Peninsular bighorn sheep
(Ovis canadensis nelsoni)

5-Year Review:
Summary and Evaluation

Desert bighorn sheep (*Ovis canadensis nelsoni*). Photo Credit: National Park Service.

U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California

April 21, 2011

5-YEAR REVIEW

Peninsular bighorn sheep (*Ovis canadensis nelsoni)*

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed. Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

As summarized in the final listing rule and the Recovery Plan for Bighorn Sheep in the Peninsular Ranges, California (Recovery Plan), desert bighorn sheep are large mammals in the family Bovidae. The listed entity is a Distinct Population Segment (DPS) of a desert bighorn sheep subspecies, *Ovis canadensis nelsoni*, that inhabits the Peninsular Ranges in southern California from the San Jacinto Mountains south to the United States-Mexico International Border. However, the range of the subspecies extends south to Volcan de Tres Virgenes Mountains in Baja California, Mexico. The Peninsular Ranges population of desert bighorn sheep (Peninsular bighorn sheep) occupies moderate to steep slopes from approximately 100 to 1,400 meters (m) (300 to 4,600 feet (ft)) in elevation, with use of alluvial fans and washes, and valley floors depending on environmental conditions and dispersal requirements. This population of the subspecies exhibits a metapopulation structure, and requires habitat necessary to accommodate movements of males (rams), and more rarely females (ewes), between ewe groups (subpopulations). This taxon was listed under the California Endangered Species Act (CESA) as threatened in 1971.

Methodology Used to Complete This Review:

This review was prepared by Susan North, Fish and Wildlife Biologist at the Carlsbad Fish and Wildlife Office (CFWO), following the Region 8 guidance issued in March 2008. For this review, we used information from the Recovery Plan, survey information from species experts who monitor this population, published peer-reviewed scientific studies, and other information in our files to update the Peninsular bighorn sheep's status and threats. The Recovery Plan was authored by a member of the Bighorn Sheep Recovery Team in cooperation with members of the Recovery Team and other experts in bighorn sheep biology. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to what was known at the time of listing and at the time of completion of the Recovery Plan. We focus on current threats to the species identified under each of the Act's five listing factors. The review synthesizes all of this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next five years.

Contact Information:

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Lead Field Office: Susan North, Fish and Wildlife Biologist, and Bradd Baskerville-Bridges, Recovery Branch Chief, Carlsbad Fish and Wildlife Office; (760) 431–9440.

Federal Register (FR) Notice Citation Announcing Initiation of This Review:

A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the **Federal Register** on March 25, 2009 (USFWS 2009a, p. 12878). No information relevant to the taxon reviewed here was received in response to the **Federal Register** notice.

Listing History:

Original Listing
FR Notice: 63 FR 13134
Date of Final Listing Rule: March 18, 1998
Entity Listed: Bighorn sheep (Peninsular Ranges Population), (*Ovis canadensis*)
Classification: Endangered

Revised Listing
FR Notice: 74 FR 17288
Date Listed: April 14, 2009
Entity Listed: Distinct Population Segment of Desert Bighorn Sheep (*Ovis canadensis nelsoni*)
Classification: Endangered

State Listing
The State of California listed this entity as a separate subspecies of bighorn sheep (*Ovis canadensis cremnobates*) and as threatened in 1971. This subspecies is now identified by the Service as the DPS of desert bighorn sheep *(Ovis canadensis nelsoni)*. To date, the State has not revised its identification of the subspecies.

Associated Rulemakings:

__Proposed Critical Habitat__
FR Notice: 65 FR 41405
Date of Critical Habitat Proposed Rule: July 5, 2000

__Final Critical Habitat__
FR Notice: 66 FR 8650
Date of Critical Habitat Final Rule: February 1, 2001

__Proposed Revision of Critical Habitat and Proposed Taxonomic Revision__
FR Notice: 72 FR 57740
Date of Proposed Rule to Revise Critical Habitat and Taxonomy: October 10, 2007

__Revision of Proposed Rule to Revise Critical Habitat__
FR Notice: 73 FR 50498
Date of Revisions to Proposed Rule to Revise Critical Habitat: August 26, 2008

__Revised Final Critical Habitat__
FR Notice: 74 FR 17288
Date of Revised Final Critical Habitat Rule: April 14, 2009

Review History:

No previous 5-year reviews have been completed for the DPS of desert bighorn sheep.

Species' Recovery Priority Number at Start of 5-Year Review:

The recovery priority number for the Peninsular Ranges population of desert bighorn sheep is 3C according to the Service's 2010 Recovery Data Call for the CFWO, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (USFWS 1983a, pp. 43098–43105; USFWS 1983b, p. 51985). This number indicates that the taxon is a DPS that faces a high degree of threat and has a high potential for recovery. The C indicates conflict with construction or other development projects or other forms of economic activity.

Recovery Plan or Outline:

Name of Plan or Outline: Recovery Plan for Bighorn Sheep in the Peninsular Ranges, California
Date Issued: October 25, 2000

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

The Act defines "species" as including any subspecies of fish or wildlife or plants, and any DPS of any species of vertebrate wildlife. This definition of species under the Act limits listing as a DPS to species of vertebrate fish or wildlife. The 1996 Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act (USFWS 1996, p. 4722) clarifies the interpretation of the phrase "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the Act.

The Service listed the Peninsular Ranges population segment of desert bighorn sheep in southern California as a DPS of the species *Ovis canadensis* (bighorn sheep) in 1998 (USFWS 1998, p. 13134). This determination was based on the geographic isolation of this population in relation to the remainder of the species to which it belongs, the significance of the population segment to the species to which it belongs, the population segment's conservation in relation to the Act's standard for listing (USFWS 1996, p. 4722), differences in the conservation status between the population in the United States and the population of desert bighorn sheep inhabiting Mexico, and the biological and ecological significance of the metapopulation to the species as a whole (USFWS 1998, p. 13135). In 2009, the taxonomy of the listed entity was revised to *Ovis canadensis nelsoni* (USFWS 2009c, p. 17288). This change does not affect the determination of the Peninsular Ranges population segment of desert bighorn sheep as a DPS of the species.

Information on the Species and Its Status:

The following information is provided to elucidate the threats and current status of bighorn sheep in the Peninsular Ranges. For additional information regarding the listed entity and the species to which it belongs, please consult the listing rule (USFWS 1998, p.13134), the Recovery Plan (USFWS 2000a), and other relevant literature.

<u>Changes in Taxonomic Classification or Nomenclature</u>

In the proposed revised critical habitat rule that was published in the **Federal Register** on October 10, 2007, we formally recognized the listed entity as the Peninsular bighorn sheep, a DPS of desert bighorn sheep (*Ovis canadensis nelsoni*). This is the currently accepted taxonomic placement of these animals. The taxonomic revision does not affect discreteness and significance of Peninsular bighorn sheep as a DPS. In the 1998 final listing rule, Peninsular bighorn sheep were listed as a DPS of the species *Ovis canadensis.* At the time of listing, at least six subspecies of bighorn sheep *(Ovis canadensis)* were named, including four desert bighorn sheep subspecies (*O. c. cremnobates, O. c. mexicana, O. c. nelsoni,* and *O. c. weemsi)* (Geist 1971, p. 9). *Ovis canadensis cremnobates* is the name that previously had been applied to the Peninsular bighorn sheep. However, because of ongoing questions regarding the distinctiveness of the subspecific taxa at that time, the Peninsular Ranges population was considered a DPS of the species *O. canadensis* rather than a subspecies or a DPS of a particular subspecies.

Relevant information regarding the systematic relationships of the infraspecific (below species rank) taxa of bighorn sheep at or near the time of listing was based on morphometric (variation in size and shape) assessments, as well as molecular analyses, such as mitochondrial DNA (mtDNA) assessments (Ramey 1993, Wehausen and Ramey 1993, Ramey 1995, Boyce *et al.* 1999) and microsatellite and histocompatibility complex loci analysis (Boyce *et al.* 1997, Gutierrez-Espeleta *et al.* 1998). While the discriminatory value of these various approaches was not addressed in the Recovery Plan (USFWS 2000a), the Service concluded in the morphology and taxonomy section of the Recovery Plan that the currently recognized subspecies for desert bighorn sheep, *Ovis canadensis nelsoni,* includes Peninsular bighorn sheep (USFWS 2000a, p. 3). This taxonomic placement was recognized in the final critical habitat designation for the Peninsular bighorn sheep published in 2001 (USFWS 2001, p. 8650). In that rule, we described the range of the DPS as coinciding with the U.S. portion of the formerly recognized *O. c. cremnobates.* The current known range for the Peninsular bighorn sheep remains the same, as does its status as a DPS of desert bighorn sheep *(O. c. nelsoni).*

Regardless of its systematic affiliation, Peninsular bighorn sheep continue to meet the criteria as a DPS. Within this document we refer to the listed entity as a DPS of desert bighorn sheep *(Ovis canadensis nelsoni)* as we did in the 2008 final revised critical habitat rule, not as a subspecies as we did in the 2007 proposed revised critical habitat rule. We will continue to use the common name Peninsular bighorn sheep when referring to this DPS. No discussions or references to the Peninsular bighorn sheep are intended to apply to any other portions of the range (e.g., San Bernardino Mountains, Joshua Tree National Park, the desert mountains of southwestern Nevada and northwestern Arizona) of desert bighorn sheep *(O. c. nelsoni).* For a detailed discussion of the DPS analysis for Peninsular bighorn sheep, see the Distinct Vertebrate Population Segment section of the 1998 final listing rule (USFWS 1998, p. 13134). The final revised critical habitat rule included a change to the List of Endangered and Threatened Wildlife at 50 CFR 17.11(h) to reflect this change (USFWS 2009c, p. 17344).

<u>Species Description</u>

Peninsular bighorn sheep are medium-sized bovids in the order Artiodactyla, with muscular bodies and thick necks; color varies from dark brown in the northern mountains to pale tan in the desert. Rams have massive brown horns that curve up and back over their ears, then down, around, and up past their cheeks in a C-shaped curl that can spread to 83 centimeters (cm) (33 inches (in)). Ewes have short, slender horns that never form more than a half-curl. An adult is 76 to 100 cm (30 to 39 in) tall at the shoulders, and approximately 152 cm (60 in) long. The ram is normally larger than the ewe, weighing an average 73 kilograms (kg) (160 pounds (lb)) to the ewe's 48 kg (105 lb) (Monson and Sumner 1980, p. 52).

<u>Species Biology and Life History</u>

Information concerning the biology and life history of Peninsular bighorn sheep has not changed substantially since the time of listing. Biological traits related to ecological requirements will be discussed in the section titled **Habitat**.

Reproduction and Survivorship

Bighorn sheep rams and ewes tend to loosely segregate during much of the year, coming together primarily during the mating season (rut) (Bleich *et al.* 1997, p. 7), which typically peaks from August through October in the Peninsular Ranges (Rubin *et al.* 2000, p. 773). During the rut, rams join the ewe groups and compete to breed with receptive ewes. The largest rams presumably are the most successful breeders, but smaller rams also breed (Hogg 1984, p. 528). Some rams are believed to be capable of successful breeding as early as six months of age (Turner and Hansen 1980, p. 146), though breeding opportunities for young rams are limited by the social pressure of larger rams (Hogg 1984, p. 526). In the Peninsular Ranges, ewes estimated to be between 2 and 16 years of age have been documented to produce lambs (Rubin *et al*. 2000, p. 776), although yearling ewes in captivity have also produced lambs (Bighorn Institute (BHI) 1999, p. 2). Research of reproductive patterns indicates that conception rates may not be limiting population growth in the Peninsular Ranges (Borjesson *et al*. 1996, p. 73; USFWS 2000a, p. 16).

As parturition (labor) approaches, ewes seek secluded sites with shelter, unobstructed views, and steep terrain, which aids in predator evasion (escape terrain) (Turner and Hansen 1980, p. 148), while rams may be found in less steep or rugged terrain (Bleich *et al.* 1997, p. 12). Ewes isolate themselves from other females while bearing their lambs (Etchberger and Krausman 1999, p. 358). Lambs are born after a gestation of approximately 6 months (Turner and Hansen 1980, p. 146), generally between February and April, although some lambing may occur as late as August (Rubin *et al*. 2000, p. 773). Lambs usually are weaned by 6 months of age (Hansen and Deming 1980, p. 156). Lamb and yearling age classes experience high mortality rates relative to adult bighorns. After reaching adulthood at 2 years of age, bighorn sheep survival is high until approximately 10 years of age (Hansen 1980, p. 223). However, observed values of annual adult survivorship of Peninsular bighorn sheep appear low relative to other reported desert populations (DeForge *et al*. 1997, p. 19; Hayes *et al*. 2000, p. 957).

Peninsular bighorn sheep are ruminants, hoofed mammals that digest plant-based material by initially softening it within the animal’s first stomach, then regurgitating the digested mass, now known as cud, and chewing it again. This digestive process is known as “ruminating.” In ruminants, reproductive success is related to the mother’s body weight, access to resources, quality of home range, and age (Etchberger and Krausman 1999, p. 358). Survival of offspring also depends on birth weight and parturition date. Festa-Bianchet and Jorgenson (1996, p. 144) found that bighorn sheep ewes reduce their care of lambs when resources are scarce to favor their own nutritional requirements over their lambs’ development. Ewes that fail to acquire a minimum level of energy reserves (i.e., body weight) may not conceive (Wehausen 1984, p. 83) or will produce smaller offspring with a poorer chance of survival (Price and White 1985, p. 195). Several studies have documented a positive relationship between winter precipitation and lamb recruitment in the following year (Douglas and Leslie 1986, p. 153; Wehausen *et al.* 1987, p. 86). However, the relationships between climate, lamb recruitment, and population trends likely differ among different bighorn sheep populations, and are not fully understood (Rubin *et al.* 2000, p. 783).

Behavior

The gregarious and philopatric (faithful to natal home range) behaviors of ewes limit their dispersal and exploratory abilities relative to those of rams, but confer adaptive advantages to bighorn sheep because home range familiarity and group alertness decrease the risk of predation (Berger 1978, p. 91; Boyce *et al*. 1999, p. 99). The movement patterns and habits of ewes are learned by their offspring (Geist 1971, p. 98). By following older animals, young bighorn sheep gather knowledge about escape terrain, water sources, foraging areas, and lambing habitat (Geist 1971, p. 98). Rams do not show the same level of year-round philopatry and tend to range more widely, often moving among ewe groups (Geist 1971, p. 98; USFWS 2000a, p. 12). As young rams reach 2 to 4 years of age, they begin to follow older rams away from their natal group (Geist 1971, p. 98; Festa-Bianchet 1991, p. 79), and may follow the same travel routes every year (Wehausen 1980, p. 158; DeForge *et al*. 1997, p. 19). Geist (1971, p. 98) theorized that a young ewe might switch to a new ewe group if she encountered neighboring bighorn sheep and followed them away from her natal ewe group. In the Peninsular Ranges, movement of radio-collared ewes between ewe groups is rare, although inter-group movement does occasionally occur (Rubin *et al.* 1998, p. 543).

Desert bighorn sheep are primarily diurnal (Krausman *et al.* 1985, p. 24), but may be active at any time of day or night (Miller *et al.* 1984, p. 23). Their daily activity pattern includes alternating feeding and resting/ruminating periods. Forage quality influences activity patterns because when forages are low in digestibility, bighorn sheep must spend more time ruminating and digesting forage. Consequently, bighorn sheep may establish a cycle of feeding and ruminating that reflects forage quality and optimizes nutrient intake (Wagner and Peek 1999, p. 107).

Bighorn sheep have large home ranges that allow animals to move in response to variations in predation pressure and changes in resource availability. Home range is defined by Burt (1943, p. 351) as "that area traversed by the individual in its normal activities of food gathering, mating, and caring for young." DeForge *et al*. (1997, p. 16) found that fixed-kernel home range sizes averaged 25 square kilometers (km^2) (9.65 square miles (mi^2)) for rams and 20 km^2 (7.72 mi^2) for ewes in the San Jacinto Mountains. Within the narrow band of available habitat, Peninsular bighorn sheep make use of sparse and sometimes sporadically available resources found within their home ranges. The size of individual or group home ranges depends on the juxtaposition of required resources such as water, forage, escape terrain, or lambing habitat and, therefore, varies geographically (USFWS 2000a, p. 13). Home range size also is affected by forage quantity and quality, season, sex, and age of the animal (Leslie 1977, p. 26; McQuivey 1978, p. 37). In many populations animals have a smaller home range in summer (McQuivey 1978, p. 38; Elenowitz 1983, p. 77), presumably due to their limited movement away from permanent water sources at that time of year. During the cooler or wetter months of the year, bighorn sheep often exhibit an expanded range as animals move farther from water sources (Simmons 1980, p. 134; Elenowitz 1983, p. 77).

The behavioral response of bighorn sheep to human activity is considered to be highly variable and dependent upon many factors, including: 1) the type of activity, 2) an animal's previous experience with humans, 3) size or composition of the bighorn sheep group, 4) location of the bighorn sheep relative to elevation of the activity, 5) distance to escape terrain, and 6) distance to the activity (USFWS 2000a, p. 14). Responses can range from cautious curiosity to immediate flight or abandonment of habitat, as well as disruption of normal social patterns and resource use.

Metapopulation Dynamics

Peninsular bighorn sheep exhibit a matrilineal social structure (based on the female associations known as ewe groups), with adult rams tending to range more widely, moving between individual ewe groups, and ewes demonstrating strong philopatry (Geist 1971, p. 98). The naturally fragmented distribution of Peninsular bighorn sheep ewe groups results in distinct subpopulations. These geographically separated subpopulations can be grouped into a metapopulation, which are networks of interacting subpopulations (Schwartz *et al*. 1986, p. 184; Bleich *et al*. 1990, p. 385; Torres *et al*. 1994, p. 17). At the time of listing, the Peninsular bighorn sheep DPS was considered to be biologically and ecologically significant to the bighorn sheep species in that they constitute one of the largest metapopulations of desert bighorn sheep, spanning approximately 160 km (100 mi) of contiguous suitable habitat in the United States (USFWS 1998, p. 13136).

Long-term viability of the metapopulation depends not only on individual subpopulations, but also on the health of the entire metapopulation. Consequently, both genetic and demographic factors are important to population viability. The potential for increased inbreeding and genetic drift (random changes in genetic frequencies) accompanies decreasing population sizes, and can lead to decreasing levels of heterozygosity (a measure of genetic diversity) that may have negative demographic effects through inbreeding depression (reduction in fitness due to mating among relatives) (Soulé 1980, p. 96) and loss of adaptability. There is also growing evidence that the level of heterozygosity affects the disease resistance of a population.

A small amount of genetic exchange among subpopulations via movements by rams can counteract inbreeding and associated decreases in genetic diversity that might otherwise develop within small isolated populations (Schwartz *et al*. 1986, p. 187). Rams have a much greater tendency than ewes to explore new ranges, which they may do in search of ewes with which to breed. If geographic distance between subpopulations within metapopulations is not great, gene migration via rams occurs readily. However, human-made barriers that impede movement between groups can quickly eliminate genetic diversity through genetic drift (Epps *et al*. 2005, p. 1035). In the absence of an operable metapopulation structure, isolated subpopulations may benefit from genetic enrichment via induced migration of individuals translocated between subpopulations (Epps *et al*. 2006, p. 4300). Another important long-term process in metapopulation dynamics is the balance between rates of natural extinction and colonization among constituent subpopulations. Colonization rates must exceed extinction rates for a metapopulation to persist (Hanski and Gilpin 1991, p. 5).

Habitat

The Peninsular Ranges are located in southern California and Mexico in the Colorado Desert, which is a division of the larger Sonoran Desert (Schoenherr 1992, p. 413). The Colorado Desert is considered to be the warmest of the deserts in the United States, where maximum temperatures frequently reach 46 degrees Celsius (115 degrees Fahrenheit) in summer months, while only occasionally dipping below freezing during winter months (Rubin *et al*. 2009, p. 860). In the Colorado Desert, average annual rainfall between 1962 and 2004 was variable (4.2 to 39.9 cm (1.7 to 15.7 in); median rainfall 13.9 cm (5.5 in)) (Rubin *et al.* 2009, p. 860). Most of the precipitation occurs between December and March (Schoenherr 1992, p. 413). As with any desert area, water availability can be extremely limited, especially during the hot summer months and periods of extended drought. To the north the Peninsular Ranges are bordered by the Transverse Ranges, where they extend south approximately 225 km (140 mi) into Baja California, Mexico (Rubin *et al*. 1998, p. 540). To the east they are bordered by the Salton Trough. To the west the Peninsular Ranges extend to the Pacific Ocean as a series of northwesterly trending basins and ranges (USFWS 2000a, p. 148), although the desert begins about 120 km (75 mi) east of the coast. Mountains and intervening habitat that support bighorn sheep subpopulations within the Peninsular Ranges include, but are not limited to (north to south): San Jacinto Mountains, Santa Rosa Mountains, Coyote Mountain (in the north), San Ysidro Mountains, Pinyon Mountains, Vallecito Mountains, Fish Creek Mountains, Tierra Blanca Mountains, Sawtooth Mountains, In-Ko-Pah Mountains, Coyote Mountains, and Jacumba Mountains (in the south) (Figure 1).

Bighorn sheep inhabit the eastern slopes of the Peninsular Ranges along a band of habitat running north to south, typically below 1,400 m (4,600 ft) in elevation (Jorgensen and Turner 1975, p. 51; DeForge *et al*. 1997, p. 11; USFWS 2000a, p. vi). Peninsular bighorn sheep are considered unique among bighorn sheep because they utilize relatively low elevation habitat. Habitat is characterized by steep slopes and cliffs, rough and rocky topography, and sparse vegetation (Monson and Sumner 1980, p. 335; Cunningham 1989, p. 138). Areas of flat terrain where topography is gentler are also utilized, such as canyons, washes, and alluvial fans (Monson and Sumner 1980, p. 335; USFWS 2000a, p. 6).

Plant community composition on the eastern side of the Peninsular Ranges varies according to elevation (as described by Rubin *et al*. (1998, p. 540)). Above 1,800 m (5,906 ft), the landscape is dominated by coniferous forest consisting mainly of *Pinus ponderosa* (ponderosa pine) and *Abies concolor* (white fir); from 1,800 to 1,500 m (5,906 to 4,921 ft) the plant community is dominated by chaparral species; and from 1,500 to 1,200 m (5,906 to 3,937 ft) it is composed primarily of *P. monophylla* (pinyon pine) and *Juniperus californica* (juniper). Elevations below 1,200 m (3,937 ft) are dominated by the following plant associations: *Agave deserti* (agave)-*Fouquieria splendens* (ocotillo), *Opuntia* spp. (cholla)-*Cercidium floridum* (palo verde), and *Larrea tridentate* (creosote)-*Prosopis* spp. (palo verde-mesquite). Peninsular bighorn sheep typically stay below the pinyon pine-juniper and chaparral vegetation for predator evasion purposes.

At the time of listing, the unique climatic and vegetational differences occurring in the Peninsular Ranges, as compared to most other areas occupied by bighorn sheep, further demonstrated the significance of Peninsular bighorn sheep. The low rainfall, high evapotranspiration rate, and temperature regime in the majority of Peninsular bighorn sheep range is notably different from other North American deserts. The species' ability to exist under these conditions suggests unique behavioral and physiological adaptations. Bighorn sheep in the Peninsular Ranges and throughout the desert southwest have specific habitat requirements that

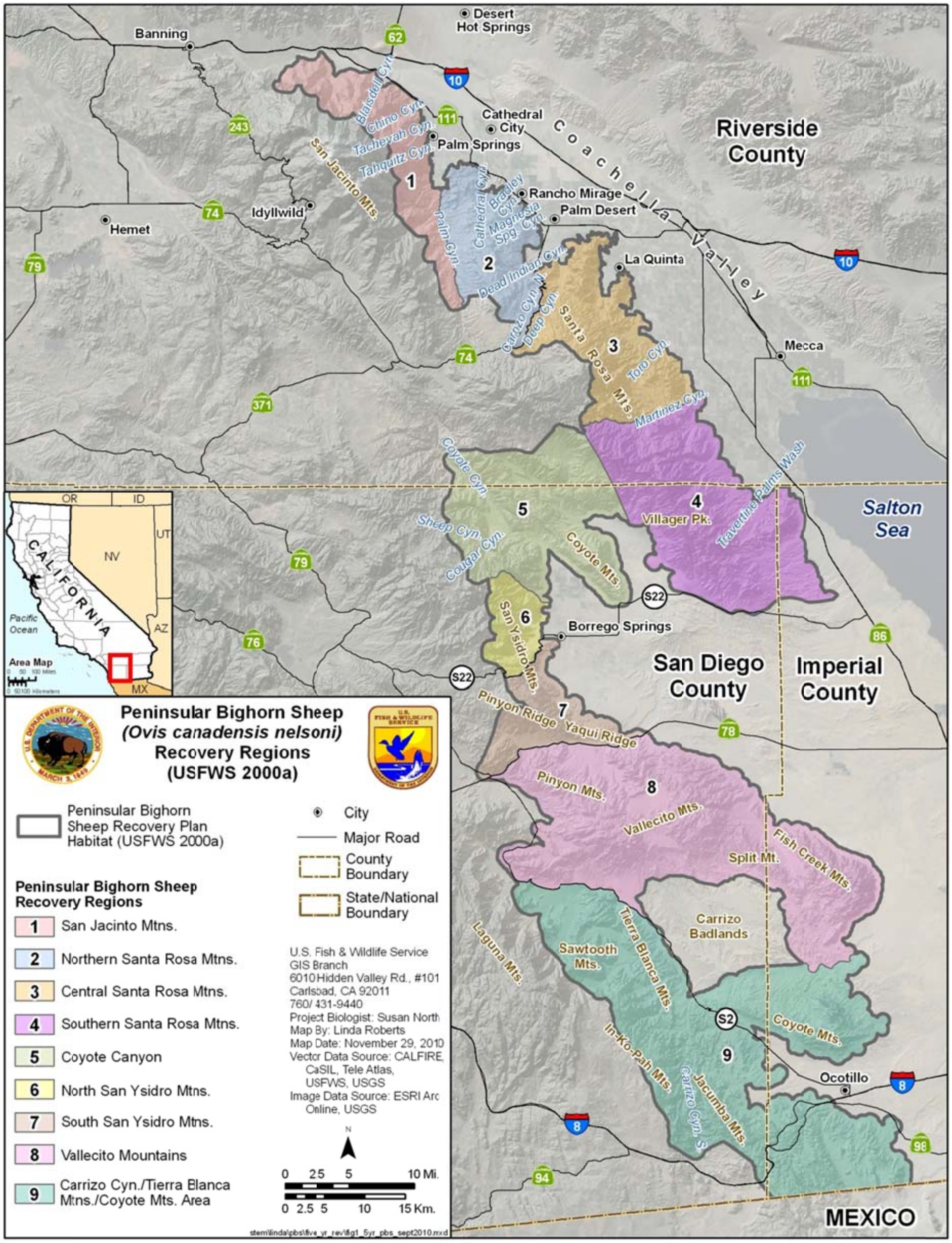

Figure 1: Recovery Regions and Recovery Plan Habitat for Peninsular bighorn sheep (*Ovis canadensis nelsoni*) as delineated in the Recovery Plan (USFWS 2000a).

relate to topography, visibility, water availability, and forage. These requirements are discussed below.

