BEFORE THE SECRETARY OF THE INTERIOR

Petition to List the Sierra Nevada Red Fox (*Vulpes vulpes necator)* as Threatened or Endangered Under the Endangered Species Act

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27 April 2011

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27 April 2011

Mr. Ken Salazar
Secretary of the Interior
Department of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

Mr. Ren Lohoefener
Pacific Southwest Regional Director
U.S. Fish and Wildlife Service
2800 Cottage Way, Room W-2605
Sacramento, CA 95825

RE: PETITION TO LIST SIERRA NEVADA RED FOX (*Vulpes vulpes necator*) AS A THREATENED OR ENDANGERED SPECIES AND TO DESIGNATE CRITICAL HABITAT CONCURRENT WITH LISTING.

Dear Mr. Salazar and Mr. Lohoefener:

The Sierra Nevada red fox (*Vulpes vulpes necator*) is a subspecies of red fox that historically ranged from the southern Sierra Nevada Mountains northward through the southern Cascade Mountains of California and Oregon. Despite 31 years of protection as a threatened species under the California Endangered Species Act, Sierra Nevada red fox remains critically endangered and in imminent danger of extinction: it is today restricted to two small California populations; one near Lassen Peak with fewer than 20 known foxes and a second near Sonora Pass with only three known foxes. The total number of remaining foxes is likely less than 50; it could be less than 20. Its perilously small population size makes it inherently vulnerable to extinction, and sharply magnifies the extinction potential of several threats. None of those threats are abated by existing regulatory mechanisms. Therefore, pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. §1533(b), Section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 553(e), and 50 C.F.R. §424.14(a), the Center for Biological Diversity hereby formally petitions the Secretary of the Interior, through the United States Fish and Wildlife Service ("FWS", "the Service"), to list the Sierra Nevada red fox (*Vulpes vulpes necator*) as a Threatened or Endangered subspecies and to designate critical habitat concurrent with listing.

U.S. Fish and Wildlife Service has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on FWS. Specifically, FWS must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. §1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id.* Petitioners need not demonstrate that listing *is* warranted, rather, petitioners must only present information demonstrating that such listing *may* be warranted. While petitioners believe that the best available scientific information demonstrates that listing the Sierra Nevada red fox as endangered *is* in fact warranted, there can be no reasonable dispute that the available information indicates that listing the species as either threatened or endangered *may* be warranted. As such, FWS must promptly make an initial finding on the petition and commence a status review as required by 16 U.S.C. § 1533(b)(3)(B).

PETITIONER:

The Center for Biological Diversity is a nonprofit conservation organization with over 320,000 members and online activists. Failure to grant the requested petition will adversely affect the aesthetic, recreational, commercial, research, and scientific interests of petitioning organizations' members and of the citizens of the United States. Morally, aesthetically, recreationally, and commercially, the public shows increasing concern for wild ecosystems and for biodiversity in general.

27 April 2011

Taylor W. McKinnon
Center for Biological Diversity

Date

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EXECUTIVE SUMMARY

The Sierra Nevada red fox (*Vulpes vulpes necator)* is a critically endangered subspecies of red fox native to the Sierra Nevada and southern Cascade Mountains of California and Oregon. Once widespread and occurring in low population densities, the secretive Sierra Nevada red fox has undergone precipitous declines over the past century. Today it is restricted to two relict populations in California; one known population of fewer than 20 foxes near Lassen Peak and a second population of three known foxes near Sonora Pass. While exact population numbers are unknown, the total number of remaining foxes likely does not exceed 50 individuals and may be fewer than 20. The perilously small size, isolation, and low reproductive potential of remaining populations make Sierra Nevada red fox particularly vulnerable to extinction. That vulnerability is magnified by threats including development, climate change, disease, fire suppression, logging, livestock grazing, wildlife control activities, hunting, trapping, recreation and other factors. Given the fox's perilously small population, any of those threats could cause extinction. Despite being protected from intentional trapping in California since 1974 and being listed as threatened under the California Endangered Species Act since 1980, those protections have not curbed fox population declines in recent decades. Even after 31 years of California Endangered Species Act protection, a coordinated, range-wide inter-agency program to research, monitor, protect and recover Sierra Nevada red fox populations does not exist. The resulting lack of basic ecological information about the fox remains a threat to the species, just as it did in 1987. These facts demonstrate the inadequacy of existing federal and state regulatory mechanisms to protect the red fox from extinction. The Endangered Species Act states that a species shall be determined to be endangered or threatened based on any one of five factors (16 U.S.C. § 1533 (a)(1)). The Sierra Nevada red fox is threatened by all five of these factors and warrants listing as a threatened or endangered subspecies; it is imminently threatened with extinction due to loss and curtailment of habitat or range, overutilization, disease and predation, numerous other natural and human-caused factors, and the inadequacy of existing regulatory mechanisms to ensure its continued existence.

INTRODUCTION

The Sierra Nevada red fox (*Vulpes vulpes necator)* historically occupied alpine and subalpine habitats in the Sierra Nevada and Cascade Mountains of California and Oregon. Inhabiting remote, high elevation habitats, Sierra Nevada red fox was historically widespread but occurred at low population densities throughout its range. Recent genetic research indicates that the Sierra Nevada red fox consists of two closely-related populations, one in the Sierra Nevada and the other in the Cascade Mountains south of the Columbia River (Sacks et al. 2010). Montane red foxes in Oregon's Cascade Mountains were previously considered to be Cascade red fox (*Vulpes vulpes cascadensis).* Only two populations of Sierra Nevada red fox persist today; one near Lassen Volcanic National Park, and a second near Yosemite National Park and Sonora Pass. This petition summarizes the natural history of the Sierra Nevada red fox, its range contraction and population status, and the ongoing threats to the subspecies and its habitat. The Petition demonstrates that Sierra Nevada red fox warrants listing as a threatened or endangered species under the Endangered Species Act according to the Act's five listing factors.

NATURAL HISTORY AND ECOLOGY

Description

The Sierra Nevada red fox is characterized by its small, slender body and legs, long, pointed ears, an elongated snout and a long white-tipped tail. It is sexually dimorphic and typically smaller than lowland red fox subspecies; males and females are reported to weigh 4.0 – 4.2 and 3.3 – 3.5 kg, and have total body lengths up to 1040 and 978 mm, respectively; their tails constitute about half their overall body-length (Perrine 2005; Roest 1977). Sierra Nevada red fox occurs in three genetically-determined color phases: red, black/silver and cross. In the red phase, a reddish brown upper body contrasts with white cheeks, chin, throat and abdomen. In the silver/black phase, which varies from silver to black, silver guard hairs afford a "frosted" appearance. The cross phase, which is dominant among Sierra Nevada red fox, exhibits characteristics of red and silver/black phases, including a gray-brown coat and black guard hairs. All color phases can occur in a litter, and white-tipped tails are common to all color phases.

Taxonomy

Sierra Nevada red fox (*Vulpes vulpes necator)* is in the Kingdom Animalia, Class Mammalia, Order Carnivora and Family Canidae. Occurring in North America, Europe, Asia and Africa in biomes ranging from tundra to semi-arid desert, the red fox (*Vulpes vulpes)* is the most ubiquitous terrestrial carnivore in the world (Laraviere and Pasitschniak-Arts 1996). The Sierra Nevada red fox is one of 10 subspecies of red fox now recognized in North America and one of 44 subspecies recognized globally (Hall 1981; Laraviere and Pasitschniak-Arts 1996, but see Sacks et al. 2010), and, alongside Cascade red fox (*V.v. cascadensis)* and Rocky Mountain red fox (*V.v. macroura)*, is one of three subspecies of "mountain" or "montane" red foxes. Montane red foxes inhabit high-elevation alpine and subalpine environments and are phylogenetically, morphologically and ecologically distinct from other red foxes in North America (Laraviere and Pasitschniak-Arts 1996, Roest 1977, Aubry 1983, Crabtree 1993, Perrine et al. 2007, Perrine 2010, Sacks et al. 2010). The three subspecies derive from a common Wisconsonian source population from which they arose allopatrically following an early Holocene retreat to isolated boreal habitats (Aubrey 1983, Aubrey et al. 2009).

The earliest descriptions of North American red foxes did not distinguish them from those in Europe (Lineus 1758, Baird 1857). Later, Desmarest (1820) asserted that North American red foxes were a subspecies; Merriam first described the Sierra Nevada red fox in 1900 as *V. necator*. His description limited Sierra Nevada red fox's distribution to the southern Sierra Nevada based on one type specimen collected near Mt. Whitney (Merriam 1900). He described red foxes of the Cascade Mountains of California, Oregon and Washington as *V. cascadensis* (Merriam 1900). Seton (1929) later described the montane red foxes (*V. fulva)* as a subspecies of North American red foxes. Grinnell et al. (1937) described a single native subspecies of montane red fox in California as *V.v. necator* rather than *V.v. cascadensi.* Churcher's (1959) description of the subspecies establishes the current taxonomy (Perrine et al. 2006). This taxonomy is recognized today by the American Society of Mammalogists (Laraviere and Pasitschniak-Arts 1996).

As discussed below, recent genetic research indicates that Sierra Nevada red fox is and was historically comprised of two genetically distinct population segments; a Southern Cascade population in the Cascade Mountains of northern California and Oregon, and a Sierra Nevada population in the Sierra Nevada Mountains (Perrine et al. 2007, Sacks et al. 2010). These populations form Distinct Population Segments (DPS) under the Policy Regarding the Recognition of Distinct Vertebrate Population Segments under the Endangered Species Act ("the Policy," USDI 1996). Under the Policy, three elements are considered in a decision regarding the status of a possible DPS as endangered or threatened under the Act:

1) Discreteness of the population segment in relation to the remainder of the species to which it belongs;
2) The significance of the population segment to the species to which it belongs;
3) The population segment's conservation status in relation to the Act's standards for listing.

For a population segment to be considered discrete, it must satisfy either one of the following conditions:

1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation.
2) It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

Both the Southern Cascade and Sierra Nevada populations of Sierra Nevada red fox meet the first discreteness criterion because they are genetically distinct from one another as well as from other red fox populations. Using cytochrome b and mtDNA markers from historical and modern samples, Sacks et al. (2010) identify five major montane populations of red fox which are genetically distinct from one another including the Southern Cascades and Sierra Nevada populations (Fig. 1, p. 1528-1529). The authors propose a northern range extension for Sierra Nevada fox, stating:

> "Our results support Grinnell et al.'s (1937) view that a single subspecies of montane red fox occurs in California, and also demonstrate that its range extends northward into Oregon. Based on both mtDNA and microsatellite data, the Southern Cascades and Sierra Nevada populations are very closely related, whereas the Northern Cascades population is not closely related to either. Thus, consistent with previous zoogeographic arguments (Gordon 1966), our results show that the Columbia River provides a barrier to gene flow among populations of red foxes that are currently classified in a single subspecies (*V. v. cascadensis*). Accordingly, we propose that the range of the Sierra Nevada red fox (*V. v. necator*) be modified to include the southern Cascade Range in California and Oregon,

> and that the range of the Cascade red fox (*V. v. cascadensis*) be limited to the Cascade Range in Washington" (p. 1536).

Genetic research thus demonstrates that Sierra Nevada red fox is genetically distinct from other subspecies of montane red fox, and that the Southern Cascade and Sierra Nevada populations of Sierra Nevada red fox, though closely related, are further distinguishable from one another (Sacks et al. 2010).

For a population to be considered significant, it must satisfy any one of the following conditions:

1) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon;
2) Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon;
3) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range, or
4) Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

Both the Sierra Nevada and Southern Cascades populations of Sierra Nevada red fox satisfy the significance criteria because the loss of either population would result in a significant gap in the range of the taxon, and because they differ markedly from other populations of the species and from one another in their genetic characteristics.

The Sierra Nevada red fox subspecies historically ranged discontinuously from the Sierra Nevada mountains through the Cascade Mountains of California and Oregon north to the Columbia River (Sacks et al. 2010). The loss of either or both of these distinct populations would clearly create a significant gap in the range of the taxon. Because these populations differ from each other and from other red fox populations in their genetic characteristics (Sacks et al. 2010), their loss would mean the loss of unique haplotypes.

The Sierra Nevada red fox (*Vulpes vulpes necator*) is a recognized subspecies and therefore meets the definition of "species" under the ESA and should be considered for listing as such. While we believe the petition clearly demonstrates that the full subspecies meets the definition of endangered under the ESA and should be listed as such, because the subspecies is comprised of discrete populations centered in the Sierra Nevada and Southern Cascades, the Service should also assess whether these two populations qualify as distinct population segments (DPSs) under the ESA and warrant separate protection as such.

