linear strips. In such cases they are spreading poisons out much further while growing fewer plants. Just because plant counts drop, doesn't mean the problem has gone away.	Noted. Text not modified, as basic concept remains the same (toxicants placed around plants).
Toxicants	72:2063-2065	WS	Thompson et al. 2013 documented reduced survival for female fishers with more MJCSs in their home ranges. This probably has a population level effect, especially given the coincident seasonality of growsites and denning season.	Text modified.
Toxicants	73:2083	JMH WS	This number is substantially higher now, again I would refer you to Mourad if you would like to update. At Hoopa we have had 7 male and 1 female mortality due to toxicosis. 6 were AR, 2 males were other rat poisons. Toxicosis is the leading cause of death for male fishers at Hoopa. Update with latest figures. Also, this information belongs in the AR	Footnote added to Toxicant Section to reflect this update.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			section.	
Toxicants	73: 2085-2086	BZ	Yes, any cumulative impact – esp. of an illegal activity – is "*hard to quantify at the population level*" but the widespread and ubiquitous nature of the threat should be a major concern, even if hard to quantify. Stating how difficult it is to quantify suggests to the reader that it doesn't have a significant negative effect.	Text modified to indicate that the cumulative impact of individual toxicity and exposure on has not been quantified at the population level. Nevertheless, this is a significant concern because of the widespread distribution of illegal marijuana grows and use of pesticides at those sites.
Toxicants	74:2082	MG	Would it worth to mention organic pesticides, which are infrequently discovered . Highlighting that currently, toxic substances tend to be the norm for MJCS.	Noted. Text not modified, as no specific recommendations are included for types of substances and their toxicity, and table already includes an entry for "other insecticides" which would cover many of the commonly used organic pesticides.
Toxicants		CT	The document states that 4 fishers have died from AR poisoning. I believe the current statistic is 12 documented mortalities statewide directly attributed AR or pesticide poisoning. 8% of all observed classified mortality from the Kings River and SNAMP studies (n=93) can be directly attributed to AR poisoning, and this is likely an underestimate. A 10% increase in mortality can be sufficient to cause population decline. So if sublethal AR effects inflate natural mortality by only 2%, this factor alone can inhibit expansion or even initiate decline.	Information from Thompson et al. 2013 now included in report and report now identifies toxicants as a potentially significant issue.
Toxicants	2083	CT	Number should be updated; I believe there are currently 12	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			documented cases of direct AR poisoning statewide, 7 in the southern ESU and 5 in the northern.	
Toxicants	74:2091	JMH	I know that I created a similar map for you that used the boundaries of the current range that you sent me, so you could use that map (which I will send you to be sure you have it) to be consistent with all of your other maps.	Noted.
Toxicants	75:2106-2108	WS	I agree that more study is needed, but this sentence seems to downplay the likely high significance of these effects (proximity to MJCS and exposure to ARs).	Noted.
Toxicants	75:2127	WS	Only small mammals? I strongly suspect that the apparent decline and absence of porcupines from large areas (e.g., mid elevation forests of the SSN) is due to, or exacerbated by, the MJCS rodenticide issue. And porcupines are important fisher prey in other regions where they co-occur.	Porcupine poisoning issue discussed elsewhere (e.g. Overexploitation, p.89)
Toxicants	75:2133	WS	Yes, but, there is strong inference behind this speculation. Downplaying potential significance of such factors seems to bias the assessment toward a finding of "not warranted."	Statement revised.
Toxicants	76:2134-2142	WS	This topic mentioned above. Organize content.	Section has been reorganized.
Toxicants	76:2149-2154	WS	Good summary info to use in the	Section has been reorganized.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			introductory paragraphs of this toxicant section.	
Climate Change		CT	The combination of a unique genotype and local adaptations to warmer temperatures would appear to make the southern ESU particularly valuable in the face of climate change.	Climate change section has been revised.
	1347-1352 (perhaps should be addressed in Climate Change)	CT	Fishers in the southern ESU exist at the southern extent of the North American range and can be expected to be better suitable for handling increasing temperatures. Data from BC indicates that fishers use subterranean rest sites when the ambient temperature drops below a certain threshold. In the southern Sierras, there are indications that fishers use subterranean rest sites when the temperature exceeds certain thresholds.	Climate change section has been revised.
Climate Change	76:2165-2166	WS	There are strong regional patterns to such trends (temp., precip., snowpack)within California.	Noted. Regional variation in climate and climate modeling are discussed in document.
Climate Change	78: 2210-2211	RP	Splitting infinitives is accepted by most writers of English ("to boldly go"). Nonetheless, splitting infinitives can have unanticipated effects that a good writer must consider. When an infinitive is split (for example, "to indirectly affect fishers"), the reader understands (usually unconsciously) that the adverb is more important than the verb because the adverb comes	Text modified to emphasize that climate change is likely to affect fishers indirectly.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			first. If a writer really means to put heavy emphasis on the adverb, then splitting the infinitive is the right thing to do. If the adverb is not very important (if the fact that a fishers are affected is way more important than whether the effect was direct or indirect) then splitting the infinitive misinforms the reader. You split several infinitives that I think you should not split.	
Climate Change	80:2264	MG	And fishers were lost from two NP lands. they are expected to persist in YOSE but it was unclear in the paper if they were in decline or stable.	Noted. Text not modified, as the parks that fishers were expected to be extirpated from are far from California (Glacier NP in Montana and Acadia NP in Maine) and the paper did not speculate as to whether specific species projected to persist in specific parks would be declining, stable, or increasing within those parks
Climate Change	80:2266	JMH	I think that it is important to also discuss sudden oak death, as it may be exacerbated by climate change (especially if we have warmer, wetter conditions. We could easily end up with an expansion of Klamath mixed evergreen forest that is perpetually in an early seral stage condition as intense wildfire and disease complement each other.	Brief discussion of sudden oak death added.
Climate Change	80: lines not specified	BZ	Somewhere around here it should be stated that the reduced snowpack expected in the future may be a benefit to fishers, which do more poorly in deep snow than do martens and other carnivores (see Krohn et al. refs).	Text revised to incorporate this reference and indicate that reduced snowpack may benefit fishers.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
	80:2266-2276	SM	Consideration of the potential impacts of Sudden Oak Death on the tanoak communities of the NC population should be considered.	Brief discussion of sudden oak death added.
Existing Management, Monitoring, and Research Activities				
General		BZ	**<u>Uncertain implementation of purported protections by land management agencies</u>**. In the section entitled "*Existing Management…Activities*" the review cites rules/regs on federal, state and private lands as though they have been implemented and have been demonstrated to be effective at protecting fishers or their habitat. However, many of these policies are protection in words only. The tone of some of the writing is decidedly optimistic, in terms of fisher habitat outcomes. In a number of cases, I believe this tone is not justified given how little evidence exists that rules/regs have been implemented and have resulted in benefits.	The reviewer expressed similar concern in other sections of the document where management on federal, state, and private lands was described. He contended that by describing existing regulations and policies without evidence of their effectiveness, the document presented an overly optimistic picture of their benefits to fishers. To address this concern, text was added to the beginning of the section to reflect that although regulations and policies designed to retain habitat or habitat elements for fishers are likely beneficial, their long-term effectiveness at maintaining viable fisher populations has yet to be demonstrated.