Topography

Bighorn sheep evolved predator evasion behaviors such as the use of escape terrain, which is generally defined as steep, rugged slopes (Hansen 1980, p. 70; Cunningham 1989, p. 136). Escape terrain is important because bighorn sheep typically do not depend upon speed alone to outrun their predators, but use their exceptional climbing abilities to out-maneuver predators on steep, rocky outcrops and talus slopes (McQuivey 1978, p. 37). When ewes are ready to give birth they will typically seek out the most precipitous terrain, where they and their lambs will be safest (Geist 1971, p. 242). Therefore, the presence of such steep terrain for predator evasion and lambing is a crucial component of bighorn sheep habitat.

In addition to mountainous terrain, other types of habitat are fundamental to bighorn sheep. Areas of gentle terrain, such as valley floors, are important linkages between adjacent mountainous regions, thereby providing bighorn sheep temporary access to resources (e.g., forage, water, lambing habitat) in neighboring areas, and allowing gene flow to occur between subpopulations (Krausman and Leopold 1986, p. 59; Schwartz *et al.* 1986, p. 187; Bleich *et al.* 1990, p. 383; Bleich *et al.* 1996, p. 358). Though not documented, Peninsular bighorn sheep probably traveled across gentle terrain, such as the Coachella and Imperial Valleys, to move between mountain ranges as other desert bighorn sheep are documented to do in California, Arizona, and Nevada (Simmons 1980, p. 130). During such movements, bighorn sheep are known to move quickly, using the shortest route possible to cross wide valleys. In some cases, bighorn sheep cross highways to make inter-mountain movements (Simmons 1980, p. 130).

Gentle terrain (e.g., alluvial fans and washes) also provide nutritious forage during droughts and other challenging periods, such as lactation (Leslie and Douglas 1979, p. 25; Hansen 1980, p. 77; Wehausen 1980, p. 81; Schwartz *et al*. 1986, p. 37; Berger 1991, p. 61). Peninsular bighorn sheep are known to forage on alluvial fans and washes at various times of the year. For instance, the Borrego Palm Canyon alluvial fan is used for forage during cooler months, and for water from May to November (M. Jorgensen, California State Parks, pers. comm. 2000). Other areas, such as Harper Flat in Anza-Borrego Desert State Park (Anza-Borrego DSP) and Chino Canyon, are also used by Peninsular bighorn sheep. In the summer, alluvial fans and washes may be the only areas with nutritious forage (Andrew 1994, p. 54).

Variations in slope and aspect also help bighorn sheep survive in a harsh environment. During hot weather, desert bighorn sheep seek shade under boulders, hanging rocks, and cliffs, or they may move to north-facing slopes (Merritt 1974, p. 20; Andrew 1994, p. 52) where temperatures are moderate. During inclement weather, bighorns may again seek caves, overhangs, or slopes that are protected from strong winds, and on cold winter days they may move to sunny, south-facing slopes (Andrew 1994, p. 52).

Visibility

Bighorn sheep generally avoid using habitat that is heavily vegetated, as it reduces their ability to detect and evade potential predators (Risenhoover and Baily 1985, p. 799). This appears to be the case in the Peninsular Ranges, where bighorn sheep usually remain below the chaparral and pinyon-pine juniper associations (≤ 1,400 m (4,600 ft)) (Weaver *et al*. 1968, p. 3; Rubin *et al*. 1998, p. 541). The patterns of vegetation associations in the Peninsular Ranges, in combination with bighorn sheep predator avoidance behavior, result in habitat use that is more restricted to lower elevations than most other bighorn sheep populations.

Water Availability

In hot arid deserts, water is an important resource for bighorn sheep (Jones *et al.* 1957, p. 152; Blong and Pollard 1968, p. 289; Leslie and Douglas 1979, p. 21; Turner and Weaver 1980, p. 101; Cunningham and Ohmart 1986, p. 18). Bighorn sheep require a quantity of water approximately equal to 4 percent of their body weight (3.8 liters; 1 gallon) per day during the summer months (Turner and Weaver 1980, p. 104). However, when body temperature exceeds air temperature, bighorn sheep may drink more than 20 percent of their body weight (Turner and Weaver 1980, p. 101). Mountains within the Peninsular Ranges are mainly of granitic and volcanic origin; such rocks produce potholes, or tinajas, that hold runoff stream water (Hansen 1980, p. 72). Because annual rainfall averages are very low, tinajas are important water sources. More rainfall occurs at higher altitudes above 900 m (2,950 ft). However, the elevational distribution of Peninsular bighorn sheep limits use of water sources in higher mountain regions (Weaver *et al*. 1968, p. 3). Water sources are most valuable to bighorn sheep if they occur in close proximity to adequate escape terrain with good visibility (Cunningham 1989, p. 136; Andrew 1994, p. 56).

A number of studies have shown that desert bighorn sheep will concentrate around water sources in the summer, with most animals found within a 3 to 5 km (2 to 3 mi) radius of water (Jones *et al.* 1957, p. 182; Blong and Pollard 1968, p. 289; Leslie and Douglas 1979, p. 33; Cunningham and Ohmart 1986, p. 17). In the Peninsular Ranges, bighorn sheep migrate seasonally during the hot season, leaving mountain ranges where no standing water is known to exist, such as Coyote Mountains, and moving to adjacent mountain ranges where standing water is available year-round, such as south Carrizo Canyon. They then center their activity near standing water for the hot season. However, bighorn sheep have recently begun to stay in the Coyote Mountains year-round (R. Botta, CDFG, pers. comm. 2010).

The importance of free-standing water to bighorn sheep has been questioned (Krausman and Leopold 1986, p. 59; Broyles 1995, p. 663), and some populations may exist without free-standing water (Krausman and Leopold 1986, p. 59; Broyles 1995, p. 666; Cain *et al*. 2008, p. 1). Cunningham (1989, p. 135) noted that most of these “waterless” populations are small and in smaller mountain ranges. In some areas, such as the Peninsular Ranges, sheep distribution is less coincident with permanent water sources during periods of more abundant rainfall and cooler temperatures (Leslie and Douglas 1979, p. 33). Enough water can generally be obtained from temporary sources (i.e., tinajas) and vegetation to meet hydration requirements during cooler, wetter portions of the year. However, the seasonal concentration of Peninsular bighorn sheep around permanent water sources during the summer may indicate that vegetation alone does not provide sufficient water and, at least in some mountain ranges, standing water is a requirement. Furthermore, dry years that might cause Peninsular bighorn sheep to be particularly dependent on vegetation for hydration may also desiccate that vegetation, reducing its viability as a moisture source while potentially creating additional problems due to consumption of dry matter (Turner and Weaver 1980, p. 102).

Historically, artificial water sources (guzzlers, pothole improvements, apron catchments) were made available to bighorn sheep throughout the western United States, including in the Peninsular Ranges, to assist survival through dry summers and aid dispersal into new habitat. In most populations bighorn sheep will drink regularly when water is available from either natural or artificial sources.

Forage

Peninsular bighorn sheep use a wide variety of plant species as their food source (Weaver *et al.* 1968, p. 12). Jones *et al*. (1957, p. 188) reported at least 34 species of plants that were eaten by Peninsular bighorn sheep, and the presence of another eight species existing within the Peninsular Ranges that were consumed by bighorn sheep elsewhere, including *Fouquieria splendens* and *Ferocactus* spp. Cunningham and Ohmart (1986, p. 14) determined that the bighorn sheep diet in Carrizo Canyon (at the southern end of the U.S. Peninsular Ranges) consisted of 57 percent shrubs, 32 percent forbs, 8 percent cacti, and 2 percent grasses. Similar diet compositions were reported at the northern end of the Peninsular bighorn sheep range (Turner 1976, p. 169; Scott 1986, p. 21). Diet composition varied among seasons (Cunningham and Ohmart 1986, p. 15; Scott 1986, p. 23), presumably because of variations in forage availability, selection of specific plant species during different times of the year (Scott 1986, p. 24), and seasonal movements of bighorn sheep. Several plant species, including *Simmondsia chinensis* (joboba), *Encelia farinosa* (brittlebush), *Krameria canescens* (white ratany), *Hyptis emoryi* (bee sage), *Ambrosia* spp., *Caesalpinia* spp., and *Sphaeralcea* spp. have been identified as important year-round food sources (Jones *et al* 1957, p. 188; Scott 1986, p. 24). During the fall primary food sources may include grasses such as *Aristida adscensionis* (sixweeks threeawn), *Bromus madritensis* subsp. *rubens* (red brome), and cacti *Opuntia* spp. (cholla) (Scott 1986, p. 24). Forbs such as *Plantago ovata* (insularis) and *Ditaxis neomexicana* (common ditaxis) are primary food sources in the spring (Scott 1986, p. 24). Additionally, desert bighorn sheep in the mountains of Arizona are known to utilize *Ferocactus* spp. (barrel cacti), which may provide both water and food (Warrick and Krausman 1989, p. 484).

Bighorn ewes have very demanding energy and protein requirements during late gestation, lambing, and nursing. The survival of newborn ungulates can be at risk if sufficient nutrients are not acquired by ewes during late gestation and nursing (Thorne *et al.* 1976, p. 330; Holl *et al.* 1979, p. 68; Berger 1991, p. 61). Crude protein and digestible energy values of plants that produce new shoots in the spring (early green-up plants) are usually much higher than those of plants that produce new shoots later in the year (dormant forages) during the critical late gestation, lambing, and rearing seasons (White 1983, pp. 380–382). With their high nutrient content, even minor volumes of these forages within the overall diet composition may contribute important nutritional value at crucial life stages (Wagner 2000).

During the reproductive season, due to the varied topography of bighorn sheep habitat, foraging ewes typically are concentrated on specific sites, such as alluvial fans and washes, where more productive soils support greater herbaceous growth and greater diversity of browse species. Hence, these are more important sources of higher quality forage than steeper, rockier soils (Leslie and Douglas 1979, p. 37). In summer and times of drought, wash vegetation remains green longer than forage areas found on mountainsides, thus providing forage higher in nutrients and digestibility (Andrew 1994, p. 54). Leslie and Douglas (1979, p. 37) noted that these areas became increasingly important to bighorn sheep not only in summer, but during any period of limited forage availability. Forage green-up follows an elevational gradient with lower elevations beginning spring growth earlier than higher elevations (Wehausen 1980, p. 58; Berger 1991, p. 62). Access to a range of elevations provides bighorn sheep enhanced opportunities to acquire nutrients during different seasons and lifecycle stages (Wehausen 1980, p. 93; Berger 1991, p. 61).

Spatial Distribution

Historically, bighorn sheep are found along the Peninsular Ranges from the San Jacinto Mountains in Riverside County, California, south into the Volcan de Tres Virgenes Mountains near Santa Rosalia, Baja California, Mexico (USFWS 1998, p. 13135). At the time of listing, the metapopulation of Peninsular bighorn sheep was known to be distributed among at least eight subpopulations in Riverside, Imperial, and San Diego Counties from the San Jacinto Mountains south to the border of Mexico (Rubin *et al*. 1998, p. 539; USFWS 1998, p. 13136). The Santa Rosa Mountains were thought to have two subpopulations at listing. Since listing, an additional subpopulation was identified in the Santa Rosa Mountains. This was reflected in the Recovery Plan (USFWS 2000a, p. 63), which identified Recovery Regions (required for the recovery of subpopulations) as the nine following areas from north to south (Figure 1):

1. San Jacinto Mountains
2. Santa Rosa Mountains—north of Hwy 74 (North Santa Rosa Mountains)
3. Santa Rosa Mountains—south of Hwy 74 through Martinez Canyon (Central Santa Rosa Mountains)
4. Santa Rosa Mountains—south of Martinez Canyon (South Santa Rosa Mountains)
5. Coyote Canyon
6. North San Ysidro Mountains—Henderson Canyon to County Road S-22
7. South San Ysidro Mountains—County Road S-22 to State Hwy 78
8. Vallecito Mountains
9. Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area

These nine regions are the currently accepted representation of Recovery Regions for the Peninsular bighorn sheep metapopulation. However, the delineation of subpopulations is not limited to the delineation of Recovery Regions. The Recovery Plan indicated that Recovery Regions may be inhabited by more than one subpopulation (USFWS 2000a, p. 32). Since that time radio-collar data has shown this to be true for some Recovery Regions (Wagner, USFWS, pers. obs. 2010). The status of Peninsular bighorn sheep in this status review will be discussed in terms of the Recovery Regions for which population data are available and recovery criteria are outlined (USFWS 2000a, p. 62).

The Recovery Plan identified “Essential Habitat” for Peninsular bighorn sheep to delineate areas believed to be necessary for a self-sustaining population with a high probability for long-term survival and recovery in the Peninsular Ranges (Figure 1). Essential Habitat, as used in the Recovery Plan, is not used in the same manner as it is used in the definition of critical habitat for Peninsular bighorn sheep (USFWS 2009c, p. 17288). The Recovery Plan provides important information about the species and the actions needed to bring about its recovery, while critical habitat identifies specific areas that are essential to the conservation of the species as defined under section 3 of the Act. For more information regarding this distinction, please see the 2009 final revised critical habitat rule (USFWS 2009c, p. 17290). Essential Habitat within the context of the Recovery Plan is discussed in this 5-year review to provide context regarding how the Recovery Regions were delineated, and will herein be referred to as Recovery Plan Habitat.

Recovery Plan Habitat consists of the areas that provide bighorn sheep with the various physical and biological resources (e.g., space, food, water, cover) potentially needed for:
(1) Individual and population growth, and (2) normal behavior with protection from disturbance (USFWS 2000a, p. 154). This Recovery Plan Habitat boundary delineates the exterior boundary of the Recovery Regions. Within the Recovery Plan Habitat, Recovery Regions were defined according to population growth needs, habitat requirements, canyons, artificial barriers, and the distribution of subpopulations. Natural processes, including habitat heterogeneity and behavioral characteristics, cause a naturally patchy distribution of Peninsular bighorn sheep (Hansen 1980, p. 78; Bleich *et al*. 1996, p. 354). Artificial processes (e.g., habitat loss due to increased human use) and artificial barriers (e.g., roads and highways) also cause separations between subpopulations (DeForge *et al*. 1997, p. 18; Rubin *et al*. 1998, p. 540).

Rubin *et al.* (2009, p. 859) developed two predictive habitat models, and then compared the models to each other and to the expert-based model presented in the Recovery Plan (USFWS 2000a, p. 154) that delineated Recovery Plan Habitat for the Peninsular bighorn sheep metapopulation. The study found the model with higher predictive power also supported the model presented in the Recovery Plan. All three models identified continuous bighorn sheep habitat throughout the study area, supporting the Recovery Plan’s recommendation that maintaining connectivity throughout the range is important. Within the Recovery Plan Habitat boundary, Recovery Regions were delineated in the following manner (Figure 1):

1. Palm Canyon distinguishes Recovery Regions 1 and 2 (San Jacinto Mountains and the North Santa Rosa Mountains);
2. Deep Canyon distinguishes Recovery Regions 2 and 3 (North Santa Rosa Mountains and Central Santa Rosa Mountains);
3. Martinez Canyon distinguishes Recovery Regions 3 and 4 (Central Santa Rosa Mountains and South Santa Rosa Mountains);
4. Coyote Creek distinguishes Recovery Regions 5 and 6 (Coyote Canyon and North San Ysidro Mountains);
5. County Road 22 distinguishes Recovery Regions 6 and 7 (North San Ysidro Mountains and South San Ysidro Mountains);

6. Highway 78 distinguishes Recovery Regions 7 and 8 (South San Ysidro Mountains and Vallecito Mountains); and,
7. County Road 2 distinguishes Recovery Regions 8 and 9 (Vallecito Mountains and Tierra Blanca Mountains).

Within Recovery Region 9, County Road 2 also runs between the Jacumba and Coyote Mountains, and Interstate 8 runs between the Jacumba Mountains. As stated above, various factors were considered to define Recovery Regions. Although canyons are used to delineate Recovery Regions, these areas are a distinct aspect of Peninsular bighorn sheep habitat, and are not meant to represent barriers or unutilized portions of habitat.

Past records and data suggest that the distribution of Peninsular bighorn sheep in California has changed since the mid-1970s (USFWS 2000a, p. 30). Interstate 10 and other developments in the northern extent of the range limit any movement north of the Peninsular Ranges. A subpopulation north of Chino Canyon in the north San Jacinto Mountains (Recovery Region 1) was extirpated in the 1980s (DeForge *et al.* 1997, p. 18). Though the direct cause for the loss of this subpopulation is not known, the primary factors thought to drive the changes in Peninsular bighorn sheep distribution in the north San Jacinto Mountains were human disturbance, habitat fragmentation, and disease (DeForge *et al.* 1997, p. 18). The Palm Springs Aerial Tramway (Tramway) opened in the San Jacinto Mountains in 1963, reaching from the floor of the Coachella Valley through Chino Canyon to nearly the top of San Jacinto Peak. The construction of the Tramway essentially divided the San Jacinto Mountains into northern and southern regions in terms of bighorn sheep use. After construction of the road leading to the Tramway (Tram Way Road), sheep north of Chino Canyon would cross the road from time to time. However, after approximately 20 years, this subpopulation was extirpated (USFWS 2000a, p. 31).

The number and distribution of ewes in the North Santa Rosa Mountains (Recovery Region 2), particularly in north Carrizo and Dead Indian Canyons, declined substantially between the 1980s and the time of listing (BHI 1998a, 1999). Historically, at least two subpopulations occupied the North Santa Rosa Mountains. However, prior to listing, the subpopulation near Dead Indian Canyon was extirpated due to unknown causes, although development and recreation in the area increased simultaneously. At the time of listing, one subpopulation occupied the North Santa Rosa Mountains, primarily utilizing the region around Cathedral, Bradley, and Magnesia Spring Canyons.

In the 1930s, Highway 74 was constructed adjacent to bighorn sheep habitat in Deep Canyon (Figure 1) between the North Santa Rosa Mountains and Central Santa Rosa Mountains (Recovery Regions 2 and 3). Ewes were observed crossing Highway 74 in the 1970s (D. Jessup, *in litt.* 1999), but no radio-collared ewes were observed crossing this road from 1993 to 2000 (USFWS 2000a, p. 32). The construction of the highway and increased traffic were significant barriers to bighorn sheep crossings.

The apparent extirpation (population extinction) of another subpopulation near the United States-Mexico border (Recovery Region 9) in the 1980s caused a gap in the historical range, essentially dividing the metapopulation that originally extended south of the international border. This limited the southern extent of the range in the United States at the time of listing to the northern side of Interstate 8 in San Diego County (Rubin *et al*. 1998, p. 548). Although the loss of this subpopulation was poorly documented, construction of Interstate 8 in the mid-1960s, railroad activity, livestock grazing, poaching, and fire suppression were identified as contributing causes by Rubin *et al*. (1998, p. 548). At the time of listing, the range of the Peninsular bighorn sheep metapopulation was effectively confined between Interstate 10 in the north and Interstate 8 in the south (Figure 1) due to the extirpation of the southern subpopulation.

To summarize, prior to listing the Peninsular bighorn sheep metapopulation experienced three documented extirpations of individual subpopulations at the following locations: (1) north of Chino Canyon (San Jacinto Mountains), (2) Dead Indian Canyon (North Santa Rosa Mountains), and (3) near the United States-Mexico Border (Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area). This changed the distribution such that the range occupied by Peninsular bighorn sheep extended from south of Chino Canyon in the San Jacinto Mountains to north of Interstate 8 in the Jacumba Mountains. The actual portion of the historical range suitable for potential occupancy at the time of listing was approximately from Interstate 10 in the north to beyond the United States-Mexico border (into Mexico) in the south.

Since 1982, BHI in Palm Desert, Riverside County, has maintained a captive breeding herd to conduct research and provide for population augmentation in the San Jacinto Mountains and North Santa Rosa Mountains, and conduct additional research in the Central Santa Rosa Mountains. Since 1985, 122 captive-reared adult bighorn sheep (63 ewes, 59 rams) have been released into the San Jacinto Mountains and North Santa Rosa Mountains (BHI 2009, p. 2). Released captive sheep readily assimilate into wild populations, which contributed significantly to the recent population resurgences of these two ewe groups. Breeding by captive-reared bighorn sheep has also been reported in the wild (BHI 1999, p. 19; 2009, p. 3).

In 2005, a group of wild bighorn sheep was documented crossing Chino Canyon to the north San Jacinto Mountains enroute to Blaisdell Canyon, where it remained for several days before re-crossing and returning to Tachevah Canyon (BHI 2005, p. 5). The group, consisting of adult ewes, female lambs and yearlings, and male yearlings, has been regularly located within Chino Canyon since 2005 (BHI 2005, p. 5; 2009, p. 5). However, they have not permanently recolonized the northern area. This was considered an exploratory movement northwards into the historical range (Wagner, pers. obs. 2010). The Service and CDFG are actively pursuing a reintroduction program in the north San Jacinto Mountains. In 2006, CDFG, BHI, and the Service facilitated the release of three yearling rams into Blaisdell Canyon in the north San Jacinto Mountains, two of which lived for approximately 3 years. Both rams annually crossed Chino Canyon to join the subpopulation in the south San Jacinto Mountains during the rut, and at least 12 other crossings were documented, as well as movement by one ram to the North Santa Rosa Mountains (BHI 2008, p. 6). All of these movements indicate that Chino Canyon, including the Tram Way Road, remains crossable by Peninsular bighorn sheep, but individuals need to rediscover this habitat. The rams that made these crossings have since died, but the reintroduction program by BHI is now focused solely on the San Jacinto Mountains subpopulation.

The North Santa Rosa Mountains are currently occupied by two subpopulations (BHI 1999, p. 17). The northern subpopulation inhabits the area around the City of Rancho Mirage, east of

Dunn Road and west of Highway 111, including Cathedral, Bradley, and Magnesia Spring Canyons. The southern subpopulation occupies the area closer to Highway 74 around north Carrizo and Dead Indian Canyons. The southern subpopulation probably became established when ewes began crossing Highway 74 northwards from the Deep Canyon area in the Central Santa Rosa Mountains. Between 2004 and 2009, bighorn sheep were increasingly observed crossing Highway 74 than in years past, and in at least one location documented by BHI (BHI 2004, p. 6). The small number of individuals in the north Carrizo/Dead Indian Canyon subpopulation fluctuates from three to five (Wagner *in litt.* 2010). If Highway 74 was not in place, the north Carrizo/Dead Indian and Deep Canyon subpopulations would likely intermingle more freely, as they occur in very close proximity to one another and are separated only by Highway 74. Radio-collar points indicate that more movement occurs across Highway 74 (between Recovery Regions 2 and 3) than north of Highway 74 (within Recovery Region 2), although bighorn sheep in the south are known to move to lambing areas in the north within Recovery Region 2.

In terms of reestablishing the historical range, one of the most important changes in the metapopulation since listing is movement from the south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area south into the Jacumba Mountains (Recovery Region 9), which was made possible by the significant increase in abundance in this Recovery Region. Recently, Peninsular bighorn sheep sightings and their sign (droppings) have become common around the Mountain Spring area of Interstate 8. On the westbound lanes of Interstate 8, Peninsular bighorn sheep have learned to utilize two relatively high bridges over Devil's Canyon as underpasses, and in doing so they have moved into an area known as the Interstate 8 island (an approximately 7,400 ha (3,000 ac) area located between the eastbound and westbound lanes of Interstate 8). Currently, there are approximately 50 Peninsular bighorn sheep in this area (Wagner, pers. obs. 2010). Some individuals have been observed crossing the eastbound lanes on the highway's surface at specific locations. Because there are no large underpasses or bridges on the eastbound lanes to facilitate connectivity, Interstate 8 presents a semi-permeable barrier to southward movement. Attempts to cross the eastbound lanes have resulted in mortalities due to vehicle collisions (Wagner, pers obs. 2010). Bighorn sheep have been detected farther south in the Jacumba Mountains by the United States Border Patrol (K. Roblek, USFWS, pers. obs. 2008), demonstrating that some individuals apparently do safely cross the interstate. The use of habitat around Interstate 8 indicates Peninsular bighorn sheep are expanding their distribution to within 3 to 5 km (2 to 3 mi) of the United States-Mexico border. Such movements could eventually reconnect subpopulations in the United States to those in Mexico, expanding the metapopulation to near its historical distribution.

Therefore, since the time of listing, Peninsular bighorn sheep have attempted to recolonize the suitable historical range. In particular, areas where subpopulations were previously extirpated are beginning to be utilized again. Individuals have:

1. Demonstrated exploratory movements through Chino Canyon and into Blaisdell Canyon (San Jacinto Mountains);
2. recolonized habitat in Dead Indian Canyon (North Santa Rosa Mountains);
3. recolonized habitat north of and within the Interstate 8 island (Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area/Jacumba Mountains);

4. crossed Interstate 8 moving in a southerly direction (Jacumba Mountains); and
5. potentially moved very close to or past the United States-Mexico Border (Jacumba Mountains).

No permanent emigration of ewes has been observed even though radio-collared animals have been regularly monitored in the San Jacinto and Santa Rosa Mountains since 1981 (Ostermann *et al.* 2001, p. 754), and throughout the range since 1993 (E. Rubin, pers. comm. 2000; DeForge *et al.* 1997, p. 17). Bighorn sheep evolved movement patterns that were adapted to exploiting stable patches of habitat. Compared to other North American ungulates they are regarded as poor dispersers, and genetic analyses reflect a low rate of ewe dispersal across the Peninsular Ranges in the evolutionary past (Boyce *et al.* 1999, p. 99). Nevertheless, dispersal and exploratory movements do occur, as discussed above. Responses to habitat and resource availability may shift the distribution of subpopulations over time (Rubin *et al*. 1998, p. 549). Additionally, the abundance of Peninsular bighorn sheep may influence the distributional patterns if population size increases or decreases (Rubin *et al*. 1998, p. 549). Outside the Peninsular Ranges, genetic evidence indicates that unaided natural recolonization of empty habitat by both sexes has occurred, with subsequent reproduction occurring in those areas as well (Epps *et al*. 2010, p. 522).

Abundance

Although bighorn sheep have been documented in the Peninsular Ranges since early explorers such as Juan Bautista de Anza observed them in the 1700s (Bolton 1930), rangewide population estimates were not made until the 1970s. Published estimates were as high as 971 in 1972 (Weaver 1972, p. 60) and 1,171 in 1974 (Weaver 1975, p. 63). Rangewide estimates declined to 570 in 1988 (Weaver 1989, p. 11), 400 in 1992 (USFWS 1992, p. 19837), and between 327 and 524 in 1993 (Torres *et al.* 1994, p. 24). Starting in 1994 a biennial helicopter census was conducted throughout the Peninsular Ranges using radio-collared animals to estimate sighting probabilities.

The rangewide population estimates made until 2004 are approximate due to standard survey error, as well as slightly differing methods used by the two parties providing the counts (CDFG and BHI). These methods were standardized for the 2006 estimation. In 1994, the rangewide population estimate was 347, and in 1996, the population estimate declined to a low of 276 adults (USFWS 2000a, p. 32). At the time of listing in 1998, the rangewide population estimate was approximately 335. Since listing, the population as a whole has steadily increased (Table 1; Appendices 2, 3, and 4). Population estimates for 2000, 2002, 2006 and 2008 were 406, 666,793, and 876, respectively. An accurate population estimate for 2004 is unavailable due to a lack of survey data for the Central Santa Rosa Mountains and South Santa Rosa Mountains. Estimates from the 2010 rangewide population census suggest that the population as a whole has experienced a stable to slightly increasing trend since 2008, although lamb survivorship appears to be very low (Botta, pers. comm. 2010). The overall population estimate for 2010 is 981 adult bighorn sheep (CDFG 2011, p. 1).