Range

Sierra Nevada red fox historically ranged from the southern Sierra Nevada Mountains northward through the Cascade Mountains south of the Columbia River. In the Sierra Nevada Mountains, the Sierra Nevada red fox historically ranged from Tulare Country northward through California and far-western Nevada to Sierra County (Grinnell et al. 1937). There is no evidence of Sierra

Nevada red fox having occurred in California's coast range (Grinnell et al. 1937). In the Cascade Mountains, the Sierra Nevada red fox historically ranged from northern California near Mt. Lassen, Mt. Shasta and the Trinity Mountains (Grinnell et al. 1937) northward through the

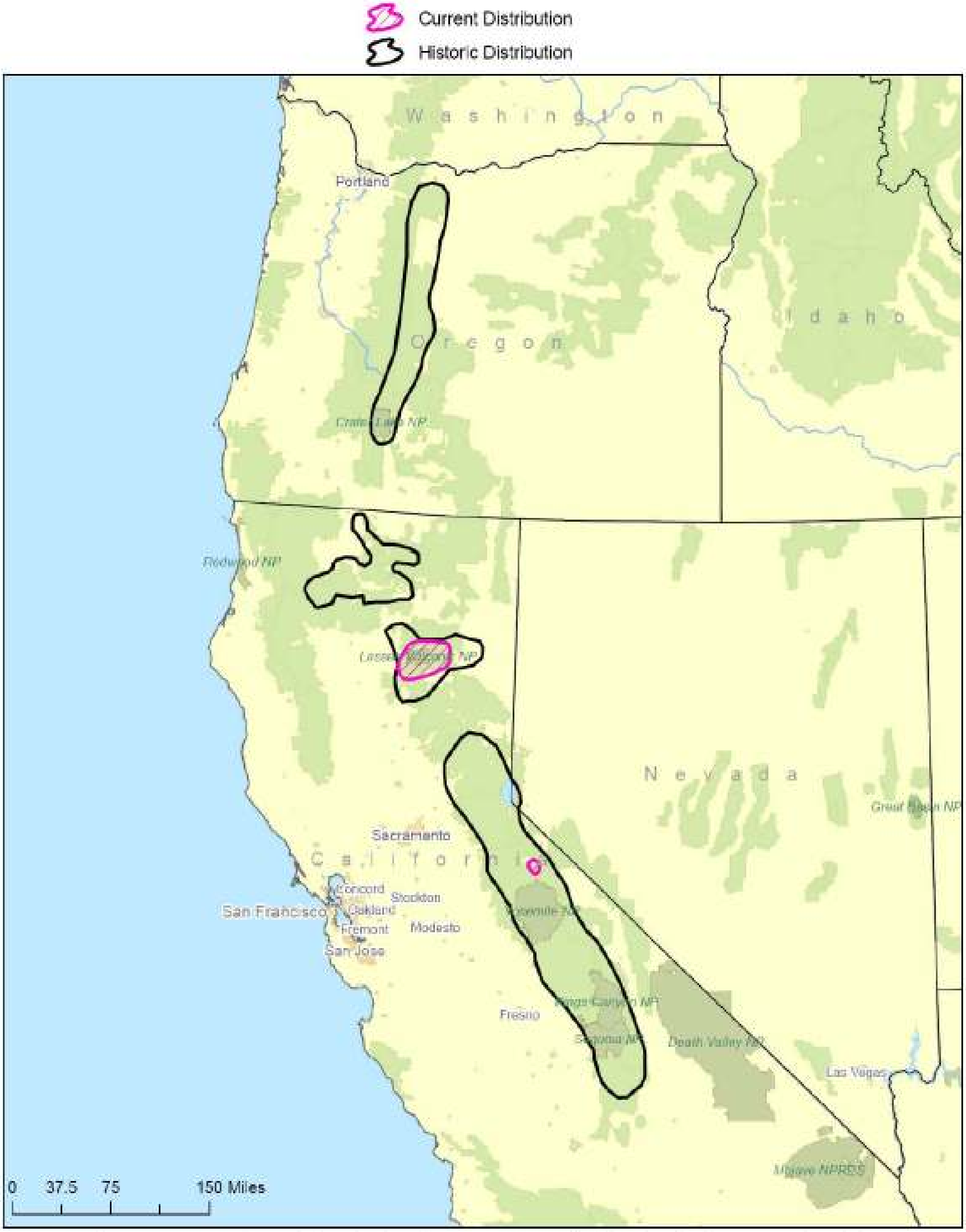

Figure 1. Approximate historical and known current distribution of Sierra Nevada red fox.

Cascade Mountains to the Columbia River (Sacks et al. 2010).

The known range of Sierra Nevada red fox today is limited to two small populations in California—one near Lassen Peak (Perrine et al. 2007, Sacks et al. 2010), and a second near Sonora Pass on the Humboldt-Toiyabe and Stanislaus National Forests. The Lassen population is limited to a small area that includes portions of the Lassen Volcanic National Park and Lassen National Forest (Perrine et al. 2010). In August 2010 a red fox was detected at a camera station on the Humboldt-Toiyabe National Forest near Sonora Pass (Perrine et al. 2010). Saliva tests confirmed this to be a Sierra Nevada red fox reflective of a population distinct from the Lassen foxes. In September 2010 two Sierra Nevada red foxes, one male and one female, were detected at another camera stations located on the Stanislaus National Forest four miles away from the first detection. The size and distribution of the Sonora Pass population is unknown but believed to be small. Although there are no other recent genetically-verified detections of Sierra Nevada red fox in California, Oregon or western Nevada, it is unlikely that a third remnant population persists in southern Oregon, as discussed below.

The lack of Sierra Nevada red fox detections in regional carnivore surveys further suggests sharp range contractions. Between 1996 and 2002 Zielinski et al. (2005) surveyed 3,000,000 ha of historical Sierra Nevada red fox habitat in California using an array of 344 sample units each consisting of six track plates and one camera station. No Sierra Nevada red foxes were detected. Similarly, recent marten (*M. Americana)*, fisher (*M. pennanti*) and wolverine (*Gulo gulo*) surveys using baited track plates and camera stations in Sequoia and King Canyon National Parks did not detect red foxes (Institute for Wildlife Studies 2006); nor did recent fisher surveys in Yosemite National Park (Lew Chow, U.S. Geological Survey pers. comm. cited in Perrine et al. 2010).

Five montane red foxes were detected with remote cameras in southern Oregon between 1991 and 2001 (USFS 2010); none of these has been genetically verified as Sierra Nevada red fox. Three were recorded on the High Cascade Ranger District of the Rogue River-Siskiyou National Forest during the winters of 1998, 2000 and 2001 (USFS 2010). The latter two of those were described as black-phase Cascade red foxes (USFS 2010). Two additional detections were reported in the winter of 1993-94 from the Diamond Lake Ranger District of the Umpqua National Forest (USFS 2010). No detections have been reported in Oregon since 2001 despite ongoing camera station surveys (USFS 2010). The success of camera station detections of Sierra Nevada red fox where foxes do occur suggests that negative detections reflect fox absence.

The Center for Biological Diversity mapped the approximate historical and known current ranges of Sierra Nevada red fox (Figure 1) using a conservative interpretation of historical range maps (Grinnell et al. 1937 for California, Aubrey 1983 for the Oregon Cascade Mountains) and information about the fox's current known range (Perrine 2005, USFS and CFGD 2010). While this map should be considered a very rough estimate of both ranges, it depicts a 96 percent reduction from approximate historical range (12,454,124 acres) to approximate current known range (566,197 acres).

Land Management

The U.S. Forest Service and National Park Service administer federal public lands comprising most of the historical and current known ranges of the Sierra Nevada red fox. The historical range of Sierra Nevada red fox spans five national parks: Yosemite, Kings Canyon, Sequoia, Lassen Volcanic and Crater Lake National Parks. The current known range of Sierra Nevada red fox spans Lassen Volcanic and possibly also Yosemite National Parks. National forests that intersect the historical range of Sierra Nevada red fox include the Sequoia, Sierra, Inyo, Stanislaus, El Dorado, Humboldt-Toiyabe, Tahoe and Lake Tahoe Basin, Plumas, Lassen, Shasta-Trinity, Klamath, Winema, Fremont, Umpqua, Deschutes, Willamette and Mt. Hood. The current known distribution of Sierra Nevada red fox spans portions of the Lassen, Humboldt-Toiyabe and Stanislaus National Forests. The historical range of Sierra Nevada red fox includes relatively small swaths of private land, tribal land, and land administered by the Department of Defense and the Bureaus of Land Management and Reclamation; none of these ownerships intersect the fox's approximate known range today. The Center for Biological Diversity mapped the approximate historical and known current ranges of Sierra Nevada red fox using historical range maps and information about the fox's current known range (Figure 1). While this map should be treated as a very rough estimate of both ranges, it nonetheless provides an informative approximation of acreage and relative percentage of land ownership (Table 1).

Table 1. Acreage by ownership for approximate historical and approximate current known range of Sierra Nevada red fox.

Ownership	Approximate Historical Range (acres)	Relative Percent of Acreage	Approximate Current Known Range (acres)	Relative Percent of Acreage
Bureau of Indian Affairs	420,195	3.37	0	0.00
Bureau of Land Management	153,748	1.23	0	0.00
Bureau of Reclamation	16,561	0.13	0	0.00
Department of Defense	1,649	0.01	0	0.00
United States Forest Service	9,966,785	80.03	457,260	80.76
National Park Service	1,895,186	15.22	108,937	19.24
Total	**12,454,124**		**566,197**	

Habitat

Sierra Nevada red fox uses a wide range of remote, high-elevation alpine and subalpine habitats including meadows, dense, mature forest, talus, and fell fields. Habitat use varies seasonally; Sierra Nevada red foxes are seasonal elevational migrants, moving from alpine and subalpine habitats in summer down to mid-elevation habitats in winter. They exhibit geographically and elevationally distinct winter and summer home ranges; elevational migration is driven by the impacts of heavy winter and spring snow packs on fox mobility, prey availability and avoidance of competitors, especially coyotes (Perrine 2005).

Using baited camera stations and telemetry tracking, Perrine (2005) investigated habitat relationships of the Lassen population. (The author notes that his sampling design may have been temporally and spatially biased.) Foxes used habitats within an elevation range of 1379-2612 m across a geographic area of 935 km^2 spanning nine California Wildlife Habitat Relationship community types, including: Barren, Eastside Pine, Lodgepole Pine, Montane Chaparral, Red Fir, White Fir, Sub-Alpine Mixed Conifer, Sierran Mixed Conifer, and Wet Meadow. While foxes were detected in a variety of community types at high elevations, they were not detected in structurally similar types at lower elevations. Fox detections were positively associated with elevation and negatively associated with herbaceous cover and shrub extent.

In summer foxes selected barren habitats and avoided mid-elevation conifer, hardwood and herbaceous communities. High elevation conifer and shrub communities were used proportionally to their availability; this use was variable among individual collared foxes. In winter fox detections were positively associated with dense, mature conifer forests exhibiting canopy cover greater than 40 percent and trees larger than 60 cm diameter at breast height (dbh). The author found that a 1.5 percent increase in the extent of mature, closed canopy forest resulted in a 3.5 percent increase in the probability of red fox detection. Winter home ranges were dominated by Sierran Mixed Conifer, Red Fir, Montane Chaparral and White Fir communities; foxes used cavities under fallen logs and trees in addition to the protected wells beneath snow-bound conifer trees. Winter day rests were most frequent within White Fir, Sierran mixed Conifer, White Fir, Montane Chaparral and Aspen communities.

Benson et al. (2005) inferred winter habitat relationships of the Lassen population using snow tracks. They found that foxes selected forest cover in proportions greater than its availability and openings in proportions less than their availability. Foxes avoided traveling directly through openings and selected the forested side of edges along and around openings. Fox tracks were also located in ski and snowshoe tracks. They suggest that foxes select forests over openings during winter to avoid the deepest snow and for cover from weather and predators.

Sighting reports provide additional information on habitat use by Sierra Nevada red fox. In the northern Sierra Nevada, sightings have been recorded about equally in fir and mixed conifer forests, with additional sightings in mixed pine and lodgepole pine. In the southern Sierra Nevada, reports were predominately from mixed conifer forests with additional sightings in lodgepole pine and fir (Schempf and White 1977). Red fox sightings on the Lassen National Forest in winter have been in mixed conifer and red fir forests above 1,500 m. Sightings in Lassen Volcanic National Park in 2000 and 2001 were concentrated in campgrounds, parking areas and along the main park road, where two to three red foxes begged for food from humans (Perrine 2005).

Little information exists on Sierra Nevada red fox dens. Trapping records summarized by Grinnell et al. (1937) reported dens in large talus and rock slide cavities; no earthen dens were reported. Neither Perrine (2005) nor Benson et al. (2005) documented den sites for the Lassen population. Aubrey (1983) reported one den in a vacation cabin and another earthen den located in a dense forest of white bark pine and mountain hemlock. The earthen den included seven openings across 294 feet of a rough contour line. Five openings were located in dense forest; two were located in a clear cut. The openings were about 10” by 12” in size; excavated dirt extended three to five feet from each hole. The den was located about 33' from water and roughly 200' from a road. The elevation of the cabin and earthen dens were 5200' and 4700' respectively.