General (Fisher Working Groups)		BZ	Contributions of fisher working groups. I was surprised that the document did not reference the activities of the 2 fisher working	Text modified to include information about the contributions of fisher working groups.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			groups: the California Fisher Working Group and the Southern Sierra Nevada Working Group. The latter, in particular, has committees focused on various threats and research needs which, collectively, represent hope for the future. These efforts represent human capital and social solutions to the plight of fishers and should be recognized in this document. Kathryn Purcell organized and manages these groups and I'm sure could offer a brief summary of their activities (kpurcell@fs.fed.us).	
U.S. Forest Service	80: 2277 and onward	RP	Existing actions and regulations aimed to protect fishers and their habitat exist because of the fisher's status. If protection for fishers is removed, then many (or at least some) of those protections will disappear. Thus, what is important is not what regulations and policies exist to protect fishers but, rather, what regulations and policies not having anything to do with fishers specifically will continue to protect fishers if fishers lose protection. Consequently, I recommend huge changes in this section to emphasize the protections that exist for fishers not because they	Noted. The existing, management, and research activities described in this and subsequent sections (lines 2277-2657) depict activities that were initiated independently of the fisher's status as a state candidate species. Should special designations afforded to fisher (e.g., US Forest Service Sensitive, California Species of Special Concern) be removed, specific actions implemented to protect individual animals or habitats may cease or be reduced. However, those protections are not expected to be lessened in the foreseeable future.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			are candidate species but because fishers simply get covered. If the Commission chooses not to list fishers, this section needs to show how background protections are adequate. If the Commission chooses to list fishers, then this section needs to show how background protections are not adequate. Protections created by the fisher's present, candidate status are irrelevant.	
U.S. Forest Service	80:2284-2286	WS	Not Sequoia NF?	Fisher is considered a Sensitive Species in the Sequoia National Forest.
U.S. Forest Service	81: 2298	BZ	I have reviewed many such "cumulative effects" analyses by the USFS and they are superficial at best and, at worst, give the reader a false sense of security about the effects of projects. Direct and indirect cumulative effects analyses boil down to simple descriptions of existing conditions. Limited faith should be placed on NEPA as a policy tool that will help maintain fisher populations on FS land.	Text modified to acknowledge criticism of NEPA as procedural versus substantive and incorporated the reviewer's view that limited faith should be placed on NEPA as a tool to maintain fisher populations on USFS lands.
U.S. Forest Service – Specially Designated Lands, Management, and Research	81: 2315-2318	LD	But the reality is there has been far less timber harvesting than what was intended for the matrix lands. I have read reviews indicating the NWFP has not been successful in	Noted. No supporting documentation or reference provided by the reviewer.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			achieving the predicted harvest levels while protecting other resources.	
U.S. Forest Service – Specially Designated Lands, Management, and Research	81: 2318	BZ	This implies that the NWFP protects sites important to fishers, but fishers are not one of the species individually identified for such protections. This is another instance where the regulations have not been demonstrated to address fisher conservation.	Fishers were specifically recognized in the Northwest Forest Plan (Standards and Guides C-40) by requiring retention standards for coarse woody debris. Modified text to incorporate comment from the reviewer that the provisions of the NWFP have not been demonstrated to benefit fisher conservation.
U.S. Forest Service – Specially Designated Lands, Management, and Research	85: 2403-2404	BZ	Where is the analysis that suggests that wilderness areas provide considerable suitable habitat? Is it optimism that fuels the statement referred to here? Our work, in the Klamath province (Zielinski et al. 2010) found that little predicted fisher habitat occurred in wilderness**.**	Additional explanation was provided in text and table form. Approximately 33% of the NC ESU is composed of Wilderness, National Park, Late Successional Reserve, or in other land designations predicted to provide habitat of intermediate or high quality for fishers. In the Southern Sierra Nevada, about 71% of the SSN ESU is designated as Wilderness, National Park, Southern Sierra Fisher Conservation Area , or other lands predicted to provide intermediate or high quality habitat for fishers.
U.S. Forest Service – Specially Designated Lands, Management, and Research	86: 2414, 2418-2421	BZ	Certainly there is the "intention" to manage the monument for viable populations of fishers. But having reviewed that document, and seeing what has occurred on the ground since its signing, it is faith alone that would lead one to conclude that the GSNM has a plan that will assure viable fisher populations. The GSNM is not monitoring or managing for the conservation of fishers that I am aware of, at least in any accountable fashion. Similarly, text	Noted. The reviewer contended that Monument has failed to monitor or manage for the conservation of fishers, but did not provide supporting documentation for his opinion. CDFW's reference to the intent and objectives of the Monument's management plan did not offer any measure of certainty one way or the other that those objectives would be implemented or effective.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			on lines 2418 – 2421, gives the reader a false sense of comfort when these objectives are listed, but in reality there is nothing to guarantee that these steps are, or will be taken.	
U.S. Forest Service – Specially Designated Lands, Management, and Research	86:2429-2431	WS	This CDFW assessment doesn't seem to benefit much from the massive amount of useful data generated by this study (and the KRFP, below). Lots of new insights on fisher biology, threats, management needs, etc., come from these studies, much of it summarized in the SSNFCA and being used to develop the SSN Fisher Conservation Strategy	Additional information from the KFRP study has been incorporated into the text.
U.S. Forest Service – Specially Designated Lands, Management, and Research	86:2440	WS	Why this one tidbit of results? The study has also revealed threats of MJCS, habitat relationships, demography, etc., etc.	Information from Kings River Fisher Project studies is incorporated throughout the document.
Bureau of Land Management	87: 2443-2469	BZ	The contributions that BLM and NPS are making to fisher conservation are treated very superficially and, in the case of the BLM account, give a false sense of responsible management intended to protect fishers. Yes, the BLM has regs and objectives to "support viable populations" of fishers, but they have neither comprehensive management plan nor monitoring plan to tell us whether they have (or will) succeed or not. The statements here seem to be	Noted. CDFW agrees that monitoring is a critical component of effective resource management. The reviewer offered the opinion that BLM had neither a comprehensive management plan nor monitoring plan to evaluate its success or failure at meeting its objectives, but offered no documentation to support this contention.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			provided only to add to a list of other good intentions that, if examined carefully will reveal that "the emperor has no clothes". On the other hand, the NPS in the Sierra ESU is providing real habitat management in the form of low intensity Rx fire, restoring conditions that many believe the fisher used prior to the era of fire suppression; something positive should be said about this in the NPS section.	
National Park Service	87: 2461-2469	BZ	The NPS in the Sierra ESU is providing real habitat management in the form of low intensity Rx fire, restoring conditions that many believe the fisher used prior to the era of fire suppression; something positive should be said about this in the NPS section.	Noted. The reviewer, in contrast to his comments about the effectiveness of BLM's actions under its Resource Management Plans, believed that the NPS has implemented real habitat management in the form of prescribed fire. Fire is an important element in the maintenance of fisher habitat, but we are not aware of studies that have demonstrated the beneficial effects of prescribed fire to fishers on NPS lands. The reviewer indicated that many believe that this practice will restore habitats used by fisher historically, but did not provide documentation to support this opinion.