Table 1: Total population abundance estimates (adult rams + adult ewes + yearlings) per Recovery Region for the Peninsular bighorn sheep (*Ovis canadensis nelsoni*) through time. References: BHI 1998b, 2004; CDFG 2009a, 2009b, 2011.

	Recovery Region	Estimated Adult Population at Listing (1998)	Estimated Adult Population (2006)	Estimated Adult Population (2008)	Estimated Adult Population (2010)
1	San Jacinto Mountains	23	21	26	16
2	North Santa Rosa Mountains	22	49	77	90
3	Central Santa Rosa Mountains	72	163	122	133
4	South Santa Rosa Mountains	35	179	155	149
5	Coyote Canyon	35	42	52	66
6	North San Ysidro Mountains	34	79	82	72
7	South San Ysidro Mountains	41	38	53	55
8	Vallecito Mountains	45	77	123	142
9	Carrizo Canyon/Tierra Blanca Mountains./Coyote Mountains Area	28	145	186	232
	Total	335	793	876	955*

*This estimation is the total of individual subpopulations, as opposed to the overall population abundance estimate (981) provided by CDFG (2011), generated using Chapman's (1951) modification of the Peterson estimator (Seber 1982).

Since the time of listing, all subpopulations have significantly increased in size, with the exception of the San Jacinto Mountains subpopulation. BHI has been augmenting this subpopulation since 2002, and by 2009, 21 of 28 (75 percent including lambs) Peninsular bighorn sheep in the San Jacinto Mountains were either directly released or offspring from captive-reared bighorn sheep at BHI, and 13 of 14 ewes (93 percent) were directly released or offspring of released bighorn sheep from BHI (BHI 2009, p. 3). In comparison, in 2009, only 8 of the 62 (13 percent) adult bighorn sheep in the North Santa Rosa Mountains subpopulation were previously released by BHI (BHI 2009, p. 3).

Within each of the Recovery Regions annual recruitment and survivorship of lambs varies from year to year. A good year in one subpopulation may coincide with a poor year in another subpopulation. Of four subpopulations studied by Rubin *et al*. (2000, p. 780) in the mid-1990s, the North Santa Rosa subpopulations had the lowest lamb survival rate while during the same timeframe the Central Santa Rosa subpopulation experienced the highest lamb survival rate. Rubin *et al.* (1998, p. 539) suggested that subpopulations in different portions of the Peninsular Ranges are under local influences and exhibit independent population dynamics, such as local and landscape-scale factors. Climatic patterns are correlated across the Peninsular Ranges, suggesting that other local factors (e.g., habitat quality, predation, or disease) specific to each subpopulation play important roles in determining long-term abundance trends (Rubin *et al.* 1998, p. 549). Bighorn sheep are relatively long-lived animals that have the potential to reproduce over an extended period of time (2 to 16 years). Therefore, periods of above average recruitment may compensate for periods of low recruitment (Wehausen 1992, p. 28). Conversely, if mortality agents begin impacting adult survival, then subpopulation levels may drop dramatically and endanger a subpopulation's existence. Consequently, a subpopulation's persistence is vulnerable to disease outbreaks, high levels of predation, mortality caused by urbanization, habitat loss from development, and human disturbance.

Ownership, Conservation, and Management

Land ownership across the Peninsular Ranges is divided among many entities (Figure 2), which has important implications for the recovery of Peninsular bighorn sheep. Threats in the northern portion of the Peninsular Ranges (San Jacinto Mountains; North, Central, and South Santa Rosa Mountains) are slightly different from threats in the southern portion of the Peninsular Ranges (Coyote Canyon; North and South San Ysidro Mountains; Vallecito Mountains; and Carrizo Canyon/Tierra Blanca/Coyote Mountains Area). In the Northern Peninsular Ranges, ownership is encompassed in planned or existing development and conservation areas owned by local cities, private landowners, State lands, Indian Reservation lands, Federal lands managed by Bureau of Land Management (BLM), and a private research area owned by the University of California Natural Reserve System. Additionally, the Northern Peninsular Ranges are almost entirely within the Santa Rosa and San Jacinto Mountains National Monument (National Monument), which was established in 2000 and encompasses 110,074 hectares (ha) (272,000 acres (ac)). In the Southern Peninsular Ranges, ownership consists almost entirely of large blocks of Federal (BLM) and State lands, with sparse private holdings and some private conservation areas. State land in the southern ranges is almost all within Anza-Borrego DSP, which provides protection to approximately 243,000 ha (600,466 ac) (USFWS 2000a, p. 52). BLM land in the San Jacinto Mountains, Santa Rosa Mountains, Tierra Blanca Mountains, Fish Creek Mountains, Coyote Mountains, and Jacumba Mountains are in designated Wilderness Areas of the same name.

Genetics

Different methods used to study genetic diversity will provide different levels of insight into the variability of a species. An evaluation of bighorn sheep genetic variability by Boyce *et al.* (1997, p. 421) found high levels of genetic diversity within and between populations of desert bighorn sheep, including sheep subpopulations within the Peninsular Ranges. Based on this study, there is at least one unique MS allele (Boyce *et al.* 1997, p. 424) that is restricted entirely to Peninsular bighorn sheep. Gutierrez-Espleta *et al*. (1998, p. 3) similarly found significant variation among all bighorn sheep populations studied. In contrast, Ramey (1995, p. 429) found very little variation between groups of desert bighorn. However, this study did identify at least one distinct haplotype unique to Peninsular bighorn sheep. Results of the three studies differ due to the analytical techniques used, as well as the molecular markers (e.g., mitochondrial DNA, microsatellites, allozymes), which have differing rates of mutation, and are likely affected by different evolutionary processes. All genetic studies of bighorn sheep have found that genetic diversity increases with geographic distance. Boyce *et al*. (1997, p. 422) and Bleich *et al.* (1996, p. 362) found support for partitioning of genetic variation among metapopulations of desert bighorn sheep (e.g., the Mojave and Peninsular metapopulations), with high levels of gene flow within metapopulations, including the Peninsular Ranges, and low levels between metapopulations.

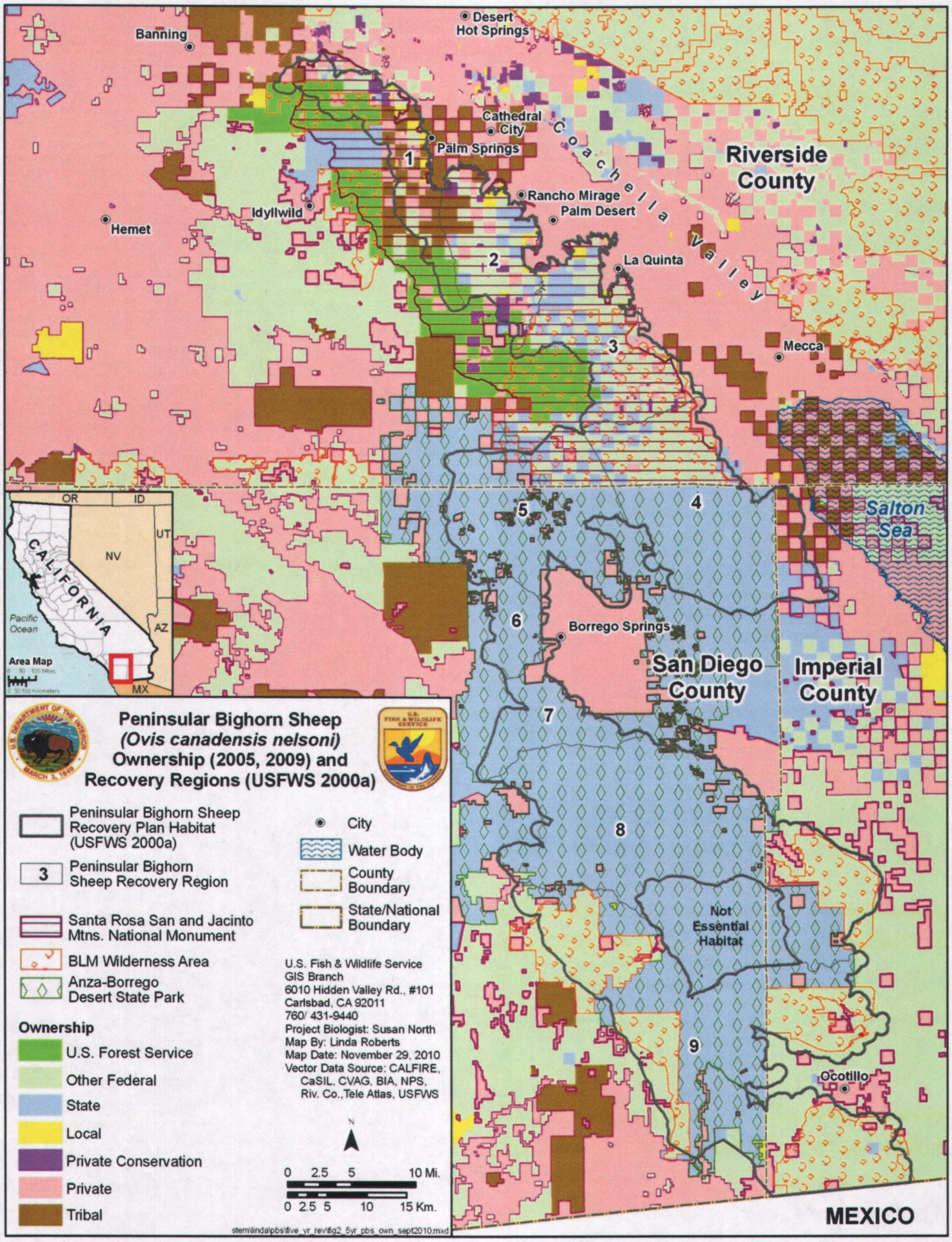

Figure 2: Ownership (USFWS 2010d) and Recovery Regions (USFWS 2000a) for Peninsular bighorn sheep (*Ovis canadensis nelsoni*).

Based on sampling of roughly one-third of the individuals from eight subpopulations within the Peninsular Ranges, Boyce *et al*. (1999, p. 99) found that seven haplotypes were distributed in a non-random fashion, and that a significant amount of mitochondrial DNA variation was partitioned among these subpopulations, which indicates a high level of genetic structure. As discussed above in the **Species Biology and Life History** section, the structure among subpopulations was probably influenced primarily by differences in founding ewes and their limited movements throughout the range (USFWS 2000a, p. 4). Boyce *et al*. (1999, p. 105) concluded that the movement of ewes (and therefore the flow of mitochondrial DNA) between subpopulations is limited, but has occurred at low levels in the past. This result is in contrast to the greater level of nuclear gene flow, which is mediated by the movement of rams among subpopulations, as discussed above.

Species-specific Research and/or Grant-supported Activities

Bighorn Institute (BHI)

BHI is a nonprofit organization founded in 1982 by biologists and veterinarians to investigate the causes of bighorn sheep (*Ovis canadensis*) population declines (BHI 2009, p. 1). The organization has worked on wild sheep projects throughout the world, but the primary focus is the ecology and recovery of Peninsular bighorn sheep. Since 1984, BHI has conducted a Captive Breeding and Wild Population Augmentation Program for Peninsular bighorn sheep, resulting in the release of 122 adult bighorn into the wild by 2009 (BHI 2009, p. 1). BHI has also studied the demography, habitat use, behavior, health, and general ecology of the species by monitoring radio-collared bighorn in the Santa Rosa and San Jacinto Mountains since 1981 and 1992, respectively. BHI research sites are located in the San Jacinto Mountains, the North Santa Rosa Mountains, and the La Quinta area of the Central Santa Rosa Mountains. Multiple projects are proposed and investigated annually. All BHI work is done in collaboration with, and under the authority of, CDFG and the Service.

Recent (2009) project results include the release of two captive-born yearlings into the wild, capturing and collaring wild Peninsular bighorn sheep, continued intensive field monitoring of radio-collared bighorn sheep, and data collection for long-term studies. BHI also met with and provided information to government agencies and local organizations to assist with Peninsular bighorn habitat conservation and recovery efforts. BHI has played a valuable role in the recovery efforts for Peninsular bighorn sheep, including (but not limited to) the following:

1. Collection and analysis of biological and ecological data that has facilitated important management decisions;
2. population augmentation in the San Jacinto Mountains and North Santa Rosa Mountains that has likely kept these subpopulations from becoming extirpated;
3. population augmentation in the San Jacinto Mountains that has resulted in important findings on movement patterns in this portion of the range;
4. working with local partners to educate local communities on the importance of Peninsular bighorn sheep conservation; and
5. cooperating with other organizations to construct a barrier fence between the City of Rancho Mirage and the North Santa Rosa Mountains subpopulation, which has been

crucial for the recovery of this subpopulation by preventing bighorn sheep contact with mortality factors (e.g., vehicle collisions, toxic nonnative plants, parasites transmitted in the urban environment, contact with domesticated animals) and helping prevent ewes from temporarily abandoning lambs while going into urban areas to feed on lawns. This has probably assisted the increase in survivorship in the North Santa Rosa Mountains.

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act. Threats at the time of listing and current threats to Peninsular bighorn sheep will be discussed below (also see **Appendix 1**). At the time of listing, the Service determined that the Peninsular bighorn sheep was in danger of extinction throughout a significant portion of its range due to: (1) Habitat fragmentation, degradation, and loss by urban and commercial development; (2) disease; (3) predation coinciding with low population numbers; (4) response to human disturbance; (5) insufficient lamb recruitment; (6) nonnative toxic plants; and (7) prolonged drought.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

At the time of listing, habitat fragmentation, degradation, and loss (particularly in canyon bottoms) were rangewide concerns. Development was associated with the proliferation of residential and commercial development, roads and highways, mining, water projects, and trails and recreational uses. Urban and commercial development caused habitat loss, degradation, and fragmentation in four Recovery Regions (San Jacinto Mountains, North Santa Rosa Mountains, Central Santa Rosa Mountains, and South Santa Rosa Mountains); agriculture utilized water resources (habitat loss) in at least one Recovery Region (South Santa Rosa Mountains); mines caused habitat loss in two Recovery Regions (Vallecito Mountains and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); roads and highways caused negative effects associated with the fragmentation of six Recovery Regions (North Santa Rosa Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); trails and recreational uses caused fragmentation and degradation rangewide; and OHV use impacted two Recovery Regions (Central Santa Rosa Mountains and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area). Addressing threats to Peninsular bighorn sheep habitat has naturally evolved to include northern and southern elements that are represented within the context of the nine Recovery Regions; this dichotomy is described below. Threats to the habitat from fragmentation, degradation, and loss, as well as metapopulation effects, are described first for the northern and southern portions of the range, followed by the rangewide threats of fire and nonnative vegetation.

<u>Habitat Fragmentation, Degradation, and Loss</u>

Three principle factors cause Peninsular bighorn sheep to be susceptible to negative effects from habitat fragmentation:

1. Elevational distribution of habitat (narrow band at low elevation),
2. use of habitat (e.g., occupying low elevations), and
3. metapopulation structure of bighorn sheep (USFWS 1998, p. 13143).

Peninsular bighorn sheep are typically restricted to habitat at elevations below 1,400 m (4,600 ft), approximately below the level of chaparral habitat growth. These low elevation areas are also the most preferable for human development. As a result, encroaching urban development and human-related disturbance have had the dual effects of restricting the remaining animals to a smaller area due to habitat loss and severed connections between subpopulations (USFWS 1998, p. 13143). Urban development includes city expansion, commercial and housing developments, golf courses, roads, freeways, highways, canals, agriculture, construction projects, and recreational trails. Housing developments and golf courses occur in many of the alluvial fans and washes, which has important implications for bighorn sheep because these areas are valuable for movement and forage.

In addition to the physical constraints listed above, habitat fragmentation can also result from increased traffic on roads, which may cause bighorn sheep (especially ewes) to be hesitant to cross roads (Rubin *et al.* 1998, p. 547). Rubin *et al.* (1998, p. 547) suggested that in portions of the range, roads or increased traffic have contributed to habitat fragmentation by restricting ewe movement, as evidenced by four subpopulations whose home ranges are delineated by roadways: (1) North Santa Rosa Mountains (north of Highway 74), (2) Central Santa Rosa Mountains (south of Highway 74 through Martinez Canyon), (3) North San Ysidro Mountains (Henderson Canyon to County Road S-22), and (4) South San Ysidro Mountains (County Road S22 to Highway 78). Individuals that do cross are at risk of mortality from automobile collisions (McQuivey 1978, p. 52; Cunningham and deVos 1992, p. 27; BHI 1999, p. 21; BHI 2009, p. 7), with the result that a group whose range is bisected by a road can have reduced viability in the long-term (Cunningham and deVos 1992, p. 29). Mortality events associated with urbanization are discussed below in **Factor E**. The presence of trails in some areas has also fragmented the habitat, though it is likely that without the presence of humans sheep will cross these trails to move between patches of habitat.

As human development encroaches into bighorn sheep habitat, resources may be eliminated or reduced in value, and the survival of subpopulations threatened. Urbanization in and around the Coachella Valley has altered foraging resources (native plants displaced with nonnative and potentially toxic plants), water resources (altering the hydrology or access to water), and habitat continuity (affecting predator evasion requirements). Bighorn sheep are sensitive to habitat modification because they are relatively poor dispersers, largely learning their ranging patterns from older animals, with ewes then demonstrating extreme philopatry for the remainder of their lives (Geist 1971, p. 91; USFWS 2000a, p. 38). When habitat and resources are lost or modified, the affected group may remain within their familiar surroundings where they will experience a reduced likelihood of population persistence due to the reduced quantity or quality of resources (USFWS 2000a, p. 38). The listing rule stated that the continued threat of urban and commercial development, compounded by the expectation of substantial human population growth in the region, might ultimately fragment the metapopulation into isolated groups too small to maintain long-term viability (USFWS 1998, p. 13143).

Anthropogenic fragmentation of habitat may pose a threat to a species with a metapopulation structure because overall survival depends on interaction among subpopulations. If habitat fragmentation and associated demographic isolation occurs, population decline becomes inevitable. The inability of rams and occasional ewes to move between subpopulations may reduce the genetic fitness of isolated groups (USFWS 1998, p. 13143). Isolated small groups of animals are subject to greater risks of extinction, while inter-connected small groups acquire much of the resilience of larger populations. The movement of rams and occasional ewes between subpopulations maintains genetic diversity and demographically augments individual subpopulations (Brown and Kodric-Brown 1977, p. 445; Krausman and Leopold 1986, p. 59; Schwartz *et al.* 1986, p. 185). Temporary movements by ewes between neighboring subpopulations could also provide those individuals with new habitat knowledge, facilitating future range expansion (Geist 1971, pp. 107–109). Epps *et al*. (2010, p. 522) demonstrated that both native and translocated desert bighorn sheep (outside the Peninsular Ranges) have naturally recolonized unoccupied habitats, and suggests that colonization could partially offset local extirpation if connectivity is maintained. Increased fragmentation reduces such possibilities and increases the risk of subpopulation extirpation.

Northern Peninsular Ranges – Development, Off-Highway Vehicle Activity, and Trails and Recreational Use

At the time of listing, the northeastern portion of the Peninsular Ranges (San Jacinto Mountains and Santa Rosa Mountains) was heavily impacted by the growing cities of the Coachella Valley (Palm Springs, Cathedral City, Rancho Mirage, Palm Desert, and La Quinta). Many of the threats facing bighorn sheep were associated with the high density urban developments across the Coachella Valley, and subsequent effects on the adjacent mountains. The Recovery Plan identified at least 7,490 ha (18,500 ac) of suitable habitat lost to urbanization and agriculture within the range of the three subpopulations that occur along the urban interface between the cities of Palm Springs and La Quinta (San Jacinto Mountains, North Santa Rosa Mountains, Central Santa Rosa Mountains) (USFWS 2000a, p. 38). Bighorn sheep movement across the Coachella Valley may have once occurred, as it does between other mountain ranges in the desert southwest (Simmons 1980, p. 130). At the time of listing, development limited any potential northerly or easterly movement across the Coachella Valley. Ram movements towards or within the cities of Palm Springs and La Quinta may exemplify attempts by Peninsular bighorn sheep to utilize or cross historical areas that are now developed (DeForge *et al*. 1997, p. 11). The listing rule predicted that the effects of increased development and human disturbance in and around the Northern Peninsular Ranges would increase substantially by 2010, given that the Coachella Valley Association of Governments anticipated a human population increase from 227,000 to over 497,000, not including 165,000 to 200,000 seasonal residents (USFWS 1998, p. 13143). Behavioral effects associated with human disturbance to Peninsular bighorn sheep are discussed below in **Factor E**.

Development (Urbanization)

Urbanization in the San Jacinto Mountains caused habitat loss for Peninsular bighorn sheep in the alluvial fans and washes in major canyons, including Blaisdell Canyon, lower Chino Cone, Palm Canyon, and other smaller canyons. The listing rule discussed the potential impacts of the approved Shadowrock Golf Course and Resort in Chino Canyon (USFWS 1998, p. 13143). This project would develop the area such that bighorn sheep in the south San Jacinto Mountains likely would be unable to cross the canyon, thereby limiting movement of animals from the south San Jacinto Mountains into the northern historical range. The status of this development is discussed below in the **California Endangered Species Act (CESA)** section under **Factor D**.

Urbanization in the North Santa Rosa Mountains caused habitat loss in the alluvial fans and washes in major canyons, such as Bradley Canyon, developed with City of Rancho Mirage housing; Magnesia Spring Canyon, developed with homes and a golf course; and Dead Indian and Deep Canyons, developed with housing at the intersection of the two canyons. One subpopulation occupied the North Santa Rosa Mountains, primarily utilizing the region around Cathedral, Bradley, and Magnesia Spring Canyons. In the higher elevation areas where this subpopulation exists the terrain contains steep and flat portions, with the latter considered suitable for development. Much of this area was owned by private landowners. The steepest terrain in this area occurs at a low elevation directly above the City of Rancho Mirage, situating bighorn sheep habitat directly adjacent to a major urban area. Development in this region began in the 1950s, subsequently transforming the low elevation habitat to well-watered grassy areas and housing developments such as Thunderbird Estates, which was mentioned in the listing rule. Such development destroyed habitat and eliminated natural foraging resources directly adjacent to escape terrain by replacing native plant species with nonnative grasses and ornamental plants. Additionally, fragmentation of the habitat occurred through the creation of numerous recreational trails and establishment of Highway 74 in the southern end of the North Santa Rosa Mountains.

Annual aerial censuses by BHI and CDFG identified many new trails at the time of listing in important habitat areas in the Central Santa Rosa Mountains near the City of La Quinta (USFWS 1998, p. 13147). The listing rule also noted that habitat was being destroyed outside the regulatory process around the City of La Quinta (USFWS 1998, p. 13149). The South Santa Rosa Mountains, situated just west of the Salton Sea, are located in between the growing cities in Coachella Valley in the north, and the agricultural areas of the Imperial Valley to the south. The listing rule noted that water withdrawals associated with urban developments and agriculture decreased the amount of water available to Peninsular bighorn sheep rangewide (USFWS 1998, p. 13146).

Since the time of listing, threats to the habitat of Peninsular bighorn sheep in the Northern Peninsular Ranges continue to persist as a result of previous or continuing development. However, a large amount of land has been purchased for conservation of the species, as illustrated in Table 2 (also see **Factor D**). Land ownership in the Northern Peninsular Ranges is highly parcelized, allowing for potential fragmentation of various subpopulations should development continue (Figure 2). In 2007, the Coachella Valley Association of Governments (CVAG) finalized a Multiple Species Habitat Conservation Plan (Coachella Valley MSHCP) with conservation areas to protect habitat for species, including the Peninsular bighorn sheep (CVAG 2007, p. 1-2). Conservation areas were designated with a target goal for preservation (no development) in 90 percent of private lands within conservation areas, while 10 percent can be developed (Figure 3). Though development proposals have been approved by local governments in Peninsular bighorn sheep habitat inside conservation areas since 1996 (the Coachella Valley baseline year for the accounting of bighorn sheep habitat losses), none have been constructed yet. This resulted from the Coachella Valley MSHCP conservation area boundaries being adjusted to avoid including projects that were vested prior to and during preparation of the plan, or because other project approvals were overturned by citizens' referenda.

Table 2. Land purchased for contribution to Coachella Valley Multiple Species Habitat Conservation Plan (Coachella Valley MSHCP) conservation areas within Peninsular bighorn sheep Recovery Plan Habitat (USFWS 2000a, p. 154) since 1998 (USFWS GIS data, 2010b).