Territory and Home Range

Urine and other scents are used to distinguish fox territorial boundaries. Both overlapping and non-overlapping red fox home territories have been observed (Ables 1975, Voigt 1987). Territory overlap may increase among populations with large home ranges. Foxes will defend the boundaries of their territories with attacks or by giving chase (Voigt1987). Estimates of Sierra Nevada red fox home ranges vary from 160 to 17,150 acres. Using trapping records, Grinnell et al. (1937) estimated that up to four individual foxes could occupy a 640 acre home range. Aubrey's (1983) home range estimates ranged from 160 to 760 acres (averaging 473 acres). Females with young exhibit smaller home ranges. Aubrey's estimates are based on daytime telemetry readings from four foxes; because foxes mostly forage at night, they may underestimate home ranges. Perrine (2005) estimated average summer and winter home ranges of 6,335 and 8,043 acres based on telemetry readings from five individuals. Summer home ranges varied from 647 to 17,250 acres. Perrine (2005) suggests that the large home ranges observed in the Lassen population reflect resource scarcity, the need for forage over large geographic areas, increased energy demands associated with breeding, and avoidance of competition from coyotes. Insofar as home range size reflects resource availability, the increasing size of home ranges observed from early (160 acres, Grinnell 1937) to later studies (647 – 17,250 acres, Perrine 2005) may signal declining resource availability concurrent with declining range extent.

Diet and Foraging

Sierra Nevada red fox is a nocturnal or crepuscular opportunistic predator. Sierra Nevada red fox diet varies seasonally with food availability, is dominated by rodents, and includes other mammals, birds, reptiles and fruit. Grinnell et al. (1937) reported Sierra Nevada red foxes hunting golden-mantled ground squirrels (*S. lateralis*), voles (*Microtus* sp.) and snowshoe hares (*L. americanus*). He noted foxes are likely to feed on hairy woodpeckers (*Picoides villosus*), Williamson's sapsuckers (*Sphyrapicus thyroideus*), Clark's nutcrackers (*Nucifraga columbiana*), mountain chickadees (*Poecile gambeli*), blue grouse (*Dendragapus obscurus*), flying squirrels (*Glaucomys sabrinus*), pikas (*Ochotona princeps*), weasels (*Mustela* spp.), and livestock carcasses. His analysis of Sierra Nevada red fox scats confirmed remains of mice, woodrats *(Neotoma cinerea*), Douglas squirrels (*Tamiasciurus douglasii*), Belding's ground squirrels (*Spermophilus beldingi*), chipmunks (*Tamias* sp.), and white-tailed jackrabbits (*Lepus townsendii*).

Perrine (2005) showed that Sierra Nevada red fox diet consists of mammals, reptiles, arthropods, fruit and manmade items, in that order of abundance. At least 24 species of mammals accounted for between 77.8 (winter) and 58.3 (summer) relative percent occurrence of food items. At least 14 species of rodents accounted for between 37.2 (summer) and 45.2 (fall) percent of food items; pocket gophers (*Thomomys monitcola)*, mice (*Peromyscus sp.)* voles (*Microtus sp.*) and ground squirrels (*Spermophilus sp.)* were particularly abundant. Less abundant mammalian food items included mule deer carrion (*Odocoileus hemionus),* insectivores (*Scapanus latimanus* and *Sorex* *spp.)*. Birds and manzanita (*Arctostaphylos nevadensis*) fruit were common in autumn scats, as were arthropods in summer scats. Although mule deer was a less abundant food item, it was taken year round, most prominently in winter and spring. Perrine (2005) postulates that this represents carrion and notes the importance of ungulate carrion to red fox and other carnivores during winter even if those carcasses are relatively rare.

Both Perrine (2005) and Aubrey (1983) suggest that pocket gophers are a particularly important food item for red fox, but Perrine (2010) notes that it's unclear whether foxes take them in proportion to their abundance. Perrine (2005) suggests that the scarcity of lagomorphs coupled with the difficulty of hunting rodents in heavy winter snows explains winter migration to lower elevations and lesser snow packs. He also suggests that foxes' winter lower elevational range is limited by avoidance of food-competing coyotes; coyotes, with higher foot pressure less suited to snow travel, tend to avoid deep snow packs and thus occupy lower elevations. This may confine foxes to food-scarce winter habitats and, together with coyote competition during non-snow seasons, explains Perrine's (2005) notion of high-elevation competition refugia, his observations of relatively large home ranges, and taking of "starvation" food items by foxes across all seasons. As discussed later, these factors bear on Sierra Nevada red fox in the face of higher, shorter-duration snow packs.

Aubrey (1983) reported food habits generally similar to Perrine's (2005) findings when studying Cascade red fox in southern Washington. Rodents comprised the most significant component of food items year-round (ranging from about 41 percent in summer to 58 percent in spring), other mammals were more frequently taken in winter and spring than summer and fall, fruit and arthropods were more frequently taken in summer and fall, and birds were infrequently taken in spring, summer and fall but not winter. A notable difference between Aubrey and Perrine's findings involves fox taking of artiodactyls and lagomorphs. In the Lassen population, artiodactyls were an important food item in winter and spring while lagomorphs were absent; during the same seasons lagomorphs were an important food item for foxes while artiodactyl food items were far less prominent (Perrine 2005). The unavailability of lagomorphs in the Lassen population's prey base presents a third factor (alongside heavy snow packs and coyote competition avoidance) potentially contributing to their large home ranges and taking of "starvation" foods in winter (Perrine 2005).

Life History and Demography

Sierra Nevada red fox breeding occurs between December and March. Mating and den construction occur in January and February; the fox is believed to be monogamous (Grinnel et al. 1937). The gestation period for the fox is between 52-54 days; pups are born in early to mid-April, and move outside the den by June but are not very mobile until later in the summer (Grinnell 1937, Aubry 1983, Perrine 2005). Although Grinnel and others (1937) reported Sierra Nevada red fox litter sizes between three and nine pups (averaging six pups), more recent accounts from California (summarized by Perrine 2010) suggest that litter sizes of two or three pups are more common. Because red fox reproduction is correlated with food availability (Voigt 1987), limited food availability in alpine and subalpine habitats may limit reproductive output relative to foxes occupying more productive environs. The resulting relatively low reproductive capacity of Sierra Nevada red fox makes recovery from population decline more difficult than for other foxes. Sierra Nevada red fox pups reach sexual maturity in their first year. Aubrey (1983) reported a female red fox having a litter of three pups in her first year. Because no studies have documented age-specific mortality rates, demographic structure, longevity or sex ratios within Sierra Nevada red fox populations, little is known about Sierra Nevada red fox demographics (Perrine et al. 2010).

Actual, potential and past mortality factors for Sierra Nevada red fox include hunting, poaching, trapping, disease, recreation, vehicle strikes and poisoning through animal-control programs associated with livestock grazing (Perrine 2005, Grinnell and others 1937). Some of these are discussed later in this petition's "threats" section. Natural sources of fox mortality include or historically included predation by larger carnivores including wolves, mountain lions, bobcats, and coyotes (Larivière and Pasitschniak-Arts 1996, Tjernberg 1981, Dekker 1983, Perrine 2005, Sargeant and Allen 1989 cited in Perrine 2010). Grinnell et al. (1937) considered golden eagles to be a potentially significant predator of the fox. Diseases can also be a source of red fox mortality, including rabies, distemper, canine hepatitis, parvovirus, taxoplasosis, leptospirosis, tularemia and encephalitis (Nowak 1999, Voigt 1987). Sacroptic mange is often fatal to red foxes (Samual and Nelson 1982). Parasites, including ticks, fleas, trematodes, nematodes, protozoans and heartworms can also plague red foxes (Larivière and Pasitschniak-Arts 1996).

Status and Trend

Only two relict populations of Sierra Nevada red fox persist today, both in California. One known population near Lassen Peak is believed to consist of fewer than 20 foxes (USFS and CGFD 2010); a second population of only three known foxes occurs near Sonora Pass (USFS and CGFD 2010). While exact population numbers are unknown, the total number of remaining foxes likely does not exceed 50 individuals and may be fewer than 20 (USFS and CGFD 2010). Given its perilously small population, Sierra Nevada red fox is considered "threatened," "endangered" and "critically endangered" (CDFG 1996, Perrine et al. 2007, Sacks et al. 2010).

Declines in genetic diversity have occurred concurrently with observed declines in fox population abundance and range extent during the last century (Sacks et al. 2010, Schempf and White 1977, Gould 1980, CDFG 1996). Sacks et al (2010) conclude that declines in mtDNA and nuclear genetic diversity have accompanied population declines:

> "The temporal estimate of recent Ne for the montane group was an order of magnitude lower than the long-term estimate based on coalescent simulations, indicating a range-wide decline. Lastly, AMOVAs using both markers showed clear increases in isolation in the modern period relative to the historical period" (p. 1535).
>
> and
>
> "In California, montane populations of the red fox have declined in abundance over the past several decades to critically low numbers (Perrine et al. in press). Our findings of (1) substantial declines in both mtDNA and nuclear genetic diversity, (2) estimates of contemporary genetic effective population sizes based on these markers, and (3)

> heterozygote excesses indicative of recent bottlenecks in the modern sample are consistent with this decline (p. 1536).

The authors conclude that estimates of contemporary genetic effective population size are so low as to raise concern about the survival of the subspecies, because the population is very small and vulnerable to extirpation.

Similarly, Perrine et al. (2007) report a reduction from four to one haplotypes in historical and contemporary Sierra Nevada red fox, providing genetic evidence of population decline:

> "…all nine samples from this population had the same haplotype, suggesting that several historic haplotypes may have become lost… The lack of haplotype diversity within this modern population is consistent with high levels of genetic drift and loss of rare alleles as would be expected within small, isolated populations…"

This loss of genetic diversity heightens the risk of extinction for Sierra Nevada red fox. Only two relict populations of Sierra Nevada red fox are known to persist today; as discussed earlier in the petition, one additional population may persist in southern Oregon, but this is unlikely. The lack of recent montane red fox camera detections in southern Oregon may suggest recent population declines. While the population size of Sierra Nevada red fox is unknown, a rapid reduction of population size during the past century can be reasonably inferred to have corresponded to range contractions witnessed across the last century throughout its range. Despite the lack of historical or current population numbers, given apparently sharp range contractions and genetic evidence of decline, Perrine et al. (2007), Sacks et al. (2010), and others consider Sierra Nevada red fox to be "critically endangered."

Conservation Status

NatureServe (2010) lists Sierra Nevada red fox conservation status as G5T1T3, a critically imperiled subspecies of red fox. Sierra Nevada red fox was removed from the candidate list for protection under the federal Endangered Species Act in 1994 (USFWS 1994) and is now a U.S. Fish and Wildlife Service Region 1 Species of Concern (USFWS 2010). In 1980 the Sierra Nevada red fox was listed as a threatened species under the California Endangered Species Act. The listing status was retained in 1987 due to ongoing threats from logging, grazing and human disturbance (CDFG 1987). Sierra Nevada red fox does not enjoy any elevated conservation status in the states of Oregon or Nevada.

SIERRA NEVADA RED FOX WARRANTS LISTING UNDER THE ENDANGERED SPECIES ACT

Under the ESA, 16 U.S.C. § 1533(a)(1), FWS is required to list the Sierra Nevada red fox if it is in danger of extinction or likely to become endangered in all or a significant portion of its range. In making such a determination, FWS must analyze the fox's status in light of five statutory listing factors:

(1) the present or threatened destruction, modification, or curtailment of habitat or range;

(2) overutilization for commercial, recreational, scientific, or educational purposes;

(3) disease or predation;

(4) the inadequacy of existing regulatory mechanisms;

(5) other natural or manmade factors affecting its continued existence.

16 U.S.C. § 1533(a)(1)(A)-(E); 50 C.F.R. § 424.11(c)(1) - (5).

All five of these factors threaten the fox. The Sierra Nevada red fox is threatened by habitat destruction and modification, overutilization, predation, the inadequacy of existing regulatory mechanisms, and other factors including small population size, restricted breeding range, recreation, disease and global climate change. Threats to the fox in light of each of these factors are discussed in detail below. Due to its small population size, restricted range, and imminent threats, the Sierra Nevada red fox clearly warrants protection under the Endangered Species Act.

THREATS

As detailed below, the Sierra Nevada red fox's already heightened vulnerability to extinction—owing to its critically small population size (likely fewer than 50 individuals), the isolation of its two relict populations, its low genetic diversity and low reproductive capability—radically magnify the extinction potential of other threats.

1. Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Threats to the fox's habitat are numerous and include logging, fire suppression, salvage logging, domestic livestock grazing, recreation, and over-snow and off-road vehicle use.

