

State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION

EVALUATION OF THE PETITION FROM THE CENTER FOR BIOLOGICAL DIVERSITY
TO LIST THE CASCADES FROG (*RANA CASCADEAE*) AS ENDANGERED OR
THREATENED UNDER THE CALIFORNIA ENDANGERED SPECIES ACT



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I. Executive Summary

The Center for Biological Diversity (CBD) submitted a petition (Petition) to the Fish and Game Commission (Commission) to list the Cascades Frog (*Rana cascadae*) as endangered or threatened pursuant to the California Endangered Species Act (CESA), Fish and Game Code Section 2050 et seq.

The Commission referred the Petition to the Department of Fish and Wildlife (Department) in accordance with Fish and Game Code Section 2073. (Cal. Reg. Notice Register 2017, No. 13-Z, p. 479.) Pursuant to Fish and Game Code Section 2073.5 and Section 670.1 of Title 14 of the California Code of Regulations, the Department has prepared this evaluation report for the Petition (Petition Evaluation). The Petition Evaluation is an evaluation of the scientific information discussed and cited in the Petition in relation to other relevant and available scientific information possessed by the Department during the evaluation period. The Department's recommendation as to whether to make Cascades Frog a candidate for listing under CESA is based on an assessment of whether the scientific information in the Petition is sufficient under the criteria prescribed by CESA to consider listing Cascades Frog as endangered or threatened.

After reviewing the Petition and other relevant information, the Department makes the following findings:

- Population Trend. The Petition contains sufficient information to indicate that the overall trend in California populations of Cascades Frogs is declining, with the most precipitous declines occurring in the southern portion of the species' range.
- Range. The Petition contains a sufficient description of the Cascades Frog's range in California, including evidence suggesting range contractions in the Lassen and Mount Shasta regions.
- Distribution. The Petition contains a sufficient description of the historical and recent distribution of Cascades Frogs' populations in California, which indicate declines across the species' range, with the most extensive losses occurring in the southern portion.
- Abundance. The Petition contains a sufficient description of what was known about historical and recent abundance of Cascades Frogs' populations, which indicate declines across the species' range, with the most extensive reductions in population size occurring in the southern portion.
- Life History. The Petition contains a sufficient description of the life history of Cascades Frogs based on the scientific information available for the species, which indicates some aspects may render it particularly vulnerable to natural and anthropogenic impacts.
- Kind of Habitat Necessary for Survival. The Petition contains a sufficient description of the types and conditions of habitats required for Cascades Frog survival, including the fact that it is a highly aquatic species with specialized needs.

- Factors Affecting the Ability to Survive and Reproduce. The Petition contains sufficient information to suggest that Cascades Frogs are adversely affected by historical habitat damage and a number of on-going and future threats such as habitat loss, climate change, disease, and introduced fish, that act together in threatening the species' continued survival.
- Degree and Immediacy of Threat. The Petition contains sufficient information to indicate impacts from some of the primary threats to the long-term survival of Cascades Frogs will continue or potentially worsen in the future.
- Impacts of Existing Management. The Petition contains sufficient information to suggest that existing regulatory mechanisms and management efforts do not adequately protect Cascades Frogs from impacts that threaten their long-term survival.
- Suggestions for Future Management. The Petition contains sufficient scientific information on additional management actions that may aid in maintaining and increasing self-sustaining populations of Cascades Frogs in California.
- Availability and Sources of Information. The Petition contains a 17-page bibliography of literature cited, the majority of which were provided to the Department.
- A Detailed Distribution Map. The Petition contains a sufficiently detailed map of the historical and contemporary distribution of Cascades Frogs in California.

In completing its Petition Evaluation, the Department has determined the Petition provides sufficient scientific information to indicate that the petitioned action may be warranted. Therefore, the Department recommends the Commission accept the Petition for further consideration under CESA.

II. Introduction

A. Candidacy Evaluation

CESA sets forth a two-step process for listing a species as threatened or endangered. First, the Commission determines whether to designate a species as a candidate for listing by determining whether the petition provides "sufficient information to indicate that the petitioned action may be warranted." (Fish & G. Code, § 2074.2, subd. (e)(2).) If the petition is accepted for consideration, the second step requires the Department to produce within 12 months of the Commission's acceptance of the petition a peer reviewed report based upon the best scientific information available that indicates whether the petitioned action is warranted. (Fish & G. Code, § 2074.6.) The Commission, based on that report and other information in the administrative record, then determines whether or not the petitioned action to list the species as threatened or endangered is warranted. (Fish & G. Code, § 2075.5.)

A petition to list a species under CESA must include “information regarding the population trend, range, distribution, abundance, and life history of a species, the factors affecting the ability of the population to survive and reproduce, the degree and immediacy of the threat, the impact of existing management efforts, suggestions for future management, and the availability and sources of information. The petition shall also include information regarding the kind of habitat necessary for species survival, a detailed distribution map, and other factors the petitioner deems relevant.” (Fish & G. Code, § 2072.3; see also Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1).) The range of a species for the Department’s petition evaluation and recommendation is the species’ California range. (*Cal. Forestry Assn. v. Cal. Fish and Game Com.* (2007) 156 Cal. App. 4th 1535, 1551.)

Within 10 days of receipt of a petition, the Commission must refer the petition to the Department for evaluation. (Fish & G. Code, § 2073.) The Commission must also publish notice of receipt of the petition in the California Regulatory Notice Register. (Fish & G. Code, § 2073.3.) Within 90 days of receipt of the petition, the Department must evaluate the petition on its face and in relation to other relevant information and submit to the Commission a written evaluation report with one of the following recommendations:

- Based upon the information contained in the petition, there is not sufficient information to indicate that the petitioned action may be warranted, and the petition should be rejected; or
- Based upon the information contained in the petition, there is sufficient information to indicate that the petitioned action may be warranted, and the petition should be accepted and considered.

(Fish & G. Code, § 2073.5, subds. (a)(1), (a)(2).) The Department’s candidacy recommendation to the Commission is based on an evaluation of whether or not the petition provides sufficient scientific information relevant to the petition components set forth in Fish and Game Code Section 2072.3 and the California Code of Regulations, Title 14, Section 670.1, subdivision (d)(1).

In *Center for Biological Diversity v. California Fish and Game Commission* (2008) 166 Cal.App.4th 597, the California Court of Appeals addressed the parameters of the Commission’s determination of whether a petitioned action should be accepted for consideration pursuant to Fish and Game Code Section 2074.2, subdivision (e), resulting in the species being listed as a candidate species. The court began its discussion by describing the standard for accepting a petition for consideration previously set forth in *Natural Resources Defense Council v. California Fish and Game Commission* (1994) 28 Cal.App.4th 1104:

As we explained in *Natural Resources Defense Council* [citation], “the term ‘sufficient information’ in section 2074.2 means that amount of information, when considered with the Department’s written report and the comments received, that would lead a reasonable person to conclude the petitioned action may be warranted.” The phrase “may be warranted” “is appropriately characterized as a ‘substantial possibility that listing could occur.’” [Citation.] “Substantial possibility,”

in turn, means something more than the one-sided “reasonable possibility” test for an environmental impact report but does not require that listing be more likely than not. [Citation.]

(*Center for Biological Diversity, supra*, 166 Cal.App.4th at pp. 609-10.) The court acknowledged that “the Commission is the finder of fact in the first instance in evaluating the information in the record.” (*Id.* at p. 611.) However, the court clarified:

[T]he standard, at this threshold in the listing process, requires only that a substantial possibility of listing could be found by an objective, reasonable person. The Commission is not free to choose between conflicting inferences on subordinate issues and thereafter rely upon those choices in assessing how a reasonable person would view the listing decision. Its decision turns not on rationally based doubt about listing, but on the absence of any substantial possibility that the species could be listed after the requisite review of the status of the species by the Department under [Fish and Game Code] section 2074.6.

(*Ibid.*)

B. Petition History

On March 1, 2017, CBD submitted the Petition to the Commission to list Cascades Frog as endangered or threatened under CESA. On March 6, 2017, the Commission referred the Petition to the Department for evaluation. The Department requested of the Commission, and was granted, a 30-day extension to the 90-day Petition evaluation period. This Petition Evaluation report was submitted to the Commission on July 25, 2017.

The Department evaluated the scientific information presented in the Petition as well as other relevant information the Department possessed at the time of review. The Department did not receive any information from the public during the Petition Evaluation period pursuant to Fish and Game Code Section 2073.4. Pursuant to Fish and Game Code Section 2072.3 and Section 670.1, subdivision (d)(1), of Title 14 of the California Code of Regulations, the Department evaluated whether the Petition includes sufficient scientific information regarding each of the following petition components to indicate that the petitioned action may be warranted:

- Population trend;
- Range;
- Distribution;
- Abundance;
- Life history;
- Kind of habitat necessary for survival;

- Factors affecting ability to survive and reproduce;
- Degree and immediacy of threat;
- Impacts of existing management;
- Suggestions for future management;
- Availability and sources of information; and
- A detailed distribution map.

C. Overview of Cascades Frog Ecology

The Cascades Frog (*Rana cascadae*) is a medium-sized member of the “true frog” family Ranidae. Females are larger than males and can grow to over 8 cm (3.1 in) in length (Garwood and Welsh 2007). The species’ typical dorsal (top) coloration is brown, tan, or drab-green with well-defined inky black spots, a cream-colored jaw stripe, and strong dorsolateral folds (Thomson et al. 2016). Their sides are mottled and fade into a cream or buff ventral (bottom) coloration, usually with yellowish (sometimes reddish) areas posteriorly and on the undersides of their legs (Slater 1939, Thomson et al. 2016). California populations are genetically distinct from populations in Oregon and Washington (Monsen and Blouin 2003).

Within California, Cascades Frogs range from the Klamath-Trinity region, along the Cascades Range axis in the vicinity of Mt. Shasta, southward to the headwater tributaries of the Feather River (Jennings and Hayes 1994). The historical elevation range of Cascades Frogs in California was from approximately 230 to 2500 m (750 to 8200 ft), although extant populations appear to be restricted to sites above 1220 m (4000 ft) (Garwood and Welsh 2007). There are two disjunct populations recognized in California: the Southern Cascades, which comprises about 40% of their California range, and Klamath Mountains, which comprises about 60% (Pope et al. 2014); however, they do not appear to form distinct genetic units (Chang and Shaffer 2010).

Cascades Frogs inhabit a variety of mostly lentic (still water) habitats such as large lakes, ponds, wet meadows, and streams (Jennings and Hayes 1994, Pope et al. 2014). Adult Cascades Frogs demonstrate a high degree of site fidelity (Olson 1992), and at a site in the Trinity Alps, they were often observed moving from different breeding, feeding, and overwintering habitats in a consistent pattern year after year (Garwood 2009). They are diurnal (active during the day) and are typically found close to water, often in open, sunny areas along shorelines that provide basking and foraging opportunities, but they can move between basins by crossing over mountain ridges (Brown 1997, Garwood 2009, Pope et al. 2014, Welsh et al. 2006).