Contributors	**Land Purchased**	
	Acres	**Hectares**
Permittees		
Coachella Valley Association of Governments	121	49
Coachella Valley Water District	102	41
Coachella Valley Conservation Commission	80	32
City of Palm Desert	67	27
City of Cathedral City	65	26
Total	**435**	**176**
Private Organizations		
Friends of the Desert Mountains	10,054	4,069
Center for Natural Lands Management	935	378
Wildlands Conservancy	736	298
Mojave Desert Land Trust	136	55
Total	**11,861**	**4,800**
State Organizations		
Coachella Valley Mountains Conservancy	3,066	1,241
California Department of Fish and Game/ Wildlife Conservation Board	219	89
Total	**3,285**	**1,329**
Federal Agencies		
Bureau of Land Management	3,193	1,292
United States Park Service	1,198	485
United States Forest Service	1,300	526
Total	**5,691**	**2,303**
Total Area Purchased since 1998	**21,272**	**8,609**

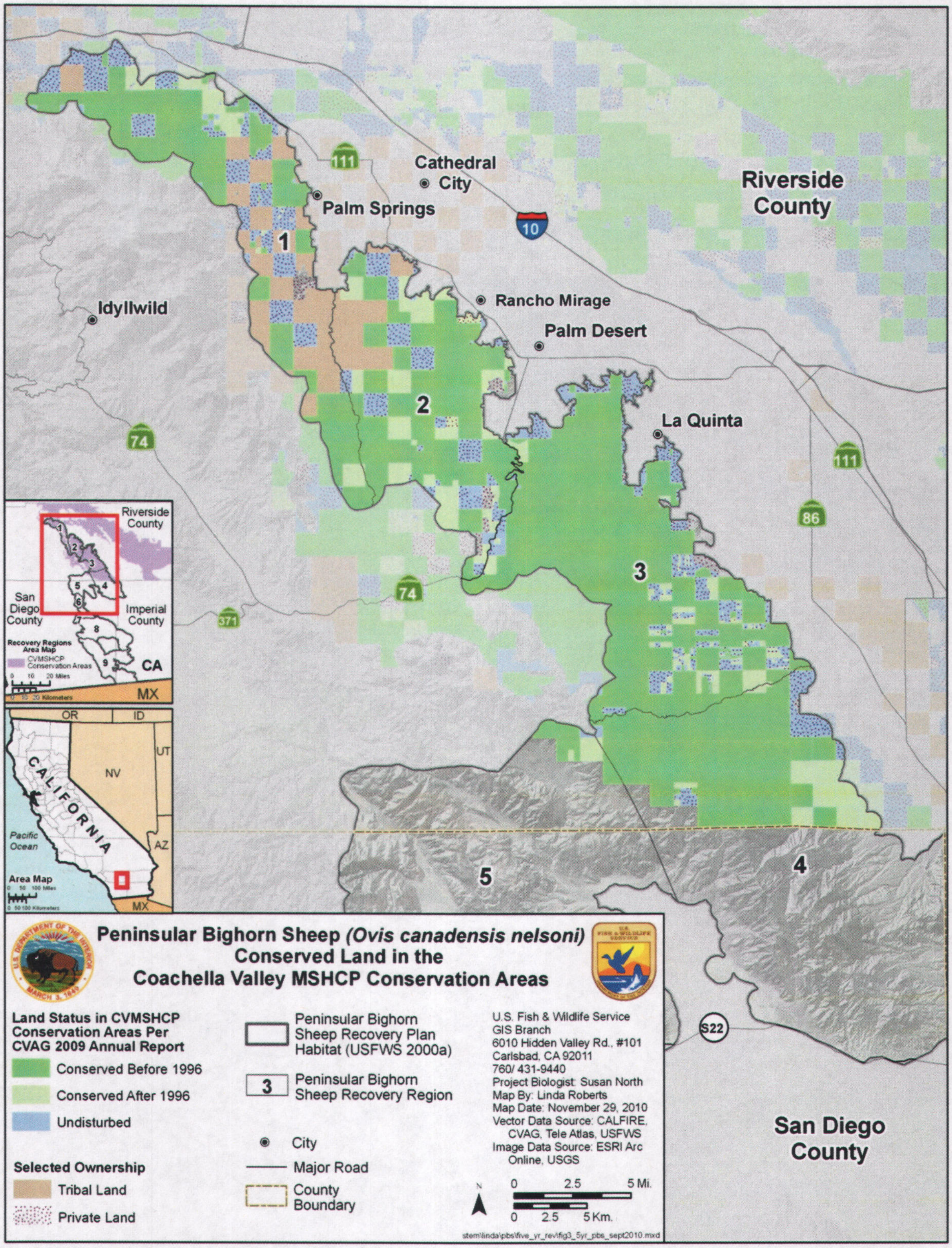

Figure 3. Conserved lands in the Northern Peninsular Ranges (CVMSHCP 2007, GIS data), Agua Caliente Indian Reservation lands and other lands owned by the Tribe (CVAG 2009c, GIS data), and Recovery Regions (USFWS 2000a) for Peninsular bighorn sheep (*Ovis canadensis nelsoni*).

Development of lands in Peninsular bighorn sheep Recovery Plan Habitat outside of conservation areas caused a loss of 134 ha (330 ac) between 1996 and 2009 (CVAG 2009b, p. 64). The majority of this development occurred on unincorporated land in Riverside County (54 ha (134 ac)), the City of Palm Desert (63 ha (156 ac)), and the City of La Quinta (15 ha (37 ac)) (CVAG 2009b, p. 64). Development in the Coachella Valley has slowed substantially in recent years, presumably due to the recent economic downturn. However, population growth has continued as suggested in the listing rule. The most recent projections estimated that the populations of most cities in the Coachella Valley would increase substantially between 2000 and 2010, including Palm Springs (15 percent), Palm Desert (23 percent), Cathedral City (31 percent), Rancho Mirage (43 percent), and Indio (59 percent). The cities of Coachella, La Quinta, and Desert Hot Springs were estimated to approximately double in size between 2000 and 2010 (CVAG 2008, p. 3). In 2005, there were nearly 423,000 residents in the Coachella Valley, and the projection for 2010 increased to 501,000 (CVAG 2008, p. 3). Future projections are now for 703,000 in 2020 and 1,029,000 in 2035, potentially quadrupling the population of the Coachella Valley over a 40-year period. Although development has recently slowed, residual effects from previously approved developments and increasing population growth remain a threat to Peninsular bighorn sheep habitat.

The San Jacinto Mountains, divided primarily among Federal, State and Indian Reservation lands, may face the greatest threats from habitat fragmentation and loss (Figure 2). The Coachella Valley MSHCP provides for some development throughout the northern portion of the range, including the San Jacinto Mountains. Because of the scale of the MSHCP, certain areas and projects proposed for potential development in the plan area were addressed by establishing a process to identify and incorporate appropriate conservation at the project level, rather than having site-specific acreage commitments provided in the MSHCP. While there is an absolute acreage limit within each of the Recovery Units located within the MSHCP, and specific limits for the local jurisdictions within each of those, these were not stepped-down any further to individual owners/parcels. This includes several Special Provisions Areas where guidance for development is provided in the MSHCP, but the specific project configurations are still pending. The Service's permit also imposes additional requirements as to the need for a specific process to facilitate appropriate development clustering and configurations in key areas. Because these measures have yet to be implemented, it would be premature to judge their success or the exact nature and extent of impacts to sheep. However, the loss of acreage will be at or below what is allowed by the permit.

Additional developments are likely in the San Jacinto Mountains. The Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation, California (Agua Caliente Tribe), has indicated a desire to develop, or allow to be developed, parts of their lands in Palm Canyon and the south San Jacinto Mountains. Ownership of the south San Jacinto Mountains is nearly equally divided between private land ownership and lands held in trust for the Agua Caliente Tribe or its members. The potential development of this area poses a fragmentation threat to the Peninsular bighorn sheep metapopulation (Figures 1 and 2). Development through the south San Jacinto Mountains and along Palm Canyon has the potential to significantly interrupt metapopulation dynamics by reducing the size of and fragmenting the habitat, potentially isolating the entire San Jacinto Mountains subpopulation. This subpopulation has already experienced the greatest difficulty with recovery since listing. Even with annual population augmentation the population has fluctuated to as few as four ewes. Development within the remaining corridor, and expanding human activities within or adjacent to that movement corridor, likely would prevent or greatly reduce movement of new individuals into the area and create a genetic bottleneck for the subpopulation. If this subpopulation becomes isolated, a result similar to the extirpated north San Jacinto subpopulation could be expected. Isolation and potential extirpation of the San Jacinto Mountains subpopulation due to development of the Palm Canyon corridor represents the most significant threat from habitat loss and fragmentation rangewide.

Since listing, Federal and State land management agencies, and nonprofit conservation groups such as Friends of the Desert Mountains, have purchased lands considered suitable for development in the higher elevation areas of the North Santa Rosa Mountains (as shown in Table 2 above). Decreasing water availability, which was noted as a rangewide threat at the time of listing, is difficult to assess due to the lack of comprehensive research, especially with regards to groundwater depletion concerns. It is likely that decreasing water availability has been a threat to the habitat in the North Santa Rosa Mountains since the time of listing. Currently, all natural water sources have disappeared or have been paved over in this area (Wagner, pers. obs. 2010). As a result of water availability issues, a number of artificial water sources are maintained for bighorn sheep in this area (Wagner, pers. obs. 2010). In Magnesia Spring Canyon, after a golf course and artificial stream were built, the nearby natural springs were depleted. The Service reached an agreement with the landowner whereby an artificial water source would be created in lieu of the lost natural source; this artificial source is not currently functioning (Wagner, pers. obs. 2010).

Threats associated with urbanization have continued in the Central Santa Rosa Mountains, though not as severely as in the northern areas. Due to extreme topographic boundaries, human access in much of this area is limited. Additionally, the ownership is not divided between as many parties and a larger proportion of habitat is protected. The Service is attempting to facilitate the purchase for conservation of a large block of land (known as Section 5) that is highly parcelized into very small lots and at risk of development. Immediately adjacent to this land is alluvial fan/wash habitat (north of Toro Canyon) that has been approved for the Travertine development of homes and golf courses by the City of La Quinta and the Service (USFWS 2005, pp. 1–7). When completed, this project will impact foraging resources and reduce access to forage at the base of the Central Santa Rosa Mountains. Travertine has acquired lands in Section 5 to offset this habitat loss.

The Travertine Palms Wash is an alluvial fan/wash area that is proposed for development in the South Santa Rosa Mountains (Wagner, pers. obs. 2010). Two developments, Travertine Estates and Travertine Point, are planning the creation of an urban center that would accommodate 30,000 people with homes, schools, and shopping centers. In addition to direct mortality threats (e.g., vehicle collision, nonnative toxic plant poisoning, and attacks by domestic dogs) associated with urbanization near Peninsular bighorn sheep habitat, these proposed developments may interrupt accessibility to the Palm Wash tinajas, which are utilized as water sources in the summer and in the fall prior to winter rains. The proposed Travertine projects represent the southernmost edge of urban development in the Northern Peninsular Ranges, and exemplify the expansion of urban development directly adjacent to and within Peninsular bighorn sheep habitat. Residual effects of previously impacted habitat remain, especially in agricultural lands and alluvial fans along the base of the South Santa Rosa Mountains. Although the listing rule noted that water sources from the South Santa Rosa Mountains were utilized for nearby agriculture, we have no new research regarding this concern.

Off-Highway Vehicle (OHV) Activity

An additional threat to the habitat in the South Santa Rosa Mountains since listing is OHV activity. OHV activity occurs legally in Peninsular bighorn sheep habitat just adjacent to Anza-Borrego DSP at Ocotillo Wells State Vehicular Recreation Area (Ocotillo Wells SVRA). However, OHV recreationists regularly ride illegally in Peninsular bighorn sheep habitat, northeast of Ocotillo Wells SVRA (Wagner, pers. obs. 2010). OHV activity causes direct impacts to habitat, such as altering vegetation communities, increasing levels of water and wind erosion, and increasing soil compaction (Luckenbach and Bury 1983, p. 265; Lovich and Bainbridge 1999, p. 309). OHV groups recently attempted to purchase the area being used illegally to add to Ocotillo Wells SVRA. Negotiations between CDFG, OHV groups, private conservation groups, and the Service are likely to result in a change in ownership of these lands, which are located at the southeastern corner of the South Santa Rosa Mountains in Peninsular bighorn sheep habitat. California Department of Parks and Recreation (CDPR) is expected to acquire the northwest half, which would add nearly 2,400 ha (6,000 ac) to Anza-Borrego DSP and preclude OHV use in this area (thus ensuring suitability for the bighorn sheep). The Ocotillo Wells SVRA is expected to acquire the southeast half, which is the area most highly impacted by ongoing illegal use (Botta, pers. comm. 2010), adding over 1,600 ha (4,000 ac) to the recreation area, and thus precluding future Peninsular bighorn sheep use within this section. Conservation of this additional 2,400 ha (6000 ac) of sheep habitat (including the removal of illegal OHV use) also is expected to offset impacts that may be caused by the Sunrise Powerlink, which is discussed under **Factor D** below.

Trails and Recreational Use

A large number of legal and unauthorized walking, hiking, and biking trails are still present in the North Santa Rosa Mountains (USFWS 2010a, p. 38), and recreation in this area has likely increased contemporaneously with population growth in the nearby cities (USFWS 2010a, p. 103). The Coachella Valley MSHCP, and the corresponding Coachella Valley Amendment for the California Desert Conservation Area put forth by BLM, include a process for better assessing the effects of trails within Peninsular bighorn sheep habitat in the Northern Peninsular Ranges. This includes research on how hikers use the trails, as well as the effects of those activities on Peninsular bighorn sheep. Following that research, the Trails Plan will be finalized and identify trails to be closed and decommissioned, those to be closed seasonally, and/or those to be re-routed to minimize impacts on Peninsular bighorn sheep resulting from recreational activities. The Service's permit provides specific time frames to complete these requirements. However, that effort is still in process, so any reductions in effects to Peninsular bighorn sheep cannot yet be assessed.

Southern Peninsular Ranges – Development, OHVs, Trails and Recreational Use

At the time of listing, Peninsular bighorn sheep in the Southern Peninsular Ranges (Coyote Canyon, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, Fish Creek Mountains, south Carrizo Canyon, Tierra Blanca Mountains, Coyote Mountains, In-Ko-Pah Mountains, and Jacumba Mountains) faced less of a threat from habitat fragmentation, degradation, and loss than those in the Northern Peninsular Ranges. The Southern Peninsular Ranges were not bordered by large urban areas, and ownership has long been characterized by large intact blocks of Federal and State land. Most State land was already included in Anza-Borrego DSP. A number of mines (gravel and gypsum) existed in the Coyote Mountains, Fish Creek Mountains, and Jacumba Mountains, with minimal effect on the habitat at the time of listing. Habitat loss in the Southern Peninsular Ranges has not been a significant threat historically, but fragmentation of habitat through the creation of major roads and freeways has occurred (County Road 22, Highway 78, County Road 2, Interstate 8, and Highway 98). Recreational trails fragmented the habitat throughout the Southern Peninsular Ranges, although Anza-Borrego DSP had a trails management program with an intense educational program, along with a prohibition against dogs (on trails), and strong management to ensure adequate compliance (USFWS 2000a, p. 84). Habitat destruction by OHVs was cited as the most critical problem in Anza-Borrego DSP, particularly in south Carrizo Canyon and Coyote Canyon (Jorgensen and Turner 1973, p. 52). Jorgensen (1974, p. 18) reported waterhole use was reduced 50 percent on days with OHVs. As discussed under the **Distribution** section, the construction of Interstate 8 in the 1980s likely contributed to the extirpation of the southernmost subpopulation of Peninsular bighorn sheep in the United States.

Threats identified at the time of listing, including development (mining and urbanization), OHV activity, and trails and recreational use continue to impact Peninsular bighorn sheep habitat in the Southern Peninsular Ranges. New threats include a significant increase in development of both public and privately-owned lands (urbanization and expansion of renewable energy projects).

Development (Mining)

Most of the mines that were known at the time of listing continue to be in operation in Peninsular bighorn sheep habitat (Coyote Mountains, Fish Creek Mountains, and Jacumba Mountains). Though existing gravel and gypsum mines have eliminated significant amounts of alluvial fan and mountainous habitat, respectively, mining activity is highly localized and a vast majority of sheep habitat still remains. To date, past mining activities do not appear to have had a significant impact on the habitat where they exist in two Recovery Regions (Vallecito Mountains and Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area), largely because mineral resources and associated commercial demand has been limited in bighorn sheep habitat. Some mining operations have expressed interest or proposed an expansion of activities. Depending on the degree of increase, there may be potentially significant habitat loss and fragmentation impacts (of lambing and foraging areas) in the two Recovery Regions (Botta, pers. comm. 2010).

Development (Urbanization)

Additional impacts associated with development have emerged in the Southern Peninsular Ranges since the time of listing. The City of Borrego Springs has increased in size and approved several urban developments directly adjacent to Peninsular bighorn sheep habitat in the North San Ysidro Mountains and South San Ysidro Mountains (Botta, pers. comm. 2010), very similar to that which occurred in the Northern Peninsular Ranges prior to listing. As a result, mortality events associated with urbanization (e.g., vehicle collisions, toxic nonnative plants, and disease transmission) near bighorn sheep habitat have increased significantly, and will likely continue. This will be discussed further in **Effects of Human Disturbance** under **Factor E**. The local water district in Borrego Springs has proposed a large water storage improvement project in Peninsular bighorn sheep habitat (Botta, pers. comm. 2010). This project proposes to use explosives to clear the area for the construction of storage pads and large tanks. The current location under consideration for this project is a Peninsular bighorn sheep lambing area on private land in Coyote Canyon (Botta, pers. comm. 2010).

Ground water pumping for urban and agricultural areas now utilizes the water resources of two Recovery Regions (Coyote Canyon and North San Ysidro Mountains) (Botta, pers. comm. 2010). Coyote Creek, which flows between the two Recovery Regions, is a water replenishment source for the City of Borrego Springs and surrounding agricultural areas. Landowners drill private wells that utilize water from this source as well (Botta, pers. comm. 2010).

In the Culp Valley (between the North San Ysidro Mountains and South San Ysidro Mountains), a large block of privately owned land is located in one of the narrowest corridors for movement rangewide (Figure 2). While this area is not currently at risk of development, its location (in the middle of the range), narrow width, and regular use by Peninsular bighorn sheep indicate its high conservation value. The current landowner has provided assistance to Peninsular bighorn sheep by constructing an artificial water source on his property.

Development (Renewable Energy Projects)

Renewable energy projects on the Imperial Valley floor are a considerable new threat to sheep habitat in the Southern Peninsular Ranges. At the low elevation area between the Coyote and Jacumba Mountains near the town of Ocotillo, a large-scale wind energy farm is planned for development. Just east of this area a solar energy farm was recently approved. Peninsular bighorn sheep were identified on the solar energy farm site as recently as 2009 (Wagner, pers. obs. 2010). The timing of their presence (early spring) suggests they may have been foraging, though they also may have been travelling between mountain ranges (Wagner, pers. obs. 2010). An additional wind farm is expected to be developed in the Jacumba Mountains, and the recently approved Sunrise Powerlink project will transmit power from eastern desert areas in California to major urban centers on the coast (USFWS 2009b, p. 5). This large power line project will run between the Coyote and Jacumba Mountains, then directly through the Jacumba Mountains and the middle of the Interstate 8 Island, which is regularly occupied by approximately 50 Peninsular bighorn sheep. The presence of this power line is not expected to have long-term impacts, such as the interruption of Peninsular bighorn sheep movement. However, the construction phase is expected to cause some disturbance, which is discussed below under **Factor E**.

Individual projects might not have lasting impacts on bighorn sheep in Recovery Region 9, but the cumulative impact of these projects would curtail north-south movement opportunities and access to seasonal resources on alluvial fans along the base of the desert escarpment. The timeline for construction of these renewable energy projects is very short (1 to 2 years), effectively exposing Peninsular bighorn sheep in this area to a vastly different landscape in a brief time. The effect of multiple energy projects (some of which will be fenced off precluding movement through the project sites), in conjunction with an existing housing development near the town of Ocotillo, will significantly reduce corridors for movement between the Coyote and Jacumba Mountains, as well as southeast movement across the Imperial Valley towards Mexico. Peninsular bighorn sheep are already very limited in their movement across the eastbound lanes of Interstate 8, which essentially inhibits southward movement towards Mexico in the Jacumba Mountains. All of these factors, taken together, will increasingly contribute to fragmentation of Peninsular bighorn sheep habitat, potentially hindering a reconnection with subpopulations in Mexico.

Off-Highway Vehicle (OHV) Activity

Illegal OHV recreation now impacts habitat in three Recovery Regions (Coyote Canyon, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area). OHVs degrade and fragment the habitat in Coyote Canyon on a similar scale as when Peninsular bighorn sheep were listed. However, the CDPR now closes certain areas seasonally so Peninsular bighorn sheep can access water resources. In the Vallecito Mountains OHV activity occurs legally. The Jacumba Mountains are newly impacted by illegal OHV use (Wagner, pers. obs. 2010), where an OHV trail was created on the Interstate 8 island on BLM and privately owned lands. Use of this area has increased substantially in recent years (Botta, pers. comm. 2010).

Trails and Recreational Use

Trails and recreational uses continue to impact Peninsular bighorn sheep habitat in Anza-Borrego DSP. However, these are monitored and managed very closely, which may have assisted the population increases of Peninsular bighorn sheep in the Southern Peninsular Ranges.

<u>Fire Dynamics</u>

Alteration of natural fire frequencies was not identified as a threat at the time of listing, although fire suppression was later described as a threat in the Recovery Plan (2000a, p. 45). In the Peninsular Ranges fire is a natural event that can benefit bighorn sheep forage quality by opening up dense stands of chaparral for use during early plant successional stages, while also removing the dense vegetation that predators utilize preferentially at higher elevations. Human fire suppression activities attempt to prevent wildfire, and may allow vegetation to grow unchecked without its natural control by periodic fires. This may influence the distribution of bighorn sheep by causing them to avoid areas with low visibility (Risenhoover and Bailey 1985, p. 797; Etchberger *et al*. 1989, p. 906; Etchberger *et al*. 1990, p. 53; Krausman 1993, p. 246; Krausman *et al*. 1996, p. 162) and, in some cases, reducing forage conditions (Graf 1980, p. 311).

Etchberger *et al.* (1989, p. 902) observed that habitat abandoned by bighorn sheep (*Ovis canadensis mexicana*) in the Pusch Ridge Wilderness had a greater frequency of human activities and reduced visibility due to fire suppression, compared with occupied habitat.

In the Peninsular Ranges, changes in vegetation succession resulting from fire suppression are evident primarily at higher elevations of Peninsular bighorn sheep habitat, most notably in Coyote Canyon (Botta, pers. comm. 2010). Here, as well as in some high elevation areas, the landscape is shifting from sparse open vegetation that often includes brittle bush scrub (Sawyer *et al.* 2009, p. 500) to chaparral and pinyon-juniper habitats. This change has decreased bighorn sheep use of certain canyons and springs (M. Jorgensen, *in litt.* 2000). In Coyote Canyon, one-third of Recovery Plan Habitat (at high elevation) is currently too dense to be utilized by Peninsular bighorn sheep, likely because it has not burned in such a long time (Botta, pers. comm. 2010). In the evaluation of Peninsular bighorn sheep habitat provided by Rubin *et al*. (2009, p. 866), the western boundary (higher elevation area) of the Peninsular Ranges was found to represent marginal habitat, possibly because of increased vegetation cover due to lack of fire in this fire-adapted habitat. However, limitations of the western distribution of bighorn sheep are due in part to the presence of mountain lions within that dense cover. While bighorn sheep in the Peninsular Ranges are rarely found at elevations higher than 1,800 m (5,906 ft), use of the upper elevation habitat types has been documented in Mexico, where different fire regimes may affect vegetation cover differently (Minnich *et al*. 2000, p. 105). Therefore, if fire suppression activities were reduced such that natural wildfire cycles could resume, available habitat and forage might increase at higher elevations.

Wildfires on the eastern side (lower elevation area) of the Peninsular Ranges are normally rare in the native habitat type. However, fire suppression at high elevation has resulted in dense stands of chaparral and pinyon-juniper habitat, and the invasion of flammable nonnative grasses and shrubs at low elevation has altered the landscape such that a catastrophic fire could be carried across the altitudinal gradient (Botta, pers. comm. 2010) into areas where fire previously would have been quite rare. This threat was exemplified in the 2001 Pines Fire, which started at a high elevation and was carried by winds through the San Ysidro Mountains, nearly reaching the nonnative grass fuel load in the low elevation area immediately adjacent to Borrego Springs (Botta, pers. comm. 2010). It is unknown whether this fire caused any mortality of bighorn sheep. However, a large wildfire may threaten individuals in the future. Bighorn sheep were later documented foraging in the burned areas at high elevation (Botta, pers. comm. 2010), thus suggesting a potential, if transient, benefit.

Fire may be an important threat in low elevation areas that are overwhelmed with nonnative grasses, particularly in urbanized canyon bottoms where human presence may increase the chance of accidental ignition. Frequent repeated wildfires in the north San Jacinto Mountains have supplanted native shrub cover with nonnative grasses across extensive areas, including much of Blaisdell Canyon. *Stipa capensis* (Mediterranean steppe grass), a recently introduced nonnative grass from South Africa, now dominates much of this burned landscape and threatens to spread farther south along the Peninsular Ranges. At lower elevations, fire can permanently degrade sheep habitat through displacement of forage species by nonnative plants with limited or no nutritional value.

Although not identified as a threat at the time of listing, fire suppression has likely been a threat to bighorn sheep habitat since its inception as a fire management strategy because it has steadily increased fuel load and decreased foraging area at high elevations rangewide. Though wildfires were not identified as a threat at listing, CDFG land managers characterized the potential for a catastrophic wildfire to occur in Peninsular bighorn sheep habitat as high, especially in urbanized canyons (Botta, pers. comm. 2010). Impacts of both fire suppression at the higher elevations and more frequent wildfires at lower elevations (due to nonnative plant cover) have increased the magnitude of this threat throughout the range since listing, and may be especially important in Recovery Regions near urban areas, such as San Jacinto Mountains, North Santa Rosa Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, and South San Ysidro Mountains.

<u>Habitat Modification Due to Invasive Nonnative Plants</u>

The listing rule did not identify nontoxic nonnative plants as a threat to Peninsular bighorn sheep habitat, although the Recovery Plan discussed this threat (2000a, p. 45). The presence of *Tamarix* spp. (tamarisk), also known as saltcedar, was identified as a major threat to Peninsular bighorn sheep because its rapid reproductive and dispersal rates allow it to outcompete native plant species in canyon bottoms and washes. Tamarisk significantly reduces or eliminates the standing water on which bighorn sheep depend, and it grows to thick, often impenetrable, stands that block access to water sources and provide cover for predators (Sanchez 1975, p. 12; Lovich *et al.* 1994, p. 168). Nonnative *Brassica tournefortii* (Saharan mustard) and *Schismus barbatus* (Mediterranean grass) also alter the habitat by outcompeting native species for limited resources, such as soil moisture. Other nonnative plant species in bighorn sheep habitat include *Pennisetum setaceum* (fountain grass) and *Cyperus* spp. (umbrella flat sedge).

Nonnative plants have become a significant component of the native habitat community at low elevations in all Recovery Regions (Botta, pers. comm. 2010). Nonnative grasses continue to be a threat throughout the range, and may alter the frequency of fire regimes. Management guidelines provided in the Coachella Valley MSHCP (2007, p. 4-179) restricted the use of several invasive nonnative plants in new Coachella Valley urban developments (Table 4-113), including *Nerium oleander* (oleander), *Tamarix* spp., *Pennisetum setaceum*, *Schismus barbatus*, and *Brassica tournefortii*. Additionally, the Agua Caliente Tribe has done much tamarisk and fountain grass control on its lands in Indian and Tahquitz Canyons. CDFG aggressively removes nonnative plants throughout the Anza-Borrego DSP. Despite these proactive measures and removal efforts, invasive nonnative plants continue to impact bighorn sheep habitat rangewide, and are a constant challenge throughout canyon bottoms and washes in all Recovery Regions.

Summary of Factor A

By the time the Recovery Plan was completed in 2000, impacts from development resulted in a substantial loss of habitat (7,490 ha (18,500 ac)) in predominantly low elevation areas of the Northern Peninsular Ranges. This limited access to forage, generated significant indirect effects from increased human activity in bighorn sheep habitat, and restricted movement opportunities. Future development projects will continue to fill in low elevation areas that have important resource value for Peninsular bighorn sheep. Despite current population growth no new development has occurred in habitat occupied by bighorn sheep within the Coachella Valley MSHCP conservation areas in the Northern Peninsular Ranges. Habitat loss and fragmentation in the Southern Peninsular Ranges, however, is a new phenomenon since listing, associated with the rapid expansion of renewable energy projects and OHV use in the desert.