Logging

Logging operations, including large machines felling and forwarding logs, stacking slash, constructing landings, or building or improving roads, have the potential to kill Sierra Nevada red fox, especially juvenile foxes that are still relatively immobile in late spring and early summer. Logging can also destroy mature, dense, mid-elevation forests that foxes use in winter. Perrine (2005) found that fox detections were positively associated with dense, mature conifer forests exhibiting canopy cover greater than 40 percent and trees larger than 60 cm dbh. The author found that a 1.5 percent increase in the extent of mature, closed canopy forest resulted in a 3.5 percent increase in the probability of detection. Winter home ranges were dominated by Sierran Mixed Conifer, Red Fir and White Fir communities; foxes used cavities under fallen logs and trees in addition to the protected wells beneath snow-bound conifer trees. Winter day rests were most frequent within white fir, Sierran mixed conifer, montane chaparral and aspen communities. Benson et al. (2005) found that Sierra Nevada red foxes selected forest cover in proportions greater than its availability and openings in proportions less than their availability. Foxes avoided traveling directly through openings and selected the forested side of edges along and around openings. They suggest that foxes select forests over openings during winter to avoid the deepest snow and for cover from weather and predators (Benson et al. 2005). By reducing canopy cover and densities of large trees, logging threatens to destroy and modify dense, mature mid-elevation forests that Sierra Nevada red fox select in winter (Perrine 2005, Benson et al. 2005). Further, those structural changes could facilitate invasion by coyotes or lowland red foxes, causing increased competition, predation and possibly interbreeding with non-native red fox. Increases in competition and predation could reduce Sierra Nevada fox population numbers and reproductive success. Logging of large trees could reduce number of snow tree-wells formed by large trees, thereby reducing the availability of day rests for foxes. Similarly, removal of large trees could reduce the long-term availability of fallen logs beneath which red foxes use cavities as day rests. Because dense, mature forest structures, including downed logs and tree wells that large trees create, form one necessary element of the habitat matrix that Sierra Nevada red fox's require, the structural changes caused by logging render broader habitat matrices less or totally unusable.

The extent of mature and old growth forest conditions have been severely reduced during the past century throughout the historical range of Sierra Nevada red fox in the Sierra Nevada and southern Cascade Mountains. Strittholt et al. (2005) found severe declines in mature and old growth forest structure throughout the Cascade Mountains during the past century. In the southern Cascade Mountains, the extent of old conifer forest has been reduced by 82 percent, from 3,361,005 to 1,328,796 acres (Strittholt et al. 2005). The extent of eastern Cascade Mountain forests has declined from 3,238,883 to 687,836 acres, or 79 percent (Strittholt et al. 2005). The Sierra Nevada Ecosystem Project found similar declines in forests of the Sierra Nevada Mountains. Today forests exhibiting high levels of late successional structural complexity comprise 19 percent of all mid-elevation forests on federal lands; 13 percent of those occur on national forest lands while 55 percent occur within national parks. The proportion of federal forest exhibiting moderate levels of late successional forest structural complexity is 47 percent; 42 percent on national forests and 82 percent in national parks. Late successional old-growth forests of middle elevations (west-side mixed conifer, red fir, white fir, east-side mixed conifer, and east-side pine types) at present constitute 7 percent–30 percent of the forest cover, depending on forest type. On average, national forests have about 25 percent the amount of the national parks. The authors considered the amount of late successional forest on national park land to be an approximate benchmark for pre-settlement forest conditions.

Livestock Grazing

Domestic livestock grazing is a common land use across national forest lands located in the Sierra Nevada and southern Cascade Mountains. As shown in Figure 2, a total of 294 national forest and BLM grazing allotments intersect the approximate historical range of Sierra Nevada red fox in California and Oregon and a total of 27 national forest grazing allotments intersect the fox's approximate current known range. The names of those allotments are listed in Appendix 1. As explained below, domestic livestock grazing is a primary threat to Sierra Nevada red fox.

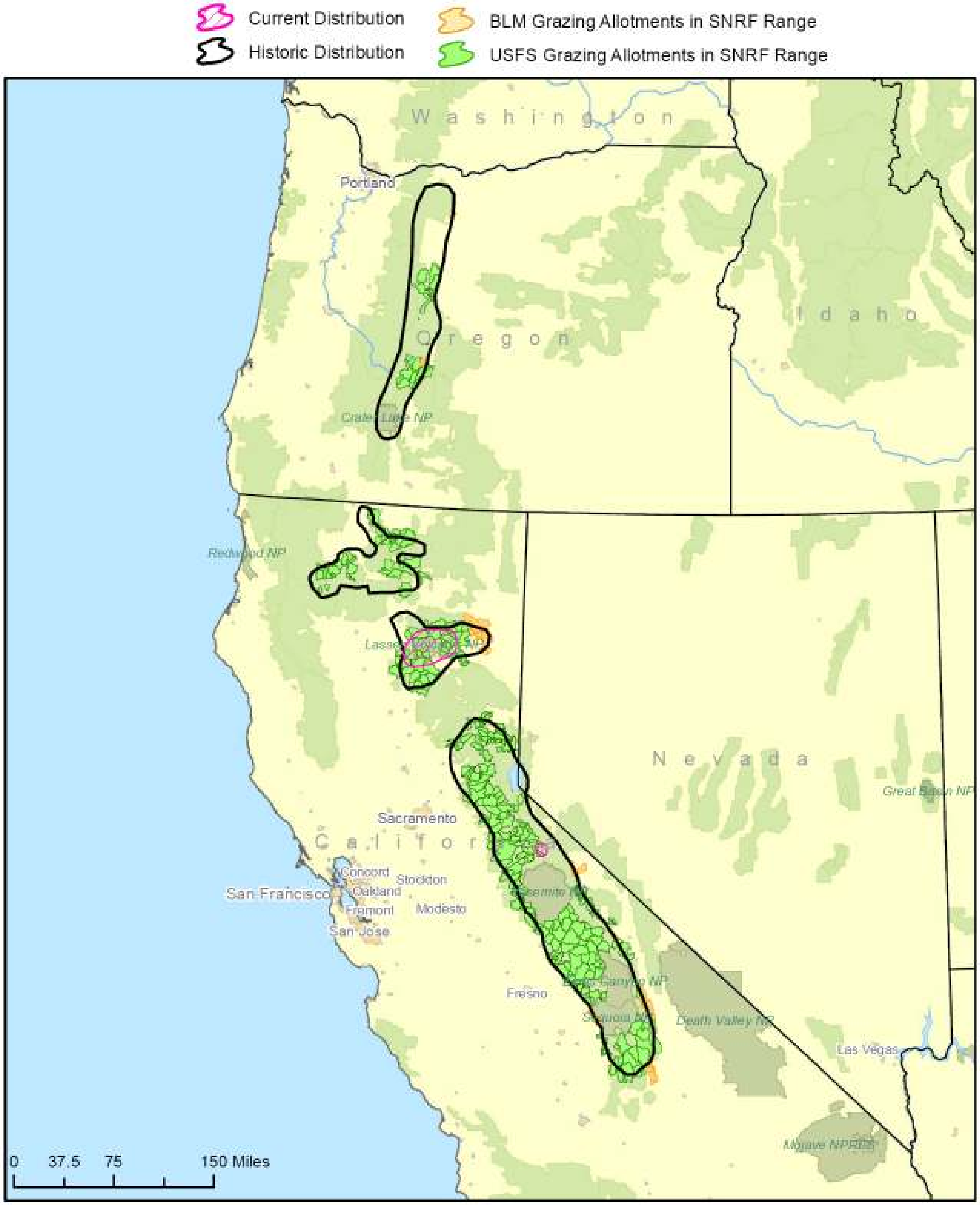

Figure 2. A total of 294 National Forest and Bureau of Land Management livestock grazing allotments intersect the historic or current known range of Sierra Nevada red fox.

Small mammals and rodents make up the majority of Sierra Nevada red fox diet (Perrine 2005, Grinnell et al. 1937, Aubrey 1983); livestock grazing can reduce the abundance, density, species richness and habitat quality of those species, thereby compromising prey availability for red fox (Perrine et al. 2010). Citing reductions of available forage to grassland prey species like voles, Grinnell et al. (1937) described overgrazing by sheep to be “the greatest menace to the productivity” of Sierra Nevada red fox. Livestock grazing threatens Sierra Nevada red fox by negatively affecting the species that form the fox’s prey base, including rodents, other small mammals, deer and birds. Many small mammals are granivorous and thus compete with livestock for native grass forage. Grant et al. (1982) found that the overall biomass of small mammals was lower at grazed sites than un-grazed sites in three of four grassland types. Kauffman and Krueger (1984) found that “livestock grazing and the subsequent removal of forage…cause[d] significant short-term decreases in small mammal composition and densities.” Hayward et al. (1997) found that “small mammals were 50 percent more abundant on plots from which livestock were excluded [for 10 years]." Hanley and Page (1982) found that "Microtine rodents were consistently found in lower abundance in livestock-grazed than –ungrazed communities. Other species…appeared to act as ‘decreasers’ in zeric haitats…”

Perrine (2005) found that mule deer, though not an abundant food item for Sierra Nevada red fox, was taken year round, most prominently in winter and spring when resource scarcity is greatest for the fox. He postulates that this represents carrion and notes the importance of ungulate carrion to red fox during winter even if those carcasses are relatively rare (Perrine 2005). Livestock grazing can thus impact Sierra Nevada red fox by negatively impacting deer habitat quality, abundance and density, thereby reducing the availability of winter and spring deer carcasses. For example, Loft et al. (1991) found that, “In the absence of grazing, meadow-riparian habitat comprised a greater proportion of deer home ranges…” “Within home ranges, deer preferred meadow-riparian habitat.” Bowyer and Bleich (1984) “found significantly fewer…deer…in meadows where cattle occurred than in similar areas where cattle were prohibited." Loft et al. (1993) found that "Deer home ranges increased in area as cattle grazing level increased" and that "…deer and cattle were attracted to distributed meadow-riparian and aspen habitats where herbaceous forage was most available…" Kie (1996) found that increased cattle grazing increased doe foraging time beyond the preferred crepuscular activity periods.

Birds, including but not limited to hairy woodpeckers (*Picoides villosus*), Williamson’s sapsuckers (*Sphyrapicus thyroideus*), Clark’s nutcrackers (*Nucifraga columbiana*), mountain chickadees (*Poecile gambeli*), and blue grouse (*Dendragapus obscurus*) are also an important food item for Sierra Nevada red fox, especially in spring, summer and fall (Perrine 2005, Grinnell et al. 1937, Aubrey 1983). Reductions in the density, abundance and viability of birds caused by livestock grazing or its secondary effects in turn compromises that prey base for Sierra Nevada red fox. For example, the Sierra Nevada Ecosystem Project (1996) found that “among the potential risks faced by Sierran land birds, grazing and its secondary effects appear to be the single most significant negative factor" and concluded that "…grazing is the primary negative factor affecting the viability of native Sierran bird populations." Graber (1996) concluded that "Grazing of Sierran habitats, particularly mountain meadow and montane riparian habitats, may constitute a significant threat to Sierran landbirds" and found that "…grazing tends to decrease the amount of herbaceous plant woodland, and brushland habitats, thereby negatively affecting the food resources of many granivorous and some insectivorous [birds]…"

Reduced prey availability and secondary exposure to the use of strychnine and other toxins and rodenticides in conjunction with livestock grazing also threatens Sierra Nevada red fox (Perrine et al. 2010). Perrine et al. (2010) summarize that threat as follows:

> "The widespread and indiscriminant use of strychnine to control predator populations on grazing lands has largely been outlawed, especially in California. However, rodenticides are still widely used on public and private lands to protect vegetation and livestock and to control plague. The most widely used chemicals appear to be strychnine, used for pocket gopher control, and diphacinone, used to control ground squirrel and chipmunk populations primarily in response to plague outbreaks in human recreation areas (Dave Bakke, USDA Forest Service, pers. comm.). Historically, the widespread aboveground application of strychnine for rodent control caused extensive mortality of non-target species, including canids (Linsdale 1931 and 1932). Application of strychnine occurs on an average of several thousand acres per year out of the 21 million acres managed by the Forest Service in California, and diphacinone use is relatively rare, occurring in one to two campgrounds a year (Dave Bakke, USDA Forest Service, pers. comm.). Current laws and regulations for controlling pocket gophers with strychnine are designed to minimize non-target species mortality by applying the toxin underground, monitoring the treatment area and removing rodent carcasses on the surface. However, even underground treatment for pocket gophers can cause reduction in local ground squirrel populations, and strychnine may remain in the gastrointestinal tracts of affected ground squirrels (Anthony and others 1984). Therefore, a risk of secondary poisoning remains should predators or scavengers consume a sufficiently large number of poisoned animals. Sierra Nevada red foxes may face a higher risk than other predators or scavengers (e.g., birds) as pocket gophers are an important food year-round (Perrine 2005). Furthermore, they routinely dig gophers out of their burrows, making it likely that they would also be able to access poisoned carcasses and residual traces of bait belowground. The risk may be higher with the use of anticoagulant rodenticides such as diphacinone. As a first-generation anti-coagulant, diphacinone has relatively low toxicity to rodents and requires multiple applications to ensure effective treatment. These baits typically are applied aboveground, and evidence suggests that secondary poisonings are possible if a predator consumes the gastrointestinal tract or cheek pouches of poisoned rodents (Mendenhall and Pank 1980; Hegdal and others 1981; Littrell 1990). These treatments are usually applied at recreation sites such as campgrounds, which may increase the exposure to human-habituated red foxes" (p. 29-30)

The threat of livestock grazing is demonstrated by the coincidence of national forest grazing allotments and the fox's approximate historical and current known range.