Breeding occurs shortly after snowmelt as surface water becomes available, and eggs are typically deposited in shallow lake alcoves, ponds, potholes, flooded meadows, and sometimes

slow-moving streams and anthropogenic (human-made) wetland habitats (Garwood et al. 2007, Pope 2008b, Pope and Larson 2010, Quinn et al. 2001). Cascades Frogs are explosive breeders, with all egg laying taking place at a site over a period of 3 to 14 days (Briggs 1987, Garwood 2009, Nussbaum et al. 1983, Olson 1988, Sype 1975). For breeding to be successful, sites cannot freeze over after eggs are deposited and must possess water long enough to support egg and larval development, which can take three to four months depending on temperature (Pope and Larson 2010, Pope et al. 2014, Pope et al. 2011). Larvae (tadpoles) can tolerate a wide range of temperatures and tend to aggregate in warmer areas (Pope n.d., Wollmuth et al. 1987); however, some shallow sites may exceed their critical thermal threshold (Pope et al. 2014, Pope and Larson n.d.). Larvae that do not metamorphose prior to winter probably do not survive (Garwood 2009). Adults and juveniles likely hibernate in mud at the bottom of ponds, spring-fed saturated ground, and deep ponds and springs (Briggs 1987, Pope et al. 2014) and require sites that do not freeze solid to survive. Annual adult survival is generally relatively high, although substantial mortality can occur during prolonged winters with heavy snow if individuals do not possess the energy reserves to last the duration of the season (Briggs and Storm 1970, Pope 2008b, Pope et al. 2014).

Juvenile and adult Cascades Frogs are generalist predators, primarily consuming aquatic and terrestrial invertebrates (Joseph et al. 2011, Larson 2012) but occasionally preying on larvae or recently metamorphosed Pacific treefrogs or conspecifics (i.e., cannibalism) (Pope et al. 2014). The most common Cascades Frog prey items in one study included grasshoppers, spiders, ants, crane flies, and insect larvae (Larson 2012). Aquatic invertebrates are consumed less at sites with non-native fish, which may compete for the same prey (Joseph et al. 2011). Non-native fish may also prey on Cascades Frogs, at least their young life stages. Welsh et al (2006) reported that Cascades Frog larvae were 3.7 times (CL: 1.8-5.6) less likely to be found in lakes with fish than those without, and Pope (2008a) reported an increase in survival of young frogs from 59% to 94% and an increase in frog density by a factor of 13.6 due to increased recruitment within 3 years of removing non-native fish from 3 lakes.

Natural predators on Cascades Frogs include: gartersnakes, American dippers, American robins, Clark's nutcrackers, river otters, rough-skinned newts, diving beetles, giant water bugs, dragonfly naiads, and predatory leeches (Briggs and Storm 1970, Garwood 2006, Garwood and Welsh 2007, Garwood and Wheeler 2007, Nauman and Dettlaff 1999, Peterson and Blaustein 1991, Pope et al. 2008, Stead and Pope 2010).

III. Sufficiency of Scientific Information to Indicate the Petitioned Action May Be Warranted

The order in which the petition components are evaluated below more closely reflects the order that they were provided in the Petition. This differs from their sequence in Fish and Game Code section 2072.3 and Section 670.1, subdivision (d)(1), of Title 14 of the California Code of Regulations, as well as in the Executive Summary and Introduction of this Petition Evaluation.

A. Range

1. Scientific Information in the Petition

The Petition provides the following information on the Cascades Frog's range on pages 4 and 5. However, for purposes of this Petition Evaluation, "range" is limited to the species' California range. (*Cal. Forestry Assn. v. Cal. Fish and Game Com.*, *supra*, 156 Cal. App. 4th at p. 1551.)

The Cascades Frog's range extends along the length the Cascade Range, from approximately 24 km (15 mi) south of the border with British Columbia in northern Washington, to the northern edge of the Sierra Nevada in California (Pearl and Adams 2005). Within California, the species' range extends from the Klamath-Trinity region, along the Cascades' axis in the vicinity of Mt. Shasta, southward to the headwater tributaries of the Feather River at elevations from approximately 230 to 2500 m (750 to 8200 ft) (Jennings and Hayes 1994). There are two disjunct populations: the Southern Cascades, which comprise about 40% of their California range, and Klamath Mountains, which comprise about 60% (Pope et al. 2014).

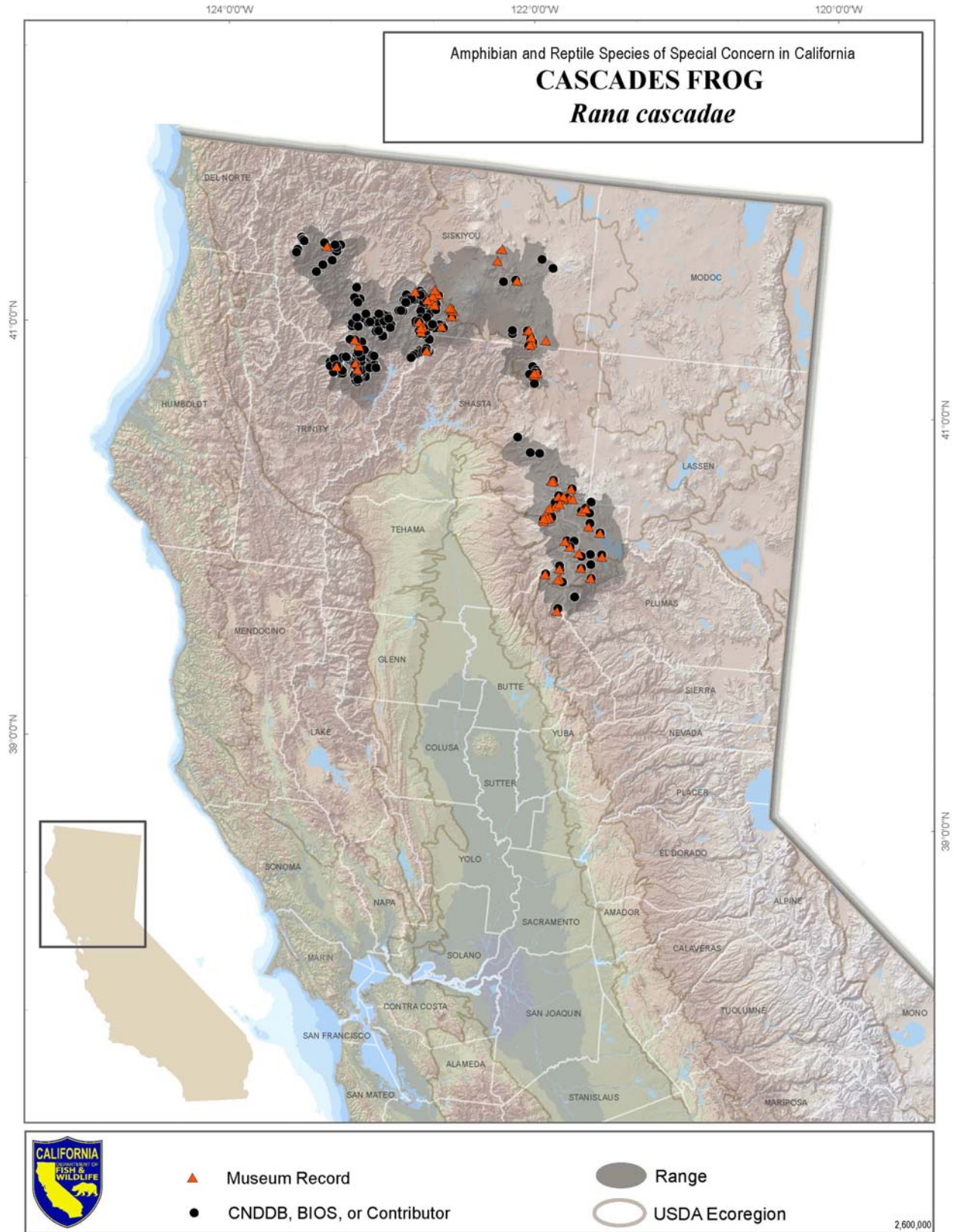
2. Other Relevant Scientific Information

Figure 1 shows the presumed range of Cascades Frogs in California (Thomson et al. 2016). The range of the Southern Cascades population encompasses parts of Butte, Lassen, Plumas, Shasta, and Tehama counties. The range of the Klamath Mountains population encompasses parts of Shasta, Siskiyou, and Trinity counties. The total area of the Cascades Frog range in California (gray area in Figure 1) is 321,346 ha (794,062 ac) in the Southern Cascades and 715,730 ha (1,768,600 ac) in the Klamath Mountains, but the species is patchily distributed within these areas.

In addition, there is a recent sighting of a Cascades Frog on private land approximately 500 m (1640 ft) outside of the range boundary depicted in Figure 1 (CDFW 2017a). While this distance represents a minimal extension, it suggests that, where suitable habitat exists in close proximity to the existing recognized range, the species may be present. For example, there are a few clusters of suitable habitat that have not been sufficiently surveyed that, if occupied, could slightly expand the species' range in the vicinity of the Shasta-Trinity and Lassen national forests (J. Garwood pers. comm.).

3. Sufficiency of the Petition with regard to Range

The Department concludes the Petition contains a sufficient description of the Cascades Frog's range in California, including evidence suggesting range contractions in the Lassen and Mount Shasta regions.



B. Life History

1. Scientific Information in the Petition

The Petition contains the following information on the Cascades Frog's life history on pages 4 to 8, including species description, taxonomy, life cycle, diet, movements, and sources of mortality.

Cascades Frogs are brown, copper, tan, or olive colored with a spotted back and yellowish to cream underside, dark mottling around the groin, and a cream-colored stripe extending from the jaw to the shoulders. Adults grow to 4.4-7.6 cm (1.75-3 in) in length, and females are larger than males (Stebbins 2003). Cascades Frog larvae are dark brown with copper and pinkish speckling, golden coloring on the sides, and a finely speckled tail (Nafis 2013). Their bodies are oval, their eyes are dorsally located (as opposed to on the sides of their head), and they grow to approximately 5 cm (2 in) in length. Cascades Frog eggs are black above, white below, and widely spaced within a gelatinous mass containing 300-800 eggs (Nafis 2013).