Since listing, development has resulted in habitat fragmentation, degradation, and loss rangewide. Impacts due to urban and commercial development have increased in seven Recovery Regions (San Jacinto Mountains, Central Santa Rosa Mountains, South Santa Rosa Mountains, Coyote Canyon, North San Ysidro Mountains, South San Ysidro Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); and remained constant in the remaining two Recovery Regions (North Santa Rosa Mountains and Vallecito Mountains). Decreasing water availability for agricultural or urban developments (habitat loss) threatens at least four Recovery Regions (North Santa Rosa Mountains, South Santa Rosa Mountains, Coyote Canyon, and North San Ysidro Mountains); mines have continued to degrade habitat in two Recovery Regions (Vallecito Mountains and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); increased use of roads and highways continue to cause negative effects associated with the fragmentation of six Recovery Regions (North Santa Rosa Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); trails and recreational uses are a continual habitat fragmentation and degradation concern rangewide, although effects appear to be stabilizing in the five southern Recovery Regions (Coyote Canyon, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area); and OHV use impacts habitat in four Recovery Regions (South Santa Rosa Mountains, Coyote Canyon, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area), causing further fragmentation of Peninsular bighorn sheep habitat.

Although not identified as threats at listing, invasive nonnative plants, fire suppression, and catastrophic fire impact Peninsular bighorn sheep habitat throughout the elevation gradient rangewide. The proliferation of invasive nonnative plants is degrading habitat at low elevations (especially in canyons and waterways). Fire suppression is primarily degrading high elevation habitat, and is especially significant in one Recovery Region (Coyote Canyon). Catastrophic wildfire is a rangewide threat with a greater potential in low elevation habitat, especially in five Recovery Regions near urban areas where nonnative cover has increased greatly (San Jacinto Mountains, North Santa Rosa Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, and South San Ysidro Mountains).

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Overutilization for commercial purposes was not known to be a factor in the 1998 final listing rule (USFWS 1998, p. 13143). While there is no open hunting season for Peninsular bighorn sheep in the United States, the listing rule noted that the limited opportunities for other populations of desert bighorn sheep hunting in California create a temptation for taking without a license. We have no information to indicate that legal hunting in authorized locations outside the listed entity's distribution has triggered any illegal hunting of Peninsular bighorn sheep, and poaching does not appear to be a problem at this time. In 2008, CDFG proposed to eliminate the existing State Game Refuge system, which is made up of areas of land on which hunting is not permitted at any time unless specifically authorized. With this change, these areas would revert to the prevailing regulations on the surrounding lands that allow for hunting of State-designated game species. There are two State Game Refuges within Peninsular bighorn sheep Recovery Plan Habitat in two Recovery Regions (San Jacinto Mountains and North Santa Rosa Mountains). While Peninsular bighorn sheep are protected from hunting, hunting within their habitat could have negative behavioral effects. However, due to the location, topography, and accessibility in the areas within these refuges, it is possible that hunting will not increase substantially (Botta, pers. comm. 2010). BHI and Living Desert Museum maintain captive populations of Peninsular bighorn sheep for scientific and educational purposes, but this is considered to have no negative impact on wild Peninsular bighorn sheep. Therefore, overutilization for any purpose is not a known to be a threat at this time.

FACTOR C: Disease or Predation

At the time of listing, disease and predation were identified as major factors responsible for the precipitous decline of Peninsular bighorn sheep in the North Santa Rosa Mountains (USFWS 1998, p. 13143). These threats appeared to contribute significantly to population declines throughout the range.

<u>Disease</u>

Researchers and land managers suggest that disease plays an important role in the population dynamics of Peninsular bighorn sheep (DeForge and Scott 1982, p. 76; DeForge *et al*. 1982, p. 76; Turner and Payson 1982, p. 235; Wehausen *et al*. 1987, p. 86). Numerous endoparasites and ectoparasites are known to occur in bighorn sheep (Russi and Monroe 1976, p. 36; Lopez-Fonseca 1979, p. 78). A variety of bacterial, fungal, and viral infections have also been isolated or detected from Peninsular bighorn sheep individuals by serologic assay (DeForge *et al.* 1982, p. 76; Turner and Payson 1982, p. 235; Clark *et al.* 1985, p. 1175). Such pathogens include blue-tongue virus, contagious ecthyma virus, parainfluenza-3 virus, bovine respiratory syncytial virus, *Anaplasma*, *Chlamydia*, *Leptospira*, *Pasteurella*, *Psoroptes*, and *Dermacentor* (DeForge *et al*. 1982, p. 76; Clark *et al*. 1985, p. 1175; Mazet *et al*. 1992, p. 542; Clark *et al*. 1993, p. 48; Elliott *et al*. 1994, p. 317; Crosbie *et al*. 1997, p. 31; DeForge *et al*. 1997, p. 12). Detection of pathogens does not in itself imply a causal relationship between disease and population declines. However, several studies provide support for this hypothesis (DeForge *et al*. 1982, p. 76; Clark *et al*. 1985, p. 1178; Wehausen *et al*. 1987, p. 86; Clark *et al*. 1993, p. 52; Elliott *et al*. 1994, p. 317; DeForge *et al*. 1995, p. 50). Elliott *et al.* (1994, p. 317) found a higher level of exposure to viral and bacterial pathogens in the Peninsular bighorn sheep population than in other California bighorn sheep populations. The relationship between disease, its transmission, and factors such as stress, density, competition, water availability, and disturbance was not well understood at the time of listing, and continues to be unclear. Disease manifestation may occur during stressful periods for the population, such as high or low population levels, reproductive activity, low nutrient availability, and climatic extremes (Taylor 1976, p. 52; Turner and Payson 1982, p. 240).

Lambs and older sheep may be most susceptible to disease, and at the time of listing disease was considered to be responsible for high lamb mortality rates (Sanchez *et al.* 1988, pp. 31–33; USFWS 1998, p. 13144). In the North Santa Rosa Mountains, excessive lamb mortality occurred from 1977 until the time of listing (DeForge *et al.* 1995, p. 50). DeForge *et al.* (1982, p. 76) reported evidence that bighorn sheep lamb mortality in the Santa Rosa Mountains was due to pneumonia. Bacterial pneumonia is usually a sign of weakness caused by another agent, such as a virus, parasite, or environmental stress, that lowers an animal's resistance to disease (USFWS 1998, p. 13144). Poor nutrition, predation, climatic changes, and human related impacts may also have contributed to high lamb mortality.

The consequences of novel exposure to nonnative pathogens can be very serious because Peninsular bighorn sheep have not evolved resistance to such pathogens. Several viruses discovered in sick Peninsular bighorn sheep lambs were nonnative and thought to have been introduced by domestic livestock (USFWS 1998, p. 13144). The role of livestock in disease transmission is unclear, and varies depending on the disease. Following the removal of 117 feral cattle from the Anza-Borrego DSP from 1972 to 1987 (Jorgensen 1989, p. 2; USFWS 2000a, p. 54), disease sampling revealed the presence of six different viruses in the cattle, including viruses that Peninsular bighorn sheep are susceptible to, such as parainfluenza-3, blue-tongue, and bovine respiratory syncytial virus (Jorgensen 1989, p. 3). Other livestock may transmit diseases as well. For example, domestic sheep harbor bacteria (*Pasteurella* spp.) and viruses that can kill bighorn sheep, with close contact resulting in transmission to, and the subsequent death of, most or all of the exposed animals (Foreyt and Jessup 1982, p. 163). Neither the BLM nor the United States Forest Service (USFS) have issued grazing allotments for domestic sheep near habitat occupied by Peninsular bighorn sheep, although domestic sheep associated with commercial operations have escaped into Peninsular bighorn sheep habitat. The potential negative consequences of the presence of domestic livestock does not require direct contact for transmission of pathogens to occur, because some pathogens and parasites can be transmitted through vector species such as mule deer (*Odocoileus hemionus*) (Jessup 1985, p. 30) or mosquitoes. For example, overlap in habitat use by Peninsular bighorn sheep, mule deer, and the biting midge (*Culicoides* spp.), which causes blue-tongue disease, may provide a pathway for disease transmission from deer populations that are associated with livestock to bighorn sheep. Due to overlap in habitat use between vector species and Peninsular bighorn sheep, future disease transmission may occur.

At the time of listing, irrigated lawns, golf courses, and ponded waters in and around the Santa Rosa Mountains were thought to facilitate the exposure and spread of pathogens, such as the biting midge and the strongyle (gastrointestinal) parasite, to Peninsular bighorn sheep. Rubin *et al.* (2002, p. 251) confirmed this after analyzing data collected in 1993, which showed that ewes using urban areas had internal parasites not found elsewhere in the Peninsular Ranges. The life cycle of the strongyle parasite cannot be completed in an arid environment. However, high moisture content made available through artificially maintained urban sources (i.e., artificial water sources, irrigated lawns) provides suitable conditions for survival of the parasite through the larval stage. Furthermore, bighorn sheep can be exposed to the parasite from the feces of an infected individual, which generally occurs when high densities of bighorn sheep graze irrigated lawns. While infection of the strongyle parasite in domestic ruminant, horse, and pig hosts are common, infections of Peninsular bighorn sheep are generally rare in the desert (Georgi 1969, p. 156). However, between 1991 and 1996, at least 85 percent of individuals from the North Santa Rosa Mountains subpopulation were infected with the strongyle parasite (USFWS 1998, p. 13144; DeForge 1998, pp. 18–19). Signs of infection were only reported from the Santa Rosa Mountains, and considered rare or absent in other subpopulations. Infection with the strongyle parasite can result in decreased activity, minimized foraging, weakening and emaciation of individuals, unusual adherence to water sources, anemia, and mortality (Georgi 1969, p. 158). Peninsular bighorn sheep exhibiting physiological stress due to an infestation of the strongyle parasite are less likely to reproduce, and are at greater risk of predation. The population decline of Peninsular bighorn sheep near the borders of developed areas of the Coachella Valley was 35 percent greater than that in Anza-Borrego DSP at listing, suggesting that urban-related threats were impacting survivorship rates. While the pathogens responsible for the diseases in the Santa Rosa Mountains were also detected in Anza-Borrego DSP (Elliott *et al*. 1994, p. 317), the population in Anza-Borrego DSP declined at a slower rate (57 percent versus 92 percent).

Since the time of listing, a pneumonia outbreak that began in the Peninsular Ranges in the mid-1990s has continued. Continually low lamb recruitment has been observed in the North San Ysidro Mountains since 2004 (Botta, pers. comm. 2010). In 2008, a pilot project was initiated by CDFG to examine disease effects on survivorship of lambs and ewes. This project is ongoing, and CDFG has already made important observations. In the North San Ysidro Mountains, many sick lambs have been observed (62 percent in 2008 (Botta, *in litt*. 2010)), and this Recovery Region has experienced high lamb mortality and low recruitment. There are also sick lambs in the South San Ysidro Mountains (8 percent in 2008 (Botta, *in litt*. 2010)), although mortality and recruitment appear to be less of a problem. A number of sick and dead lambs have been observed and recovered throughout the entire range, although there has been higher lamb survivorship at the southern end of the range (south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area) (Botta, pers. comm. 2010).

Exposure of Peninsular bighorn sheep to domesticated sheep and goats has continued, and since listing, there have been at least five instances documented where these animals have escaped into Peninsular bighorn sheep habitat. Domesticated goats are kept in Blaisdell Canyon at the base of the San Jacinto Mountains by two landowners. Prior to the rut in 2009, a BHI technician observed a radio-collared ram with an escaped goat in this area. Because the domestic goat might have exposed the ram to any number of diseases, the ram was euthanized before it could rejoin and potentially expose other Peninsular bighorn sheep to disease during the upcoming rut. In the Central Santa Rosa Mountains, domestic goats and sheep escaped from a farm just adjacent to Peninsular bighorn sheep habitat (<0.6 km (1 mi)), resulting in the euthanasia of the escaped animals when they were found. There have been three instances where domestic goats have been found in the Vallecito Mountains and in south Carrizo Canyon. Some landowners are cooperating with the Service and CDFG to construct double-fenced areas around pens of domestic animals to limit contact with Peninsular bighorn sheep.

Disease transmission from feral goats and sheep in Mexico is a potentially significant threat that would result from reestablishing connectivity with Mexico. CDFG is currently pursuing a collaring program that will investigate disease and livestock contact with Peninsular bighorn sheep at the extreme ends of the range (San Jacinto Mountains and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area). Other measures were considered to encourage connectivity with Mexico, with careful monitoring and management measures put in place (e.g., gated fences). This would also provide a way to stop the interaction of subpopulations in the United States with those in Mexico if disease transmission increased (Botta, pers. comm. 2010). This would be feasible because of the isolated movement corridors between the United States and Mexico.

No programs have been established to inoculate Peninsular bighorn sheep against nonnative introduced diseases, viruses, and parasites, and attempted trials elsewhere have experienced little success (Wagner, pers. obs. 2010). The construction of the fence between the North Santa Rosa Mountains subpopulation and the City of Rancho Mirage may have helped reduce rates of infection and transmission by preventing exposure to domesticated livestock and irrigated areas. Due to the susceptibility of Peninsular bighorn sheep to introduced pathogens, disease will continue to pose a significant and persistent threat rangewide.

Since the time of listing, disease has become an increasingly severe problem in three Recovery Regions (Coyote Canyon, North San Ysidro Mountains, South San Ysidro Mountains), remained constant in five Recovery Regions (San Jacinto Mountains, Central Santa Rosa Mountains, South Santa Rosa Mountains, Vallecito Mountains, south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area), and decreased in one Recovery Region (North Santa Rosa Mountains).

Predation

At the time of listing, predation coinciding with low population numbers was a rangewide threat. Coyote (*Canis latrans*), bobcat (*Lynx rufus*), mountain lion (*Puma concolor*), gray fox (*Urocyon cinereoargenteus*), golden eagle (*Aquila chryseatos*), and free-roaming domestic dogs have been reported to prey upon bighorn sheep (Weaver and Mensch 1970, p. 7; Jorgensen and Turner 1975, p. 52; USFWS 1998, p. 13145). Bighorn sheep evolved in the presence of predators, and developed effective physical and behavioral mechanisms for dealing with them. Similar to other desert bighorn populations, sheep in the Peninsular Ranges have likely experienced varying levels of mountain lion predation for thousands of years. However, when other factors such as drought, habitat loss, and fragmentation due to urbanization, diseases, fire suppression, and other factors reduce populations to low levels or alter the abundance and distribution of alternate prey species (such as mule deer), then the influence of predation on population dynamics may increase (Logan and Sweanor 2001, p. 354). For example, prey populations frequently respond to the presence of mountain lions by changing their distribution at a landscape scale (Hornocker 1970, p. 36). Where habitats have become fragmented by human development, bighorn sheep may not be able to move away from areas of high predation risk.

The expansion of unnatural environments at the urban interface may have increased the risk of predation in some subpopulations. Encroaching development generally increases the abundance of domestic dogs along the urban-wilderness interface, which are capable of injuring and killing lambs, ewes, and rams. Furthermore, developed areas provide unnatural cover (such as hedgerows) and dense patches of tall vegetation that is suitable for predators to hide in to ambush prey. Prior to listing, the Service received complaints from residents of Thunderbird Cove (adjacent to the Northern Peninsular Ranges) that the presence of Peninsular bighorn sheep feeding on lawns attracted mountain lions, which some of the residents had observed (USFWS 1998, p. 13145).

At the time of listing, mountain lion predation of Peninsular bighorn sheep was increasing in the North Santa Rosa Mountains, and the deaths of several radio-collared sheep in Anza-Borrego DSP were attributed to mountain lions throughout the 1990s (Botta, pers. comm. 2010). Mountain lion predation coinciding with low population numbers was identified as a limiting factor for most subpopulations in the Peninsular Ranges (USFWS 2000a, p. 41). From 1992 to 1998, 42 of the 61 mortalities (69 percent) of radio-collared sheep between Highway 74 in the Santa Rosa Mountains and the Mexican border were attributed to mountain lions, resulting in an average adult annual survival rate of 79 percent for all six southern subpopulations (Hayes *et al*. 2000, p. 954). This average survival rate was low compared to rates reported for desert bighorn sheep in southeastern California (≥91 percent) (Andrew *et al.* 1997, p. 68). Subpopulations in the southern range experienced higher rates of natural predation (Boyce 1995, p. 23) than urban-related mortalities (e.g., vehicle collisions, toxic nonnative plant poisonings, disease infections), which were more common in the Northern Peninsular Ranges. The southern subpopulations are larger than those in the Northern Peninsular Ranges, and do not have restricted home ranges or fenced areas associated with major predation events in the North Santa Rosa Mountains subpopulation. Subpopulations in the Southern Peninsular Ranges may tolerate high predation levels better than those in the north because, as Wilson *et al*. (1980, p. 4) observed, predation (as a mortality factor) decreases in significance as the size of a population increases. Natural predation is not known to be a limiting factor in free-roaming desert bighorn sheep subpopulations that have adequate escape cover.

Since the time of listing, predation coinciding with low population numbers has been a fairly constant threat in the two northernmost Recovery Regions (San Jacinto Mountains, North Santa Rosa Mountains), while increased population size in the other two northern Recovery Regions (Central Santa Rosa Mountains, South Santa Rosa Mountains) has decreased the impacts of predation in those locations. In the Northern Peninsular Ranges, between 1998 and 2009, 13 mortalities of radio-collared individuals were due to mountain lion predation, 7 were due to coyote predation, and 8 were due to either bobcat or coyote predation (BHI Annual Reports 2001 to 2009, see sections titled Mortality). Since 2002, when a fence was constructed to separate the North Santa Rosa Mountains subpopulation from the City of Rancho Mirage, predation near this urban area appears to have decreased. Data for the same period of time in the Southern Peninsular Ranges indicates that, while mountain lion predation continues (28 mortalities due to mountain lions and another 24 mortalities likely due to mountain lions), impacts from predation have decreased in magnitude in all five southern Recovery Regions (Coyote Canyon, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area) since listing (Botta, *in litt*. 2010). This decrease is probably related to the increase in abundance in all five of those Recovery Regions. One possibility for the decreased incidence of mountain lion predation in the Southern Peninsular Ranges is that there are currently fewer mountains lions in proportion to Peninsular bighorn sheep. CDFG staff have observed a relationship between mountain lion and mule deer populations, which suggests that, as habitat conditions have declined for mule deer, mountain lion populations may have declined, resulting in decreased predation on Peninsular bighorn sheep. However, bighorn sheep continue to be preyed upon, and this generally occurs in the summer when they are concentrated around water sources (Botta, pers. comm. 2010). Due to regularly fluctuating population dynamics and predator-prey relationships, it should be expected that predation may once again become significant in the future. Such a possibility is a greater threat to small populations and, therefore, the smallest subpopulation (San Jacinto Mountains) should be monitored closely for such a shift in dynamics.

In the future, impacts from mountain lion predation are expected to fluctuate rangewide according to the population sizes of Peninsular bighorn sheep, mule deer, and mountain lions. In areas where the urban environment is encroaching into Peninsular bighorn sheep habitat (such as the cities of La Quinta and Borrego Springs), subpopulations of three of the Recovery Regions (Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains) may potentially be impacted by higher predation rates due to bighorn sheep increasingly leaving escape terrain to forage and drink at attractive sites, such as golf courses along the urban interface.

In an analysis of all Recovery Regions, with the exception of the San Jacinto Mountains, Ernest *et al*. (2002, p. 75) performed fecal DNA analyses to identify individual mountain lions associated with Peninsular bighorn sheep kills between 1993 and 1999; 18 mountain lions were identified at 26 kill sites. Results indicate that not all mountain lions kill Peninsular bighorn sheep repeatedly, and some mountain lions may not kill any Peninsular bighorn sheep (Ernest *et al*. 2002, p. 82). These results support other research that suggests individual mountain lions may specialize on a single prey species such as bighorn sheep, as opposed to hunting any prey available (Ross *et al*. 1997, p. 774; Linnel *et al*. 1999, p. 701). Ross *et al*. (1997, p. 773) found that one mountain lion in Alberta, Canada, killed 17 bighorn sheep (9 percent of the total population, and 26 percent of all lambs) in 4 years, and was likely responsible for the observed population decline. In a study from 2002 to 2004 in the Southern Peninsular Ranges, Clemenza *et al*. (2009, p. 1) found that three radio-collared mountain lions each killed multiple radio-collared and uncollared bighorn sheep (total ≥23), and that bighorn sheep with radio-collars were not targeted preferentially.

Mortalities of Peninsular bighorn sheep due to individual mountain lions specializing on them has important management implications in both the Northern and Southern Peninsular Ranges. Various strategies have been suggested to deal with mountain lion predation (Ernest *et al*. 2002, p. 84; Bodenchuk and Hayes 2007, p. 221). Mountain lions are native to the Peninsular Ranges, and removing them for the benefit of bighorn sheep has been contentious due to evidence of mountain lion declines in much of the western United States. Removing specific individuals that specialize on Peninsular bighorn sheep may offer the greatest benefit to this endangered DPS with the least impact to mountain lion populations. Ideally, as subpopulation sizes increase, the threat of predation should be reduced to natural levels and become a minor determinant of Peninsular bighorn sheep population dynamics.

In 2000, the California State Legislature passed a law to allow CDFG to control mountain lion populations in the Peninsular Ranges in order to reduce predation and promote the recovery of

Peninsular bighorn sheep. This legislation and the steps that CDFG has taken to control mountain lions have improved management options to prevent predation of Peninsular bighorn sheep. This includes the removal of one mountain lion in the Peninsular Ranges (Botta, pers. comm. 2010).

Summary of Factor C

At the time of listing, disease and predation were associated with significant declines of Peninsular bighorn sheep throughout the range. These threats were not mutually exclusive; urban development compounded the effects of both disease and predation. Since that time, Peninsular bighorn sheep have been limited in their ability to interact with the urban environment in those areas considered to be most detrimental (North Santa Rosa Mountains), though exposure to disease and predation may become a problem in three additional Recovery Regions (Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains) due to increased contact with the urban environment. Disease is a constant threat rangewide, and has become an important concern in three Recovery Regions (Coyote Canyon, South San Ysidro Mountains, North San Ysidro Mountains). Wildlife agencies are taking aggressive precautions to limit the exposure of Peninsular bighorn sheep to domesticated animals. Similarly, wildlife agencies have arranged measures to control mountain lion predation, which continues to be a greater concern for the relatively smaller populations in the two northernmost Recovery Regions (San Jacinto Mountains and North Santa Rosa Mountains).

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing, regulatory mechanisms thought to have some potential to protect Peninsular bighorn sheep included: (1) listing under CESA, (2) the Clean Water Act (CWA), and (3) the Act in those cases where Peninsular bighorn sheep occurred and were incidentally protected in habitat occupied by a listed wildlife species. The listing rule provides an analysis of the level of protection anticipated from those regulatory mechanisms (USFWS 1998, p. 13145). There are several State and Federal laws and regulations that were not described in the listing rule, but are pertinent to the conservation of Peninsular bighorn sheep in varying degrees. All such regulatory mechanisms are described below.

State Protections in California

The State's authority to conserve rare wildlife comprises three major pieces of legislation: CESA, the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning (NCCP) Act.

<u>California Endangered Species Act (CESA)</u>

The State of California listed a subspecies of bighorn sheep (*Ovis canadensis cremnobates*) as threatened in 1971 (CDFG 1971). This subspecies is the same entity identified by the Service as the Peninsular Ranges Population of Desert Bighorn Sheep. To date, the State has not revised its identification of the subspecies in response to new information regarding the taxonomy of bighorn sheep.

Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. CESA requires State agencies to consult with the CDFG on activities that may affect a State-listed species and mitigate for any adverse impacts to the species or its habitat. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. CESA (California Fish and Game Code, section 2080 *et seq.*) prohibits the unauthorized take of State-listed threatened or endangered species. However, sections 2081(b) and (c) of CESA allow the CDFG to issue incidental take permits for State-listed threatened and endangered species if:

1. Authorized take is incidental to an otherwise lawful activity;
2. impacts of the authorized take are minimized and fully mitigated;
3. measures required to minimize and fully mitigate the impacts of the authorized take are roughly proportional in extent to the impact of the taking on the species, maintain the applicant's objectives to the greatest extent possible, and are capable of successful implementation;
4. adequate funding is provided to implement the required minimization and mitigation measures, and to monitor compliance with and the effectiveness of the measures; and
5. issuance of the permit will not jeopardize the continued existence of a State-listed species.

At the time of listing, most of the activities occurring within the range of Peninsular bighorn sheep were not State authorized, funded, or permitted, resulting in few consultations under CESA. The City of Palm Springs approved projects that would eliminate important canyon bottom habitat (such as alluvial fans and washes) and compromise or curtail sheep movement corridors. One project (Andreas Cove) was processed by the City of Palm Springs without an Environmental Impact Report. Since listing, a settlement agreement between CDFG and one developer allowed the Shadowrock Golf Course project to continue. However, this project has not yet been developed, and approval by the City was overturned by a voter referendum leaving the project site without any permits at this time. Regional conservation planning efforts have significantly improved the level of protection offered to Peninsular bighorn sheep by local governments. This will be discussed below under the NCCP Act and the Act.

<u>California Department of Fish and Game Code – Section 4900</u>

Bighorn sheep (*Ovis canadensis nelsoni*) are a Fully Protected Species according to CDFG Code Section 4900. Fully Protected Species may not be taken or possessed at any time, and no licenses may be issued for their take except for collection for necessary scientific research and, in the case of *Ovis canadensis nelsoni*, CDFG may authorize sport hunting of mature rams under the provisions of subsection 4902b. Prior to authorizing take from sport hunting, CDFG must assess the statewide population status, including the population size in the management units designated for hunting, as well as adhere to other information requirements described in Section 4901. There is currently no authorized sport hunting of Peninsular bighorn sheep.

California Environmental Quality Act (CEQA)

CEQA is the principal statute mandating environmental assessment of projects in California. The purpose of CEQA is to evaluate whether a proposed project may have an adverse effect on the environment and, if so, to determine whether that effect can be reduced or eliminated by pursuing an alternative course of action or through mitigation. CEQA applies to projects proposed to be undertaken by, or requiring the approval of, State and local public agencies (*http://www.ceres.ca.gov/topic/env_law/ceqa/summary.html*). CEQA requires disclosure of potential environmental impacts and a determination of "significant" if a project has the potential to reduce the number or restrict the range of a rare or endangered plant or animal. However, projects may move forward if there is a statement of overriding consideration. If significant effects are identified, the lead agency has the option to require mitigation through changes in the project or decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Natural Community Conservation Planning (NCCP) Act

In 1991, the State of California passed the NCCP Act to address the conservation needs of natural ecosystems throughout the State (CFG 28002835). The NCCP program is a cooperative effort involving the State of California and numerous private and public partners to protect regional habitats and species. The primary objective of NCCPs is to conserve natural communities at the ecosystem scale, while accommodating compatible land uses. NCCPs help identify, and provide for, the regional or area-wide protection of plants, animals, and their habitats, while allowing compatible and appropriate economic activity. Many NCCPs are developed in conjunction with Habitat Conservation Plans (HCPs) prepared pursuant to the Act. In September 2008, NCCP Approval and Take Authorization were issued by CDFG for the Coachella Valley MSHCP. Peninsular bighorn sheep is a Covered Species under this plan. The specific measures under the Coachella Valley MSHCP that afford protection to Peninsular bighorn sheep are discussed in the **Federal Protections** section below.

California Wildlife Protection Act of 1990

In 2000, the California State Legislature amended the California Wildlife Protection Act of 1990 (Amendment A.B. 560) to allow CDFG, or a local agency authorized by it, to take or remove mountain lions perceived by the department to be an imminent threat to the survival of any endangered, threatened, candidate, or fully-protected sheep species, including Peninsular bighorn sheep. This was done to assist in the reduction of predation, and to promote their recovery. This legislation and the steps that CDFG has taken to control mountain lions have improved management options to prevent mountain lion predation of Peninsular bighorn sheep.