Fire Suppression

Over the long-term, wildfire plays a role in developing the habitat components on which Sierra Nevada red fox depends, including mature and old growth forests, fell fields, montane meadows and forest mosaics in varying stages of post-fire recovery. Suppression of natural fires, including the suppression of natural high-severity fire, threatens to reduce the overall extent of meadows, forest openings, fell fields and early-seral, post-fire habitats that provide important foraging habitat to Sierra Nevada red fox and important habitat to mule deer, birds and especially small mammals that form majority of the fox's prey base. For example, the Final EIS for the 2004 Sierra Nevada Forest Plan Amendment indicates that, on average, there are about 15,000 acres of high-intensity fire occurring per year in Sierra Nevada forests (entire Sierra Nevada included) (USDA 2004). Given the size of the forested area in the Sierra Nevada, about 13 million acres (Franklin and Fites-Kaufman 1996), this equates to a high-intensity fire rotation interval of more than 800 years in current forests (longer rotation intervals correspond to less high-intensity fire) (Hanson 2007). Natural high severity fire rotations are estimated to occur at much lower intervals, resulting in comparatively more acreage left in open, post-fire seral stages that exist today (Hanson 2007).

Due to the fox's critically low population abundance and restricted known range, fire suppression activities including temporary road construction, road reconstruction, bulldozer line construction, helicopter pad construction, back-burn and "burnout" operations, snag and tree felling, fire retardant dispersion and post-fire seeding, felling and soil contouring threaten the Sierra Nevada red fox with direct mortality, visual or auditory disruption and increased stress hormones, and alteration and fragmentation of the structure, composition, and long-term habitat suitability. Backer et al. (2004) provide a useful overview fire suppression impacts on natural communities that is applicable to the communities upon which Sierra Nevada red fox depend.

Fire suppression further threatens the red fox because the use of fire retardants in fire suppression operations exacerbates the threat posed to the fox by salmon poisoning disease, discussed below under Disease.

Recreation

Recreational activities, including use of off-highway vehicles, snowmobiles, dirt bikes, hiking, and camping, could degrade Sierra Nevada red fox habitat, interfere with normal fox behavior, and/or cause foxes to shift to less than optimal habitat areas where they are move vulnerable to predation or starvation. The threat posed to the fox by recreation is potentially serious because they are associated with remote conditions and have not evolved with human disturbance. Due to the remoteness of Sierra Nevada red fox habitat and the increasing capability of recreational users—especially motorized users—to access remote, high-elevation habitats in all seasons, recreation poses an increasing threat to the fox.

a. Road Construction and Other Development

Human development and roads within the range of Sierra Nevada red fox may enable non-native red foxes and coyotes to penetrate previously impenetrable habitat for native red fox, increasing the potential for interbreeding, competition with and predation of Sierra Nevada red fox. Development and roads within the range of Sierra Nevada red fox also pose a threat to the species through an increased risk of predation from domestic pets, disease transmission, vehicle strikes, poisoning and other human-wildlife conflicts (Perrine et al. 2010). Roads and other development may facilitate movement of coyotes into Sierra Nevada red fox habitat, thereby increasing predation and interspecific competition. Roads may facilitate the movement of non-native red fox into Sierra Nevada red fox habitat, thereby facilitating interbreeding. Road and human development threats, and the increased human activity they bring, may be magnified by Sierra Nevada red fox's propensity for begging behavior and habituation to humans and human development (Perrine 2005). The threats posed to Sierra Nevada red fox by road construction and development are magnified by its small population size, population isolation and reduced genetic diversity.

b. Over-snow Vehicle (OSV) Use

Over-snow vehicles have the potential to cause mortality, habitat loss and harassment of wildlife, including Sierra Nevada red fox. They have been shown to cause direct and indirect mortality to native canids as OSV users chase them to death for sport and through direct vehicle strikes (Baldwin 1970, Malaher 1967, Wettersten 1971, Kopischke 1973, Heath 1974). OSV harassment can also adversely impact animals' critical energy balance, potentially causing increased mortality, decreased productivity, or increased vulnerability to interspecific competition or predation through habitat displacement (Huff et al. 1972). Displacement by OSVs to lower-elevation habitats more prone to coyote competition and predation could be a particular problem for Sierra Nevada red fox. Over-snow vehicles can also travel at speeds similar to or greater than cars on highways, hindering the driver's ability to avoid foxes, and the fox's ability to avoid strikes. Sierra Nevada red fox's selection of packed snow (such as snowmobile trails) for winter movement (Benson et al. 2005), further heightens the subspecies' vulnerability to OSV harassment and strikes.

Noise and visual disturbance from over-snow vehicle use in winter and spring may disrupt Sierra Nevada red fox mating and breeding behavior, may increase stress hormones and energy expenditures in gestating females, and could disrupt foraging and scavenging behavior and success during a time of year when food resources are scarce and energy expenditures necessary to obtain food items are relatively high. Natural soundscapes are necessary for natural ecological function (Burson 2008). Animals exposed to high-intensity sounds can suffer both anatomical and physiological damage, including both auditory and non-auditory damage (Brattstrom and Bondello 1983). Indirectly, the noise generated by over-snow and off-road vehicles can adversely impact animals by impairing feeding, breeding, courting, social behaviors, territory establishment and maintenance, increasing stress, and/or by making animals or their young more susceptible to predation (Janssen 1978, Weinstein 1978, EPA 1971, Bury 1978, Jeske 1985, and Vos et al. 1985). Studies of observable wildlife responses to snowmobiles have documented elevated heart rates and elevated glucocorticoid stress levels (Baker and Bithmann 2005). Similarly, because winter climate and deep snow have an impact on animal energy expenditures, those impacts to Sierra Nevada red fox would be exacerbated by disturbances by OSV use; this could be particularly pronounced in the late spring, when food resources for Sierra Nevada red fox are scarce, and energy expenditures are further elevated owing to breeding and rearing young (Perrine 2005).

Over-snow vehicles threaten Serra Nevada red fox by negatively impacting species comprising the fox's prey base, especially small mammals. Compaction of subnivean spaces by OSVs can reduce the temperature of those spaces and can in turn increase the metabolic demands of small mammals living in those spaces by 25 calories per hour (Neumann and Merriam, 1972). Compaction can also restrict movement of small mammals and can force small mammals to the snow surface where they're vulnerable to predation (Canadian Wildlife Federation 1998). Compaction can also cause asphyxiation of small mammals by eliminating oxygen flow and causing deadly accumulations of carbon dioxide (Canadian Wildlife Federation, 1998). Jarvinen and Schmid (1971) found that subnivean compaction by OSVs reduced rodent and shrew use of subnivean habitats to zero. Rongstad (1980) found that compaction of subnivean spaces by OSVs eliminated the small mammal population previously occupying that space. Brander (1974) suggests that killing subnivean species can reduce populations of species preying on those species, including foxes. Because red fox reproduction is related to food availability (Voigt 1987), and because fox populations are already faced with resource scarcity during winter, disruption of access to food availability by over-snow vehicles further limits reproductive output.

Threats include ongoing and increasing OSV use in red fox habitat facilitated by Forest Service trail head plowing and trail grooming in the Sierra Nevada which is largely funded by the State of California. (CDPR 2010) Ongoing and increasing use of OSVs in the Bridgeport Winter Recreation Area specifically threatens the red fox population recently found in the area. (Sacks et al. 2010) A new proposal to open a Pacific Crest Trail Crossing to facilitate increased access to the Bridgeport Winter Recreation Area also threatens the Sierra Nevada red fox found in this area. (USFS 2011).

c. Off-road Vehicle (ORV) Use

Off-road vehicle use entails many of the same threats to Sierra Nevada red fox as over-snow vehicles (OSVs). Like OSVs, ORVs can cause noise and visual disruption of Sierra Nevada red fox foraging, feeding, breeding, gestation, rearing of young, denning, and other behaviors. As with OSVs, harassment or chasing of foxes by ORVs would increase energy expenditure, heart rate and stress hormones (Baker and Bithmann, 2005) and, as with OSVs, could result in direct or indirect mortality (Baldwin 1970, Malaher 1967, Wettersten 1971, Kopischke 1973, Heath 1974). Harassment and disruption could reduce fox fitness or reproductive success. Harassment or disruption by ORV use could also temporarily or permanently displace foxes to more marginal, resource-scarce habitats, or to habitats occupied by coyotes, thereby increasing interspecific competition and the potential for predation. Because off-road vehicles can travel at speeds similar to or greater than cars on highways, those vehicles' ability to avoid foxes, and foxes' ability to avoid strikes, are thus similar; off road vehicle use in Sierra Nevada red fox habitat thus increases the probability of mortality.

2. Overutilization for Commercial, Scientific, Educational, or Recreational Purposes

Historical estimates of Sierra Nevada red fox killed for sport in California range from 21 individuals annually (Grinnell et al. 1937), 135 individuals between 1940 and 1959 (Gould 1980), and two per year after 1959 (Gray 1975). Although Grinnell et al. (1937) claimed sport killing wasn't a threat to Sierra Nevada red fox, the California legislature banned non-scientific take in 1974 to reduce preventable mortality of a declining species (Gould 1980). Notably, today's two known populations of Sierra Nevada red fox persist within or near National Parks where historical trapping and hunting were prohibited (e.g., Buskirk 1999).

Sierra Nevada red fox are still vulnerable to poaching and incidental capture and killing in live-traps set for other furbearers in California, Oregon and Nevada. Sierra Nevada red fox can be legally taken in the entire state of Oregon from 15 October through 15 January and can be trapped year round in Malheur, Baker, Harney, Morrow, Gilliam, Umatilla, Union, Wallowa and Wheeler counties (ODFW 2010a). Trapping also remains a threat in Nevada where red fox can be trapped statewide; in 2009 and 2010 residents and non-residents could trap red fox between 1 Oct and 28 February.

The threat posed to the Sierra Nevada red fox by accidental capture and poaching in California, Oregon and Nevada and by legal trapping in Oregon and Nevada is magnified by other threats such as small population size, population isolation, and reduced genetic diversity.

3. Predation and Disease

As explained below, Sierra Nevada red fox is imminently threatened by fish stocking and salmon poisoning disease, increased predation by natural predators in logged forests and by predation and disease transmission from domestic dogs.

Fish Stocking and Salmon Poisoning Disease (SPD)

Fish stocking for recreational sport fishing is a threat to Sierra Nevada red fox throughout its current and historical range. Stocked trout and salmon are vectors for *Neorickettsia helminthoeca,* a rickettial organism that, if consumed, can cause Salmon poisoning disease (SPD) in canids. Salmon poisoning disease is usually fatal to canids (Gorham and Foreyt 1990). Symptoms of SPD in canids include fever, anorexia, weight loss, dehydration, vomiting, bloody diarrhea and death (Rikihisa et al. 1991). Mortality rates can be high; mortality can occur within 11 days of exposure (Cordy and Gorham 1950). Perrine and et al. (2010) provide the following discussion of the threat of fish stocking and salmon poisoning disease to Sierra Nevada red fox:

> "The rickettsial infection is known to occur in wild populations of salmonid fish in northern California, Oregon and Washington, but may be spread beyond these areas via translocations from infected hatchery populations (Hedrick and others 1990; Mack and others 1990). The trematode host of N. helmintoeca has been detected in at least three state hatcheries and four private farms in northern California, and rickettsia-infected fish from at least one of these sites were used to stock portions of the Truckee River Basin (Hedrick and others 1990). Red foxes could be exposed to SPD by scavenging off (of fish removed from water by) recreational fishing or due to the failure of aerial stocking to hit the targeted lake. Additionally, dead salmonids from hatcheries have been used as bait for photographic surveys of wild carnivores in some areas (Tom Rickman, Lassen National Forest, pers. comm.). Because of the documented occurrence of infected salmonids in both natural and hatchery fish populations within the range of Sierra Nevada red fox, and the high mortality rate of SPD in canids, further investigation of this potential threat, including possible routes of infection, seems warranted."

Figure 3. Trout-stocked waterbodies in 2002 – 2006 and the approximate historical and current and known range of Sierra Nevada red fox.

The states of California and Oregon continue active fish stocking programs within water bodies that fall within the current and historical range of Sierra Nevada red fox. For example, the Oregon Department of Fish and Wildlife lists several water bodies on its 2010 trout stocking schedule that are within the historical and possible current range of Sierra Nevada red fox (ODFW 2010b). Those include several high elevation lakes and reservoirs (>5000' elevation) under the jurisdictions of the Bend and Klamath District Offices (ODFW 2010b) that are in such geographic proximity to recent camera station detections of montane red fox to threaten foxes with salmon poisoning disease.

Similarly, based on a spatial analysis conducted by the Center for Biological Diversity (Figure 3), 632 water bodies within the approximate historical range of Sierra Nevada red fox in California were stocked with trout or salmon between 2002 and 2006 (CGFG 2008). During the same time period, 47 water bodies within the fox's approximate current known range were stocked with trout or salmon (CDFG 2008). For a list of those water-bodies, see Appendix 2.