The Cascades Frog is a medium-sized member of the family Ranidae, the "true frogs." It is morphologically (Dunlap 1955, Slater 1939) and genetically (Case 1978; Green 1986a, 1986b) distinct from other Ranids. Populations in California have been isolated from Oregon and Washington populations for approximately 2 million years and differ significantly genetically (Monsen and Blouin 2003). The extent of genetic differentiation between the Southern Cascades and Klamath Mountains populations in California is unknown (Pope et al. 2014). The species typically exhibits a metapopulation structure, but high degrees of genetic isolation have been observed in some local populations over relatively small distances (Monsen and Blouin 2004, Pope et al. 2014). Gene flow likely drops over a distance of 10 km (6.2 mi) between populations (Pope et al. 2014).

Cascades Frogs are relatively long-lived, and late-maturing (Pope et al. 2014). Males attain sexual maturity between 3 and 4 years of age, while females mature between 4 and 5 years of age, and lifespan is typically 5 to 10 years (Ibid.). Cascades Frogs are active during the day (Stebbins 1985).

Cascades Frog reproduction is triggered by spring snowmelt, which can occur from March to mid-August (Stebbins 1985) depending on location, seasonal conditions, and elevation. Males enter the breeding sites first after ice and snow thaw, opening up surface water along the shoreline, and form chorusing groups (Briggs 1987, Garwood and Welsh 2007). Calling occurs above and below the surface (Stebbins 1985). It appears that males do not defend territories, but their interactions may result in regular spacing across breeding habitat (Olson 1988). Females are rarely seen during breeding; they primarily swim underwater to oviposition sites and leave after breeding is complete (Olson 1992).

Egg masses are typically laid communally in pond and lake habitats but singly in meadow pools (Garwood et al. 2007, Pope and Larson 2010), and a small portion have been found in small low-gradient streams with slow flows (Pope 2008b). They are usually deposited near the surface in shallow water attached to emergent vegetation, wood, boulders, or the shoreline, but they have also been found 2 m (6.6 ft) deep and free-floating (Garwood et al. 2007, Pope and Larson

2010). Because breeding occurs soon after open water habitat becomes available, egg masses may be vulnerable to late freezes (Pope and Larson 2010, Pope et al. 2011).

The duration of embryonic development (i.e., time to hatching) is temperature-dependent but typically takes around three weeks in California (Blouin and Brown 2000, Garwood and Larson n.d., Sype 1975). In spring-fed sites with consistently cold water (2 to 10 °C [35 to 50 °F]), hatching may be delayed slightly, but since egg masses are usually laid in shallow open water, sun exposure rapidly increases temperatures to above 13 °C (55 °F), which are better for development. Larvae are able to tolerate a wide range of water temperatures and tend to aggregate in the warmest areas of ponds and lakes during the day (Pope n.d., Wollmuth et al. 1987). These areas are typically near shore, gently sloping, and protected from the wind (O'Hara 1981, Olson 1992) where temperatures can reach over 20 °C (68 °F) during the day and drop to near freezing at night. Larvae have also been observed in shallow pools as warm as 38 °C (100 °F), but they appeared highly stressed (Pope and Larson n.d.).

Larval development is also temperature-dependent and can take from 2 to 4 months to metamorphosis (Pope et al. 2014). At sites with short hydroperiods, larvae can become stranded and desiccate prior to metamorphosis (Garwood 2009, O'Hara 1981, Pope et al. 2011, Sype 1975). Larvae that fail to metamorphose prior to the onset of winter do not apparently survive overwintering (Garwood 2009). Larvae and metamorphs (individuals transitioning from larvae to frog) preferentially associate with kin over non-kin (Blaustein and O'Hara 1982a, 1982b, 1987; Blaustein et al. 1984; O'Hara and Blaustein 1981, 1985). This kind of kin association can affect growth, predator avoidance, and other factors (Hokit and Blaustein 1994, 1995, 1997). Garwood (2009) found that newly metamorphosed frogs tended to remain near their natal ponds.

Adult Cascades Frogs demonstrate a high degree of site fidelity (Olson 1992), and at a site in the Trinity Alps, they were often observed moving from different breeding, feeding, and overwintering habitats in a consistent pattern year after year (Garwood 2009). In other areas that can support all habitat needs, they may remain at the waterbody year-round (Pope 2008a).

Adult Cascades Frog survival varies by location. Survival rates in the Trinity Alps were estimated between 68 and 93% (Pope 2008b, Pope et al. 2014), but Briggs and Storm (1970) reported survival at around 55% from a site in central Oregon. In the latter study, it appeared most of the mortality occurred over winter. This can occur during unusually long winters with heavy snowfall if individuals do not possess sufficient energy stores to survive the protracted season (Pope et al. 2014).

Juvenile and adult Cascades Frogs are generalist predators, primarily consuming aquatic and terrestrial invertebrates (Joseph et al. 2011, Larson 2012) but occasionally preying on larvae or recently metamorphosed Pacific Treefrogs (*Pseudacris regilla*) or conspecifics (Pope et al. 2014). The extent to which aquatic prey are consumed appears to be influenced by the presence of fish; in fishless lakes, more aquatic invertebrates were eaten, whereas in lakes with fish, more terrestrial species were eaten (Joseph et al. 2011). Larson (2012) recorded invertebrates from 102 families in Cascades Frog stomach contents with 5 groups among the

most important diet components: grasshoppers (Acridiadae), spiders (Aranae), ants (Formicidae), crane flies (Tupilidae), and insect larvae.

Natural predators of Cascades Frog include: gartersnakes (*Thamnophis* spp.) (Garwood and Welsh 2007, Pope et al. 2008); birds such as American dippers (*Cinclus mexicanus*) (Garwood and Welsh 2007), American robins (*Turdus migratorius*) (Briggs and Storm 1970), and Clark's nutcrackers (*Nucifraga columbiana*) (Garwood 2006); mammals such as river otters (*Lontra canadensis*) (Pope et al. 2014); other amphibians such as Rough-skinned Newts (*Taricha granulosa*) (Peterson and Blaustein 1991); aquatic insects such as diving beetles (Dytiscidae), giant water bugs (Belostomatidae), and dragonfly naiads (Odonata) (Garwood and Wheeler 2007, Nauman and Dettlaff 1999); and predatory leeches (Hirudinida) (Stead and Pope 2010). Predatory leeches have been implicated as a potential contributor to dramatic declines in Cascades Frogs in the Lassen region (Ibid.).

2. Other Relevant Scientific Information

Cascades Frogs have prominent dorsolateral folds, and their dorsal black spots are often described as “inky” with sharply defined edges (Stebbins 2003, Thomson et al. 2016). Jennings and Hayes (1994) note that numerous specimens from eastern Siskiyou and Shasta counties were previously misidentified as Oregon Spotted Frogs (*Rana pretiosa*). The last verified Oregon Spotted Frog in California was from a 1918 museum collection; the species is considered likely extirpated in the state (USFWS 2014, 2016a), so future misidentifications are not likely to occur.

Preliminary data indicate Southern Cascades and Klamath Mountains populations of Cascades Frogs are not separate genetic units (Chang and Shaffer 2010). Instead, populations from southeastern Siskiyou County and Shasta counties appear to form one group, while the rest form another (Ibid.). This suggests that populations from southern portion of the range (Plumas and Tehama counties) are more closely related to those in Trinity Alps than they are to those in Shasta County (i.e., their nearest neighbor), although the authors noted that the southern-most populations may also form a separate group (Ibid.). They cautioned that these results are preliminary and may change with a larger dataset (Ibid.).

In addition, a second genetic study at the University of Wisconsin-Madison is currently exploring if any broad- and fine-scale patterns of Cascades Frog genetic structure occurs throughout isolated populations of California and its entire range (Bennett Hardy pers. comm.). This study is using more advanced sequencing techniques and single nucleotide polymorphism datasets. The Department was involved with providing tissues to this study from the Klamath Mountains region in 2016.

Cascades Frogs are considered explosive breeders (Sype 1975). The typical oviposition period for a particular site lasts between 3 to 14 days (Briggs 1987, Garwood 2009, Olson 1988), and mature females are thought to produce a maximum of one clutch of eggs per year (Sype 1975). This life history strategy makes the species particularly vulnerable to late freezes, which can eliminate an entire cohort.

The species does not appear to possess a bet-hedging strategy where some individuals breed early and some later when conditions may be more favorable.

Cascades Frog dispersal appears to be limited, which has implications for gene flow among extant populations and recolonization of extirpated populations. Garwood (2009) measured Cascades Frog dispersal in the Klamath Mountains and found significant differences in patch connectivity within a basin relative to between basins. Garwood (2009) found on average 51% of juvenile Cascades Frogs dispersed from their natal patches within an individual basin, and only 1% dispersed over mountain passes to colonize adjacent basins. The study indicated habitats occurring in close proximity, but in separate adjacent basins, should be recognized as essential for gene flow given the low dispersal rates between basins.

3. Sufficiency of the Petition with regard to Life History

The Department concludes the Petition contains a sufficient description of the life history of Cascades Frogs based on the scientific information available for the species, which indicates some aspects may render it particularly vulnerable to natural and anthropogenic impacts.

C. Kind of Habitat Necessary for Survival

1. Scientific Information in the Petition

The Petition contains the following information on Cascades Frog habitat use and requirements on page 7.

Cascades Frogs inhabit a variety of mostly lentic habitats such as large lakes, ponds, wet meadows, and streams at mid- to high-elevations (Jennings and Hayes 1994, Pope et al. 2014). They are typically found close to water, often in open, sunny areas along shorelines that provide basking and foraging opportunities, but can occasionally move between basins by crossing over mountain ridges (Brown 1997, Garwood 2009, Pope et al. 2014, Welsh et al. 2006). Cascades Frogs are less likely to occupy wetlands that are farther away from lakes, and their abundance is often lower at these sites as well (Cole and North 2014).

Breeding occurs in areas that are first to become available after snowmelt such as shallow lake alcoves, ponds, potholes, flooded meadows, and sometimes slow-moving streams and anthropogenic (human-made) wetland habitats. For breeding to be successful, sites must possess water long enough to support egg and larval development, which can take three to four months depending on temperature (Pope and Larson 2010, Pope et al. 2014). As previously mentioned, while larvae can tolerate a wide range of temperatures and will select for warmer areas, some shallow sites may exceed their critical thermal threshold (Pope and Larson n.d., Pope et al. 2014).

Cascades Frogs require overwintering sites that do not freeze solid. They likely hibernate in mud at the bottom of ponds, spring-fed saturated ground, and deep ponds and springs (Briggs 1987, Pope et al. 2014).

2. Other Relevant Scientific Information

The effect of non-native fish presence on Cascades Frogs is discussed in more detail below in Section F-1, but it is worth briefly noting here as it relates to habitat quality and its ability to sustain healthy populations of Cascades Frogs. Welsh et al. (2006) found that Cascades Frog larvae were 3.7 times more likely to be found in fishless lakes than lakes with fish. Garwood and Welsh (2007) reported Cascades Frog densities were 6.3 times greater in a fishless meadow than one with trout. Pope (2008a) observed an increase in survival of young frogs from 59% to 94% and an increase in frog density by a factor of 13.6 due to increased recruitment within 3 years of removing non-native fish from 3 lakes.