State Lands				
Private Timberlands	88:2507, 2510; 89: 2560-2564	RP	These lines mention optional actions that, if taken, benefit fishers. Unless these optional actions have been shown to have been taken and, when taken, benefitted fishers, they are irrelevant. So, do not mention optional actions that are not taken or that do not benefit fishers.	Modified text to indicate that the measures described are voluntary and that how frequently they are implemented and the benefit to fishers has not been demonstrated.
Private	88:2486	LD	CEQA applies equally to private	Modified section describing regulations on private

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Timberlands			timberlands and in fact is typically the most important regulation that comes in to play on factors such as retention of late seral elements not specifically covered by FPRs.	timberlands to include the California Environmental Quality Act.
Private Timberlands	88: 2484-2486 (lines may have been incorrectly referenced)	BZ	Again, yes these regs are "on the books" but where is the evidence that they have, or will, protect fisher habitat? The assumption throughout this section is that stuff that is on paper will manifest in conservation actions. But this paints a rosier view than exists, in my opinion. We need to know more than what the FPRs say, we need to know how they were implemented and whether they contribute to well-being of fishers and their habitat. That, itself, may be hard to demonstrate, but the reader should be made aware of these shortcomings so as to not develop a false sense of assurance.	To address this concern, text was added to the beginning of the section to reflect that although regulations and policies designed to retain habitat or habitat elements for fishers are likely beneficial, their long-term effectiveness at maintaining viable fisher populations has yet to be demonstrated.
Private Timberlands	88:2490-2492	WS	Break out by NC and SSN ESUs. I suspect the proportion is much higher in north than south.	Noted. Information on private land ownership by ESU is provided on page 64.
Private Timberlands	89:2516	LD	Green Diamond data indicate a minimum of 25% of coastal watersheds are in riparian reserves. Although GD is operating under an aquatic HCP, similar amounts of riparian reserve would be required in all watersheds that fall within the Anadromous Salmonid Protection, ASP, rules.	Noted. No data or documentation provided to support this analysis.
Private	89: 2517,	BZ	Yes WLPZs <u>may</u> constitute 15% or	Text was modified to provide more information about the

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Timberlands	2520		more of a watershed, but where is the analysis that represents what they do constitute. Here again, the max value is cited (via pers. comm.), presumably to curry favor with a skeptical reader (?). Same thing on line 2520, where the author states that WLPZs "may" provide a network of older forest (rather than a likely alternative that they "may not"). Each outcome is as likely when there is no evidence presented to confirm or deny. Moreover, the WLPZs feature riparian areas; shouldn't something be stated about the protections, or lack thereof, in upland areas?	retention of habitat within Watercourse and Lake Protection Zones and to indicate that the amount of area encompassed by these zones is, in part, a function of the density of streams and watercourse classifications with a harvest plan area. The reviewer questioned whether provisions of the California Forest Practice relating to upland areas should be addressed. Refer to information presented earlier in the section relating to the Forest Practice Rules (CCR, Title 14, § 897(b)(1)(B)), requiring the maintenance of "functional wildlife habitat" within planning watersheds.
Private Timberlands	89:2519	LD	ASP rules require that the 13 largest trees/acre be retained which would protect and promote fisher rest and den trees. Outside the ASP zones, the rules simply require retaining 2 trees/acre 16" dbh or larger.)	Add text indicating that for watersheds that fall within Anadromous Salmonid Protection rules, the 13 largest trees/acre (live or dead) must be retained. Over time, implementation of these rules may promote the development of trees of sufficient size and structure suitable for use by fishers for resting and denning. Reference to the retention of 2 trees/acre 16" dbh or larger was not included because it was not considered to contribute substantially to section.
Private Timberlands	89:2520-2521	SM	WLPZs may offer protection for trees in bottom 1/3 of drainages, but many early/midseason fisher den sites are in the middle to upper 3rds of drainages/slopes, affording solar/thermal advantages (Matthews, personal communication)	Text modified to indicated that many early season dens occur upslope of WLPZs.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Private Timberlands	89: 2535-2536	BZ	Here, on the contrary, is an example appropriate wording when there is no evidence. The author states "*However, the plans are…flexible, making their… effectiveness in providing… habitat uncertain*." This states the case fairly, not biasing the reader one way or the other.	Noted.
Private Timberlands	90: 2554-2558	BZ	What are the "*feasible mitigation measures*" (a table listing them would be helpful)? And, what are the "measures taken" when impacts cannot be avoided? Stating what is in the FPRs is just lip service if it can't be demonstrated what the measures are, and importantly, how they compensate for impacts.	Text revised to include a description of CDFW review timber harvest plans where the harvest of late succession stands is proposed.
Private Timberlands	90: 2560	BZ	It is not enough to say that "*some companies.. have instituted voluntary management policies….*" What are they, and as a Department, what is your opinion of their efficacy?	Text modified to reflect the use of trees voluntarily retained in harvest units by individual fishers and the Department's lack of information indicating these measures have benefited fisher populations.
Private Timberlands	90:2562	LD	Although they are termed "voluntary", it is my experience that they typically are the result of timberland owners being faced with frequent impasses on THPs with CDFW that resulted in development of management plans to avoid significant adverse impacts of wildlife structure under	Noted. Voluntary in the sense used, is meant to indicate that landowners in some instances implement policies not specifically required under the Forest Practice Rules that benefit wildlife.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			CEQA.)	
Private Timberlands – Conservation, Management, and Research	90: 2568-2574	RP	These lines mention optional actions that, if taken, benefit fishers. Unless these optional actions have been shown to have been taken and, when taken, benefitted fishers, they are irrelevant. So, do not mention optional actions that are not taken or that do not benefit fishers.	Noted.
Private Timberlands – Conservation, Management, and Research	91:2585	WS	Note all HCP's are within the NC ESU.	Noted.
Private Timberlands – Conservation, Management, and Research	91: 2587	LD	The Green Diamond aquatic HCP also has provisions that over the next 50 years will set aside more than 100,000 acres of riparian and geologic reserves that should develop late seral elements beneficial to fishers.	Incorporated into the document.
Private Timberlands – Conservation, Management, and Research	92: lines not specified	BZ	Conspicuous by its absence in the "covered species" column in this table is the fisher, esp. for GD and Fruit Growers. This absence should be noted, as well as its implications to fisher conservation.	Noted. This was described earlier in the document (lines 2584-2587).
Private Timberlands – Conservation, Management, and Research	93: 2627-2631	LD	Would it make sense to compare this to the translocation in Olympic National Park that was comparatively much less successful?)	Noted. Differences in reproductive rates between fisher translocation projects California and Washington may be due to a number of factors. Comparisons of the relative success rates for those projects have yet to be analyzed and published.
Tribal Lands	93:2647	CT & WS	The Tule River Reservation	Text modified to include information about the Tule River

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			represents a significant portion of fisher habitat in the southern ESU. They have cooperated with state and federal agencies and are concerned with fisher conservation. Similar to the Hoopa Tribe, they have ongoing problems with trespass marijuana cultivation on their lands.	Tribe.