Anza-Borrego Desert State Park (Anza-Borrego DSP)

Anza-Borrego DSP, one of many California State Parks established in 1933, comprises 243,000 ha (600,000 ac) along the Peninsular Ranges, including approximately 47 percent of the Peninsular bighorn sheep habitat. Anza-Borrego DSP also contains most of the rangewide population, and has actively managed the area for over 40 years. There are private inholdings within the boundaries of Anza-Borrego DSP that could potentially be developed. A lack of funding or willingness of landowners to sell has prevented public acquisition of this habitat. Peninsular bighorn sheep habitat is typically acquired for conservation when available. For example, nearly 2,400 ha (6,000 ac) is expected to be acquired and added to Anza-Borrego DSP in the South Santa Rosa Mountains to offset impacts associated with the Sunrise Powerlink (see **Factor A** discussion above).

Federal Protections

Endangered Species Act of 1973, as amended (Act)

At the time of listing, Peninsular bighorn sheep benefited from a slight co-occurrence with two federally listed species: least Bell's vireo (*Vireo bellii pusillus*) and southwestern willow flycatcher (*Empidonax traillii extimus*). However, this benefit has always been limited due to the specialized habitats (riparian woodlands) utilized by the birds.

Since listing, the Act is the primary Federal law providing protection for this species. The Service's responsibilities include administering the Act, including sections 7, 9, and 10 that address take. Since listing, the Service has analyzed the potential effects of Federal projects under section 7(a)(2) of the Act, which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. A jeopardy determination is made for a project that is reasonably expected, either directly or indirectly, to appreciably reduce the likelihood of both the survival and recovery of a listed species in the wild by reducing its reproduction, numbers, or distribution (50 CFR 402.02). A non-jeopardy opinion may include reasonable and prudent measures that minimize the amount or extent of incidental take of listed species associated with a project.

Critical habitat (341,918 ha (844,897 ac)) was designated On February 1, 2001, in the Peninsular Ranges of the United States in Riverside, Imperial, and San Diego Counties (USFWS 2001, p. 8650). The 2001 designation of critical habitat was based on the methodology used in the Recovery Plan (USFWS 2000a) to delineate Essential Habitat, as that phrase is used in the Recovery Plan (see the **Distribution** section above for additional details). On July 31, 2006, a court-approved consent decree resulted in the partial vacature of critical habitat designation on tribal and other lands, and remanded the critical habitat designation back to the Service for a new rulemaking. A proposed revised critical habitat designation of approximately 155,565 ha (384,410 ac) was published on October 10, 2007 (USFWS 2007, p. 57739). After receiving and evaluating comments from the public and peer reviewers, the designation was further revised, and approximately 152,542 ha (376,938 ac) designated as critical habitat on April 14, 2009 (USFWS 2009c, p. 17288). Changes between the revised 2009 rule (USFWS 2009c, p. 17288) and the original 2001 designation (USFWS 2001, p. 8649) included: 1) A revision of the primary constituent elements (PCEs); 2) a reduction of 155,564 hectares (460,487 acres), based on revised criteria for designating critical habitat; 3) increased emphasis on occurrence data and use of occurrence data acquired since 2001; and 4) exclusion of Agua Caliente Tribal lands and lands covered by the Coachella Valley MSHCP. Since the designation of critical habitat in 2009, the Service has analyzed the potential effects of Federal projects under section 7(a)(2) of the Act, which requires Federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may destroy or adversely modify areas designated as critical habitat.

Section 9 prohibits the taking of any federally listed endangered or threatened species. Section 3(18) of the Act defines "take" to mean "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Service regulations (50 CFR 17.3) define "harm" to include significant habitat modification or degradation which actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering. Harassment is defined by the Service as an intentional or negligent action that creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species. Incidental take refers to taking of listed species that results from, but is not the purpose of, carrying out an otherwise lawful activity by a Federal agency or applicant (50 CFR 402.02). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved HCP that details measures to [avoid] minimize and mitigate the project's adverse impacts to listed species, including listed plants. Issuance of an incidental take permit by the Service is subject to section 7 of the Act; thus, the Service is required to ensure that the actions proposed in an HCP are not likely to jeopardize the animal or plant species or result in the destruction or adverse modification of critical habitat. Therefore, HCPs may provide an additional layer of regulatory protection. Section 10(a)(1)(B) of the Act allows for exceptions to take prohibitions under section 9 for animals. Many NCCPs are developed in conjunction with HCPs prepared pursuant to the Act. The Coachella Valley MSHCP and the Draft Agua Caliente Tribal Habitat Conservation Plan (Draft Agua Caliente THCP) are discussed below.

Coachella Valley Multiple Species Habitat Conservation Plan (Coachella Valley MSHCP):

The purpose of the Coachella Valley MSHCP is to protect natural communities and various habitats for 27 species found throughout the Coachella Valley, maintain the essential ecological processes to keep these habitats viable, and link habitats to maximize the conservation value of the land (CVAG 2007, p. 1-2). This is a multispecies plan, and provides coverage for activities specified in the plan for incidental take of Peninsular bighorn sheep for the 75-year life of the permit. After reviewing the current status, environmental baseline, effects of the proposed action, and cumulative effects, it is our opinion that the issuance of an Incidental Take Permit to the Permittees under the Coachella Valley MSHCP is not likely to jeopardize the continued existence of the Peninsular bighorn sheep, nor will it adversely modify designated or proposed critical habitat (USFWS 2008b, p. 181). Coachella Valley MSHCP permittees are required to conserve up to 67,119 ha (165,856 ac) of Peninsular bighorn sheep habitat within conservation areas in exchange for up to 1,565 ha (3,867 ac) of authorized disturbance (CVAG 2007, Table 9-34). The plan will create up to 50,586 ha (125,000 ac) of new conservation lands (added to pre-existing conservation lands) throughout the preserve system, which now encompasses 275,186 ha (680,000 ac) of conservation lands. The planning area covers 445,154 ha (1.1 million ac) of the Coachella Valley.

The Coachella Valley MSHCP also identifies three species-specific conservation goals and objectives pertaining to Peninsular bighorn sheep (CVMSHCP 2007, p. 9-257):

1. Ensure species persistence in the plan area by securing Essential Habitat [Recovery Plan Habitat], and associated essential ecological processes, allowing evolutionary processes and natural population fluctuations to occur. Minimize fragmentation, human-caused disturbance, and edge effects to Core Habitat by conserving contiguous habitat patches and effective linkages between patches of Core Habitat.
    a. Objective 1a: Ensure conservation of Essential Habitat [Recovery Plan Habitat], from a range of environmental conditions within which the Peninsular bighorn sheep is known to occur, to provide for population fluctuation and genetic diversity, within three Conservation Areas with the goal of including a total of 67,119 ha (165,856 ac). Conservation areas are listed below, along with the target acreages to be conserved in each respective area:
        i. Cabazon Conservation Area (36 ha; 83 ac);
        ii. Snow Creek/Windy Point Conservation Area (259 ha; 640 ac); and
        iii. Santa Rosa and San Jacinto Mountains Conservation Area (66,827 ha; 165,133 ac).
    b. Objective 1b: Ensure implementation of avoidance, minimization, and mitigation measures and Land Use Agency Guidelines.
    c. Objective 1c: Ensure that implementation of the Coachella Valley MSHCP is consistent with the recovery strategy delineated in the Recovery Plan for Bighorn Sheep in the Peninsular Ranges, California (USFWS 2000a).
    d. Objective 1d: Ensure that any development allowed does not fragment Essential Habitat [Recovery Plan Habitat], and that edge effects from such development are minimized.
2. Maintain connectivity by preventing habitat fragmentation within and between the four recovery regions (San Jacinto Mountains, North Santa Rosa Mountains, Central Santa Rosa Mountains, and South Santa Rosa Mountains) within Essential Habitat [Recovery Plan Habitat] areas to allow dispersal and movement of bighorn sheep.
    a. Objective 2: Include habitat linkages and biological corridors within Essential Habitat [Recovery Plan Habitat] areas to allow dispersal and movement of bighorn sheep.
3. Ensure conservation of the Peninsular bighorn sheep by maintaining the long-term persistence of self-sustaining populations and conserving habitat quality through biological monitoring and adaptive management actions in the plan area.
    a. Objective 3: Implement monitoring and adaptive management actions to ensure self-sustaining populations within each Core Habitat area.

At the time of the Permittees' approval of the Coachella Valley MSHCP in 2007, 54,887 ha (135,630 ac) of Peninsular bighorn sheep habitat in the plan area were included in pre-existing Conservation Areas, while 12,232 ha (30,226 ac) remained to be conserved (CVMSHCP 2007, Table 9-34). Peninsular bighorn sheep habitat within Conservation Areas includes 1,565 ha (3,867 ac) of authorized disturbance area, of which 1,538 ha (3,802 ac) is in the San Jacinto and Santa Rosa Mountains Conservation Area. Since 2007, Permittees (Coachella Valley Conservation Commission and Coachella Valley Water District) have purchased 74 ha (182 ac) of land, and private conservation groups (Center for Natural Lands Management and Friends of Desert Mountains) have purchased 837 ha (2,069 ac) for addition to the Coachella Valley MSHCP Conservation Areas.

The Coachella Valley MSHCP contains two key monitoring and management components related to Peninsular bighorn sheep: (1) Annual monitoring of population trends under the reserve system management and monitoring plan, and (2) a specified 5-year research program under the Trails Management Program in the Santa Rosa and San Jacinto Mountains Conservation Area (USFWS 2008b, p. 36). This program is designed to combine adaptive management with an emphasis on research, whereby scientific data would be collected to evaluate the effects of recreational trail use on Peninsular bighorn sheep health, habitat selection, and long-term population dynamics. The principle goal is to obtain empirical data from the plan area to guide trails management, with additional goals to monitor human trail use while integrating educational and awareness efforts, and implement other trail management prescriptions. This trails management component of the Coachella Valley MSHCP is meant to investigate the response of bighorn sheep to human recreational disturbance, as well as population-level effects and impacts to long-term persistence of bighorn sheep. Research is also intended to determine the effects of new trail construction on Peninsular bighorn sheep. The Trails Management Subcommittee will annually review the effectiveness of the overall public use and Trails Management Program. Because available funding was allocated to other plan priorities, including the biannual helicopter surveys of Peninsular bighorn sheep (K. Barrows, *in litt*. 2010, p. 61), neither the annual population monitoring, nor the focused research of the effects of recreation, have been initiated (CVCC 2009a, p. 2; CVCC 2009b, p. 3). However, we expect the annual population monitoring and the focused research efforts to be initiated, and anticipate they will provide the benefits described above.

The Coachella Valley MSHCP also requires that an Implementation Manual be prepared and implemented to enact numerous specific measures to avoid and minimize the effects of future development in and adjacent to bighorn sheep habitat. The manual will include (but not be limited to): stipulated development standards related to clustering, siting requirements relative to various topographic features, viewshed considerations, distance to water sources, habitat linkages and population connectivity, and slope constraints.

In summary, the Coachella Valley MSHCP is providing significant conservation value to bighorn sheep habitat. Although some conservation is already in place, additional conservation and management that will benefit Peninsular bighorn sheep is expected to occur as the plan is implemented over the remaining 72 years of the 75-year permit.

Draft Agua Caliente Tribal Habitat Conservation Plan (Draft Agua Caliente THCP):

Development is planned on the lands of the Agua Caliente Band of Cahuilla Indians of the Agua Caliente Indian Reservation, California (Agua Caliente Tribe), in Palm Canyon and portions of the San Jacinto and North Santa Rosa Mountains. Some of this development would affect an important corridor between the San Jacinto Mountains subpopulation and the North Santa Rosa Mountains subpopulation. For the benefit of Peninsular bighorn sheep the Tribe has established conservation programs for Indian Canyons Heritage Park and Tahquitz Canyon within the

Mountains and Canyons Conservation Area (MCCA) (Helix Environmental Planning (HEP) 2007, p. ES-7). The management plan developed for Indian Canyons Heritage Park emphasizes the preservation of a habitat linkage area that runs east to west between the San Jacinto and Santa Rosa Mountains (HEP 2007, p. 2-4). Additionally, the Tribe manages trails according to the Trail Management Plan, Indian Canyons Master Plan, and the Cooperative Agreement with the BLM (HEP 2007, p. 2-7). Indian Canyons Heritage Park and Tahquitz Canyon are the only areas within the San Jacinto Mountains where hours of operation and access are controlled, and the Tribe has installed signage to help hikers stay on established trails. Both Indian Canyons and Tahquitz Canyons are closed on the weekdays between July and October. Therefore, the summer months, which coincide with the period when water availability may be more limited for the Peninsular bighorn sheep, have lower usage by hikers (HEP 2007, p. 2-7). The tribal staff undertakes other activities for the benefit of Peninsular bighorn sheep, such as prohibition of dogs, tamarisk removal, fountain grass removal, maintenance of creeks and springs, and public education.

Under the Draft Agua Caliente THCP, a maximum of 15 percent (subject to additional requirements) of habitat of covered species, such as the Peninsular bighorn sheep, in the MCCA may be subject to ground disturbance associated with covered projects, resulting in an overall minimum of 85 percent of such habitat being conserved and dedicated to the preserve. No disturbance shall be allowed within a use area or defined linkage for Peninsular bighorn sheep, and certain lands adjacent to those areas would require specified levels of conservation. Additionally, within portions of the Valley Floor Conservation Area within 500 feet of Peninsular bighorn sheep habitat, covered activities would be subject to conservation restrictions for the benefit of this species (HEP 2007, p. ES-8). The Draft Agua Caliente THCP remains in draft form, and the Tribe has recently informed the Service that it does not intend to continue the planning effort in the near term due to funding constraints.

Clean Water Act (CWA)

Under section 404 of the CWA, the U.S. Army Corps of Engineers (Corps) regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term “wetland” refers to areas meeting the Corps’s criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted to growing in wetlands). Any action with the potential to impact waters of the United States must be reviewed under the CWA, National Environmental Policy Act (NEPA), and the Act. These reviews require consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts.

The Corps interprets “the waters of the United States” expansively to include not only traditional navigable waters and wetlands, but also other defined waters adjacent or hydrologically connected to traditional navigable waters. However, recent Supreme Court rulings have called into question this definition. On June 19, 2006, the U.S. Supreme Court vacated two district court judgments that upheld this interpretation as it applied to two cases involving “isolated” wetlands. Currently, Corps regulatory oversight of such wetlands (e.g., vernal pools) is in doubt because of their “isolated” nature. In response to the Supreme Court decision, the Corps and the

U.S. Environmental Protection Agency (EPA) have recently released a memorandum providing guidelines for determining jurisdiction under the Clean Water Act. The guidelines provide for a case-by-case determination of a "significant nexus" standard that may protect some, but not all, isolated wetland habitat (USEPA and USACE 2007). The overall effect of the new permit guidelines on loss of isolated wetlands, such as vernal pool habitat, is not known at this time.

At the time of listing, section 404 of the CWA provided limited protection to small portions of the Peninsular bighorn sheep range through the Corps regulation of discharge of dredged and fill material into certain waters and wetlands of the United States. This protection continues to provide a limited benefit to Peninsular bighorn sheep because the Act's section 7 nexus would rarely occur on private lands in arid upland habitats, as these areas do not usually support jurisdictional waters regulated under section 404. Waterways at low elevations may cause an initiation of section 7 consultation with the Corps.

National Environmental Policy Act (NEPA)

NEPA (42 U.S.C. 4371 *et seq.*) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

National Park Service (NPS) Organic Act

The NPS Organic Act of 1916 (39 Stat. 535, 16 U.S.C. 1, as amended), states that the National Park Service "shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations … to conserve the scenery and the national and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The National Park Service Management Policies indicate that the Park Service will "meet its obligations under the National Park Service Organic Act and the Endangered Species Act to both pro-actively conserve listed species and prevent detrimental effects on these species." This includes working with the Service and undertaking active management programs to inventory, monitor, restore, and maintain listed species habitats, among other actions.

The Santa Rosa and San Jacinto Mountains National Monument was established through an Act of Congress on October 24, 2000, "in order to preserve the nationally significant biological, cultural, recreational, geological, educational, and scientific values found in the Santa Rosa and San Jacinto Mountains and to secure now and for future generations the opportunity to experience and enjoy the magnificent vistas, wildlife, land forms, and natural and cultural resources in these mountains and then recreate therein" (Public Law 106-351). The National Monument includes 110,074 ha (272,000 ac), including 36,219 ha (89,500 ac) within BLM's California Desert Conservation Area (Figure 2). The National Monument contains two Federal

Wilderness Areas: 1) the Santa Rosa Wilderness, containing 24,928 ha (61,600 ac) of BLM and USFS lands; and 2) the USFS' San Jacinto Wilderness, containing 7,879 ha (19,470 ac). Of the 110,074 ha (272,000 ac) of National Monument lands, 75,936 ha (187,641 ac) encompasses Peninsular bighorn sheep Recovery Plan Habitat. The National Monument is bordered by lands owned by the Agua Caliente Tribe, CDPR, CDFG, other agencies of the State of California, and private landowners. An advisory committee, composed of individuals representing various jurisdictions and interests, makes recommendations that help guide management of the National Monument.

Beneficial measures afforded to Peninsular bighorn sheep through the establishment of the National Monument include: a prohibition on development on Federal and State lands, a prohibition on any new mines on National Monument land, and a prohibition on helicopter sight-seeing tours. The National Monument does not prohibit development of any lands on private or tribal property, but does facilitate cooperation with these inholdings.

Federal Land Policy and Management Act of 1976 (FLPMA)

BLM is required to incorporate Federal, state, and local input into their management decisions through Federal law. The Federal Land Policy and Management Act of 1976 (FLPMA) (Public Law 94-579, 43 U.S.C. 1701) was written "to establish public land policy; to establish guidelines for its administration; to provide for the management, protection, development and enhancement of the public lands; and for other purposes." Section 102(f) of the FLPMA states that "the Secretary [of the Interior] shall allow an opportunity for public involvement and by regulation shall establish procedures … to give Federal, State, and local governments and the public, adequate notice and opportunity to comment upon and participate in the formulation of plans and programs relating to the management of the public lands." Therefore, through management plans, BLM is responsible for including input from Federal, State, and local governments and the public. Additionally, section 102(c) of the FLPMA states that the Secretary shall "give priority to the designation and protection of areas of critical environmental concern" in the development of plans for public lands. Although BLM has a multiple-use mandate under the FLPMA that allows for grazing, mining, and OHV use, BLM also has the ability under the FLPMA to establish and implement special management areas, such as Areas of Critical Environmental Concern, Wilderness Areas, and Research Areas that can reduce or eliminate actions that adversely affect species of concern (including listed species such as the Peninsular bighorn sheep).

BLM has established the following Wilderness Areas in a portion of Peninsular bighorn sheep habitat: San Jacinto Mountains, Santa Rosa Mountains, Fish Creek Mountains, Sawtooth Mountains, Coyote Mountains, Carrizo Gorge, and Jacumba Mountains. These Wilderness Areas have been very useful in conserving the perimeter areas within Recovery Plan Habitat not included in Anza-Borrego DSP (Figure 2), providing an additional 82,112 ha (202,903 ac) of protected lands (with the exception of inholdings that can still be developed). BLM will provide "reasonable access" to private property, which means that private inholdings that become developed will be provided a road by BLM, which could potentially fragment the Wilderness Areas. The use of roads has been limited by BLM.

FLPMA also established the California Desert Conservation Area (CDCA), and a requirement to complete a plan for the conservation area. To accomplish this, BLM subdivided the CDCA into discrete planning units, two of which overlap Peninsular bighorn sheep habitat: the Coachella Valley and Western Colorado Desert planning units. BLM recently completed plan amendments and formal consultation with the Service for these planning units. The Coachella Valley plan amendment, located in Riverside County, restricts a number of potential land uses that would otherwise conflict with bighorn sheep habitat requirements. It would conserve 99 percent of BLM lands in Coachella Valley MSHCP conservation areas over the long term for the benefit of bighorn sheep and other wildlife. Through consultation with the Service, BLM also agreed to offset any habitat losses through habitat acquisition of equivalent acreage, function, and value for bighorn sheep. Though the plan amendment would allow for commercial jeep tours in sheep habitat, BLM agreed to a scientifically valid monitoring and adaptive management strategy that would provide sufficient sideboards to ensure against significant adverse effects to bighorn sheep (USFWS 2010a, p. 114). Finally, the plan amendment would integrate the BLM and Coachella Valley MSHCP recreational trails program. However, as discussed above, the trails research program for bighorn sheep is not yet developed, thus limiting BLM's ability to adequately implement its obligations under the trails plan.

Though the CDCA Plan and Western Colorado Desert plan amendment do not provide the same degree of protection to Peninsular bighorn sheep in the Southern Peninsular Ranges as do the habitat protections currently afforded in the Northern Peninsular Ranges, development and recreational pressures are less severe in the Southern Peninsular Ranges. Therefore, these plans have been adequate, to date, for maintaining viable bighorn sheep populations on BLM lands in Imperial County. Recent right-of-way applications for renewable energy projects in bighorn sheep habitat within the Southern Peninsular Ranges were not specifically contemplated in the CDCA Plan. Therefore, existing plan requirements may not be adequate for bighorn sheep if current renewable energy trends and proposals extend farther into sheep habitat.

<u>The Lacey Act</u>

The Lacey Act (P.L. 97-79), as amended in 16 U.S.C. 3371, makes unlawful the import, export, or transport of any wild animals whether alive or dead taken in violation of any United States or Indian tribal law, treaty, or regulation, as well as the trade of any of these items acquired through violations of foreign law. The Lacey Act further makes unlawful the selling, receiving, acquisition, or purchasing of any wild animal, alive or dead. The designation of "wild animal" includes parts, products, eggs, or offspring.

Summary of Factor D

At the time of listing, the principle mechanism that provided protection to Peninsular bighorn sheep was CESA. Presently, several Federal and State regulatory mechanisms provide discretionary protections, although the Act is the primary law affording protection for Peninsular bighorn sheep. The San Jacinto and Santa Rosa Mountains National Monument designation in the Northern Peninsular Ranges also offers an elevated level of protection that benefits the species. In the Southern Peninsular Ranges, Peninsular bighorn sheep habitat is protected in Anza-Borrego DSP, and additional protection is afforded in the BLM Wilderness Areas.

Peninsular bighorn sheep are covered under the Coachella Valley MSHCP, which is intended to provide long-term protection of natural communities and maintain the essential ecological processes to keep these habitats viable. The Coachella Valley MSHCP affords protection to habitat on non-Federal land in the Northern Peninsular Ranges. Protections afforded by the plan have helped to preserve Peninsular bighorn sheep habitat within the conservation areas and minimize future impacts of habitat loss and fragmentation. Protection is also afforded to Peninsular bighorn sheep habitat under the Coachella Valley MSHCP by restricting use of nonnative plant species in landscapes on or adjacent to the conservation areas. Though the Agua Caliente Tribe has temporarily suspended completion of the draft Tribal HCP, the Tribe is currently taking measures to benefit the habitat and reduce human disturbance to Peninsular bighorn sheep. The Act continues to be the most important regulatory mechanism protecting Peninsular bighorn sheep. There is currently no regulatory mechanism that protects the ability of Peninsular bighorn sheep to move freely between subpopulations, such that subpopulations will not become permanently isolated, particularly in the San Jacinto Mountains. However, seven of the nine Recovery Regions (San Jacinto Mountains, North Santa Rosa Mountains, South Santa Rosa Mountains, Central Santa Rosa Mountains, Coyote Canyon, Vallecito Mountains, south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area) exist in areas that are partly within Federal jurisdiction, and therefore provided additional regulatory protection as compared to private lands. Although impacts from development and other threats are being reduced, in the absence of the Act existing regulatory mechanisms remain inadequate to ameliorate impacts from current threats to Peninsular bighorn sheep and their habitat throughout the range.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

The listing rule attributed threats from human disturbance, toxic nonnative plants, collisions with vehicles, insufficient lamb recruitment, and a decrease in water availability to Factor E. Human disturbance, insufficient lamb recruitment, and a decrease in water availability were considered to be rangewide threats. Toxic nonnative plants were a threat in the three northernmost Recovery Regions (San Jacinto Mountains, North Santa Rosa Mountains, and Central Santa Rosa Mountains). Vehicle collisions were a threat in six Recovery Regions (North Santa Rosa Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains, Vallecito Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area), and will be discussed under urban-related mortality. These threats, and one new threat associated with Factor E (climate change), are discussed below under the respective headings: response to human disturbance, urban-related mortality, insufficient lamb recruitment, toxic nonnative plants, and drought and climate change. Water availability concerns, as they relate to habitat, were discussed above under **Factor A**, and are only discussed below in terms of human disturbance and climate change threats.

<u>Response to Human Disturbance</u>

In 1933, Aldo Leopold classified bighorn sheep as a wilderness species because they usually declined when confronted with expanding human developments and activities (Leopold 1933). Several researchers and land managers have expressed concern over the impact of human activity on Peninsular bighorn sheep (Jorgensen and Turner 1973, p. 52; Hicks 1978, p. 37; Olech 1979, p. 36; Cunningham 1982, p. iv; DeForge and Scott 1982, p. 75; Gross 1987, p. 16;

Sanchez *et al*. 1988, p. 33), as well as other bighorn sheep (Hicks and Elder 1979, p. 909; Graham 1980, p. 306; Leslie and Douglas 1980, p. 289; Hamilton *et al.* 1982, p. 54; Miller and Smith 1985, p. 7; Gionfriddo and Krausman 1986, p. 334; Krausman and Leopold 1986, p. 52; Smith and Krausman 1988, p. 5; Etchberger *et al.* 1989, p. 905; Andrew 1994, p. 49; Krausman *et al.* 2001, p. 224; Papouchis *et al*. 2001, p. 573). The majority of researchers recounted changes in bighorn sheep behavior and, at times, population declines, with increases in human activity (USFWS 2000a, p. 44). Activities with the potential to disrupt bighorn sheep behavior and use of essential resources, or cause bighorn sheep to abandon traditional habitat include, but are not limited to: hiking, mountain biking, hang gliding, horseback riding, camping, hunting, livestock grazing, dog walking, OHVs, the use of aircraft, and construction, industrial, and agricultural activities (McQuivey 1978, p. 60; MacArthur *et al*. 1979, p. 2014; Olech 1979, p. 36; Graham 1980, p. 292; Leslie and Douglas 1980, p. 284; MacArthur *et al*. 1982, p. 351; Wehausen 1983, p. 15; Miller and Smith 1985, p. 7; Krausman and Leopold 1986, p. 364; Goodson 1999, p. 123; Papouchis *et al*. 1999, p. 364). Legal and illegal recreational trails have facilitated the expansion of these activities.

Factors influencing the response of Peninsular bighorn sheep to the disturbances listed above include the type and predictability of activity, presence of domestic dogs, the individual animal's previous experience with humans, size or composition of the bighorn sheep group, location of the bighorn sheep relative to elevation of the activity, distance to escape terrain, and distance to the activity (Hicks 1978, p. 36; McQuivey 1978, p. 52; Hicks and Elder 1979, p. 909; MacArthur *et al.* 1979, p. 2014; Wehausen 1980, p. 36; Hamilton *et al*. 1982, p. 53; MacArthur *et al.* 1982, p. 356; Whittaker and Knight 1998, p. 314; Papouchis *et al.* 1999, p. 372). Whittaker and Knight (1998, pp. 312–316) suggested that individual animals or subpopulations should not be characterized as habituated, attracted to, or avoiding humans based on the observations of a few individuals.