3. Sufficiency of the Petition with regard to Kind of Habitat Necessary for Survival

The Department concludes the Petition contains a sufficient description of the types and conditions of habitats required for Cascades Frog survival, including the fact that it is a highly aquatic species with specialized needs.

D. Distribution and Abundance

1. Scientific Information in the Petition

The Petition contains the following information on the changes in Cascades Frog distribution and abundance in California on pages 8 through 12. Pope et al. (2014) conducted comprehensive reviews on the status of Cascades Frogs in California, and found that the species has become extremely rare in the Southern Cascades but remains “fairly widespread” in the Klamath Mountains. The Petition separates the discussion of Cascades Frog distribution and abundance in California by these two regions.

Southern Cascades

There were no formal surveys for Cascades Frogs in the Southern Cascades prior to 1980, but data from historical museum collections suggest the species was widespread and abundant, particularly in the vicinity of Lassen Volcanic National Park and the northwestern and southern portions of the Lassen National Forest (Pope et al. 2014). This area covered portions of the Pit River and most of the headwater tributaries of Hat, Deer, Mill, Battle, and Butte creeks, and upper North Fork and West Branch Feather River (Ibid.). Declines in the Southern Cascades populations were not recognized until the 1970s (Ibid.).

By the 1990s, Cascades Frogs had apparently disappeared from a large portion of formerly occupied sites. Fellers and Drost (1993) failed to detect the species at 16 historical localities, and only detected them at 1 of 50 sites (2%) surveyed. Jennings and Hayes (1994) estimated the species had been lost from approximately 99% of its historical range in the Lassen region. From 1993 to 2007, Fellers et al. (2008) conducted 1,873 amphibian surveys at 856 sites, encompassing all Cascades Frog habitats, within Lassen Volcanic National Park and Lassen National Forest. Cascades Frogs were found at only 6 sites over the 14 years of surveys, and a

III.D.1. Information in the Petition (continued)

single frog was reported from an additional site (Ibid.). There was no evidence of reproduction at most sites, and reproduction in all but one remained lower than the annual reproductive output of one breeding pair for over 12 years (Ibid.). Three populations have been found to the south on private land and three to the north near Lassen National Forest (Pope and Larson n.d.).

In total, 12 sites have been documented to support Cascades Frogs in the Southern Cascades region since 1993 (Pope et al. 2014). Abundance estimates range from 5 individuals at Colby Creek to 150 individuals at Carter Meadow (Ibid.). Data from a mark-recapture study conducted between 2008 and 2011 indicated each population is slowly declining, and about half are at risk of extirpation, while the others are likely to continue declining (Ibid.). Cascades Frogs have not been detected in Lassen Volcanic National Park since 2008, in spite of multiple surveys of known occupied sites and suitable meadow habitats (Ibid.). The species appears to be extirpated from the park.

Klamath Mountains

By the 1970s, Cascades Frogs had been recorded from approximately 25 locations in the Shasta-Trinity National Forest, but few populations had been recorded from the Klamath National Forest, and there was no evidence of declines (Pope et al. 2014). Jennings and Hayes (1994) reported that the species seemed common in appropriate habitat in the Klamath Mountains region.

Between 1999 and 2002, occupancy and abundance data were collected for all mapped lakes, ponds, and wet meadows in the Trinity Alps Wilderness, Russian Wilderness, Marble Mountains Wilderness, Siskiyou Wilderness, Red Buttes Wilderness, Castle Crags Wilderness, and parts of the Shasta-Trinity and Klamath National Forests outside of wilderness areas (Welsh and Pope 2004). No Cascades frogs were found in the Siskiyou or Red Buttes wilderness areas (Ibid.). Occupancy (i.e., at least one of any life stage) and evidence of reproduction (i.e., observation of at least one egg mass or larvae) data from the remaining areas are summarized in Table 1.

Table 1. Summary of Cascades Frogs Population Data in the Klamath Mountains (from Welsh and Pope 2004, cited in Pope et al. 2014)

Wilderness Area	Occupied (%)	n (sites)	Reproducing (%)	n (sites)
Trinity Alps	58.7	223/380	30.5	116/380
Russian	31	17/54	5.5	3/54
Marble Mountains	32	80/250	11	28/250
Castle Crags	19	3/16	-	-
Shasta-Trinity	100	15/15	-	-

In 2008, 112 previously occupied sites in the Klamath Mountains were re-surveyed, and 79% were found to still support Cascades Frogs (Piovia-Scott et al. 2011, Pope et al. 2014). While no

III.D.1. Information in the Petition (continued)

significant declines were noted, the abundances of some previously robust populations appeared low (Pope et al. 2014).

Of the 695 water bodies surveyed between 1999 to 2001 in the Trinity Alps, Russian, and Marble Mountain wilderness areas, the maximum number of adult Cascades Frogs seen at a water body was 32, and the mean number of adults encountered at occupied sites was only 4 (Welsh and Pope 2004). Since that survey effort, a 9-year mark-recapture study was conducted on 8 of these populations. At 5 of the sites, adult abundance was fewer than 25 individuals, while the other 3 appeared relatively robust (Garwood n.d., Pope 2008a). Pope and Piovio-Scott (2010) estimated two headwater lakes supported more than 500 Cascades Frogs in 2010; only one other site in the Trinity Alps is believed to support similar numbers (Pope et al. 2014).

The Cascades Frog populations in the Klamath Mountains have not experienced the same dramatic declines as those in the Southern Cascades, but low abundance and some extirpations are cause for concern (Pope et al. 2014).

2. Other Relevant Scientific Information

As previously noted in the Range section (A.2), a limited number of potentially suitable habitats that have not been surveyed occur slightly outside of the known range, which have the potential to slightly expand the distribution and potential abundance of this species if present (J. Garwood pers. comm.).

Aside from the observations denoted on the distribution map provided in the Petition on page 9 and those in Figure 1, little is known about the distribution and abundance of Cascades Frogs in the Mount Shasta region, which is located in the northeastern portion of the species' range in California.

3. Sufficiency of the Petition with regard to Distribution and Abundance

The Department concludes the Petition contains a sufficient description of what was known about historical and recent Cascades Frog distribution and abundance to indicate that both have declined across the species' range in California, to some extent, with the most precipitous declines occurring in the southern portion.

E. Population Trend

1. Scientific Information in the Petition

The Petition contains the following information on Cascades Frog population trends in California on page 12.

Cascades Frog populations have declined significantly in the Southern Cascades region. The species appears to be extirpated from Lassen Volcanic National Park, where it was once considered abundant. After several intensive survey efforts, it appears that only 12 sites continue to support the species, all with low numbers that are slowly declining. Pope et al.

III.E.1. Information in the Petition (continued)

(2014) determined that without active management, some of these populations will disappear within 10 years, and the remainders are at risk of extirpation.

Cascades Frogs are still widespread and relatively abundant in the Klamath Mountains region. Some recent extirpations have been documented, and some previously robust populations have declined. These instances are more common in the eastern portion of the region in the Castle Crags Wilderness and Klamath National Forest where population sizes are generally small.

Overall, the Cascades Frog's range has contracted at the southern end. Fellers and Drost (1993) and Jennings and Hayes (1994) estimated that the species had been extirpated from around 99% of the populations surrounding Mount Lassen and 50% of their total historical distribution in California. More recently, Fellers et al. (2008) noted that the range has contracted further.

2. Other Relevant Scientific Information

A long-term population monitoring study sponsored, in part, by the Department has been ongoing since 2003 in the Klamath Mountains (J. Garwood pers. obs.). Overall captures of adult and juvenile Cascades Frogs have decreased steadily through the duration of the study (Figure 2), indicating the population is in steady decline. In addition, annual Cascades Frog egg mass counts have ranged from 46 to 82 masses annually across 8 to 14 patches. The number of egg masses produced does not appear to be in steady decline, but the number of patches used for breeding within the population has steadily declined from 14 to 9 indicating patch-level extinctions.

3. Sufficiency of the Petition with regard to Population Trend

The Department concludes the Petition contains sufficient information to indicate that the overall trend in California populations of Cascades Frogs is declining, with the most precipitous declines occurring in the southern portion of the species' range.

F. Factors Affecting the Ability to Survive and Reproduce and Degree and Immediacy of Threat

1. Scientific Information in the Petition

The Petition contains the following information on threats affecting the ability of Cascades Frogs to survive and their degree and immediacy on pages 12 through 25. These include airborne contaminants, climate change, disease, fire suppression, habitat loss and alteration, introduced fish, livestock grazing, recreational activities, and small population sizes.

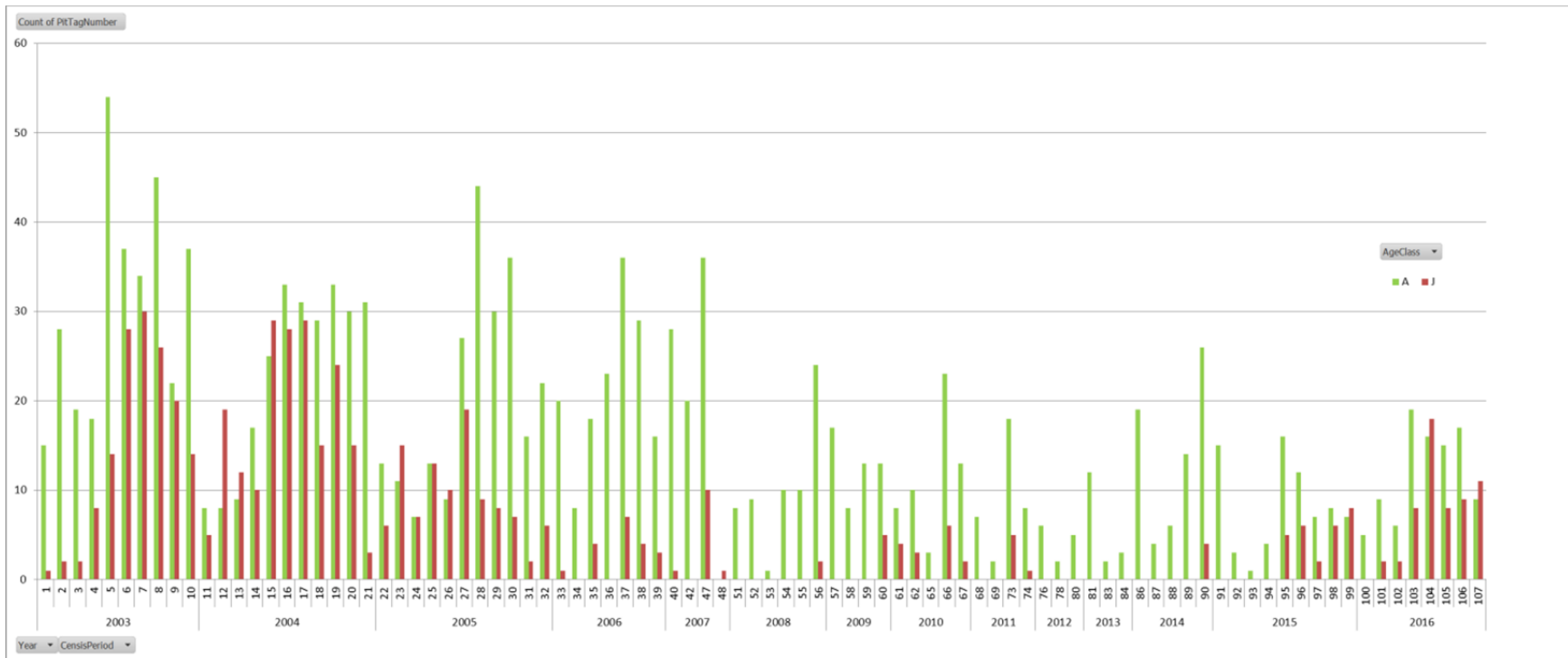


Figure 2. Captures of uniquely marked Cascades Frogs separated by age class, census period, and year across three habitat patches in Echo Lake Basin from 2003 to 2016, Klamath Mountains, CA. Green bars represent adult Cascades Frogs and red bars represent juveniles (J. Garwood pers. obs.).