Tribal Lands	93-94: 2647-2655	LD	Wouldn't it be important to note that their continued monitoring has documented a fluctuating but high density of fishers on a landscape managed for multiple use including timber harvest?	Noted. information about densities of fishers on Hoopa Valley Tribal lands is presented on page 42: lines 1241-1246.
Tribal Lands	95:2652	JT	No mention here of the Tule River Indian Reservation??	Text modified to include information about the Tule River Tribe.
Management and Monitoring Recommendations	94: entire	BZ	This is an impressive, and very expensive, wish list: each of which – I would assume – would be easier to achieve if the species were listed. I could add to this list, but given the reality of achieving these objectives, the list seems long enough already.	Noted.
Management and Monitoring Recommendations	94:2669-2671	RP	1669-1671 – The Department blatantly ignored this recommendation by not considering our Section 6 proposal earlier this year. By not considering our proposal, the Department also contradicted recommendation 6 on page 95. I find these recommendations disingenuous and recommend that they be	Noted. Reviewer attributed his comment to pages 1669-1671, but likely mean pages 2669-2671. CDFW did consider the author's proposal, however, it was not recommended for funding due to a finite amount of money available for projects and the submission of proposals considered to be of higher priority at that time.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			deleted unless the Department is willing to make a public commitment. Alternately, we could use these public recommendations in our proposals and make public the Department's contradictory behavior and lack of commitment if our proposals are not funded.	
Management and Monitoring Recommendations	95: 2695-2702	RP	The Department blatantly ignored this recommendation by not considering our Section 6 proposal earlier this year. By not considering our proposal, the Department also contradicted recommendation 6 on page 95. I find these recommendations disingenuous and recommend that they be deleted unless the Department is willing to make a public commitment. Alternately, we could use these public recommendations in our proposals and make public the Department's contradictory behavior and lack of commitment if our proposals are not funded.	Noted. CDFW has continued its commitment to support the monitoring of fishers reintroduced to the Sierra Nevada under a cooperative project involving the US Fish and Wildlife Service, Sierra Pacific Industries, North Carolina State University, and the Wildlife Conservation Society. This has included financial support and commitments of staff since the project's inception.
Management and Monitoring Recommendations	95:2665	MG	There is nothing specifically tailored to address the predation topic. Fishers are being predated on at a rate of 60-70% in some projects and within this range for the entire state of CA. Until Wengert et al, initiated a project in 2011-12 to study bobcats in forested areas, this main predator of fishers is lacking relevant studies. It should be noted that	Noted. Predation has been reported by some studies to be the primary source of mortality in California. This is not unexpected and CDFW is not aware of evidence indicating that the level of predation is "higher than normal."

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			predation, the #1 cause of mortality for fishers needs to be addressed and studied to determine if landscape changes, diseases or other factors may be the root of this higher than normal rate of mortality for this species.	
Management and Monitoring Recommendations	97:2691	JT	What does this mean? Kind of vague ("Focused study to address how fishers use landscapes")	This recommendation was incorporated into item #1 as follows: 1. Support research and continue scientific study to define landscape conditions that provide for the long-term viability of fishers throughout their range in California. Focused study to address how fishers use landscapes, including thresholds for forest structural elements used by fishers is also needed.
Management and Monitoring Recommendations	95:2701	JMH	I totally agree with your list and particularly these last 3.	Noted.
Management and Monitoring Recommendations	95:2704	WS	Why no mention of the SSNFCS, which is a collaborative interagency planning effort to conserve and recover the SSN fisher population and its habitat? CDFW has a slot on the Fisher Interagency Leadership Team (FIALT), the decision-making body for the effort.	Section for Fisher Working Groups added and the Southern Sierra Nevada Fisher Working Group is included.
Summary of Listing Factors				
General (conclusions related to the SN ESU)	various	BZ	There were a number of locations in the document where risk factors/threats were described for each ESU but those risks were	A section on the combined effects of threats was added and the listing recommendation has been changed.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			presumed to affect the SN ESU – which is smaller and more vulnerable - more negatively than the NC ESU. Viewed collectively, the following factors may interact to put the SN ESU at greater risk than the NC ESU: (1) ARs, (2) climate change, (3) fire severity, (4) susceptibility to fragmentation, (5) small existing population size and (6) fewer state and fed land allocations that may indirectly benefit fishers. The generally low reproductive capacity of fishers (line 659) compound these risks. The review states, on page 53, that "*Fishers in the southern SN are geographically isolated….and do not appear to be expanding their range northward*." Moreover, lines 3085-3087 state that "*Events such as drought, high intensity fires and disease, <u>should they occur</u>… have a higher probability of adversely affecting the fisher(s).. in the southern Sierra*". I would argue that these factor factors <u>are</u> occurring and thus, they <u>are</u> having a disproportionate effect on the SN ESU. The totality of evidence, in my opinion, would lead one to conclude that the SN ESU will	

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			require more protection than the NC ESU, yet the apparent conclusion the Department is poised to make, renders the same conclusion for both ESUs, i.e., that neither requires the protection of listing.	
General (fuels management)		BZ	**Inadequate consideration of the effects of fuels management**. The document covers well the threat and history of timber harvest on fishers, and the potential impact of fire, but does not do justice to one of the foremost new threats to fisher habitat in California: fuels management via forest thinning. There is huge momentum to treat an increasing number of acres in the fisher range, particularly in the SN ESU, to simplify forest structure. There are few published studies that have evaluated the effects of these activities on fisher habitat, but they should be highlighted and their collective results summarized. These papers include: Scheller et al. 2011, Thompson et al. 2011, Truex and Zielinski 2013, Garner 2013 and Zielinski et al. 2013. And, it appears that Sweitzer et al. have	The document was modified to include discussion of the effects of fuels treatments on fisher.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			something in the works that may be available by request (I'll send a subsequent email with this information).	
General (listing factors)		BZ	The only factors that I believe are negligible or not significant to warrant serious concern are overexploitation, predation, competition and disease. Predation is, indeed, the leading cause of mortality but fishers have to die of something. I do, however, view this as a potential listing factor only insofar as land management has changed to favor the abundance of habitat-generalist predators such as bobcats and lions. The science and predictions about climate change are ambiguous. It is very hard to link climate change to bleak future outcomes for fishers since there are some negatives (increased fire) and some positives (potential expansion of hardwoods and mixed hardwood/conifer forests). The authors have not made, in my opinion, an effective case that "modification of habitat" or "toxicants" are not significant listing factors. Regarding "modification of habitat" there are	Text was modified to include recent research by Garner (2013) and Zielinski et al. (2013) and additional assessments of federal and state regulations and policies with respect to fishers. Nevertheless, the reviewer did not provide support for his opinion that the federal policies will prevent significant habitat alteration of wildlife habitat and that his perception of the lack of enforcement of the Forest Practice Rules will lead to significant habitat modification adversely affecting fishers. He also contended that CDFW failed to make an effective case that toxicants are not a significant listing factor for fishers. If by this statement, the reviewer believed that the impact of toxicants on fisher populations was so serious that listing is warranted, he did not provide information to support this view.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			a growing number of pieces of research that can assist in evaluating habitat modification at the landscape level (i.e., Thompson et al. (2011), Garner (2013), Zielinski et al. (2013)). However, relying on federal land policy (line 2759) that only "*considers the effects on wildlife*" is not a guarantee that significant habitat alteration will not occur, nor is the fact that USFS and BLM have "*consideration for species guided by management plans*"(line 2765). As noted earlier (see # 3, above) many of these policies are intention statements with little or no teeth to guarantee their implementation. Nor are the FPRs much protection since they include "*language [that] may result in actions that …are beneficial*". Salvage logging, the likely loss of snags that were once considered unmerchantable but are now merchantable, persecution of hardwoods (hack n squirt) all conspire to the conclusion (together with lackluster existing regulations) that lack of enforcement of existing rules and the lack of proactive protections	

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			will lead to significant "modification of habitat".	