The use of fire retardant in fire suppression operations exacerbates the threat posed to the fox by this disease by creating an additional mortality factor for infected fish. Fire retardant is regularly used in fire suppression on National Forest lands throughout the current and historical range of Sierra Nevada red fox. The United States Forest Service (2007) provides the following discussion on the chemical composition of fire retardant:

> "Current retardant formulations are primarily inorganic fertilizers, the active compound being ammonia sulfate, or ammonia polyphosphates, most commonly the latter (Dennis 1969). Although retardant is approximately 85 percent water, the ammonia compounds constitute about 60 to 90 percent of the remainder of the product. The other ingredients include thickeners, such as guar gum and attupulgite clay, dyes, and corrosion inhibitors (Johnson and Sanders 1977; Pattle Delamore Partners 1996). The ammonia salt causes the solution to adhere to vegetation and other surfaces; this stickiness makes the solution effective in retarding the advance of fire (Johansen and Dieterich 1971). Corrosion inhibitors are needed to minimize the deterioration of retardant tank structures and aircraft, which contributes to flight safety (Raybould and others 1995). Previous retardant formulas contained sodium ferrocyanide2 as a corrosion inhibitor. It was found that under certain conditions, sodium ferrocyanide poses greater toxicity to aquatic species and aquatic environments than retardant solutions without this agent (Little and Calfee 2000)."

EA at 4. In its Biological Opinion on the application of fire retardants on national forest lands, the U.S. Fish and Wildlife Service (2008) found those chemicals can be fatal for fish:

> "Several laboratory studies concluded that the exposure of fish and other aquatic organisms to ammonia can result in mortality (Little and Calfee 2000, 2004, and 2005, Buhl and Hamilton 2000). Gaikowski et al. (1996) studied Phos-Chek D75-F and concluded that if we consider the concentration of the retardants used in field mixtures, which is much higher than the lab studies, an accidental spill in a waterway would lead to substantial mortality."

BO at 33. The U.S. Fish and Wildlife Service specifically concludes that accidental drops of fire retardant into waterways will result in mortality of fish:

> "Accidental delivery of retardants into a waterway could account for greater than 800 gallons of retardant per second (in medium to heavy fuel types) being released from the aircraft. In this circumstance, avoidance behavior of fish may be more effective downstream but the initial drop site will result in mortality."

BO at 34. Increased incidence of fish mortality due to the use of fire retardant thus heightens the possibility that the Sierra Nevada red fox will consume those fish and thus be exposed to salmon-poisoning disease.

Disease Transmission, Harassment and Predation by Domestic Dogs

Domestic dogs near human development or accompanying their owners along roads, trails, camping and other recreational sites can impact Sierra Nevada red fox by chasing, attacking or killing them, or by transmitting diseases including but not limited to rabies, sarcoptic mange and canine distemper or parvovirus (Ables 1975, Samuel and Nelson 1982, Lewis et al. 1993, Perrine et al. 2010).

4. Inadequacy of Existing Regulatory Mechanisms

As discussed below, existing regulatory mechanisms on federal, state, Tribal, and private lands are inadequate to ensure Sierra Nevada red fox's survival and recovery.

California Endangered Species Act

Recognizing that certain species of plants and animals have become extinct "as a consequence of man's activities, untempered by adequate concern for conservation," (Fish and Game Code § 2051 (a)); that other species are in danger of, or threatened with, extinction because their habitats are threatened with destruction, adverse modification, or severe curtailment, or because of overexploitation, disease, predation, or other factors (Fish and Game Code § 2051 (b)); and that "[t]hese species of fish, wildlife, and plants are of ecological, educational, historical, recreational, esthetic, economic, and scientific value to the people of this state, and the conservation, protection, and enhancement of these species and their habitat is of statewide concern." (Fish and Game Code § 2051 (c)) the California Legislature enacted the California Endangered Species Act ("CESA"). The purpose of CESA is to "conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat...." (Fish and Game Code § 2052). To this end, CESA provides for the listing of species as "threatened" and "endangered." The California Fish and Game Commission ("Commission") is the administrative body that makes all final CESA listing decisions, while the California Department of Fish and Game ("Department") is the expert agency that makes recommendations as to which species warrant CESA listing.

The Sierra Nevada red fox has been listed as a State Threatened species under the California Endangered Species Act since 1980. It has been protected from intentional hunting and trapping in California since 1974. The fox's listing status under the California Endangered Species Act was retained in a 1987 five-year status review (CDFG 1987). The status review retained the fox's threatened status because "its high-elevation habitats are under increasing threat from logging activities, livestock grazing, recreation and other human-induced disturbance" (CDFG 1987). The status review also cited an "urgent need for more information regarding current habitat condition and population trends," noted that "the paucity of information on this species makes accurate assessment of threat difficult because little cause and effect relationship can be documented" and that "the virtual absence of data upon which to base management planning is itself a threat to the population" (CDFG 1987).

Despite more than three decades of protection under California Endangered Species Act, and despite an explicit, longstanding recognition that a better understanding of Sierra Nevada red fox habitat relationships, population trends and causes of decline is a prerequisite to acutely address its conservation and recovery needs, the California Department of Fish and Game has failed to enact a coordinated, range-wide inter-agency program to research, monitor, protect and recover Sierra Nevada red fox populations. That thirty-year data void perpetuates a paucity of detailed information about the fox's habitat relationships, ecology and population that effectively precludes robust, science-informed recovery strategies to "conserve, protect, restore, and enhance any endangered species or any threatened species and its habitat...."

As a result, the fox's circumstances have worsened rather than improved since its 1980 listing. Today Sierra Nevada red fox populations are perilously small, isolated and may still be declining (Perrine et al. 2010). They suffer from reduced genetic diversity (Perrine 2007, Sacks et al. 2010) and apparently little reproductive potential (Perrine 2005). Only two relict populations in California are known to remain; one population of fewer than 20 foxes near Lassen Peak and a second of three known foxes near Sonora Pass. The total number of remaining foxes likely does not exceed 50 individuals and may be fewer than 20. The California Department of Fish and Game itself still considers the Sierra Nevada red fox to be "extremely endangered," with fewer than 6 viable occurrences or less than 1,000 individuals or less than 2,000 acres (810 hectares) of occupied habitat (CDFG 2004).

The California Fish and Game Department's failure since 1980 to recover Sierra Nevada red fox and the extremely small remaining population size demonstrate the inadequacy of state listing to protect the subspecies.

Climate Initiatives Are Insufficient

As discussed on pages 32-39, greenhouse gas emissions also pose a primary threat to the continued existence of the Sierra Nevada red fox, and yet are among the least regulated threats. Regulatory mechanisms at the state, national and international level do not require the greenhouse gas emissions reductions necessary to protect the Sierra Nevada red fox from extinction.

a. State Climate Initiatives Are Insufficient

California is the world's sixth largest economy and the twelfth largest polluter in its own right, and is also a leader in climate change response, with a number of laws and policies that aim to reduce the state's greenhouse gas emissions. Foremost among these is the Global Warming Solutions Act of 2006 (AB 32) which requires the reduction of greenhouse gas emissions to 1990 levels by the year 2020. (Cal. Health and Safety Code § 38500 et seq.) The Global Warming Solutions Act is supplemented by other laws such as the California Environmental Quality Act, (California Public Resources Code §21000 et seq., "CEQA"), which requires state and local agencies to assess and reduce to the extent feasible all significant environmental impacts from new project approvals. State and local agencies are not currently fully implementing CEQA with regard to greenhouse gas emissions, but were they to do so this would greatly assist the state in meeting or surpassing the reductions required under the statewide cap by sharply limiting emissions from new development. In addition, Governor Schwarzenegger's Executive Order S-3-05 sets a goal of reducing greenhouse gas emissions as follows: by 2010, reduce emissions to 2000 levels; by 2020, reduce emissions to 1990 levels; and by 2050, reduce GHG emissions to 80 percent below 1990 levels. Executive branch agencies including California EPA and the California Resources Agency have ongoing programs aimed at meeting these targets. Progress to date, however, has been slow under all of these authorities, and even if all legal mandates were fully and successfully implemented, existing California law provides only a fraction of the emissions reductions needed to prevent the extinction of the Sierra Nevada red fox.

b. United States Climate Initiatives Are Ineffective

The United States is responsible for approximately 20% of worldwide annual carbon dioxide emissions (U.S. Energy Information Administration 2010, http://www.eia.gov), yet does not currently have adequate regulations to reduce greenhouse gas emissions. This was acknowledged by the Department of Interior in the final listing rule for the polar bear, which concluded that regulatory mechanisms in the United States are inadequate to effectively address climate change (73 Fed. Reg. 28287-28288). While existing laws including the Clean Air Act, Energy Policy and Conservation Act, Clean Water Act, Endangered Species Act, and others provide authority to executive branch agencies to require greenhouse gas emissions reductions from virtually all major sources in the U.S., these agencies are either failing to implement or only partially implementing these laws for greenhouse gases. For example, the EPA has issued a rulemaking regulating greenhouse gas emissions from automobiles (75 Fed. Reg. 25324, Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule), has initiated a process for issuing rules for greenhouse gas emissions from power plants and oil refineries (*see, e.g*. 75 Fed. Reg. 82392, Proposed Settlement Agreement, Clean Air Act Citizen Suit), and on January 2, 2011 began implementing, in a slow, cautious, and phased manner, the new source review program for greenhouse gases (75 Fed. Reg. 17004, Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs). However, the EPA has as yet failed to implement the critically important criteria air pollutant/national ambient air quality standards program for greenhouse gases, has failed to issue any greenhouse rules for many other stationary and mobile sources, and there is no evidence that existing and currently proposed rulemakings would provide anything close to the greenhouse reductions needed to avert the warming that imperils the Sierra Nevada red fox. While full implementation of the nation's flagship environmental laws, particularly the Clean Air Act, would provide an effective and comprehensive greenhouse gas reduction strategy, due to their non-implementation, existing regulatory mechanisms must be considered inadequate to protect the Sierra Nevada red fox from climate change.

c. International Climate Initiatives Are Insufficient

The primary international regulatory mechanisms addressing greenhouse gas emissions are the United Nations Framework Convention on Climate Change and the Kyoto Protocol. As acknowledged by the Department of Interior in the final listing rule for the polar bear, these international initiatives are inadequate to effectively address climate change (73 Fed. Reg. 28287-28288). The Kyoto Protocol's first commitment period only sets targets for action through 2012. Importantly, there is still no binding international agreement governing greenhouse gas emissions in the years beyond 2012. While the 2009 U.N. Climate Change Conference in Copenhagen called on countries to hold the increase in global temperature below 2°C (an inadequate target for avoiding dangerous climate change), the *non-binding* "Copenhagen Accord" that emerged from the conference failed to enact binding regulations that limit emissions to reach this goal. Even if countries did meet their pledges, analyses of the Accord found that collective national pledges to cut greenhouse gas emissions are inadequate to achieve the 2°C, and instead suggest emission scenarios leading to 2.5 to 5°C warming (Rogelj et al. 2010, UNEP 2010). Thus international regulatory mechanisms must be considered inadequate to protect the Sierra Nevada red fox from climate change.

Other State Regulatory Mechanisms

The California legislature banned hunting and trapping of Sierra Nevada red fox in 1974, but the species is still vulnerable to poaching and incidental capture and killing in live-traps set for other furbearers in California. California Department of Fish and Game department set forth "suggested guidelines" for Sierran Nevada red fox conservation in Timber Harvest Plans. Discretionary mechanisms are not adequate to protect Sierra Nevada red fox on state or privae land. There are no other regulatory mechanisms protecting Sierra Nevada red fox on state lands in California, Oregon or Nevada. Sierra Nevada red fox can be legally trapped in the entire state of Oregon from 15 October through 15 January and can be trapped year round in Malheur, Baker, Harney, Morrow, Gilliam, Umatilla, Union, Wallowa and Wheeler counties (ODFW 2010). Trapping also remains a threat in Nevada where red fox can be trapped statewide; in 2009 and 2010 residents and non-residents could trap red fox between 1 Oct and 28 February (NDW 2010).

Federal Lands

As detailed on pages 9-10 of this petition, the U.S. Forest Service and National Park Service administer federal public lands comprising most of the historical and current known ranges of the Sierra Nevada red fox. As reported in Table 1, the U.S. Forest Service manages an estimated 80% of the fox's historic range and 81% of the fox's current range, while the National Park Service manages 15% of the historic range and 19% of the current known range. The historical range of Sierra Nevada red fox spans five national parks: Yosemite, Kings Canyon, Sequoia, Lassen Volcanic and Crater Lake National Parks. The current known range of Sierra Nevada red fox spans Lassen Volcanic and possibly also Yosemite National Parks. National forests that intersect the historical range of Sierra Nevada red fox include the Sequoia, Sierra, Inyo, Stanislaus, El Dorado, Humbolt-Toiyabe, Tahoe and Lake Tahoe Basin, Plumas, Lassen, Shasta-Trinity, Klamath, Winema, Fremont, Umpqua, Deschutes, Willamette and Mt. Hood. The current known distribution of Sierra Nevada red fox spans portions of the Lassen, Humboldt-Toiyabe and Stanislaus National Forests.