III.F.1. Information in the Petition (continued)

Airborne Contaminants

Deposition of airborne agrochemical pollution from the Central Valley into the Sierra Nevada and southern Cascades is well-documented (Aston and Seiber 1997, Bradford et al. 2010, Datta et al. 1998, Davidson 2004, Davidson et al. 2002, Hageman et al. 2006, LeNoir et al. 1999, McConnell et al. 1998) and has likely contributed to declines in Cascades Frog populations in some regions (Davidson 2004, Davidson et al. 2002). On average, 62.7 million kg (168 million lbs) of pesticides were applied each year to agricultural lands (primarily in the Central Valley) between 1998 and 2014 (CDPR 2017). In the Lassen region, approximately four times more agriculture land was located upwind of extirpated Cascades Frog population sites than extant ones (Davidson et al. 2002). Chlorpyrifos, dacthal, and endosulfans, banned organochlorines, and polycyclic aromatic hydrocarbons (PCBs) were found in Cascades Frog tissues, but there was no significant pattern in pesticide concentrations between Southern Cascades and Klamath Mountains Cascades Frog populations (Davidson et al. 2012).

Paulk and Wagner (2004) reported that glyphosate and Malathion significantly adversely affected Cascades Frog larval survival and development at concentrations below the EPA-recommended maximum levels for surface water. Hatch et al. (2001) reported that juvenile Cascades Frogs were not able to sense or avoid toxic levels of fertilizers such as urea, and Marco and Blaustein (1999) reported that nitrites can affect Cascades Frog larval behavior and metamorphosis. In addition to the direct effects agricultural chemicals can have on amphibians, they may be interacting with other stressors in the environment, resulting in increased vulnerability to predators and disease, including weakening immune systems and facilitating chytridiomycosis (see “Disease” below) outbreaks (Blaustein et al. 2011, Bradford et al. 2011, Brühl et al. 2011, Davidson et al. 2007).

The degree to which airborne contaminants threaten the continued survival of Cascades Frogs is presumed to be low; however, complex interactions may exist between these chemicals and other stressors that have not been thoroughly examined (Pope et al. 2014). These effects are expected to be greatest in low- to mid-elevations downwind of agricultural areas (Ibid.).

Climate Change

As ectotherms, all aspects of amphibians' life history are strongly influenced by the external environment, particularly temperature and moisture. Higher average temperatures, varying precipitation patterns, and alterations in disturbance regimes such as fire are already affecting many wildlife species across North America (Case et al. 2015, Chen et al. 2011, Parmesan 2006, Root et al. 2003). Among a set of 195 species of plants, mammals, birds, and herpetofauna (amphibians and reptiles) from the Pacific Northwest, Case et al. (2015) determined that herpetofauna were, on average, the most sensitive group to climate change. This result was primarily driven by the fact that 90% of the amphibians and reptiles studied relied on at least one habitat type that was highly sensitive to climate change, such as the seasonal wetlands Cascades Frogs occupy (Ibid.).

Climate-associated shifts in amphibian phenology (seasonal timing), geographic range, and host-pathogen interactions have been documented (Blaustein et al. 2010, Corn 2005, Li et al.

III.F.1. Information in the Petition (continued)

2013), and evidence is emerging that climate change may be contributing to population declines as well (Lowe 2012, Rohr and Palmer 2013). Li et al. (2013) synthesized the results of 14 long-term data sets on amphibian breeding timing in the U.S. and Europe and discovered that over half the populations under study were breeding earlier. Shifts in timing of breeding can have fitness and population-level consequences; amphibians that emerge earlier in the spring can be vulnerable to subsequent freeze events (Li et al. 2013). In addition, shifts in geographic range in response to climate change can be difficult for species like Cascades Frogs with restricted high-elevation ranges and specific habitat requirements (Ibid.).

Cascades Frogs inhabit montane wetlands, frequently using hydrologically intermediate ponds, which are naturally variable, holding water in most years but occasionally drying during droughts (Lawler et al. 2014, Ryan et al. 2014). Several studies predict a decreased availability of this habitat type as the distribution and composition of Pacific Northwest montane wetlands are altered by climate change (Lawler et al. 2014, Lee et al. 2015, Ryan et al. 2014). These projections are associated with changes in snowpack volume, runoff, direct precipitation, and evaporation (Hamlet et al. 2005, IPCC 2007, Ryan et al. 2014). Snowpack is estimated to have declined by more than 50% over the past century, snowmelt runoff and peak water availability are occurring earlier in the year, and soil moisture is receding (Hamlet et al. 2007, Mote et al. 2005, Ryan et al. 2014). Rising temperatures and decreased summer precipitation will continue to reduce mountain snowpack and increase evapotranspiration and soil-moisture stress in late summer months, potentially converting more than half of the intermediate montane wetlands into ephemeral wetlands by the 2080s (Lee et al. 2015). Lawler et al. (2014) concluded that Cascades Frogs had the highest risk of climate-change related declines of the three species of amphibians they studied in the Pacific Northwest. The predicted loss of high elevation, intermediate wetlands will force Cascades Frogs to move to larger, deeper lakes that are more likely to support non-native fish, which decrease abundance and survival (Ryan et al. 2014).

In the Cascades Range, Ryan et al. (2014) reported that wetland drawdown is occurring earlier and more rapidly, water availability is greatly reduced, complete drying is occurring more frequently, and summers have longer dry periods. This can lead to stranding and desiccation of Cascades Frog larvae and decreased larval densities, along with shifts in size at metamorphosis and reduced survival due to increased water temperatures (Lawler et al. 2014, Semlitsch et al. 1988). In addition, among the most important predictors of Cascades Frog occupancy at a site was the number of available pools (Cole and North 2014).

Climate change may facilitate or exacerbate other environmental stressors, leading to population declines (Lowe 2012, Rohr and Palmer 2013). For example, a more variable climate and more frequent extreme weather events due to climate change have the potential to increase the pathogenicity of chytrid, the fungus responsible for widespread amphibian declines (Li et al. 2013, Raffel et al. 2013).

The current drought in parts of the Pacific Northwest may be indicative of average future climatic conditions in the Cascades Frog range. In some areas, near complete reproductive failure has been observed as a result of premature drying in ponds that typically remain wetted throughout the year. Dead adults have also been observed in these areas.

III.F.1. Information in the Petition (continued)

The degree to which climate change threatens the continued survival of Cascades Frogs is potentially high, particularly for populations that breed in ephemeral wetlands and those in the Southern Cascades region where the species is already rare and, therefore, highly susceptible to environmental stochasticity (Pope et al. 2014).

Disease

Chytridiomycosis is the amphibian disease caused by the fungal pathogen *Batrachochytrium dendrobatidis* (*Bd*). The result of its global rate of infection and associated mortality has been described as “the most spectacular loss of vertebrate biodiversity due to disease in recorded history” (Skerratt et al. 2007). Symptoms of adult amphibians with chytridiomycosis include lethargy and reluctance to flee, skin abnormalities, loss of righting reflex, and extended back legs. In infected larvae, the jaw sheaths and tooth rows are abnormally formed or lack pigment, which likely inhibits foraging ability (Fellers et al. 2001). The species-specific impact of *Bd* varies and can be influenced by temperature, predation pressure, pesticide exposure, and UV-B radiation, as well as the virulence of the strain (Berger et al. 2005, Farrer et al. 2011, Fisher et al. 2009, Gahl et al. 2012, Piovia-Scott et al. 2015, Retallick and Meira 2007).

Bd occurs throughout the Cascades Frog’s range, and the species is susceptible to infection (Adams et al. 2010; Garcia et al. 2006; Piovia-Scott et al. 2011, 2015). In lab experiments, Cascades Frog metamorphs exposed to *Bd* experienced significant mortality (Garcia et al. 2006), but declines in wild populations in the presence of *Bd* are not universal (Piovia-Scott et al. 2011, Pope et al. 2011). The reasons why some *Bd* infected populations decline dramatically, while others remain relatively stable, are not well known (Pope et al. 2014), but a rapid decline at one site is presumed to be the result of a particularly virulent strain (Fellers et al. 2008, Piovia-Scott et al. 2015). Juvenile Cascades Frog abundance at Section Line Lake in the Klamath Mountains decreased from hundreds in 2010 to two in 2012, and adults began to decline three years later (Piovia-Scott et al. 2015). No other factors such as predation or desiccation were evident, but a virulent strain of *Bd* was identified, and the high rate of overwintering mortality was consistent with chytridiomycosis-associated declines (Ibid.).

The significant decline in Cascades Frog populations in the southern portion of their range due to *Bd* and the prevalence of the disease throughout the species’ range is cause for concern (Pope et al. 2014). It appears that larger populations of frogs may increase resistance to *Bd* (Knapp et al. 2011), so efforts aimed at increasing Cascades Frog population sizes, such as removing predatory trout, may be crucial to ensuring the species’ survival (Ibid.). In addition, there is some evidence that treatment with antifungal drugs, such as Itraconazole, increases survival of *Bd*-infected Cascades Frogs (Hardy et al. 2015).