Present or Threatened Modification or Destruction of its Habitat		CT	Southern ESU is at High risk. The combination of the shape of fisher habitat in the southern ESU, the increase in regional fire severity, and the conflict between fisher habitat conservation and fuel management objectives strongly suggests that the S ESU is at high risk of further fragmentation.	Noted. Text in this section indicates that the fisher population in the southern Sierra Nevada is vulnerable to habitat loss and fragmentation due to catastrophic fire because of its small size, relatively small geographic area occupied, and the narrow and linear configuration of occupied habitat in the region.
Present or Threatened Modification or Destruction of its Habitat	96: 2745-2746	LD	Wouldn't Klug's thesis #101 also be relevant here?	Rich Klug's thesis was added as a reference indicating that fishers are found in a variety of low- and mid-elevation forest types.
Present or Threatened Modification or Destruction of its Habitat	96:2751	WS	… and with dense, often multi-layered canopy structure. High canopy cover (>60%) is consistently identified as important by habitat studies at all scales.	Section has been revised.
Present or Threatened Modification or Destruction of its Habitat	96:2754-2756	WS	Abundant analyses have been conducted, and are ongoing, for the SSNFCS, including statistical characterization of such "thresholds" and especially statistical characterization of the needs of breeding females (most important to sustaining/increasing population size). It is surprising that CDFW hasn't been more engaged in this effort, which would strongly affect the content of this assessment.	Information from the SSN Fisher Conservation Assessment has been widely incorporated in document, and although not directly cited, the draft SSN Fisher Conservation Strategy was reviewed and considered in the preparation of this report.
Present or Threatened	98: 2822-2823	BZ	Yes, the Dept. may not be "*aware of data indicating that the removal*	Text was modified to reflect the Department's uncertainty regarding the future effects of the harvest of hardwoods on

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Modification or Destruction of its Habitat			*of hardwoods…. Has substantially affected … fishers*" but, again, this should not console those concerned about fishers. The absence of data is no reason for optimism. Instead, economic forces suggest that hardwoods will be discriminated against and that this will likely to have negative effects on fishers.	fisher populations.
Present or Threatened Modification or Destruction of its Habitat	98:2828-2829	RP	These lines mention optional actions that, if taken, benefit fishers. Unless these optional actions have been shown to have been taken and, when taken, benefitted fishers, they are irrelevant. So, do not mention optional actions that are not taken or that do not benefit fishers.	Noted. The text indicates that where WLPZs are managed to retain or recruit trees suitable for denning and resting, WLPZs **may** be beneficial to fishers.
Present or Threatened Modification or Destruction of its Habitat	97: 2786-2789	LD	I think the single most important factor is whether or not late seral habitat elements (e.g., large snags and green wildlife trees) are retained and recruited, which you note in the paragraph below. This is not a not a function of silviculture used, because all types of silviculture can eliminate late seral habitat elements unless it is specifically targeted for retention and recruitment.)	Text modified to incorporate this comment.
Present or Threatened Modification or Destruction of its Habitat	97:2793	WS	True as a general statement, but home ranges are dominated by dense, late-seral stages, especially for females. Fishers will forage in diverse types and stages, but	Section has been revised.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			resting and denning are almost exclusively in forests with late seral characteristics and very dense canopies.	
Present or Threatened Modification or Destruction of its Habitat	97: 2780-2783; 98:2798-2799; 98: 2820-2821; 98-99: 2828-2831; 103:2835	LD	Dr. Diller contended that the California Environmental Quality Act provided an effective mechanism for the Department to protect functional wildlife habitat, late seral habitat elements, hardwoods, and den and rest trees suitable for fisher.	Noted.
Present or Threatened Modification or Destruction of its Habitat	99:2848	WS	Frequency is not the issue: size and severity (which are correlated) are the issue. Not just occupied. Conservation goals in SSN include expanding the population into historically occupied habitats from which fishers were extirpated. Fires, such as the Rim Fire, are greatly impacting this goal.	Noted.
Present or Threatened Modification or Destruction of its Habitat	2850-2853	CT	The statement that fewer acres burn presently than prehistorically is flawed and misleading. Fishers clearly co-evolved with an active fire regime, yet as stated many times within this document the current fire regime is fundamentally different. Fire severity has increased following years of suppression activities, so to compare current and past acreage is inappropriate. The Rim Fire represents a watershed event	Section has been revised.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			in Sierra Nevada management, and fire ecologists expect the frequency of those events to increase in future years. Current fires are more destructive and represent a greater loss of habitat that historic fires, regardless of acreage. Therefore it is misleading to suggest that current fires do not threaten habitat connectivity or population integrity because historically more acreage burned.	
Present or Threatened Modification or Destruction of its Habitat	99: 2850-2583	BZ	Yes, the extent of wildfire is less than that which burned prehistorically. However, the per acre severity has increased, leading to loss of overstory which has much greater implications to fisher habitat then the relatively mild, ground fires that were thought to characterize the prehistoric fire regimes.	Noted. In a number of locations in the document (e.g., Threats Section and in the paragraph referenced by the reviewer) we indicated both fire frequency and severity have increased in recent decades and this has implications for fisher habitat.
Present or Threatened Modification or Destruction of its Habitat	2859-2860	CT	National forest guidelines may or may not protect fishers from timber and fuel management activities	Noted.
Present or Threatened Modification or Destruction of its	99:2859	WS	What are these specific guidelines? These forests are actively engaged in developing such guidelines via the SSNFCSt.	Noted. Guidelines are provided under the Sierra Nevada Forest Plan Amendment Standards and Guidelines.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Habitat				
Present or Threatened Modification or Destruction of its Habitat	99: 2859-2860	BZ	That the "National Forests in the SSN ESU have adopted specific guidelines to protect habitats" means nothing unless it can be demonstrated that they have been acted on and that they have benefited fishers. I know of no such data that would suggest they have. For example, the review states (pg. 38, lines 1121 – 1123) that "*Trees used by fishers for denning and resting are typically large and considerable time (> 100 years) may be required for suitable cavities to develop*" and (on pg. 32, line 985) that "*Rest structures appear to be reused infrequently…*". If the agency directives do not need to be adhered to, or have no "teeth", what actions - short of state or federal listing - will protect the future provision of adequate amounts of large trees for a species like the fisher that may require hundreds of these slowly-renewing habitat resources within their home range and over their lifetime? Thus, the Department is taking, at face value, the wishful thinking on the part of federal and state agencies. It would be preferable to focus on what *has actually been done* to protect habitat, than what these	Text was modified to indicate that the benefits of implementing the Sierra Nevada Forest Plan Amendment with respect to fisher populations have yet to be demonstrated. Nevertheless, CDFW believes that the amendment and recent settlement agreement regarding the completion of a fisher conservation strategy and the US Forest Service's commitment to analyze an alternative in its Draft EIS consistent with the findings and recommendations of the conservation strategy are likely to benefit fisher populations in the southern Sierra Nevada.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			documents describe as goals or intentions. If the agencies cannot demonstrate that their intentions have resulted in positive outcomes for fishers then the conservative position would be to assume that there is no material benefit to fishers.	