In California (Region 5), the Sierra Nevada red fox is a Forest Service Sensitive Species. In Oregon (Region 6) the fox does not have Sensitive Species status (FS 2010). Sensitive Species status, even as a priority species, does not afford the fox or its habitat the protection it needs to survive. Sensitive Species are not afforded any regulatory habitat protection; rather the agency is only required to analyze the impacts of its actions on the fox under the National Environmental Policy Act (NEPA). This requirement in no way mandates the agency to select an environmentally benign alternative or to try to mitigate the adverse impacts of projects. Moreover, any protections afforded the Sierra Nevada red fox under the Sensitive Species program are discretionary. The 2004 Sierra Nevada Forest Plan Amendment Final Supplemental Environmental Impact Statement and Record of Decision sets forth discretionary conservation measures for activities that could impact Sierra Nevada red fox upon detection of a fox (USFS 2004b). Those measures include a voluntary “limited operating period” between 1 January and 30 June within 5 miles of the fox detection (USFS 2004b). Discretionary mechanisms are not adequate to protect the Sierra Nevada red fox on National Forest lands because National Forests are managed to meet multiple objects including livestock grazing, timber production, providing access to recreation opportunities for the public and serving as an economic development resource for the regions where they occur.

Oregon portions of the Sierra Nevada red fox’s historical range is managed under the Northwest Forest Plan (USDA/USDI 1994a, 1994b). The NWFP includes seven land allocations: Congressionally Reserved Areas, Late-Successional Reserves, Managed Late-Successional Areas, Adaptive Management Areas, Administrative Withdrawn Areas, Riparian Reserves, and Matrix lands. Each allocation has unique management guidelines. Though matrix lands harbor some of the remaining old-growth forest in the historical range of Sierra Nevada red fox, these lands were intended to provide for commercial timber harvest rather than to provide wildlife values. The NWFP neither contemplated nor affords any particular protections to Sierra Nevada red fox other than those for other species that may be incidentally beneficial to the fox.

Private Lands

There are no other regulatory mechanisms which protect the red fox or its habitat on private lands.

Tribal Lands

There are no other regulatory mechanisms which adequately protect the red fox on Tribal lands.

5. Other Natural or Anthropogenic Factors Affecting the Continued Existence of the Sierra Nevada Red Fox

Several other natural and anthropogenic factors threaten the continued survival of the Sierra Nevada red fox. These include genetic contamination by non-native red fox, small population size, population isolation, mortality from several factors, and global climate change.

Non-native Red Fox

Non-native red foxes threaten Sierra Nevada red fox through potential habitat displacement and competition, transmission of diseases or parasites (Lewis et al. 1993), and interbreeding, genetic contamination of local genotypes, hybridization and reduced fitness (Perrine et al 2010). Non-native red foxes occur in 36 counties in California (Lewis et al. 1993). Believed to have escaped fur farms, their range extends from coastal areas through the Sierra Nevada foothills from San Diego northward to San Francisco and may overlap with the range of Sierra Nevada red fox (Lewis et al. 1993). Non-native red fox distribution has expanded markedly during recent decades (Perrine et al. 2007). While there is no evidence of the non-native and Sierra Nevada red fox populations interbreeding, the two subspecies exist within dispersal distance of one another in the Lassen region (Perrine 2005) and the potential for interbreeding remains a threat (Perrine et al. 2010; Perrine et al. 2007).

Vulnerability of Small, Isolated Populations

Sierra Nevada red fox's small population size magnifies the extinction potential of other threats. A reduction in population abundance has accompanied Sierra Nevada red fox's range contractions during the last century (Schempf and White 1977, Gould 1980, CDFG 1996). Although the exact population size of Sierra Nevada red fox is unknown, it's very likely that fewer than 50 individuals persist today. Perrine (2005) estimated that as few as 15 foxes persist in the Lassen population; the same is likely true also of the recently discovered Sierra Nevada population, where evidence exists of only three individuals.

Small, isolated remnant populations of mammals are inherently vulnerable to extinction or extirpation from stochastic, demographic or environmental events (Nei et al. 1975). Genetic research by Perrine et al. (2007) indicates that the Lassen population of Sierra Nevada red fox is a small, isolated, remnant population:

> "Analysis of cytochrome-b haplotype frequencies found no significant genetic differentiation between modern and historic populations within the range of the Sierra Nevada red fox in California. All nine of the modern Cascades specimens from Lassen Peak had the haplotype (A) that was the most abundant haplotype in the Cascades and Sierra Nevada populations in California nearly a century earlier. The prominence of this haplotype in the mountain populations and its scarcity among the lowland populations is strong evidence that a remnant of the native, state-threatened Sierra Nevada red fox persists in the Lassen Peak region. The lack of haplotype diversity within this modern population is consistent with high levels of genetic drift and loss of rare alleles as would be expected within small, isolated populations (Wright 1978), as the Lassen Peak population appears to be (Perrine 2005). We cannot, however, exclude the possibility that the Lassen Peak individuals were from a single family group, although the temporal and spatial breadth of the sample makes this unlikely. The low levels of haplotype and

> nucleotide diversity observed in all three mountain fox populations are consistent with other species thought to exist in refugial Sierra Nevada populations (e.g., Wisely et al. 2004a)."

Similarly, Sacks et al (2010) conclude that declines in mtDNA and nuclear genetic diversity, estimates of contemporary genetic effective population sizes based on those markers, and estimates of heterozygote excesses signaling recent genetic bottlenecks are consistent with those observed declines:

> "In California, montane populations of the red fox have declined in abundance over the past several decades to critically low numbers (Perrine et al. in press). Our findings of (1) substantial declines in both mtDNA and nuclear genetic diversity, (2) estimates of contemporary genetic effective population sizes based on these markers, and (3) heterozygote excesses indicative of recent bottlenecks in the modern sample are consistent with this decline, and serve to validate our general approach… Although our microsatellite-based estimates of contemporary genetic effective population size (and heterozygosity) were not as low in the Sacramento Valley as in the montane population, they were consistently low enough to raise concerns. For example, the International Union for the Conservation of Nature considers populations of breeding adults below 50 to be ''critically endangered'' and those below to 250 to be ''endangered'' (IUCN 2008). Although the genetic effective population size does not necessarily reflect the present number of breeding adults, it suggests that the population was very small recently and, thus, potentially vulnerable to extirpation" (p. 1536)

Remaining Sierra Nevada red fox populations are not only isolated, but also perilously small. Detailed data on the population size of Sierra Nevada red fox is lacking, but the data that are available indicate that the populations are very small. There are very likely fewer than 50 Sierra Nevada red fox remaining. Perrine (2005) estimates the Lassen Population is comprised of fewer than 10 or 15 individuals. This is likely also the case for the newly-detected Sierra Nevada population near Sonora Pass.

Climate Change

Anthropogenic climate change also poses a significant threat to the long-term survival of the Sierra Nevada red fox. Climate change has already caused warmer and drier conditions in the Sierra Nevada and Cascade Mountains. Temperatures and heat wave frequency have increased, more precipitation is falling as rain instead of snow, and the timing of runoff and snowmelt stream-flow has advanced, leading to higher summer water stress.

Sierra Nevada red fox is particularly vulnerable to climate change. It occurs at the upper elevational ranges of the Sierra Nevada and Cascade Mountains where climate change impacts are expected to be pronounced. As a high elevation species restricted to isolated mountain ranges, it has limited options for movement in response to climate change. As climatic zones shift upward in elevation, its habitat will be compressed upward and it risks running out of suitable habitat (USGCRP 2009).

This section reviews the best-available scientific information regarding (a) recent syntheses of the climate change science, (b) observed and (c) projected climate change in the range of Sierra Nevada red fox, (d) threats to the Sierra Nevada red fox from climate change, (e) greenhouse gas reductions needed to protect the Sierra Nevada red fox, and (f) the inadequacy of existing regulatory mechanisms to address climate change.

a. Climate change is unequivocal and is having greater impacts than assessed by the IPCC in 2007

In the 2007 Fourth Assessment Report (AR4), the Intergovernmental Panel on Climate Change (IPCC) expressed in the strongest language possible its finding that global warming is occurring: "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC 2007: 30). The international scientific consensus of the IPCC is that most of the recent warming observed has been caused by human activities (IPCC 2007). The U.S. Global Change Research Program in its 2009 report *Climate Change Impacts in the United States* also stated that "global warming is unequivocal and primarily human-induced" (USGCRP 2009: 12).

Although the IPCC AR4 provides an important synthesis of the climate change science, numerous studies published since the AR4 indicate that many climate change risks are substantially greater than assessed in the AR4. Key updates that synthesize the most recent climate science include *Climate Change Science Compendium* compiled by the United Nations Environment Programme (McMullen and Jabbour 2009), *Climate Change: Global Risks, Challenges and Decisions Synthesis Report* compiled by the International Alliance of Research Universities (Richardson et al. 2009), *The Copenhagen Diagnosis* Smith et al. (2009), Lenton et al. (2008), and Fussel (2009). These updates indicate that many climate impacts are occurring at lower surface temperatures than previously estimated; temperature change during this century will likely be magnified by biological and geological carbon-cycle feedbacks; and we are approaching tipping points beyond which the climate system is expected switch to a different state.

b. Observed Climate Change in the Sierra Nevada Red Fox Range

Numerous studies that have documented climate change in California's mountain regions over the past century indicate that there has been rapid warming and a shift in the character of mountain precipitation, with more winter precipitation falling as rain instead of snow, earlier snowmelt, and earlier stream flow. Detection and attribution studies that analyze whether climatic changes have occurred due to natural climatic variations or human influence from greenhouse gas pollution have found that these climatic trends were unlikely to have arisen exclusively from natural internal climate variability, and are attributable in large part to greenhouse gas forcing.

Temperatures have increased across California including its mountain regions, with the largest increases in winter and spring (Bonfils et al. 2008a, Bonfils et al. 2008b). Across the western U.S. during 1950-1999, daily maximum and minimum temperatures in winter (January to

March) increased by 1.83°C and 1.54°C (Bonfils et al. 2008b). In concert with rising temperatures, the number of frost days in winter decreased by 7.6 days, while the number of degree-days above 0°C increased between 1950 and 1999 (Bonfils et al. 2008b). Importantly, temperature trends showed spatially and elevationally coherent patterns of warming, meaning that these trends were observed across mountainous regions. In a California-specific analysis, Bonfils et al. (2008a) found that mean and maximum daily temperatures increased in late winter and early spring between 1915 and 2000, and that minimum daily temperatures increased from January to September.

Daytime and nighttime heat wave activity has increased across California from 1948 to 2006 (Gershunov and Cayan 2008). The increase in nighttime summer heat wave events is consistent with the trend of increasing summer nighttime temperatures in California. Gershunov and Cayan (2008) highlighted that warmer nighttime temperatures encourage hotter daytime temperatures since days begin warmer, and lead to increased heat wave duration and area. They noted that nighttime heat waves increase heat stress to wildlife by eliminating the thermal refuge of cooler temperatures at night:

> During a persistent daytime heat wave, cool nights provide respite from the stressful effects of heat on the health and general well-being of plants and animals, as well as for the energy sector, and prepare nature and society to face another day of scorching heat. Heat waves strongly manifested at night eliminate this badly needed opportunity for rejuvenation and increase the chances for catastrophic failure in natural and human systems.(Gershunov and Cayan 2008: 3).

Gershunov and Cayan (2008) also found that daytime heat wave activity is increasing, with most of the increase occurring since the 1970s. Daytime heat wave activity has intensified more rapidly over the high-elevation interior of California compared to the lowland valleys. The researchers hypothesize that California's high-elevation interior is becoming more vulnerable to daytime heat waves due to the combined impacts of decreasing snowpack and earlier snowmelt and runoff that are making the interior drier:

> [I]t appears likely that the highlands, which are drying in summer due to progressively decreasing snow/rain ratio (Knowles et al. 2006), earlier spring snowmelt and runoff (Cayan et al. 2001, Stewart et al. 2005) and generally decreasing snowpack (Mote et al. 2005), are becoming relatively more prone to intensified daytime heat wave activity. (Gershunov and Cayan 2008: 10).

Drought duration and severity has increased across much of California (Andreadis and Lettenmaier 2006). A study of 20th century trends in soil moisture, runoff, and drought characteristics over the conterminous U.S. detected trends toward increased drought duration and severity and lower soil moisture across most of California, including the Sierra Nevada (Andreadis and Lettenmaier 2006).

As temperatures rise, more precipitation is falling as rain instead of snow (Knowles et al. 2006), and snowpack has decreased especially in the low and middle altitudes, which has lead to a significant decline in spring snow-water equivalent (Mote et al. 2005, Hamlet et al. 2006, Mote 2006, Pierce et al. 2008). Hamlet et al. (2005) detected downward trends in spring snowpack, measured as the 1 April snow-water equivalent (SWE), across the western United States between 1916 and 2003. Knowles et al. (2006) detected a trend toward reduced winter-total snowfall water equivalent (SFE) to winter-total precipitation (*P*) during the period 1949–2004. Trends toward reduced SFE are a response to warming across the region, with the most significant reductions occurring where winter wet-day minimum temperatures were warmer than -5°C. Das et al. (2009) detected trends across the western U.S. toward a decrease in winter-total snowy days as a fraction of winter-total wet days, a decrease in the spring snow water equivalent (1 April snow water equivalent as a fraction of October–March precipitation), and an increase in winter accumulated runoff as a fraction of water-year accumulated runoff.