Other infectious diseases may also negatively affect Cascades Frogs in California. For example, *Saprolegnia ferax* is a species of water mold that commonly infects fish that can spread to amphibians and has caused die-offs of the species in Oregon (Blaustein et al. 1994, Kiesecker and Blaustein 1997). Prevalence of *Saprolegnia* in the wild has increased due to introduction of hatchery-raised fish (Blaustein et al. 1994), and this practice has the potential to transmit more virulent strains to amphibians (Bucciarelli et al. 2014). *Saprolegnia*-associated mortality may be

III.F.1. Information in the Petition (continued)

greater with increased exposure to UV-B radiation, which is likely to occur more frequently as wetlands shrink due to climate change (Bucciarelli et al. 2014, Kiesecker and Blaustein 1995).

The degree to which disease threatens the continued survival of Cascades Frogs is considered to be high. *Bd* is present across the species' range and appears to be significantly reducing juvenile survival in many populations, which increases the risk of population extirpations (Pope et al. 2014).

Fire Suppression

Fire suppression activities in California have the potential to adversely affect Cascades Frogs, although this subject has not been well studied and most evidence is anecdotal (Pilliod et al. 2003). Fire suppression activities that could directly impact Cascades Frogs include water drafting from ponds and streams, application of fire retardant, and construction of fuel breaks. These activities could also result in indirect impacts to the species through changes in aquatic and riparian habitats via sedimentation, alteration in downed woody debris, and reduction in amounts of vegetation associated with required habitats (potentially producing both positive and negative effects). In spite of this, no known impacts to Cascades Frogs from fire suppression activities have been documented. These activities occur regularly in the lower elevations of the Cascades Frog range and near the wildland-urban interface, putting the remaining populations in the Southern Cascades region at greater risk than those in the Klamath Mountains region, which is primarily subalpine, with long fire return intervals, and largely in wilderness areas. Fire crews and other fire personnel attempt to minimize impacts to aquatic and semiaquatic species and their habitats, but inadvertent impacts may still occur.

Construction of fire lines or firebreaks can be extensive and mimic habitat changes associated with roads and road construction. Sedimentation associated with unpaved roads can be greater than from logging or fire (Rieman and Clayton 1997). Restoration activities like installation of water bars and revegetation can reduce erosion (Pilliod et al. 2003). Using mechanized equipment in wilderness areas for fire suppression is not permitted.

Application of ammonia-based fire retardant and surfactant-based fire suppressant from air tankers or fire engines has the potential to adversely affect Cascades Frogs because some are toxic to aquatic organisms (Buhl and Hamilton 2000, Gaikowski et al. 1996, McDonald et al. 1996). Tanker pilots are directed to avoid aerial application of retardant or foam within 91 m (300 ft) of waterways (USDA 2011), although accidental contamination is still possible.

Potential large-scale indirect effects of fire suppression activities on Cascades Frog habitat include decreased water input and altered peak flows into wetlands as well as increased sediment yield. Fire suppression activities over the past century have led to dense forests with very high fuel loads. Dense forests can reduce snowpack and take up water for transpiration, resulting in reduced water yields downslope (Kattelman 1996). In addition, fire suppression can increase the natural invasion of shrubs and trees into open meadows, clogging formerly open breeding habitat with vegetation (Fellers and Drost 1993). Cascades Frogs may be losing suitable habitat in Lassen Volcanic National Park in part due to woody vegetation encroachment (Ibid.). The Forest Service began actively removing fuel loads in an effort to reduce the

III.F.1. Information in the Petition (continued)

frequency and intensity of wildfires. Catastrophic fire can produce some of the most extreme and extensive alterations to watershed condition of any type of disturbance (Kattelman 1996).

The degree to which fire suppression activities threaten the continued survival of Cascades Frogs differs by location. It is unlikely to be high in wilderness and high-elevation areas with sparse vegetation, where mechanized equipment is not permitted and fire suppression activities are rare. However, it is potentially high in the Southern Cascades region, because so few populations and limited numbers of animals remain (Pope et al. 2014).

Habitat Loss and Alteration

Vegetation and fuels management, water development and diversion, mining, and road effects can degrade or destroy Cascades Frog habitat.

Timber harvest, fuels management, salvage logging, and prescribed fire can impact Cascades Frogs (Pope et al. 2014). These activities change vegetation structure, the shade it produces, and woody debris, which can alter the quality of breeding, active-season, refuge, and overwintering habitat quality (Ibid.). They can also affect soil stability, erosion, and sediment loading to aquatic habitats (Ibid.). The effects of controlled burns for fuel reduction on Cascades Frogs are not well understood (Pilliod et al. 2003). Prescribed fire may benefit the species if it reduces encroachment of woody vegetation into meadows or the likelihood of a catastrophic fire, but it can be hazardous if undertaken in areas with granitic soils. Erosion rates of burned areas on granitic soils can be 66 times as great as in undisturbed watersheds and can elevate annual sediment yields for 10 years or more (Megahan et al. 1995).

Water developments, such as dams and diversions, can dramatically alter aquatic habitats (Harris et al. 1987, Moyle and Randall 1998). Dams can raise the levels of existing lakes or ponds or flood meadow habitat, eliminating, or potentially creating, Cascades Frog habitat. Diversions can modify the hydrology and water retention at a site potentially affecting breeding habitat. Most major water developments and diversions occur at lower elevations (Moyle and Randall 1998), but hydroelectric power generation and water storage reservoirs also occur in higher elevation areas within the Cascades Frog's range, such as Lake Almanor and Butte Valley Reservoir in the Southern Cascades region and Shasta and Trinity dams in the Klamath Mountains region (Pope et al. 2014). There are about 15 small lakes and meadow systems within the species' historical range in California that have some form of hydrological development, the majority of which consist of small dam structures that raise the water level of an existing water body.

Suction-dredge gold mining in streams and rivers can impact habitat by increasing suspended sediment, rearranging stream substrate, altering stream geomorphology, and directly trapping or killing aquatic organisms, including Cascades Frogs (CDFG 2011). All instream suction-dredge mining has been suspended since 2009 in California; however, the legacy impacts of historic hydraulic mining continue, including altered stream geomorphology and release of contaminants such as acid, cadmium, mercury, and asbestos in waterways (Larson 1996).

III.F.1. Information in the Petition (continued)

Most populations of Cascades Frogs are likely not directly affected by roads, but the indirect impacts of roads on the species' habitats and dispersal ability may be significant (Pope et al. 2014). Roads have the potential to change soil density, temperature, soil water content, light input, dust, surface water flow, pattern of runoff, and rates of sedimentation, and may also serve as barriers to movement that could prevent recolonization of extirpated sites (Trombulak and Frissell 2000). Six major highways (Interstate 5 and Highways 32, 36, 44, 89, and 299) partly or completely fragment portions of the Cascades Frog's range in California. In addition, paved, dirt, and gravel roads and trails occur throughout the species' range. Road crossings of water courses have the potential to block in-channel movements and dispersal events if culverts are too steep, become blocked by debris, or become disconnected from the streambed.

The degree to which habitat loss and alteration caused by these factors threaten the continued survival of Cascades Frogs is considered to be low with the exception of population isolation and habitat alteration caused by roads, which may be moderate on private lands and on the Lassen and Klamath national forests (Pope et al. 2014).

Introduced Fish

The impacts of stocking non-native fish into historically fishless waters on ecosystem functions and native species assembles, particularly amphibians, have been well documented (Bradford 1989, Hartel et al. 2007, Hartman et al. 2013, Knapp 2005, Knapp and Matthews 2000, Knapp et al. 2001, Pilliod and Peterson 2001, Ryan et al. 2014, Schindler et al. 2001, Vredenburg 2004, Welsh et al. 2006). This impact is widespread; non-native trout and other salmonids occupy approximately 95% of large mountain lakes and 60% of smaller ponds and lakes that were formerly fishless in the western U.S. (Bahls 1992). The majority of large and deep lakes in the Klamath Mountains and Southern Cascades support non-native populations of brook trout (*Salvelinus fontinalis*) or rainbow trout (*Oncorhynchus mykiss*) (Pope et al. 2014, Welsh et al. 2006).

Introduced fishes can affect amphibians in a number of ways. Introduced fish and native species compete for resources such as invertebrate prey (Bucciarelli et al. 2014, Finlay and Vredenburg 2007). Joseph et al. (2011) reported that adult Cascades Frogs co-occurring with introduced trout had smaller proportions of aquatic invertebrate prey in their stomachs than those occupying areas without trout. Introduced fish also directly prey upon native amphibians (Finlay and Vredenburg 2007, Simons 1998). Hartman et al. (2013) observed that, in the presence of trout, Cascades Frog larvae were most often found in shallow, vegetated areas that serve as a refuge from fish. The presence of nonnative fish can also lead to an increase in other predators. For example, in the Klamath Mountains, the Aquatic Gartersnake (*Thamnophis atratus*) was able to expand its range as a result of more prey availability (introduced fish), thus facilitating opportunities to also increase predation upon Cascades Frogs (Pope et al. 2008).

Several studies have documented a "fish" effect on Cascades Frog abundance and distribution. Welsh et al. (2006) reported that Cascades Frog distribution was negatively correlated with fish distribution, and Cascades Frog larvae were 3.7 times more likely to occur in lakes without trout. Garwood and Welsh (2007) reported that the density of Cascades Frogs was 6.3 times higher in a fishless stream than a similar one containing a high density of trout. Pope (2008a) reported

III.F.1. Information in the Petition (continued)

that, within 3 years of removing fish from 3 lakes, Cascades Frog densities increased 13.6 times and juvenile survival increased from 59% to 94%. Cole and North (2014) reported that the presence of trout was one of the strongest factors predicting presence of Cascades Frogs, and at higher elevations where trout were absent, Cascades Frogs dominated the aquatic species assemblage. Given climate change predictions, it can be expected that as higher elevation, intermediate wetlands dry up, Cascades Frogs will be forced to move into deeper waterbodies that are more likely to be occupied by fish, and the shallow refuges that protect larvae will likely also dry up, forcing the species into deeper waters with less protection (Pope et al. 2014, Ryan et al. 2014).

The declines of Cascades Frog populations, as well as two other native amphibians in California, prompted a lawsuit that concluded in a ruling that the Department must consider the impacts of fish stocking on the environment and native ecosystems. The resulting Environmental Impact Statement (ICF Jones and Stokes 2010) determined that the impacts of non-native trout on Cascades Frogs were “potentially significant.” There were 175 trout stocking locations within the Cascades Frog’s range in California (ICF Jones and Stokes 2010). Although stocking has since ceased in areas known to support Cascades Frogs (ICF Jones and Stokes 2010, Pope et al. 2014), many populations of stocked fish are likely self-sustaining (Pope et al. 2014).

The degree to which introduced fish and other predators threaten the continued existence of Cascades Frogs is considered to be high and widespread (Pope et al. 2014). The adverse impacts of introduced fish on Cascades Frog presence and densities have been demonstrated in the Klamath Mountains region, strongly suggesting they also contributed to declines in the Southern Cascades region (Ibid.). In addition, the interactions of introduced fish with other stressors, such as climate change and disease, may also be high (Ibid.).