Overexploitation	100:2867	WS	Overexpoitation section seems overly long given that trapping has been a non-issue for some time now. Suggest a quick overview of the historic nature of this threat, followed by the current situation.	This section was revised.
Overexploitation	100:2873	JMH	Seems like you could reduce this section considerably since you have covered the material well above and all you really need to cover here is the incidental capture while trapping other species and animal control efforts since fishers are protected. Just a thought.	Much of trapping discussion moved to earlier overexploitation section.
Predation		CT	Northern ESU: Moderate risk. Predation has been shown to be a limiting factor. It has been shown to increase following the habitat conversion associated with fires. And there is strong evidence that exposure to toxicants increases an animal's risk of predation. Southern ESU: High risk. Same as Northern ESU, yet the impacts are significantly greater due to the small size of the southern	Section has been revised.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			population. Furthermore, increases in shrub density following fire and the linear edges generated by mechanical vegetation management can be expected to increase predation rates.	
Predation	2994-2296	CT	Statement, that adverse population impacts of predation have not been documented, is untrue. As stated on lines 2988-2989, the risk of predation is heightened by proximity to brushy or edge habitats. On the Hoopa Reservation, a 73% population decline was observed between 1998 and 2005. One contributing factor to this decline was a fire which converted a portion of the habitat to brush. Bobcat activity increased, and predation subsequently increased. Given the likelihood that fire activity will increase in future years and that fires often result in the short-term conversion of forest to shrubland, increased predation is a possibility. And a 73% population decline is clearly an "adverse population level effect".	Predation is discussed in greater detail on pp. 90-91, including the concept of habitat effects on predation rates.
Predation	103: 2994-2996	BZ	Yes, they have co-evolved but the production of more edge and disturbed habitat via timber management, fuel management and fire may have shifted the	Text was modified to strengthen this point and to indicate that predation is the most frequently reported cause of deaths for fishers in California.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			balance to favor bobcats and lions.	
Predation	103:2994-2996	WS	There is speculation (backed by some evidence) that bobcats, coyotes, and mountain lions have expanded into fisher habitat due to fragmentation and linear openings, such as roads and skid trails. Normally, these predators are rare/absent in the dense, mature forests used by fishers (especially denning females), but denning females are being predated in these areas now. See SSNFCA.	Habitat modification effect on predator community has been noted in Predation Threat section.
Predation	103:2998	WS	Contact R. Sweitzer concerning recent demographic analysis of effects of predation and other threats on SSN fisher population.	Sweitzer demographic information is incorporated in the Population Trend section and in reference to toxicants.
Predation	3003-3007	CT	Strong experimental and circumstantial evidence that sublethal exposure to toxicants can make individuals more likely to be predated upon. Predation rates are likely currently inflated. Needs additional research and documentation yet the risk should be mentioned here.	Concept discussed in Toxicants section.
Predation	103: 2994-2996	RP	This statement lacks context and is actually false in its true context. Fishers may have co-evolved with the present suite of other predators but it did not do so within a fragmented landscape. Consequently, its co-evolution with	Text modified to indicate that the conditions under which fishers co-evolved with potential predations have changed. Although this may result in fishers interacting more closely with potential predators, adverse population level effects on fishers due to predation have not been documented.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			these predators is irrelevant because the conditions of the co-evolution no longer exist. Fishers did not co-evolve interacting in close relationships with these other predators. Fishers lived in other habitats and on other parts of the landscape and, therefore, did not interact with these other predators as they do now.	
Predation	103:2995-2996	SM	The report states: "However, fishers have co-evolved with the suite of predators naturally occurring within their range…" This conclusion and the preceding paragraph fail to recognize the linkage established by Wengert (2013) and Higley et al. (2013). Fishers have co-evolved with a suite of potential predators, however under a natural forest-disturbance regime. Anthropogenic land use and fragmentation have increased fisher susceptibility to predation (Higley et al. 2013, Wengert 2013).	Noted. Text indicates that landscape level habitat changes that favor population increases in competitors may intensify interspecific competition. Also the document indicates that some forest management practices favor species adapted to disturbed and early seral habitats, some of which are known to prey on fishers (e.g., bobcat, mountain lion). Wengert (2013:99) found that proximity to open and brushy habitats heightened the risk of predation by bobcats on fishers and hypothesized that this may increase when fishers venture into habitat types they do not frequently visit.
Competition	104: lines not specified	BZ	It is not published, but you overlooked here Lori Campbell's dissertation where she looked at factors affecting the distributions of coexisting carnivores in the Sierra (see references, below). For example, she found a negative association between gray fox/spotted skunk and fishers in the Sierra and suggested that	Additional information from Campbell (2004) was incorporated into sections related to fisher population size and competition.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			"*elevated densities of generalist species may hinder the return of fishers to portions of their range*…" Importantly, Lori also did an analysis that many have overlooked whereby she sought to understand the environmental features that differed between the area occupied by fishers in the Sierra and areas that are no longer occupied. She found that the occupied area had more and larger trees (conifers and hardwoods), steeper slopes, more shrub cover and fewer roads than the unoccupied area (see her Table 5 and Fig. 10). This information may be useful to add to earlier sections and it suggests that the size of the gap may have been influenced by these features, some of which are affected by management and human uses.	
Competition		CT	Low risk. No change from historic conditions.	Noted.
Competition	104:3030	JMH	One species you haven't considered here is the barred owl which takes similar prey. In addition, barred owl density can be quite high. Therefore as the barred owl expands and increases in density there may be some level of competition with fishers. Of course, barred owls may also be preyed upon by fishers especially	Text modified to include raptors, including the barred owl as potential competitors for certain prey.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			nestlings and juveniles. However, I could totally envision a barred owl taking fisher kits following their mother. I hope that we can continue monitoring fishers through at least the end of the experimental barred owl removal study. We removed 71 barred owls in 2013-14 and we know we didn't get them all. To put that in perspective the highest number of spotted owls we ever had was 71.	
Disease		CT	Low risk. Fishers show evidence of exposure to multiple pathogens, but there do not appear to be population-level implications	Noted.