Bighorn sheep responses to human disturbance can range from cautious curiosity to immediate flight or abandonment of habitat, as well as disruption of normal social patterns and resource use. Evidence shows that even when bighorn sheep become tolerant of a particular activity, continued and frequent encounters can cause them to avoid an area, eventually interfering with use of resources such as water, mineral licks, lambing or feeding areas, or traditional movement routes (Jorgensen and Turner 1973, p. 52; McQuivey 1978, p. 59; Graham 1980, p. 306; Leslie and Douglas 1980, p. 284; DeForge and Scott 1982, p. 75; Hamilton *et al*. 1982, p. 53; Krausman and Leopold 1986, p. 58; Rubin *et al*. 1998, p. 547). Bighorn sheep prevented from using preferred foraging areas or following normal activity patterns by frequent human disturbance may experience less than adequate nutrition, which can also adversely affect the immune system (Festa-Bianchet 1988, p. 72; Wagner and Peek 1999, p. 109). Andrew (1994, p. 49) noted that bighorn sheep were found farther from areas of disturbance than random points, and that females occurred farther from disturbed areas than males. If areas of disturbance are also resource use areas, females may be less likely to use such resources, and at particular times of the year (during nursing and gestation) this may negatively affect lambs. As a result, the inability to utilize such resources could affect recruitment rates.

Extirpations of bighorn sheep populations in the southwest, where bighorn sheep experience high levels of human activity within their home ranges, appeared to be associated with human disturbance. Peninsular bighorn sheep, especially in the Northern Peninsular Ranges, face a similar situation (Krausman *et al*. 2001, p. 226). For example, a subpopulation of bighorn sheep in the Santa Catalina Mountains (outside of Tucson, Arizona) abandoned habitat that had greater human disturbance than occupied habitat, and subsequently became extirpated (Schoenecker 1997; Krausman *et al*. 2001, p. 225).

Individual bighorn sheep exhibit differences in behavior, and subpopulations have different experiences with humans (King and Workman 1986, pp. 80–83), therefore, their reactions to human disturbance will vary (Hicks and Elder 1979, p. 914; Leslie and Douglas 1980, p. 286). Ewes with lambs typically are more sensitive to disturbance (Wehausen 1980, p. 194), compared to groups without young. Papouchis *et al*. (1999, p. 364) found bighorn sheep to be more sensitive to disturbance during the spring and fall, corresponding with lambing and rutting seasons. Disturbance can result in physiological responses, such as elevated heart rate (MacArthur *et al*. 1979, p. 2010; MacArthur *et al.* 1982, p. 351), even when no behavioral response is obvious. However, bighorn sheep evolved to tolerate occasional normal disruptions, such as the presence of a predator. Beyond a certain threshold of human activity, they may simply be overwhelmed.

Variability in the research has raised doubts as to the importance of human activity on bighorn sheep behavior. Observations of human disturbance effects, from anecdotal to extensively researched field studies, reveal a disparity in responses of bighorn sheep to human disturbance, which was discussed in the Recovery Plan (USFWS 2000a, p. 43). Researchers who have cited instances where human activity resulted in no ill effects on some bighorn sheep subpopulations (Hicks and Elder 1979, p. 914; Hamilton *et al*. 1982, p. 51), have also documented altered behavior in response to anthropogenic disturbance in other cases. The Recovery Plan stated that attempts to ascribe relative importance, distinguish among, or generalize the effects of various human activities on bighorn sheep behavior are not supportable, given the range of potential reactions reported in the literature, and the different variables impinging on given situations (USFWS 2000a, p. 43). Indeed, as noted in this review, certain subpopulations of Peninsular bighorn sheep appear to have become more accustomed to human disturbance than others. The level and type of disturbance effects differ with each subpopulation.

At the time of listing, Peninsular bighorn sheep behavioral responses to human activity were thought to have an important influence on population trends. Threats associated with human disturbance were observed rangewide, although the effects on the North Santa Rosa Mountains subpopulation were magnified. However, this finding may be the result of increased research in that area. DeForge (*in litt.* 1997) observed a significant reduction in bighorn sheep use in portions of the North Santa Rosa Mountains since the construction of Dunn Road, which bisects the North Santa Rosa Mountains, running from Highway 74 northwards and ending at Cathedral Canyon. Dunn Road, originally created illegally, was utilized on a regular basis by permitted tour operators. However, because bighorn sheep appeared to be impacted by the presence of large numbers of people and vehicles in this area, and stayed approximately 1.5 to 3 km (1 to 2 mi) east of the road, Dunn Road was eventually closed to these tour operations.

Abandonment of preferred habitat was also a concern at listing. In 1982, the construction of a flood control project in Magnesia Spring Canyon within the City of Rancho Mirage took place below a lambing area occupied by the North Santa Rosa Mountains subpopulation. This caused the subpopulation to relocate their lambing area a distance of about 2.4 km (1.5 mi) away from the construction area and human activity (DeForge and Scott 1982, p. 75). As further evidence that the abandonment of the lambing area was attributable to human activities, DeForge (pers. comm. 1997) indicated that the subpopulation reoccupied the original lambing area the following year after construction-related human activities subsided. Projects adjacent to the San Jacinto Mountains were also expected to result in abandonment of the primary remaining lambing area there (USFWS 1998, p. 13143).

The proposed and approved developments within or immediately adjacent to Peninsular bighorn sheep habitat in the Northern Peninsular Ranges were expected to substantially increase human activity and human recreation in the area. In the North Santa Rosa Mountains, after an area (Magnesia Springs Canyon) was closed off to hikers, bighorn sheep immediately returned (DeForge, pers. comm. 2011). In the Southern Peninsular Ranges, Jorgensen (1974) reported that Peninsular bighorn sheep use of waterholes in Anza-Borrego DSP was reduced by about 50 percent on days when more recreational vehicle traffic occurred, compared to periods of low or no vehicle use. In Carrizo Canyon, Hicks (1978, p. 37) observed a group of bighorn sheep flee from a spring when a Navy helicopter passed overhead, and Olech (1979) noted that bighorn sheep did not use waterholes when motorcycles were heard nearby. BLM reported that, in the late 1990s, a trail that bisects a lambing area in the Carrizo Canyon received high levels of human activity, which reduced bighorn sheep use. Cunningham (1982) speculated that the use of springs by recreationists and persons entering California across the United States-Mexico border caused reduced use of this resource by bighorn sheep.

At the time of listing, the North Santa Rosa Mountains subpopulation experienced a detrimental change in behavior due to increasing exposure to human development. The close proximity of the City of Rancho Mirage to the North Santa Rosa Mountains situates bighorn sheep habitat directly adjacent to a major urban area. Bold sheep learned to utilize these lush green areas, and were then followed by other individuals. Eventually bighorn sheep from the North Santa Rosa Mountains subpopulation learned to cross Highway 111, entering homeowner's yards and a golf course in the City of Rancho Mirage (USFWS 1998, p. 13146), which also led to collisions with automobiles. BHI was able to collect a substantial amount of information on this phenomenon, showing that the North Santa Rosa Mountains subpopulation had become so accustomed to the urban environment that their behavior changed substantially from normal bighorn sheep behavior, to the degree that mortality rates were affected. Ewes left lambs unattended to go down to urban areas to feed, resulting in high lamb predation rates (BHI 1998a, p. 43; BHI 1999, pp. 41–42). Lambs also suffered from disease associated with irrigated lawns, such as viruses and strongyles (BHI 1998a, p. 57; BHI 1999, pp. 49–51).

Since the time of listing, use of the Northern Peninsular Ranges as a recreational area has grown in pace with the population of the Coachella Valley. For example, in the south San Jacinto Mountains some trails are heavily used, including the North and South Lykkens, and Skyline, Trails. The Skyline Trail goes directly through bighorn sheep habitat, while the Lykken Trails are approximately parallel to the valley floor. Peninsular bighorn sheep will typically stay above the Lykken Trails while humans are using them, which may intermittently limit resource availability and use. One previously illegal trail in the North Santa Rosa Mountains, the Art

Smith Trail, is now legal and heavily used. Human disturbance tends to be a problem for only about 6 months out of the year, when temperatures are tolerable for hikers. A number of hiking trails and human access points have been closed since the time of listing and, in some cases, bighorn sheep have returned to these areas now that human access has subsided. For example, since the closing of Dunn Road to public tours, Peninsular bighorn sheep have begun to return to the Dunn Road area (USFWS GIS data, 2010c). Peninsular bighorn sheep have now crossed Dunn Road to move farther west, dispersing into a larger area of habitat in the North Santa Rosa Mountains, and possibly reducing their density at the eastern urban/wilderness interface.

Since listing, as a result of the increased presence of Peninsular bighorn sheep in and around the City of Rancho Mirage, private landowners agreed with wildlife agencies that a fence should be constructed to prevent Peninsular bighorn sheep in the North Santa Rosa Mountains from moving into the urban areas. This resulted in the construction of a 2.4 m (8 ft) tall, 7.2 km (4.5 mi) long fence that was completed in 2002 (BHI 2009, p. 5). The fence was a major success in limiting access to urban areas. However, the same behavioral issues are beginning to arise in the Central Santa Rosa Mountains near the City of La Quinta, which is also directly adjacent to Peninsular bighorn sheep habitat (BHI 2009, p. 7) and in the North San Ysidro Mountains and South San Ysidro Mountains near the City of Borrego Springs (Botta, pers. comm. 2010). In these areas, bighorn sheep have been observed feeding on lawns (up to 40 individuals at one time on a Borrego Springs lawn), making them susceptible to disease infection (Botta, pers. comm. 2010). The threat is increased because some landowners are providing artificial water sources for bighorn sheep in the urban areas (Botta, pers. comm. 2010). Additionally, areas utilized by bighorn sheep are within access of toxic nonnative plant species (e.g., oleander). Increased use of resources in urban environments is a significant threat because it may cause a decrease in predator evasion techniques, put lambs at risk, and expose individuals to additional diseases. For these reasons fencing should be considered in the wildland-urban interface near the cities of La Quinta and Borrego Springs. Bighorn sheep near the town of Ocotillo should be observed closely for similar behaviors. As we learned from the North Santa Rosa Mountains subpopulation, once bold individuals learn to utilize urban resources they may be followed by more timid individuals, the number of Peninsular bighorn sheep leaving their native habitat will increase, which will then be followed by a population decline due to exposure to a variety of mortality factors.

The Recovery Plan also stated that activities near the United States-Mexico border may increase human disturbance in the area (USFWS 2000a, p. 79). The Recovery Plan discussed threats posed by recreationists, undocumented individuals entering the United States from Mexico who may camp at water sources and displace bighorn sheep (USFWS 2000a, p. 44), and threats posed by Border Patrol activities. Peninsular bighorn sheep population growth in the Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area (Recovery Region 9) has increased substantially since listing, along with a range expansion southwards towards the United States-Mexico border.

In the southernmost Recovery Region (south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area), construction of the Sunrise Powerlink will involve a significant number of workers, construction equipment, and helicopter flights in the area, possibly resulting in habitat abandonment by Peninsular bighorn sheep during these activities. However, this power line is not expected to have long-term impacts on the taxon (Wagner, pers. obs. 2010). The bighorn sheep in this region appear to be much more accustomed to certain human activities than some other subpopulations, likely due to Interstate 8, Border Patrol agents on foot, and undocumented persons in the area (Wagner, pers. obs. 2010). Construction is not anticipated to last more than 2 years, and no construction will occur during the lambing season. Therefore, effects to bighorn sheep as a result of this project would be largely short term in duration.

Urban-related Mortality

At the time of listing, urban-related threats were the cause of relatively high levels of mortality to Peninsular bighorn sheep in the Northern Peninsular Ranges (USFWS 1998, p. 13140). During an investigation in the North Santa Rosa Mountains, DeForge and Ostermann (1998, p. 1) reported that urbanization was the leading known cause of death to Peninsular bighorn sheep from 1990 to 1996, accounting for 32.3 percent of all recorded adult mortalities. Mortality factors directly associated with urbanization included automobile collisions, fence strangulation, and ingestion of toxic nonnative plants. Factors indirectly associated with urbanization including altered habitat use and parasite infections (DeForge and Ostermann 1998, p. 1). California Department of Transportation (Caltrans) records show that Highway 74 traffic approximately tripled from 1970 to 2000 (USFWS 2000a, p. 32). Between 1991 and 1999 at least five rams were struck by cars while crossing Highway 74, with two killed (BHI 1999, p. 21).

Since listing, mortalities of Peninsular bighorn sheep related to urbanization have continued, though to a lesser degree near the North Santa Rosa Mountains due to the construction of the fence near the City of Rancho Mirage. In the Northern Peninsular Ranges five radio-collared bighorn sheep died from causes related to urbanization, including poisoning from toxic nonnative decorative plants, attacks from domesticated canines, and drowning in a swimming pool. Four additional bighorn sheep were struck by vehicles while attempting to cross Highway 74, with three killed (BHI Annual Reports 2000–2009) since 2000. As a result, Caltrans has installed wildlife crossing signs in the area. The increasing population growth of Coachella Valley suggests that mortality events related to urbanization will likely increase. Interstate 8 has continued to cause vehicle strike mortalities, though these have not been quantified. It has been suggested that highway overpasses be constructed to prevent further mortalities of Peninsular bighorn sheep due to vehicle collisions (USFWS 2000a, p. 79; BHI 2008, p. 11). In the Southern Peninsular Ranges, four radio-collared bighorn sheep were killed by auto collisions in 2008 and 2009 at a regular crossing location on Highway 78; one radio-collared individual was killed by a vehicle in 2007 on County Road S-22; several uncollared bighorn sheep have been killed while crossing County Roads S-2 and S-3, and Highway 78 (Botta, *in litt*. 2010).

Insufficient Lamb Recruitment

The listing rule stated that insufficient lamb recruitment was contributing to the decline of Peninsular bighorn sheep throughout the range (DeForge and Scott 1982, p. 65; DeForge *et al*. 1982, p. 76; Wehausen *et al*. 1987, p. 86; DeForge *et al*. 1995, p. 50, USFWS 1998, p. 13136). Recruitment is generally considered to have occurred when a lamb reaches one year of age (yearling). Lamb recruitment in the North Santa Rosa Mountains was very low between 1977 and 1997 (DeForge *et al*. 1982, p. 76; Turner and Payson 1982, p. 239; Ostermann *et al*. 2001, p.

749). Shorter periods of low lamb-to-ewe ratios, as well as clinical signs of pneumonia among lambs, have occasionally been observed in Anza-Borrego DSP (Jorgensen and Turner 1973, p. 51; Jorgensen and Turner 1975, p. 51; Hicks 1978, p. 19), but years of high lamb-to-ewe ratios were observed in these areas as well (Cunningham 1982; p. 18). As noted in the **Species Biology and Life History** section, conception rates did not limit population increases at the time of listing. Potential causes of low recruitment rates considered in the Recovery Plan (USFWS 2000a, p. 17) were disease or disease processes complicated by environmental conditions, such as habitat modification.

Since listing, each subpopulation has experienced a steady increase in size, with the exception of the San Jacinto Mountains, as evidenced by the biannual rangewide population surveys performed by CDFG and BHI. Periods of high lamb-to-ewe ratios have been observed in some areas (M. Jorgensen, *in litt.* 2000, p. 1; Rubin *et al*. 2000, pp. 773–775); however, recruitment is still a problem. Survivorship of lambs past 3 to 4 months has been low, and it appears that after lambs reach this age they may be better able to tolerate stresses such as disease (Botta, pers. comm. 2010). Though sick adults are observed, survivorship of this age class has been higher, which has allowed those individuals that survive to a breeding age to contribute to the subpopulation increases. The 2010 rangewide census was recently completed and has shown that recruitment in the Southern Peninsular Ranges is low and may be a cause for concern.

Since listing, especially low recruitment rates have continued in the San Jacinto Mountains, where subpopulation numbers have remained low even though this region receives nearly all the augmentation done by BHI. Rubin *et al*. (2000, p. 769) studied survivorship in four areas (North Santa Rosa Mountains, Central Santa Rosa Mountains, San Ysidro Mountains, and Jacumba/In Ko Pah Mountains) during a 4-year period, and found that survivorship between groups varied during that time. Of the four subpopulations studied, the North Santa Rosa Mountains group typically had the lowest lamb survival, while the Central Santa Rosa Mountains subpopulation, located less than 8 km (5 mi) away, had the highest lamb survival. Therefore, threats specific to each region are likely responsible for variable recruitment rates. Wehausen (1992, p. 27) suggested that periods of low recruitment may not warrant alarm because long-lived animals such as bighorn sheep can exist in viable populations if pulses of high offspring recruitment, along with high survivorship of ewes, occurs periodically to break up periods of low offspring recruitment.

Toxic Nonnative Plants

At the time of listing, some species of nonnative ornamental plants (used for decorative purposes in urban developments) were identified as toxic to Peninsular bighorn sheep. Between 1991 and 1996, five Peninsular bighorn sheep from the North Santa Rosa Mountains subpopulation died from ingesting ornamental toxic plants, including *Nerium oleander* (Oleander) and *Prunus* spp. (laurel cherry) (BHI 1995, p. 5; 1996, p. 3). At the time of listing only these two plant species had been identified as toxic. However, it was also suggested that a toxic *Solanum* spp. (nightshade) caused the death of a young ram in the Palm Springs area in 1970 (Weaver and Mensch 1970), and that additional ornamental plants might be identified as toxic to Peninsular bighorn sheep. Mortalities from toxic ornamental plants were specifically linked to the North Santa Rosa Mountains subpopulation, which had become unusually accustomed to the urban environment. Such plants were considered a greater threat in all areas of habitat directly adjacent to the wilderness-urban interface.

Since listing, toxic nonnative plants are now more common in one Recovery Region near the City of La Quinta (Central Santa Rosa Mountains), and remain a concern in four Recovery Regions (San Jacinto Mountains, North Santa Rosa Mountains, North San Ysidro Mountains and South San Ysidro Mountains) (Botta, pers. comm. 2010). As described under **Factor A,** management guidelines provided in the Coachella Valley MSHCP (2007, p. 4-179) restricted the use of several invasive nonnative plants in new Coachella Valley urban developments (Table 4-113). These guidelines, in combination with the City of Rancho Mirage fence, have minimized potential exposure of bighorn sheep to toxic plants in the Northern Peninsular Ranges.

Drought and Climate Change

In the final listing rule, climate change was not listed as a threat to Peninsular bighorn sheep, although prolonged drought was considered a threat (USFWS 1998, p. 13146). Factors considered at the time of listing to limit water availability included disturbance at watering sites, urban and agricultural water withdrawals, domestic livestock (all discussed above), and recurrent drought.

The Recovery Plan (USFWS 2000a, p. 42) described recurrent drought as a natural factor that can negatively impact desert bighorn sheep populations by either limiting water sources or affecting forage quality (Hansen 1980, p. 79; Turner and Weaver 1980, p. 102; Douglas and Leslie 1986, p. 153; Wehausen *et al*. 1987, p. 86). Bighorn sheep can concentrate near remaining water sources during drought years, resulting in competition for forage and water, potentially limiting population growth (Caughley 1977; Gotelli 1995), and increasing disease transmission (Anderson and May 1979; May and Anderson 1979). In at least some parts of the Peninsular Ranges, bighorn sheep appear to be able to exist without perennial water, and the presence of perennial water is only known to be a limiting factor in cases of prolonged drought or summers without thunderstorm activity (USFWS 2000a, p. 156). Drought was not discussed specifically in terms of climate change at the time of listing, but rather considered to be one of many factors limiting water availability.

Since the time of listing, research on climate change and its potential impacts has increased considerably, and impacts to bighorn sheep have been investigated (Epps *et al*. 2004; Epps *et al*. 2006). The southwestern United States (including the Colorado Desert where Peninsular bighorn sheep exist) has been warming and drying during the last 12,000 years, which has altered the distribution of flora and fauna (Lowe and Brown 1994, pp. 8–16). However, the greatest rate of change has occurred in the last 150 years (Fredrickson *et al*. 1998). A broad consensus among climate models indicates there will be an imminent transition to a drier climate in southwest North America (Seager *et al*. 2007, p. 1181). Lane *et al*. (1994, p. 66) found that mean annual temperature in the deserts of the southwestern United States increased 0.12 degrees Celsius per decade between 1901 and 1987, and global air temperatures have been predicted to rise 1.1 to 3.5 degrees Celsius over the next century (Houghton 1996, p. 6; Field *et al*. 1999). Furthermore, the Intergovernmental Panel on Climate Change (IPCC) found that the annual mean warming in North America is likely to exceed the global mean warming in most areas, and the southwest specifically is likely to experience the largest increase in summer warming, along with a likely decrease in annual mean precipitation (IPCC 2007, p. 850).

Mortality among desert bighorn sheep has been shown to increase with drought. Therefore, should the expected decrease in precipitation cause recurrent or prolonged droughts, the effects discussed in the Recovery Plan may develop. An analysis of the effects of climate change on water sources in the Peninsular Ranges has not been conducted. The predicted summer temperature increase and precipitation decrease in the southwest United States may alter resource distribution and availability for Peninsular bighorn sheep. Kelly and Goulden (2008, p. 1) compared surveys of plant cover in the Santa Rosa Mountains in 1977 and 2006 to 2007 along a 2,314 m (7,592 ft) elevational gradient, and found that the average elevation of the dominant plant species rose by approximately 65 m (213 ft) between the surveys. This shift was associated with surface warming, increased precipitation variability, and decreased snowfall during the 30-year period. Such findings corroborate predictions made by the IPCC, which anticipates hydrological changes, higher temperatures, and an expansion of drought areas, resulting in a northward or upward elevation shift in the range for many species (IPCC 2007). No research has been performed to show an elevational shift in the distribution of Peninsular bighorn sheep that correlates with a shift in vegetation. However, Peninsular bighorn sheep are known to forage on plant species that have experienced range shifts, including *Ambrosia dumosa* (burrobush) and *Encelia farinosa* (brittlebush) (Kelly and Goulden 2008, p. 2). Other plants in Peninsular bighorn sheep habitat that also have experienced range shifts include *Larrea tridentata* (creosote bush) and *Agave deserti* (desert agave). Peninsular bighorn sheep habitat selection is based on numerous features, particularly escape terrain. Therefore, it is possible that the vegetation used by bighorn sheep will continue to shift upward in elevation without a corresponding shift by Peninsular bighorn sheep subpopulations, depending on other resource requirements. Additional research should be conducted to investigate the relationship of shifts in resource availability to Peninsular bighorn sheep distribution.

While desert bighorn sheep are well adapted to arid conditions (Wehausen 1984, p. 84), there is evidence that their range has already contracted as climate has warmed (0.12 degrees Celsius per decade in the desert southwest) over the past century. At least 26 populations have become extirpated throughout the subspecies' range (Epps *et al*. 2006, p. 4296). To analyze the role of various factors, including climate, in determining metapopulation structure and extinction probabilities, Epps *et al*. (2004, p. 109) tested multiple parameters including precipitation, elevation, dependable springs, rock formation, area, distance to cities, mining, road access, feral burros and horses, cattle, and domestic sheep. The study found that extirpation of desert bighorn sheep in California was more common in lower elevation mountain ranges (<1,500 m (4,921 ft)), where temperatures were higher, average annual precipitation was low (<200 mm (7.9 in)), perennial streams lacking, and where domestic sheep grazing allotments formerly overlapped or abutted desert bighorn habitat. The study modeled a 2 degrees Celsius temperature increase combined with a 12 percent decrease in precipitation, which resulted in an average increased extinction risk of 0.21 to 0.30 for desert bighorn sheep across California. Peninsular bighorn sheep were predicted to experience a 0 to 0.20 extinction probability over the next 60 years (Epps *et al*. 2004, p. 111). This lower extinction probability for Peninsular bighorn sheep does not take into consideration possible future climatic changes outside the model. Hanski (1999, p.

214) suggested that climate change can decrease habitat quality and lead to extirpation of populations when small interconnected populations exist, as is the case with Peninsular bighorn sheep.

Threats associated with climate change that might interrupt population dynamics or subpopulation health, such as the reduced value and availability of resources (water, forage, etc.), should be considered. Epps *et al*. (2004, p. 110) suggested that the relationship between extinction and precipitation likely results from the dynamics of water availability, soil moisture, and forage quality. An additional issue revealed by the model is the association of extinction probability with an overlap in habitat with former domestic grazing allotments, which may indicate the substantial role that introduced disease has played in extinctions. Although Peninsular bighorn sheep were modeled to have a low extinction probability, the synergistic relationship of the various threats must not be underestimated. This includes disease and predation, which were not specifically tested.

As described by the IPCC (2007), a warming trend in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). Wildfires may open new habitat at higher elevations, and a shift in distribution might follow accordingly. This could increase the importance of higher elevation montane habitat to the future conservation of this species. Conversely, a shift to higher-elevation areas could disrupt connectivity by isolating subpopulations higher on mountains. This might create a more fragmented range where forage species occur less often at lower elevations (areas of connectivity between mountains), thus decreasing movement opportunities, reducing genetic exchange, and increasing the risk of subpopulation extirpations. Future climate change models should include a range of scenarios, and resource effects should be investigated.

Summary of Factor E

Since listing, Peninsular bighorn sheep population growth has increased significantly in all Recovery Regions, with the exception of the San Jacinto Mountains. However, surveys indicate that low recruitment continues to be a concern rangewide, particularly in four Recovery Regions (San Jacinto Mountains, Coyote Canyon, North San Ysidro Mountains, and South San Ysidro Mountains). Increased tolerance of humans caused some subpopulations to experience a range of new threats that have resulted in direct and indirect mortality events. Human disturbance is an increasing threat in five Recovery Regions (San Jacinto Mountains, Central Santa Rosa Mountains, North San Ysidro Mountains, South San Ysidro Mountains, and south Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area), and has decreased in importance in one Recovery Region (North Santa Rosa Mountains). Exposure to toxic nonnative plants near wildland-urban interface areas appears to have subsided since the construction of the fence near the City of Rancho Mirage in 2002, but is now an additional threat in the low elevation wildland-urban interface area in three new Recovery Regions (Central Santa Rosa Mountains, North San Ysidro Mountains, and South San Ysidro Mountains). Climate change is a newly identified Factor E threat that existed at the time of listing, but was not described in the listing rule. Changes in climate, including higher temperatures, drought, and longer time intervals between heavy rainfall events, affect the amount of water available to Peninsular bighorn sheep, and pose a significant threat to this species rangewide. An increase in temperature over the past century has already been correlated to the elevational shift in Peninsular bighorn sheep plant forage species, and future predictions indicate there will be a warmer and dryer climate in the desert southwest, which may alter water and forage availability. This is of particular concern should these shifts result in the physical separation of habitat requirements that now overlap or are in close proximity (i.e., water and forage relative to escape terrain and lambing areas).