Livestock Grazing

Seasonal cattle and sheep grazing have occurred in California for over two centuries, and the impacts on native ecosystems have been well documented (Fleischner 1994, Menke et al. 1996). These impacts include loss of native species, changes in species composition, alteration of hydrological function, including lowered water tables, soil deterioration, degradation of fish and aquatic insect habitat, and changes in ecosystem structure and function (Belsky et al. 1999, Fleischner 1994, Flenniken et al. 2001, Kauffman and Krueger 1984). There are no published studies that have directly examined the impacts of livestock grazing on Cascades Frogs, but negative impacts to other high elevation wetland ecosystems and Ranid frog habitats have been reported, include reducing vegetative cover, creating excess nitrogen pollution, increasing siltation of breeding ponds, and altering the local hydrology through erosion (Jennings 1996, Jennings and Hayes 1994).

Livestock grazing still occurs across most of the Cascades Frog’s range, but the extent and numbers on public lands have been reduced dramatically compared to past practices. Meadow sites occupied by Cascades Frogs on private lands in the Southern Cascades region are still grazed by livestock, as is much of the species’ range in the Klamath Mountains region, although, although portions of the wilderness areas are inaccessible to cattle or are not

III.F.1. Information in the Petition (continued)

permitted for grazing. Long-term impacts of historical grazing practices are difficult to quantify, but where it has resulted in channel incision and lowered water tables, there may be less available Cascades Frog breeding habitat or it may dry up more rapidly (Pope et al. 2011). Risks from current grazing practices include trampling and water quality degradation, which are a greater threat to already small populations such as those in the Southern Cascades region (Pope et al. 2014).

The degree to which livestock grazing threatens the continued survival of Cascades Frogs is presumed to be low. Although livestock grazing is still fairly widespread across the Cascades Frog's range in California and effects from previous grazing may be extensive, the practice has not been permitted for over 10 years in most breeding habitats on public lands in the Lassen region, where the species has experienced the most extreme declines, and livestock numbers have been reduced on other public lands within the Cascades Frog's range (Pope et al. 2014). However, where livestock grazing still occurs in the Southern Cascades region, negative impacts could reduce the likelihood of persistence due to already small population sizes (Ibid.).

Recreational Activities

Approximately two-thirds of the Cascades Frog's range in California occurs on public lands; approximately 5% on national park lands and 62% on national forest lands (USDA 2011b). Approximately half of the national forest lands are designated as wilderness areas, where recreation is dispersed and limited to non-motorized activities such as hiking, fishing, and camping. On the other half, recreational use can involve motorized activities such as off-highway vehicle use, which may have the potential for greater impacts. Of the one-third of the species' range that occurs on private lands, most is owned by timber companies with limited public recreation, but there are some campsites and lodges with heavy recreational use.

There are no published studies that have directly examined the effect of recreational activities on Cascades Frogs, but potential impacts can be inferred from reports on similar habitats or species. Mid- to high-mountain lakes, streams, ponds, and wet meadows are popular recreational destinations that provide fishing and swimming opportunities and are connected through trail networks and campsites. Construction and use of trails and camps disturbs vegetation and soil structure, and anglers often create shoreline trails for access to fishing spots even at remote wilderness lakes, which can result in erosion that increases sedimentation in pools (Boyle and Samson 1985, Brönmark and Hansson 2002, Garton et al. 1977, Knight and Cole 1991). Recreational packstock (horses and mules used to assist travel in remote areas) grazing in alpine meadow habitat can adversely affect habitat quality, particularly important shallow water areas around breeding ponds and lakes, and can directly trample all life stages of frogs (Cole et al. 2004, Moore et al. 2000, Olson-Rutz et al. 1996).

Recreational activities may degrade habitat quality or frequently disturb normal basking and feeding behaviors, which can increase the production of glucocorticoid stress hormones in frogs, the long-term effects of which include suppression of growth, reproduction, and immune system functions (Moore and Jessop 2003). Stress hormones in amphibians are also elevated by exposure to *Bd* and cause increases in metabolic rates that are energetically costly (Peterson 2012, Wack et al. 2012), and the effect of environmental stress on frogs exposed to

III.F.1. Information in the Petition (continued)

Bd appears to result in lower energy stores and survival compared to unstressed frogs (Peterson 2012).

The degree to which recreational activities threaten the continued survival of Cascades Frogs is presumed to be low to moderate. Over most of the species' range, recreational activities are light and dispersed, but in some high-use areas like lakes that are not within designated wilderness and have road access, they may have measurable impacts to Cascades Frogs and their habitats (Pope et al. 2014). Recreational impacts also interact synergistically with other stressors to increase stress, which reduces the health and resilience of Cascades Frog populations (Pope et al. 2014).

Small Population Sizes

Small population size, combined with genetic isolation, increases a species' risk of extinction. Isolated sites are less likely to support Cascades Frog populations over the long-term and are less likely to be recolonized once the population is extirpated (Pope et al. 2014). Therefore, increasing population sizes and habitat connectivity are important factors in ensuring the long-term viability of Cascades Frogs.

Monsen and Blouin (2004) reported that Cascades Frogs exhibit extreme genetic isolation over relatively short distances compared to other frog species; gene flow is reduced at distances of as little as 10 km (6.2 mi). Montane habitats may promote this type of isolation, particularly for species like Cascades Frogs that have a limited active season and specialized habitat requirements, which make long-distance movements risky and infrequent (Ibid.). Recolonization of a historically occupied site in Oregon reportedly took 12 years, even though a population of Cascades Frogs was located within 2 km (1.2 mi) of the site (Blaustein et al. 1994).

The degree to which small population sizes threaten the continued survival of Cascades Frogs is potentially high in the Lassen area of the Southern Cascades region due to lack of connectivity among the remaining populations, which could lead to a genetic bottleneck (Young and Clarke 2000).

2. Other Relevant Scientific Information

Marijuana (*Cannabis* spp.) cultivation may also pose a threat to Cascades Frog survival. Marijuana cultivation is concentrated in Northern California throughout the lower elevation portion of the Cascades Frog's range, especially in habitats below 1500 m (5000 ft). Water diversions associated with illegal Marijuana cultivation can be a significant threat to desiccation-intolerant amphibian species (Bauer et al. 2015), including the highly aquatic Cascades Frog. Increased inputs of nutrients from fertilizers, toxins from pesticides, and other pollutants also potentially threaten existing Cascades Frog habitats, although these impacts have not been directly studied.

If beaver populations had declined historically in parts of the Cascades Frog's range, it may have contributed to loss or modification of breeding habitat. Cunningham et al. (2007) showed that as beavers have recolonized areas of their former range in North America, they have increased the number and diversity of available breeding sites in the landscape for pond-

breeding amphibians. Cascades Frogs are known to occur in habitats modified by beavers in the Lassen region (Pope et al. 2011).

3. Sufficiency of the Petition with regard to Factors Affecting the Ability to Survive and Reproduce and Degree and Immediacy of Threat

The Department concludes that the Petition contains sufficient information to suggest that Cascades Frogs are adversely affected by historical habitat damage and a number of on-going and future threats such as habitat degradation and loss, climate change, disease, and introduced fish, that may be synergistically acting together to threaten the species' continued survival.

G. Impact of Existing Management Efforts

1. Information in the Petition

The Petition contains the following information on the impact of existing management efforts on the Cascades Frog on pages 26 through 29.

Federal Regulatory Mechanisms

The Center for Biological Diversity petitioned the Cascades Frog for listing under the federal Endangered Species Act (CBD 2012), and the U.S. Fish and Wildlife Service determined that the petition possessed substantial information indicating listing may be warranted (USFWS 2015), but the agency does not expect to make a determination on whether or not to propose the species for listing until 2022 at the earliest (USFWS 2016b). Other federal regulatory mechanisms that could potentially provide some form of protection for the Cascades Frog include occurrence on federally protected land and consideration under the National Environmental Policy Act. There are no federal Habitat Conservation Plans in California that cover the Cascades Frog (USFWS 2017).

Occurrence on National Forests and National Parks/National Environmental Policy Act

Populations of Cascades Frogs that occur on federal lands are mostly protected from development, although other activities on these lands have the potential for harm and may threaten their long-term survival. In spite of management policies on federal lands that are designed to protect natural resources, amphibians are still declining in these areas, and the policies and practices do not provide protection from threats such as airborne contaminants and non-native predators (Adams et al. 2013). For example, even though non-native fish are no longer stocked in occupied Cascades Frog habitat (ICF Jones and Stokes 2010), there do not appear to be any current efforts to eradicate self-sustaining populations on federal lands within their range.

The national forest lands within the Cascades Frog's range in California have forest plans that provide direction on management and protection of aquatic and riparian-dependent species (Pope et al. 2014). In multiple-use areas (most non-wilderness areas), riparian management

III.G.1. Information in the Petition (continued)

zones are designated around all waterbodies and fluvial systems to emphasize their protection and to help maintain their ecological integrity. Generally, only activities that promote maintenance and restoration of these ecosystems and their functions are permitted within the riparian management zones, but timber harvest, road building, livestock grazing, and other activities that may degrade Cascades Frog habitat are not prohibited under the plans.

The Forest Service adopted the Sierra Nevada Forest Plan Amendment in 2001, which contains an Aquatic Conservation Strategy focused on reducing some threats to amphibians, including the Cascades Frog. Some of these measures include changes to livestock grazing and non-native fish stocking practices, but the plan also contains activities such as fire and fuels management that may increase risk of habitat degradation for Cascades Frogs. Efforts to weaken the environmental protections, and increase the amount of logging allowed, under the Sierra Nevada Forest Plan Amendment have been on-going since its adoption.

One of the products of the Sierra Nevada Forest Plan Amendment was publication of a conservation assessment for the Cascades Frog, in cooperation with other federal agencies, state agencies, universities, and research scientists (Pope et al. 2014, USDA 2001a). Conservation Assessments provide only management recommendations, not mandated habitat protections. The conservation assessment is envisioned to be the first of a three-phase process that also includes a conservation strategy and a conservation agreement, but given the fact that the conservation assessment took over a decade to produce, actions and protections in the planned conservation strategy and agreement will likely not be afforded to the species anytime soon.

The Cascades Frog is designated as a Sensitive Species by the Pacific Southwest Region (Region 5) of the Forest Service (USDA 1998). Under Forest Service policy, Sensitive Species are to be managed in a way that ensures their viability and precludes trends toward endangerment that would warrant federal listing. All Forest Service planned, funded, executed, or permitted programs and activities are reviewed under the National Environmental Policy Act (NEPA, 42 U.S.C.4321-4370a) for possible adverse effects on Sensitive Species, through a Biological Assessment and Evaluation. The NEPA process requires federal agencies to describe a proposed action, consider alternatives, identify and disclose potential environmental impacts of each alternative, and involve the public in the decision-making process. However, neither the Sensitive Species designation nor the NEPA process requires avoidance of impacts, just consideration and disclosure, so even if the determination is that Cascades Frogs will be harmed or destroyed, the action may be undertaken.