Other Natural Occurrences or Human-related activities		CT	Northern ESU: High risk. I do not have hard numbers for the northern ESU as I do for the southern, yet I know that the number of grow sites is greater. The northern population can be expected to be more resilient due to the spatial extent. Southern ESU: High risk. AR poisoning accounts for 8% of all documented mortality in the southern Sierras, not accounting for sublethal effects. Given the timing of most AR mortalities, associated with the denning season, and the documented transfer of toxins to nursing kits, this has the potential to inhibit population recovery even without	Lines referenced by reviewer are in the summary of the issue. Topic is discussed in much greater detail in Toxicants section beginning on p.95.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			a related increase in morbidity.	
Other Natural Occurrences or Human-related activities	105: 3067-3076	RP	Actually, the genetic evidence does not show that the fisher population in present day California had contracted to 2 independent populations. The genetic evidence shows that no gene flow existed between fishers in what are presently the northern and southern populations. Jodi Tucker has shown that rivers and canyons presently limit gene flow within the southern population itself. Many rivers and canyons cross the Sierra Nevada between Yosemite and Mt Shasta. Those rivers and canyons create gene bottlenecks that could easily have allowed a continuous population throughout Grinnell's distribution while preventing gene flow across that whole range. This possibility is real and must be considered.	Noted. Tucker et al. (2012) reported that fisher in northwestern California and the Southern Sierra Nevada became isolated far before European Settlement and that that absence of fisher in the northern Sierra Nevada was likely a long standing gap in the species' historical range. They found a genetic signal indicating a more than 90% reduction in effective population size of fishers and estimated that a decline of that magnitude was consistent with a major range contraction. Tucker et al. (2012) considered the absence of fisher from the central and northern Sierra perplexing because they believed there is no obvious geographic feature that marks a significant break in the topography or vegetation composition of the Sierra Nevada.
Other Natural Occurrences or Human-related activities	106: 3093-3097	RP	Local adaptation has never been documented, a point that is extremely important. Small populations are far more likely to experience genetic drift than local adaptations. Consequently, the genetic differences between the northern and southern populations of fishers are most likely due to genetic drift within the southern population. Until local adaptations can be demonstrated, the most logical position to take is that	Text revised to include this hypothesis that genetic difference between fishers in northern California and the southern Sierra may have been due to genetic drift within the southern Sierra Nevada population.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			genetic drift has caused the genetic changes.	
Other Natural Occurrences or Human-related activities	106: 3103-3104	BZ	This statement needs to be revisited in light of the data in the forthcoming paper by Sweitzer et al. (*in review, J. Mammal*.) where they report a lambda value for the southern Sierra fisher population < 1.0 (though not significantly less). There may be high occupancy but demographic rates do not appear as favorable.	Test was modified to include Sweitzer et al. (in review) under the Section of the Status Review titled: *Population Trend in California*. During the period of their study (2008-2012), they reported a slightly negative population growth rate and no trend in fisher population density during that same period. They did not describe a relationship between their estimates of population growth rate and density with rates of occupancy. The text was also modified to indicate that trends in occupancy may not always be an effective proxy for trends in abundance.
	107: 3134-3136	BZ	Yes, it is hard to know what the outcome will be of the widespread and unregulated use of toxicants. However, the threat is potentially very real and it would be nice to see some wording here that would suggest that the Dept. is willing to pursue an emergency listing should new evidence arise that it is a significant threat. Is emergency listing a possibility under these circumstances? If so, it would reassure many of us to read that this is an option.	Text was modified to stress that the prevalence of anticoagulant rodenticide exposure throughout the state and documented mortalities within both ESUs indicate that toxicants are a potentially significant threat that should be closely monitored. The California Fish and Game Commission may adopt a regulation which adds a species to the list of endangered species or to the list of threatened species as an emergency regulation pursuant to Article 1.5 (commencing with Section 240) to Chapter 2 of Division 1 if the commission finds that there is any emergency posing a significant threat to the continued existence of the species (Fish and Game Code Section 2076.5).
Other Natural Occurrences or Human-related activities	108:3105	JT	Overreaching in your conclusions here - Just because you have high occupancy rates from some studies of limited extent within the NWCA population does not mean that the population has not declined. You simply do not have the data to draw this inference.	Noted. All long-term or repeat study areas (Hoopa, Eastern Klamath, Green Diamond) suggest that the population has not declined substantially in recent decades. Text added acknowledging that trends in occupancy may not always be an effective proxy for trends in abundance.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
Toxicants	107:3131-3135	SM	Counter to the language in the report, toxicant use is suspected by many in the law enforcement community to be on the rise both in extent and abundance of use in recent years and we are only beginning to see its direct and indirect impact on fishers, fisher prey, other wildlife, and possibly human health. Any available data would be available through Mourad Gabriel.	Dr. Gabriel provided information and peer review comments on the draft Status Review that were incorporated into the final document.
Toxicants	107:3129	WS	This paragraph should add findings from Thompson et al. (2013) that female fisher mortality is lower in home ranges with more MJCSs.	Noted. Thompson et al. (2013) reported that female mortality was <u>higher</u> (not lower) within home ranges with more MJCSs.
Toxicants	107:3132-3134	WS	Not sure I agree with this speculation. Toxicants can reduce population size and reproduction without creating gaps in where fishers are detected. Camera detections are a very coarse metric of population status.	Noted.
Toxicants	109:3135	JT	I do not agree with this statement – as stated in the previous paragraph the extent and distribution of toxicants in the 1980's and 1990's was not documented. From personal experience running a field project in the southern Sierras our encounters with grow sites seemed to increase	Text modified/rearranged.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			substantially over time since 2002. Also, currently long term monitoring methods are designed with statistical power to detect a 20% decline in occupancy and more gradual declines would not necessarily have been detected.	
Toxicants	110-111: 3129-3140	RP	Before you can make this statement, you MUST show that marijuana fields have a long-term existence within the forests where fishers live. If marijuana fields are a recent occurrence away from the coast, then you can not make this argument.	Text modified to recognize that there is insufficient information to determine the extent that toxicants harmful to fishers were used in the past, making inferences about their effects on fisher populations uncertain.
Toxicants	109:3140	JT	In my opinion to say that toxicant exposure 'has been documented' really understates the magnitude of exposure that has been observed – this makes it sounds like it has been found occasionally versus the reality that it has been detected in the vast majority of fishers in these populations.	Text modified to show that 86% of tested fishers show some exposure to ARs.
Toxicants	107:3135	JMH	I agree that information on population level monitoring is quite limited however we have included some information on that topic in the paper cited in your document as (130) and we have included additional information in our 2013 report which I will send you. The most important things our limited analysis can provide is that fisher populations can	Text modified to indicate that in the Hoopa Valley in northern California, 5 of 17 male fisher mortalities from 2005 to 2013 resulted from poisoning (an equal number were confirmed or suspected of being predated) (Higley et al. 2013:62)

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			fluctuate widely (density dropped by 50% between 1998 and 2005) and yet may not be detectable from occupancy monitoring alone (130). Possibly more important, we have documented a decline in male fisher apparent survival from 2005 to 2013 and that the highest cause of mortality of male fishers in our study has been toxicosis. (included in our 2013 report)/	
Climate Change	3167-3170	CT	It is not "likely" that fragmentation of the southern ESU will occur during this century. It is a fact. 2013 Aspen and 2014 French fires have effectively isolated portions of the southern ESU.	Climate Change section revised.