III. RECOVERY CRITERIA

The Service published a final Recovery Plan in 2000. Recovery plans provide guidance to the Service, states, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to achieving recovery of a species, and this may be accomplished without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded, while other criteria may not have been accomplished. In that situation we may determine that the overall threats have been minimized sufficiently, and the species is robust enough, to downlist or delist. In other cases, new recovery approaches or opportunities, unknown at the time the recovery plan was finalized, may be more appropriate to achieve recovery. New information may change the extent that criteria need to be met for recovery of the species. Recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward eliminating or reducing the threats discussed in the five-factor analysis since the species was listed. In that context, progress towards fulfilling recovery criteria indicates the extent to which threat factors have been reduced or eliminated. The Peninsular bighorn sheep Recovery Plan did not contain threats-based criteria, and actions to alleviate specific threats were not addressed in the Recovery Plan. Threats that have subsided, as well as threats that remain, are described below.

The Recovery Plan (USFWS 2000a, pp. 63–67) states that Peninsular bighorn sheep can be downlisted to threatened when the following criteria are met. Below we discuss the justification for these criteria, their current applicability, progress toward meeting them, and how they help reduce or eliminate threats attributable to one or more of the listing factors above.

Downlisting Criterion 1: As determined by a scientifically credible monitoring plan, at least 25 adult ewes are present in each of the following 9 geographic regions (Figure 1) during each of 6 consecutive years (equivalent to approximately one bighorn sheep generation), without continued population augmentation:

1. San Jacinto Mountains
2. Santa Rosa Mountains—north of Highway 74
3. Santa Rosa Mountains—south of Highway 74 through Martinez Canyon
4. Santa Rosa Mountains—south of Martinez Canyon
5. Coyote Canyon
6. North San Ysidro Mountains—Henderson Canyon to County Road S-22
7. South San Ysidro Mountains—County Road S-22 to State Highway 78

8. Vallecito Mountains
9. Carrizo Canyon/Tierra Blanca Mountains/Coyote Mountains Area

Justification: The nine regions were selected on the basis of maintaining: (1) Historical distribution, (2) home range herd memory, and (3) connectivity among subpopulations to facilitate re-colonization in the event of localized extirpations. Recovery Team members with the knowledge of current and historical conditions judged that each area was capable of supporting at least 25 ewes with associated subadults and rams. Within each of the nine recovery regions, fluctuation in the number of ewe groups [subpopulations], including re-colonization of former habitats, is expected under the metapopulation model. As such, subpopulations may merge, split, and redistribute themselves over time. Although the nine areas support respective carrying capacities well in excess of 25 adult ewes, a downlisting objective based on maximum attainable population size was not selected because static population levels at full range capacity cannot be maintained in naturally variable environments, even assuming intensive management capability. The minimum group size of 25 adult females was selected by Recovery Team consensus because it:

1. Would reduce the risk of extirpation from random naturally occurring events to an acceptable level;
2. Should be achievable with prudent, population and land management practices;
3. Is consistent with management objectives for bighorn sheep in other metapopulations;
4. Should maintain subpopulation knowledge of a large home range that will minimize the extent of geographic gaps between subpopulations, thereby facilitating interchange of genes and populations within a metapopulation;
5. Falls well within known or estimated historical population levels; and
6. Should provide, in all but the most catastrophic scenarios, sufficient time for management intervention to prevent extirpation.

This recovery criterion is still applicable. Subpopulation sizes have increased in most regions, and some have become substructured, which has allowed them to disperse into some historically occupied areas. This possibility was acknowledged in the Recovery Plan, and the subpopulation size recommended was considered sufficient for each Recovery Region. Although augmentation continues to be necessary in the Northern Peninsular Ranges, all subpopulations, with the exception of the San Jacinto Mountains, have experienced an upward population trend in recent years. However, threats to Peninsular bighorn sheep have not been adequately abated. Therefore, an update of this criterion could include an assessment of threats that need to be addressed in each Recovery Region.

Although rangewide census data are not collected annually, biannual population surveys indicate that at least one Recovery Region (San Jacinto Mountains) did not support at least 25 adult ewes in 2006, 2008, and 2010 (Appendix 5). This demonstrates that, while the total abundance of adults has steadily increased in nearly all Recovery Regions since listing (Appendix 2), the number of adult ewes in at least one Recovery Region remains below the threshold to consider downlisting. Additionally, other Recovery Regions may not have fulfilled this recovery criterion. However, this is unclear because through 2008, reported population values represented adult ewes plus yearlings. As of 2010, biannual population surveys distinguish adult ewes from yearlings.

Downlisting Criterion 2: Regulatory mechanisms and land management commitments have been established that provide for long-term protection of Peninsular bighorn sheep and all Essential Habitat [Recovery Plan Habitat], as described in section II.D.1. of the Recovery Plan.

Justification: Given the major threat of fragmentation to species with metapopulation structures, connectivity among all portions of habitat must be established and assured through land management commitments, such that bighorn sheep are able to move freely throughout all habitat. In preparation for delisting, protection by means other than the Act must be assured. Such protection should include alternative regulatory mechanisms by Federal, State, and local governments, and land management commitments that would provide the protection needed for continued population stability.

This criterion is still applicable. Although management of Peninsular bighorn sheep occurs in varying degrees throughout the species' range, the highly parcelized nature of habitat in the Northern Peninsular Ranges continues to necessitate that land management commitments be established for permanent connectivity between these subpopulations. State and Federal agencies, along with non-governmental partners, have steadily secured large intact blocks of land for the conservation and connectivity of habitat, especially in the Southern Peninsular Ranges. The large number of private parcels and tribal allotments in the context of the existing regulatory mechanisms still leaves open the possibility for development within Peninsular bighorn sheep habitat, which could result in fragmentation and potential subsequent isolation of subpopulations. If this criterion were to be updated, it should require not only connectivity, but also ensure that bighorn sheep can expand into the historical range in the Northern and Southern Peninsular Ranges, including reestablishing connectivity with subpopulations in Mexico.

IV. SYNTHESIS

At the time of listing, approximately 335 Peninsular bighorn sheep were known to exist in at least eight subpopulations throughout the Peninsular Ranges. Nine Recovery Regions were identified 2 years later in the Recovery Plan for the recovery of nine subpopulations. Since listing, the metapopulation size of Peninsular bighorn sheep has increased to 876 individuals in 2008, and approximately 981 individuals in 2010. This represents nearly a three-fold increase in the 12 years since listing, and indicates that the metapopulation is coping with the multitude of threats it faces. However, the number of ewes in one Recovery Region (San Jacinto Mountains) remains well below the value recommended for downlisting in the Recovery Plan (25 ewes for 6 consecutive years). Additionally, despite augmentation of the San Jacinto Mountains subpopulation by BHI since 2002, population growth has been slow, and remains a great concern for the recovery of the Peninsular bighorn sheep metapopulation.

Seven primary threats were identified at listing that impact Peninsular bighorn sheep and their habitat: (1) habitat fragmentation, degradation, and loss due to urban and commercial development (rangewide); (2) disease (rangewide); (3) predation coinciding with low population numbers (rangewide); (4) response to human disturbance (rangewide); (5) insufficient lamb recruitment (rangewide); (6) toxic nonnative plants (San Jacinto Mountains, NorthSanta Rosa Mountains, Central Santa Rosa Mountains); and (7) prolonged drought (rangewide). These threats continue to impact the species, and most are rangewide and constant or increasing (Appendix 6). Development impacts are increasing in five Recovery Regions and stable in others. Conservation efforts from regional plans are helping to conserve land and protect Peninsular bighorn sheep habitat. Mining operations are stable in two Recovery Regions and not a threat elsewhere. Habitat fragmentation as a result of road and highway use is increasing in six Recovery Regions and stable in two. With increasing population growth in urban areas in close proximity to the Peninsular Ranges, negative effects from trails and recreational uses continue to increase in the six northern Recovery Regions, and effects have generally stabilized in the five southern Recovery Regions. OHVs have increased as a threat in four Recovery Regions and are not a threat elsewhere. The presence of invasive nonnative plants has increased rangewide, causing a change in forage quality and increasing wildfire risk at low elevation. The threat of wildfire at low elevation has increased in the five Recovery Regions near urban areas and remains constant in four. The threat of wildfire at high elevation is increasing in one Recovery Region and constant in all remaining Recovery Regions. Fire suppression is a rangewide threat to the habitat, although this has had a particularly significant effect in one Recovery Region. Negative effects from decreased water availability have increased in three Recovery Regions, remained constant in one Recovery Region, and we lack information to evaluate this threat in five Recovery Regions. Disease has increased as a threat in three Recovery Regions, remained constant in five Recovery Regions, and decreased in one Recovery Region. Predation coinciding with low population numbers has decreased as a threat in seven Recovery Regions and remained stable in two Recovery Regions. Impacts associated with human disturbance (i.e., behavioral) have increased in five Recovery Regions since listing and remain a serious threat. Insufficient lamb recruitment is an ongoing threat among most Recovery Regions and is known to be increasing in four areas. The impacts due to toxic nonnative plants has increased in three Recovery Regions, remained constant or decreased in three Recovery Regions, and is not a concern in the remaining Recovery Regions. Threats related to drought and climate change are increasing rangewide.

Habitat fragmentation, degradation, and loss have been addressed through various measures that have helped facilitate the conservation of much Peninsular bighorn sheep habitat throughout the range. The Coachella Valley MSHCP, finalized in 2007, plans to conserve 90 percent of the remaining private lands within conservation areas in Riverside County over the next 75 years, facilitating conservation in the three northernmost Recovery Regions. In 2000, the Santa Rosa and San Jacinto Mountains National Monument was dedicated, which affords protection to bighorn sheep habitat in the four northernmost Recovery Regions. If finalized, the Agua Caliente Tribe may also protect 85 percent of habitat within certain planning areas in the two northernmost Recovery Regions. However, it appears that planned development in the corridor between these two mountain ranges could isolate the San Jacinto Mountains subpopulation. Anza-Borrego DSP has secured a large area of land that remains in near pristine condition in the five southernmost Recovery Regions, and many areas not included in Anza-Borrego DSP have been conserved in BLM Wilderness Areas in seven Recovery Regions. Therefore, many layers of habitat protection have been assembled for Peninsular bighorn sheep. Research and understanding of how pervasive threats impact Peninsular bighorn sheep have also increased since listing, and management actions are attempting to control these ever-present issues through various means (i.e., limiting contact with the urban environment, potentially controlling specialist predators, closing trails seasonally, and educating the public).

Many threats, such as disease, predation, low lamb recruitment, and possibly human disturbance, will always be significant concerns to Peninsular bighorn sheep regardless of the efforts made to ameliorate them because, depending on population size, impacts can occur quickly and on a widespread scale, with potentially catastrophic effects on subpopulations or the metapopulation. For this reason, recovery efforts have concentrated on securing habitat and linkage corridors between subpopulations. In this way, the metapopulation should be able to tolerate fluctuations caused by dynamic threats because protected habitat and linkages would be available to facilitate movement of individuals and genes to assist in a population rebound. Connectivity between subpopulations remains an important concern as many important corridors and habitat linkages have yet to be included in protected areas, particularly between: (1) north San Jacinto and south San Jacinto Mountains; (2) San Jacinto and North Santa Rosa Mountains; (3) North San Ysidro and South San Ysidro Mountains; (4) Fish Creek Mountains and Vallecito Mountains; and (5) Jacumba Mountains to Mexico. Urban and commercial development continues to occur in and around the Peninsular Ranges, and essential resources remain unprotected in canyons, alluvial fans, and washes. The southernmost range is being rapidly developed by renewable energy projects. Between development of the Imperial Valley around the City of Ocotillo and the barrier posed by Interstate 8, the corridor for movement into Mexico, and reestablishing connectivity with the subpopulation in Mexico, is increasingly threatened. Given the continual nature of the threats identified at listing, new threats, the absence of permanently protected corridors between subpopulations, and the low number of ewes in three Recovery Regions, we have determined that Peninsular bighorn sheep continues to be endangered throughout its range. As a result, we recommend no change be made to the status of Peninsular bighorn sheep at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reason for delisting according to 50 CFR 424.11):
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
X No Change

New Recovery Priority Number and Brief Rationale: 9C

We recommend changing the recovery priority number for Peninsular bighorn sheep from 3C to 9C. Threats identified at listing continue to impact Peninsular bighorn sheep and its habitat. Though no threat has been completely ameliorated since listing, current regulatory mechanisms help to provide protection for this taxon in seven of the nine recovery regions. Habitat fragmentation, degradation, and loss have been addressed through various measures, which have helped conserve much Peninsular bighorn sheep habitat throughout the range. Additionally, the metapopulation size of Peninsular bighorn sheep has increased to approximately 981, which has helped buffer the metapopulation against individual threats such that the anticipated loss of individuals due to persistent rangewide threats may be manageable with existing management plans and regulatory mechanisms. The metapopulation has exhibited a high potential for recovery. Therefore, we recommend the recovery priority number be changed to 9C to reflect a moderate degree of threat, a high recovery potential, and a conflict with development.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Identify migratory routes and establish permanently protected corridors or linkages between all subpopulations, especially between the following locations:

    a. South San Jacinto Mountains and North San Jacinto Mountains,
    b. San Jacinto Mountains and North Santa Rosa Mountains,
    c. South San Ysidro Mountains and North San Ysidro Mountains, and
    d. Jacumba Mountains and Mexico.

2. Work with our partners to identify specific "no development" zones, cluster proposed development, and/or trade development rights to minimize general habitat impacts and maximize the functionality of corridor/linkage areas.

3. Study, monitor, and manage the effects of disease and domesticated livestock on Peninsular bighorn sheep in the United States and Mexico.

4. Construct wildlife crossing overpasses or underpasses over every major barrier (highway, road, etc.) to assist movement between subpopulations and reduce vehicle collision mortality.

5. Research and address the effects of both future renewable energy projects and border activities on the recovery of Peninsular bighorn sheep, and create planning guidance to minimize impacts.

6. Implement management actions to minimize impacts from recreational activities associated with hiking trails in the northern Peninsular Ranges and illegal OHV use where it occurs.

7. Research and quantify the urban and agriculture water withdrawals from the Peninsular Ranges. Address and minimize the effects of water withdrawals on the habitat and individual Peninsular bighorn sheep.

8. Work with partners and programs (such as the Partners for Fish and Wildlife Program) to identify recovery-related opportunities, such as the construction of additional fences, near major urban centers, including the cities of La Quinta, Borrego Springs, and possibly Ocotillo.

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Appendix 1: Peninsular bighorn sheep (*Ovis canadensis nelsoni*) occurrence table; prepared for 5-year review, 2010.

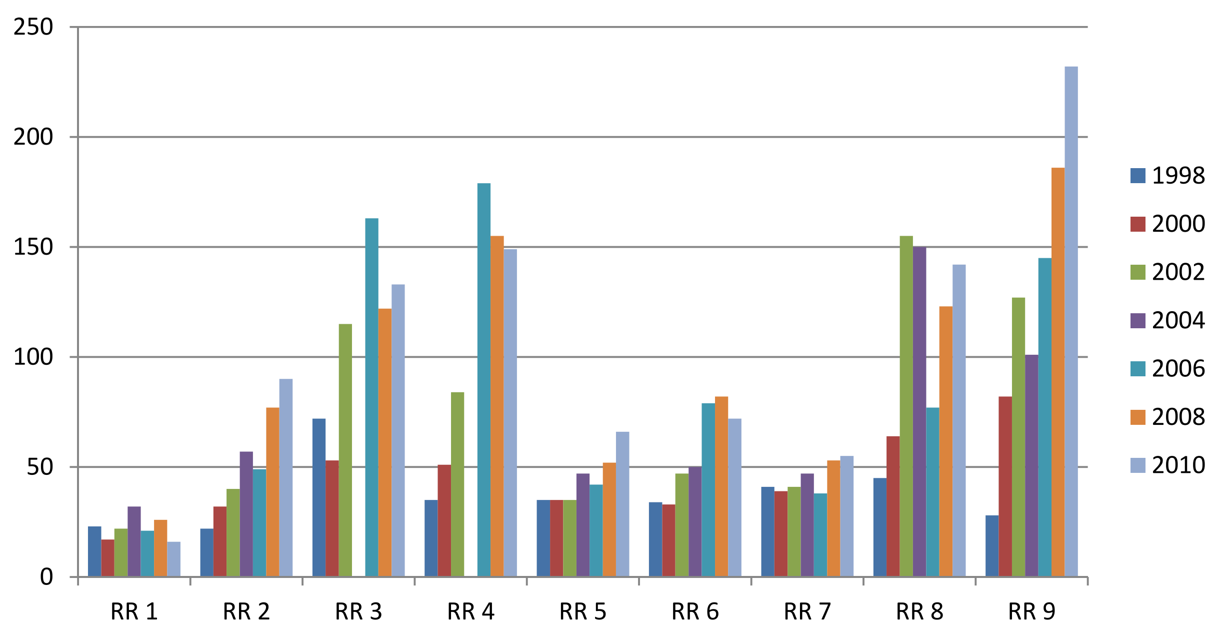
Recovery Region	Threats at Listing	Current Threats	Current Conservation	Total Population Trend
San Jacinto Mtns. (RR 1)	Factor A: Development; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, response to human disturbance.	Factor A: Development, trails and recreational use, nonnative plants, fire suppression, wildfire; Factor C: Disease and predation; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	San Jacinto and Santa Rosa Mountains National Monument, Coachella Valley MSHCP, BLM Wilderness Area, private conservation areas.	Stable at low numbers
North Santa Rosa Mtns. (RR 2)	Factor A: Development, ground water pumping, trails and recreational use, roads and highways; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, decreasing water availability, trails and recreational use, nonnative plants, fire suppression, wildfire. Factor C: Disease and predation; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	San Jacinto and Santa Rosa Mountains National Monument, Coachella Valley MSHCP, private conservation areas.	Increasing
Central Santa Rosa Mtns. (RR 3)	Factor A: Development, roads and highways; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, trails and recreational use, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	San Jacinto and Santa Rosa Mountains National Monument, Coachella Valley MSHCP, BLM Wilderness Area, private conservation areas.	Increasing
South Santa Rosa Mtns. (RR 4)	Factor A: Development; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, trails and recreational use, decreasing water availability, OHVs, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	San Jacinto and Santa Rosa Mountains National Monument, Coachella Valley MSHCP, Anza-Borrego Desert State Park, private conservation areas.	Increasing

Coyote Canyon (RR 5)	Factor A: Development; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, decreasing water availability, OHVs, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	Anza-Borrego Desert State Park	Increasing
North San Ysidro Mtns. (RR 6)	Factor A: Development, roads and highways; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, roads and highways, decreasing water availability, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	Anza-Borrego Desert State Park	Increasing
South San Ysidro Mtns. (RR 7)	Factor A: Development, roads and highways; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, roads and highways, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	Anza-Borrego Desert State Park	Increasing
Vallecito Mtns. (RR 8)	Factor A: Development, roads and highways, mining; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, roads and highways, OHVs, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	Anza-Borrego Desert State Park, BLM Wilderness Area	Increasing
Carrizo Cyn/Tierra Blanca Mtns./Coyote Mtns. (RR 9)	Factor A: Development, roads and highways, and mining; Factor C: Disease and predation; Factor E: Insufficient lamb recruitment, drought, toxic nonnative plants, response to human disturbance.	Factor A: Development, roads and highways, mining, OHVs, nonnative plants, fire suppression, wildfire; Factor C: Disease; Factor E: Response to human disturbance, insufficient lamb recruitment, drought and climate change.	Anza-Borrego Desert State Park, BLM Wilderness Area	Increasing

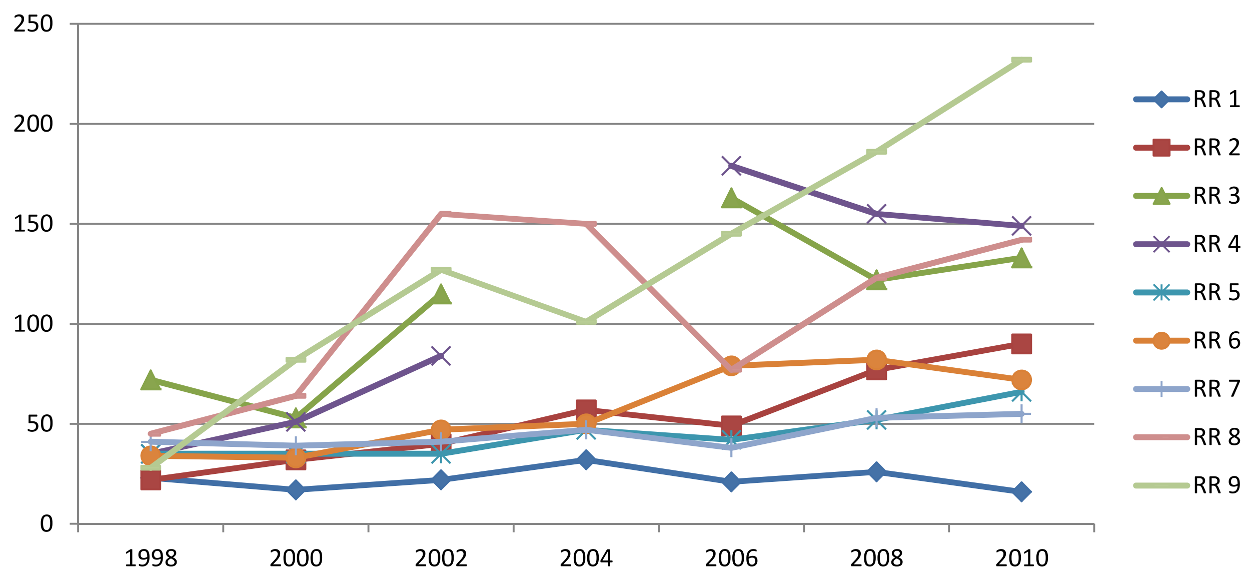
Appendix 2: Total estimated population abundance (adult ewes + adult rams + yearlings) per Recovery Region (RR) from 1998 to 2008 (CDFG 2004, 2011; BHI 1998b, 2000b, 2002b, 2004).

	RR 1	RR 2	RR 3	RR 4	RR 5	RR 6	RR 7	RR 8	RR 9	Total
1998	23	22	72	35	35	34	41	45	28	335
2000	17	32	53	51	35	33	39	64	82	406
2002	22	40	115	84	35	47	41	155	127	666
2004	32	57	Unknown	Unknown	47	50	47	150	101	Unknown
2006	21	49	163	179	42	79	38	77	145	793
2008	26	77	122	155	52	82	53	123	186	876
2010	16	90	133	149	66	72	55	142	232	955

Appendix 3: Total estimated population abundance (adult ewes + adult rams + yearlings) per Recovery Region (RR) through time (CDFG 2004, 2011; BHI 1998b, 2000b, 2002b, 2004).



Appendix 4: Total estimated population abundance (adult ewes + adult rams + yearlings) per Recovery Region (RR) through time (CDFG 2004, 2011; BHI 1998b, 2000b, 2002b, 2004).



Appendix 5: Peninsular bighorn sheep (*Ovis canadensis nelsoni*) adult ewe + yearling population estimates from 1996 to 2010 (CDFG 2004, 2009a, 2011; BHI 1996, 1998a, 2000a, 2002a, 2004, 2006, 2008); prepared for 5-year review, 2010.*

	RR 1	RR 2	RR 3	RR 4	RR 5	RR 6	RR 7	RR 8	RR 9
1996	7	11	Unknown	Unknown	23	22	12	19	24
1998	8	13	Unknown	Unknown	23	15	23	30	19
2000	8	14	Unknown	Unknown	23	17	27	39	53
2002	4	18	Unknown	Unknown	23	19	29	56	85
2004	12	32	Unknown	Unknown	25	27	33	112	71
2006	9	30	Unknown	Unknown	21	42	22	31	94
2008	12	32	Unknown	Unknown	31	54	48	102	395
2010	10	51	71	84	46	40	36	80	136
****2010**	10	50	68	75	41	35	36	72	119

*Population estimates were generated using Chapman's (1951) modification of the Peterson estimator (Seber 1982).
****2010 is the first survey year for which ewe abundance estimates were reported separately from female yearling abundance estimates. The ewe abundance estimates will be used to analyze the recovery criteria after six consecutive years (3 survey seasons) have been reported.**

Appendix 6: Approximate trends of threats to Peninsular bighorn sheep per Recovery Region (RR) in 2010. (↑ Increasing; — Constant; ↓ Decreasing; N/A: Not Applicable; ? Unknown).

Threat		RR 1	RR 2	RR 3	RR 4	RR 5	RR 6	RR 7	RR 8	RR 9
Factor A	Development (Urbanization)	↑	—	↑	↑	↑	↑	↑	—	↑
	Mining	N/A	N/A	N/A	N/A	N/A	N/A	N/A	—	—
	Road and Highway Use	—	↑	↑	—	N/A	↑	↑	↑	↑
	Trails and Recreational Use	↑	↑	↑	↑	—	—	—	—	—
	Off-Highway Vehicles	N/A	N/A	N/A	↑	↑	N/A	N/A	↑	↑
	Invasive Nonnative Plants	↑	↑	↑	↑	↑	↑	↑	↑	↑
	Fire Suppression	—	—	—	—	↑	—	—	—	—
	Wildfire at Low Elevation	↑	↑	↑	—	—	↑	↑	—	—
	Wildfire at High Elevation	—	—	—	—	↑	—	—	—	—
	Decreasing Water Availability	?	↑	?	—	↑	↑	?	?	?
Factor B	Overutilization	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Factor C	Disease	—	↓	—	—	↑	↑	↑	—	—
	Predation with Low Population Numbers	—	—	↓	↓	↓	↓	↓	↓	↓
Factor E	Human Disturbance	↑	↓	↑	—	—	↑	↑	—	↑
	Urban-related Mortality	—	↓	—	—	—	—	—	—	—
	Insufficient Lamb Recruitment	↑	—	—	—	↑	↑	↑	—	—
	Toxic Nonnative Plants	—	↓	↑	—	N/A	↑	↑	N/A	N/A
	Drought and Climate Change	↑	↑	↑	↑	↑	↑	↑	↑	↑

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Peninsular bighorn sheep (*Ovis canadensis nelsoni)*

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Review Conducted By: Carlsbad Fish and Wildlife Office

New Recovery Priority Number and Brief Rationale: 9C

We recommend changing the recovery priority number for Peninsular bighorn sheep from 3C to 9C. Threats identified at listing continue to impact Peninsular bighorn sheep and its habitat. Though no threat has been completely ameliorated since listing, current regulatory mechanisms help to provide protection for this taxon in seven of the nine recovery regions. Habitat fragmentation, degradation, and loss have been addressed through various measures, which have helped conserve much Peninsular bighorn sheep habitat throughout the range. Additionally, the metapopulation size of Peninsular bighorn sheep has increased to approximately 981, which has helped the metapopulation tolerate individual threats, such that the anticipated pace of the loss of individuals due to persistent rangewide threats is believed to be amenable to the management actions available through the existing management plans and/or regulatory mechanisms. The metapopulation has exhibited a high potential for recovery; therefore, we recommend the recovery priority number be changed to 9C to reflect a moderate degree of threat, a high recovery potential, and a conflict with development.

FIELD OFFICE APPROVAL:

ACTING **Lead Field Supervisor, U.S. Fish and Wildlife Service**

Approve ______________________________ Date APR 2 1 2011

Scott A. Sobiech