Lassen Volcanic National Park is the only national park within the Cascades Frog range in California, and its Resource Management Plan (NPS 1999) acknowledges the species' decline and provides guidance relevant to Cascades Frog conservation. These include maintaining and rehabilitating aquatic systems; protecting and monitoring populations of sensitive species; promoting cooperation among federal, state, and private entities in preserving ecosystem health; eliminating or controlling damaging non-native species; and restoring, to the extent feasible, extirpated species. However, the Cascades Frog is now extirpated from Lassen Volcanic National Park, and because fish stocking began before the park was established, it is

III.G.1. Information in the Petition (continued)

unclear which species of fish were native to each system. Even though stocking ceased completely in 1992, 16% (9 of 57) of the park's lakes still supported introduced trout as of 2004 (Stead et al. 2005).

State Regulatory Mechanisms

The Cascades Frog is listed as a Species of Special Concern by the state of California (CDFW 2017b). This is an administrative designation that reflects the fact that the species is in decline but does not afford any substantive or legal protection. Other state regulatory mechanisms that could potentially provide some form of protection for the Cascades Frog include a state aquatic biodiversity strategy and consideration under the California Environmental Quality Act. There are no Natural Community Conservation Plans that cover the Cascades Frog (CDFW 2017c).

Aquatic Biodiversity Strategy

The Department developed a strategy for maintaining aquatic biodiversity in high-elevation wilderness ecosystems, including protecting and enhancing native amphibian assemblages, while trying to optimize recreational trout fishing opportunities (Garwood and Welsh 2007). The Department began implementing this conservation strategy in 1999 in the Sierra Nevada Mountains through development of watershed-based management plans focused on Sierra Nevada and Southern Mountain Yellow-legged Frogs (*R. sierrae* and *R. muscosa*, respectively), but differences between the ecology of these species and the Cascades Frogs rendered the watershed plans inadequate to protect Cascades Frogs (Ibid.).

California Environmental Quality Act

The California Environmental Quality Act (CEQA, California Public Resources Code §§ 21000-21177) requires state agencies, local governments, and special districts to evaluate and disclose impacts from projects in the state. Under CEQA, Species of Special Concern must be considered during the environmental review process, with an analysis of the project impacts on the species, only if they meet the criteria of sensitivity under Section 15380 of the CEQA Guidelines. However, project impacts to Cascades Frogs would not need to be analyzed if project proponents determined there are insignificant impacts (e.g., if the project does not have population-level or regional effects or impacts a small proportion of the species' range).

In addition to promoting environmental protection through procedural and informational means, CEQA has substantive mandates that can benefit declining or otherwise imperiled species. Public agencies are required to deny approval of a project with significant adverse effects when feasible alternatives or feasible mitigation measures can substantially lessen such effects. However, this mandate is rarely implemented, and lead agencies may approve projects despite remaining significant adverse impacts after all mitigation measures and alternatives deemed feasible have been adopted, if it finds that social or economic factors outweigh the environmental costs. CEQA is not, nor was it ever intended to be, a habitat protection mechanism.

III.G.1. Information in the Petition (continued)

Summary

Existing federal or state regulatory mechanisms do not adequately protect Cascades Frog populations or their habitats. Without state listing, significant conservation efforts for the Cascades Frog, reintroduction of the species at unoccupied historic sites, and implementation of frog habitat restoration projects are unlikely to occur.

2. Other Relevant Information

The Department is in possession of additional information on existing management efforts for the Cascades Frog, specifically relating to introduced fish management and eradication. As stated in the Petition, fish stocking by the Department in waters known to support Cascades Frogs has ceased (ICF Jones and Stokes 2010). This has a direct bearing on Cascades Frog conservation. Some waterbodies in the Cascades Frog range lack spawning habitats and others are known to suffer from oxygen depletions caused by periodic eutrophic conditions (B. Aguilar pers. comm.). Although the Department has not assessed many of these waters since the change in stocking management, some fish populations are not self-sustaining and have likely gone extinct.

From 2003 to 2008, a fish removal experiment was conducted in four lakes across the Klamath Mountains that support extant Cascades Frog populations (Pope 2008a). Results from the Pope (2008a) experiment are covered in detail within the Petition. Currently, two of the four lakes have remained fishless as a result of the research project (K. Pope pers. comm.).

Starting in 2014, following the recommendation of a draft basin management plan, the Department began a fish removal project in Echo Lake Basin, Klamath Mountains. The goal of this project is to restore approximately 70% of the available aquatic habitat for Cascades Frogs. This basin was chosen for restoration based on its exceptional Cascades Frog habitats and because it maintains persisting Cascades Frog populations. The basin has been part of a long-term Cascades Frog population monitoring program initiated in 2003 (Garwood and Welsh 2007). Habitats containing brook trout include Echo Lake and approximately 1.6 km (1 mi) of stream channels occurring below the lake. Since the inception of the fish removal project, 724 brook trout have been removed from the lake and streams, with complete removal expected in 2017 (Demianew et al. 2016). The Department is tracking the numerical response of native amphibian populations in response to the removal of brook trout with a before-after-control-impact study design.

3. Sufficiency of the Petition with regard to Impacts of Existing Management Efforts

The Department concludes the Petition contains sufficient information to suggest that existing regulatory mechanisms and management efforts do not adequately protect Cascades Frogs from impacts that threaten their long-term survival.

H. Suggestions for Future Management

1. Information in the Petition

The Petition contains the following suggestions for future management of the Cascades Frog on page 30.

Remove Invasive Fish: Remove trout within the species' range to increase the amount of fishless habitat available, and continue to not stock in waters supporting Cascades Frogs.

Investigate Disease Treatment: Research the effectiveness of various methods to reduce the mortality rate of Bd, and determine the feasibility of treatment in the wild.

Modify Fuel Management and Livestock Grazing: Determine the effects of vegetation and fuels management and livestock grazing on Cascades Frogs, and modify management practices and grazing leases accordingly to protect and restore the species' habitat.

Restore Habitat: Determine the effectiveness of restoration and habitat enhancement methods such as modifying breeding pools, removing livestock, thinning riparian vegetation to increase basking opportunities, or thinning lodgepole pines adjacent to breeding pools; monitor populations pre- and post-restoration; prioritize sites for restoration actions.

Restrict Pesticide Use: Determine where and when pesticide uses should be restricted to prevent exposure to Cascades Frogs.

Reduce Recreational Impacts: Encourage diffuse recreation and limit camping at lakes inhabited by Cascades Frogs on federal lands.

Consider a Captive Breeding Program: Begin a captive breeding program to provide donors for reintroductions if local populations become extirpated.

Reintroduce Populations: Explore reintroduction into appropriate habitat within the historical range, and investigate the feasibility of translocation or reintroduction of captive raised Cascades Frogs, particularly in Lassen Volcanic National Park.

Monitor Populations: Institute a long-term, rangewide program to monitor extant Cascades Frog populations.

2. Other Relevant Information

The following recommendations are adapted from Thomson et al. (2016) *California Amphibian and Reptile Species of Special Concern*.

Conduct a detailed genetics study: Characterize the degree and extent of intraspecific variation and use that information to designate management units and to inform population reintroduction and augmentation efforts. Note that a current population genetics study is being conducted by the University of Wisconsin-Madison (B. Hardy pers. comm.).

Quantify interactive effects of threats: Better understanding of the relative weight of each threat (e.g., climate change, *Bd*, introduced fish, etc.) and their interactions may be useful in developing conservation strategies.

3. Sufficiency of the Petition with regard to Suggestions for Future Management

The Department concludes the Petition contains sufficient scientific information on additional management actions that may aid in maintaining and increasing self-sustaining populations of Cascades Frogs in California.

I. Availability and Sources of Information

1. Information in the Petition

The Petition contains a 17-page bibliography of literature cited on pages 31 through 47, the vast majority of which were provided to the Department on a CD.

2. Other Relevant Information

The Department used publicly available information and provided citations. The Department also used unpublished reports and personal communications that can be provided upon request. The Department did not receive any information from the public during the Petition Evaluation period pursuant to Fish and Game Code Section 2073.4.

3. Sufficiency of the Petition with regard to Availability and Sources of Information

The Department concludes the Petition contains sufficient sources of information that are readily available to attempt to determine the status of the Cascades Frog.

J. Detailed Distribution Map

1. Information in the Petition

The Petition contains a detailed map of the distribution of Cascades Frogs in California on page 9, which depicts known localities up to 2011 and distinguishes between sites that were confirmed to be occupied between the following years: 1891-1980, 1980-1999, 1999-2011 (Pope et al. 2014). All localities within the map provided by the petition fall within the Department's Cascades Frog 2016 range map (CDFW 2016).

2. Other Relevant Information

The Department's range map for Cascades Frog (Figure 1) is based on the work in Thompson et al (2016). There are subtle differences in the distribution of Cascades Frog observations in Thomson et al. (2016) and those in the Petition's map (Pope et al. 2014); however, none of these substantively change the known distribution of the species.

3. Sufficiency of the Petition with regard to a Detailed Distribution Map

The Department concludes the Petition provides a sufficiently detailed map of the historical and contemporary distribution of Cascades Frogs in California.

IV. Status of the Species

The Cascades Frog occupies mid- to high-elevation wetlands in the Klamath Mountains and Southern Cascades, and every life stage is closely associated with aquatic habitats. The species' distribution and abundance have declined in parts of its range in California, most dramatically in the Southern Cascades/Lassen region where few populations remain and nearly all are very small. Populations within the Klamath Mountains region are still relatively widespread and appear to be mostly stable, even with seemingly low overall population sizes. The Cascades Frog's breeding cycle is closely tied to snowmelt, and successful reproduction requires breeding habitats to remain stable for several months during embryonic and larval development. The direct and interactive effects of climate change, disease, and introduced fish appear to be the primary threats to continued survival of the species. Additional possible threats, which may be more severe at lower elevations and in areas with very small populations, include airborne contaminants, recreational activities, livestock grazing, fire suppression activities, and roads.

Having reviewed and evaluated the Petition on its face and in relation to other relevant information, including the material referenced in the Petition and other information in possessed or received by the Department, the Department has determined that there is sufficient scientific information available at this time to indicate that the petitioned action may be warranted and recommends that the Petition be accepted and considered. (See Fish & G. Code, § 2073.5, subd. (a)(2); Cal. Code Regs., tit. 14, § 670.1, subd. (d).)

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