Listing Recommendation				
	109	CT	I think that if the Department intends to recommend a 'not warranted' decision, the rationale needs to be spelled out more carefully in the document.	Noted.
		CT	I also believe that the Department has made a strong argument for the consideration of the southern ESU as threatened given the small population size, unique genetic material, and diverse risks. (See reasons under Listing Factors).	Noted. Document has been revised.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
		CT	Rationale for "not warranted" recommendation for southern ESU is not clear. Throughout the status review a case seems to be repeatedly made that the southern population, designated as an Evolutionary Significant Unit, is at high risk of local extirpation from a variety of causes. For example, all sources seem to agree that the population consists of <500 adults, it has been severely impacted by human activities, both historic and current, and that there is ongoing isolation and fragmentation.	Noted. Document has been revised.
		WS	The status review provides no comprehensive or integrative analysis to support a listing determination one way or another. The Department should lay out a comprehensive and transparent analysis of how these various threats may cumulatively and synergistically affect the likely extirpation of fishers in each ESU as a basis for determining whether listing is warranted.	Noted. Document organized to reflect statutory requirements.
		WS	The SSN ESU, at least, is threatened with possible extirpation due to its small size, narrow habitat arrangement, reduced genetic diversity, diverse and synergistic mortality factors, and threats of very large and severe wildfires and other	Document has been substantially revised, and now includes a section on synergistic effects of various threats.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			disturbances that can fragment the population into even smaller and more isolated subpopulations. As detailed in the SSN Fisher Conservation Assessment, fisher dispersal across major canyons is already rare, especially for female fishers (Tucker et al. 2014), and recent wildfires (e.g., the Rim, French, and Aspen fires) have probably exacerbated the situation. Because the SSN fisher population is already genetically depauperate and subdivided (Tucker et al. 2014), such events greatly increase the probability of local extirpations and ultimately extirpation of the entire SSN ESU. Such synergistic events and processes should be carefully considered by the Department in its analysis of conservation status.	
Protection Afforded by Listing				
Economic Considerations				
Literature Cited				
	Entire	LD	I suspect this particular format is required for this status review, but it is very difficult to keep track of what scientific literature is being cited with this "number system."	Citations revised to Author: year format.
	Entire	RP	The method used to cite	Citations revised to Author: year format.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			references is the worst for comprehension. Citing author and year is the best because it facilitates remembering specific publications. Using numbers for references arranged alphabetically is also better than arranging references in the order cited. Because you have no space limits, using author and year is what I recommend, strongly.	
General Comments				
Acronyms	Entire	RP	I strongly urge you not to use acronyms and abbreviations.	Most acronyms were removed from the text.
Use of available information		WS	Authors should review and incorporate information from multi-agency Southern Sierra Fisher Conservation Assessment document. Similarly the authors don't seem to be incorporating information from the California Fisher Working Group and the Southern Sierra Fisher Working group, for example SSFWG's fisher research and management priorities list.	SSNFCA has now been cited throughout document.
Grammar	Entire	RP	Names of most mammals have 2 plurals: the formal plural, ending in "s", and the sportsman's plural, which is the singular used as the plural. The formal plural is used in most other places, including most professional journals. Most journals do not have a formal policy towards plurals but leave the decision regarding use of plural to	Text revised to adopt the formal use of plural (e.g., a fisher; fisher populations; prey of fishers; the range of fishers).

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			authors. I prefer formal plurals. You are mostly consistent in using the sportsman's plural but do switch back and forth. That is a no-no.	
Grammar and Style	Entire	RP	Strunk & White, in "Elements of Style", recommended against starting sentences and independent clauses with "however" when it means "nevertheless" or "nonetheless". Starting sentence with "However" has become common in biology (though not in other disciplines) but, nonetheless, Strunk & White's rule still has merit for 2 reasons. i) At the beginning of a sentence (or independent clause) and without a comma, "However" means "No matter how". "However often I get caught in the rain, I still don't learn to bring my rain gear." A reader can mis-anticipate the sentence to come when the sentence starts with "However" meaning "Nevertheless". ii) "However," (with the comma) can be a harsh jolt for a reader and, far too often, the sentence following "however" does not make clear exactly what from the previous sentence is to be compared to something in the following sentence. You start many, many sentences with "However" when the comparison	Revised text to address frequent and sometimes unnecessary use of "however".

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			is not obvious at all. You have some paragraphs with “However” starting sentences, which is boring besides being confusing.	
Grammar and Style	Entire	RP	6) Line 613 and elsewhere – The expression “1-4" is a range. Although we read the expression as “one to four”, the “to” does not exist in the sentence formally. We could just as well rename the range “1-4" to be “Range A”. Then, replacing “1-4" in the sentence with “Range A” would not change the meaning of the sentence. If, however, you write “from 1-4", what you have written makes no sense. Writing “from” implies that some “to” must exist. Think of it as “from Range A to Range B”, but you have written only “from Range A” and the other half of the expression is missing. Either write “from 1 to 4" or revise the sentence to eliminate the “from”.	Text modified.
Misc. Comment	Not Identified	RP	An average is a single number, not a range. Averages from several studies can cover a range of numbers, however, which is what I think you mean here.	Text modified to indicate that active pregnancy may last from approximately 30 to 36 days.
Document Organization		WS	Document should be revised to focus more specifically on the conservation implications of	Document has been revised to consider the ecology and threats of each ESU separately. Document organization is constrained by statute.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			available information for the two identified ESUs. It should also establish and follow a transparent and objective analytical framework that integrates all the various threats to each ESU in a biologically meaningful way. Although a formal, quantitative population viability analysis for each ESU would be preferable, even an informal but structured assessment of how various threats may interact to affect population status and trends would be an improvement. Such an analysis should consider the specific geographic arrangements of habitats and threats in each ESU, such as the potential for fires, timber harvest, or other factors to fragment populations and increase extinction probabilities.	
Review of Literature		BZ	This is a very comprehensive review, summarizing the relevant literature in a way that is easily consumed and understood. I really respect the amount of work involved in summarizing fisher and related literature; this is a mammoth undertaking. I wanted to note this first, because it is the most impressive aspect of the document. I will be using this review as a source of fisher information for some time to come! Very few sources of	Noted.

Section Heading	Page: Line	Reviewer*	Comment	Department Response
			published literature are excluded, primarily those that appeared recently. I've listed these at the end of this review.	
An apparent bias when data are lacking		BZ	I noted a number of examples where, when data on a particular topic were lacking, the authors assumed the best rather than the worst, or something in-between. Ideally, when the conservation of a species is a stake and a document is written by the agency responsible for that species, the precautionary principle is applied. There are a number of cases where this does not seem to be the case.	Noted. Specific sections mentioned are addressed above.
An apparent bias when data are lacking		BZ	I noted a number of examples where, when data on a particular topic were lacking, the authors assumed the best rather than the worst, or something in-between. Ideally, when the conservation of a species is a stake and a document is written by the agency responsible for that species, the precautionary principle is applied. There are a number of cases where this does not seem to be the case.	Noted. Specific sections mentioned are addressed above.