As snowpack melts earlier in spring, the timing of runoff and snowmelt-driven streamflow has advanced (Stewart et al. 2004, Barnett et al. 2008, Hidalgo et al. 2009). As a result, streamflow has increased in winter and spring and decreased in summer months (Stewart et al. 2004, Das et al. 2009).

c. Projected Climate Change In Sierra Nevada Red Fox Range

As detailed below, climate projections indicate that in temperatures in California's mountains will continue to rise, mountain snowpack will continue to decrease, and streamflow will continue to shift earlier.

Temperatures over California will continue to warm significantly during the twenty-first century, with more warming in the summer than winter (Cayan et al. 2008). By 2070-2099, mean annual temperatures are projected to increase by 1.5 to 2.7°C (2.7 to 4.9°F) under the B1 emissions scenario and 2.5 to 4.5°C (4.5 to 8.1°F) under the A2 scenario. On a seasonal basis, summer (June to August) temperatures are projected to increase by 1.5 to 3.7°C (2.7 to 6.7°F) under the B1 and 2.6 to 6.4°C (4.7 to 11.5°F) under the A2 scenario, while winter (December to February) temperatures increase by 1.6 to 2.3°C (2.9 to 4.1°F) under the B1 and 2.4 to 3.4°C (4.3 to 6.1°F) under the A2. These projections are likely underestimates given that the worldwide emissions growth rate since 2000 has exceeded both the B1 and A2 scenarios and is tracking that of the most-fossil fuel intensive IPCC SRES emissions scenario, A1FI (Raupach et al. 2007). Using a regional climate model under a doubling of pre-industrial CO_2 concentrations (280 to 560 ppm), Snyder et al. (2002) found that, annual temperatures across California would increase by 1.4-3.8°C (2.5-6.8°F). Temperatures were projected to increase the most in the higher elevations of Sierra Nevada, rising by as much as 6.3 °C (11.3°F) in April and 9.2°C (16.5°F) in May (Snyder et al. 2002).

The occurrence of extremely warm days is also projected to increase significantly. Under the A2 scenario, the occurrence of extremely warm daily mean temperatures that exceed the 99.9 percentile of their historical distributions for June to September is projected to increase to 50 to 500 times their historical frequency by 2070–2099, while the incidence of even moderately cool daily mean winter temperatures decreases markedly (Cayan et al. 2008). Cayan et al. (2008) warned that these temperature increases are outside the range of local experience and that temperatures will continue to rise into the twenty-second century:

> Such climate changes would be, in the words of Hansen et al. 2007, "climate changes outside of the range of local experience." A noteworthy feature in the temperature projections is that the warming through the twenty-first Century does not level off, especially in projections using the medium and high greenhouse gas emission scenarios, implying that California's climate would continue to warm in (at least) the subsequent decades of the twenty-second century. (Cayan et al. 2008: S40).

The intensity of precipitation events is projected to increase throughout the western U.S. due to the higher water-holding capacity of warmer air, leading to more flooding (Christensen et al. 2007). For example, Leung et al. (2004) found that extreme precipitation events during the winter will increase in the Sierra Nevada of California by 10-20% by 2040-2060.

In the Sierra Nevada and southern Cascades, warmer temperatures will reduce the annual snowpack and result in increased winter runoff and earlier spring snowmelt (Snyder et al. 2002, Vicuna and Dracup 2007, Cayan et al. 2008). Using a downscaling technique to project changes in snow accumulation on California's mountainous terrain, Cayan et al. (2008) detected marked future declines in spring snow accumulation that become progressively larger as warming increases within this century. By 2070–2099, virtually no snow is left below 1,000 m under the A2 scenario. By the end of the century, decreases in snow accumulation range from 60 to 93% between ~1,000 and 2,000 m (3,280 to 6,560 ft) and from 25 to 79% between 2,000 to 3,000 m (6,560 to 9,840 ft) (Cayan et al. 2008). Using a regional climate model under a doubling of pre-industrial CO_2 concentrations, Snyder et al. (2002) found that snow accumulation would decrease by nearly 100% in April in the central Sierra Nevada (Snyder et al. 2002). Cascade Mountain snowpack may be particularly vulnerable to warming; because snow already accumulates near its melting point across much of the range, future warming is likely to cause large areas to shift from snow- to rain-dominated winter precipitation regimes (Nolin and Daily 2006). Snowpack in the Cascade Mountains is forecasted in 2050 to be less than half of today's (Leung et al. 2004).

Streamflow is projected to continue to get earlier across the western U.S., including the Sierra Nevada and southern Cascades, with many rivers running 30-40 days earlier by the end of the century (Stewart et al. 2004). Spring and summer streamflows are projected to decline by as much as 25% by 2050 and 55% by the end of the century (duVair 2003). Rauscher et al. (2008) used a high-resolution climate model to project future changes in snowmelt-driven runoff in the western United States and found that hydrological conditions will continue to trend towards earlier snowmelt and drier summer conditions. Under an end-of-the-century A2 emissions scenario, increased temperatures forced by greenhouse gas emissions were projected to result in early-season snowmelt-driven runoff as much as two months earlier than present. Throughout most of the western mountainous areas, snowmelt-driven runoff was projected to occur at least 15 days earlier in early-, middle-, and late-season flow.

d. Threats to Sierra Nevada Red Fox from Climate Change

The climate of Sierra Nevada red fox habitat is characterized by cold temperatures, moderate annual precipitation, deep winter and spring snow packs and relatively short and cool summers (Perrine 2005). Climate change is expected to have significant effects on species and habitats due to altered snowpack and precipitation patterns, vegetation changes, increased forest disease outbreaks, and other factors (Karl et al. 2009). Vegetation changes resulting from climate change could change the amount and type and availability of prey for foxes, increase the upslope movement of competitors, and could affect the availability of resting and denning sites and canopy cover, threatening dense, mature forests that foxes use in winter. As detailed below, a particular concern is that decreased snowpack extent and duration in winter and spring will expose the Sierra Nevada red fox to increased competition from coyotes. The extinction or northward shift in distribution of boreal-adapted or obligate species during the last climate warming (i.e, noble martens, mountain goats, hoary marmots) suggests that Sierra Nevada red fox is particularly threatened by climate change (Perrine et al. 2010).

Reduced Habitat Extent and Increased Competitor Interactions

A 3 degree Celsius increase in annual temperature would correspond to 62% reduction of in boreal habitat extent in the Great Basin (McDonald and Brown, 1992, Moen and others, 2004). Employed in the Sierra Nevada, this same calculation suggests a 50% reduction in boreal habitat (Perrine et al. 2010). Upslope movement of climate zones, vegetation, snowpack, and prey will shrink the overall extent of suitable Sierra Nevada red fox habitat, confining it to ever-smaller mountaintop patches. Decreased duration of snowpacks and higher-elevation snowlines will shrink the overall extent of fox habitat bound by deep snow above and coyote competition below; this may intensify intra-specific competition and resource scarcity. Warming could also facilitate upslope movement of coyotes, bobcats and non-native red fox into Sierra Nevada red fox habitat, magnifying interspecific competition and the threat of interbreeding. Upslope movement of climate zones, vegetation and prey species may facilitate upslope migration of coyotes in late spring, summer and fall, increasing competition with and predation of foxes in habitats and seasons that currently afford competition refugia (Perrine 2005).

Reduced Prey Abundance

Upslope migration of prey species in response to climate change will continue to decrease the spatial extent, overall abundance and availability of Sierra Nevada red fox prey species. In their evaluation of early 20th century to current small mammal distribution in the Sierra Nevada Mountains, Moritz et al. (2008) found that half of the species studied—primarily small mammals occupying high-elevation habitats to begin with—shifted their ranges upslope to higher elevations across that period of warming. Those species include Belding's ground squirrel (*S. beldingi*), water shrew (*Sorex palustris*), American Sierra Nevada red fox (*O. princeps*), bushy-tailed woodrat (*N. cinerea*), golden-mantled ground squirrel (*Spermophilus lateralis*), and long-tailed vole (*Microtus longicaudus*) (Moritz et al. 2008). Further warning can be expected to cause further upslope migration of Sierra Nevada red fox prey species, further reducing those species extent, overall abundance and availability to the fox.

Increased Disease

Temperature, rainfall and humidity affect many wildlife pathogens (Harvell et al. 2002). Many pathogens have expanded their ranges northward and upslope because warmer temperatures have (1) facilitated their survival and development in areas that were previously below their temperature threshold, (2) increased their rates of development, (3) increased rates of reproduction and biting of disease vectors including ticks, midges, and mosquitoes, and (4) lowered the resistance of their hosts (Harvell et al. 2002, Parmesan 2006). Warming temperatures at high elevations will increase the prevalence of diseases and disease vectors, including ticks, midges and mosquitoes, thereby exposing Sierra Nevada red fox to new diseases, increasing transmission of existing disease, and possibly increasing disease-induced mortality rates.

e. Greenhouse Gas Reductions Needed to Protect Sierra Nevada Red Fox

The best-available science indicates that atmospheric CO_2 concentrations must be reduced to at most 350 ppm to protect species and ecosystems from "dangerous anthropogenic interference" (DAI) with the climate system (Warren 2006, Hansen et al. 2008, Lenton et al. 2008, Jones et al. 2009, Smith et al. 2009). For example, Hansen et al. (2008) presented evidence that atmospheric CO_2 must be reduced from the current concentration of ~390 ppm to at most 350 ppm to avoid "dangerous climate change" and "maintain the climate to which humanity, wildlife, and the rest of the biosphere are adapted." Hansen et al. (2008) found that our current CO_2 level has committed us to a dangerous warming commitment of ~2°C temperature rise still to come and is already resulting in dangerous changes: the rapid loss of Arctic sea-ice cover, 4° poleward latitudinal shift in subtropical regions leading to increased aridity in many regions of the earth; the near-global retreat of alpine glaciers affecting water supply during the summer; accelerating mass loss from the Greenland and west Antarctic ice sheets; and increasing stress to coral reefs from rising temperatures and ocean acidification. Hansen et al. (2008) concluded that the overall target of at most 350 ppm CO_2 must be pursued on a timescale of decades since paleoclimatic evidence and ongoing changes suggest that it would be dangerous to allow emissions to overshoot this target for an extended period of time:

> "If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that." (at 217)

In order to reach a 350 ppm CO_2 target or below, global CO_2 emissions must peak before 2020, and likely by 2015, followed by rapid annual reductions bringing emissions to or very close to net zero by 2050 (CBD and 350.org 2010, UNEP 2010). The IPCC found that to reach a 450 ppm CO_2eq target, the emissions of the United States and other developed countries should be reduced by 25 to 40% below 1990 levels by 2020 and by 80-95% below 1990 levels by 2050 (Gupta et al. 2007); thus reductions to reach a 350 ppm CO_2 target must be more stringent. Baer et al. (2009) outlined a trajectory to reach 350 ppm CO_2 target by 2100 that requires 2020 global emissions to reach 42% below 1990 levels, with emissions reaching zero in 2050. They concluded that Annex I (developed country) emissions must be more than 50% below 1990 levels by 2020 and reach zero emissions in 2050 (Baer et al. 2009). With the current atmospheric CO_2 concentration (390 ppm) beyond anything seen in the past 15 to 20 million years (Tripati et al. 2009) and worldwide emissions continuing to increase by more than 2 ppm each year, rapid and substantial reductions are clearly needed immediately to protect the Sierra Nevada red fox and its habitat and avoid dangerous climate change.

Conclusion

The Sierra Nevada red fox is critically endangered and in imminent danger of extinction. Its foremost extinction threat is its perilously small population size. It is likely that fewer than 50 individual Sierra Nevada red foxes exist today. Sierra Nevada red fox has been extirpated from approximately 96 percent of its approximate historical range in California and Oregon, and is today confined to two small relict populations in California. Genetic research indicates that the Lassen population of Sierra Nevada red fox exhibits lost genetic diversity signaling population declines, and the size of this and the Sonora Pass populations are perilously small (Perrine et al. 2010). The fox's remaining habitat is threatened by logging, fire suppression, predation, disease, competition, genetic contamination, climate change, trapping, recreation, and other factors. Any of these threats, however remote, could cause Sierra Nevada red fox extinction given its perilously small population size. Regulatory mechanisms to protect the fox either do not exist or, as with the fox's listing under the California Endangered Species Act, have proven inadequate to ensure the fox's survival and recovery. Given the fox's extremely small population size, declining population trend, limited range, and the variety and magnitude of threats to its continued survival, it clearly warrants Endangered Species Act protection. The protection provided under the Endangered Species Act, along with critical habitat designation, is necessary to prevent the Sierra Nevada red fox's extinction.

Request for Critical Habitat Designation

The ESA mandates that when FWS lists a species as endangered or threatened the agency must also concurrently designate critical habitat for that species. Section 4(a)(3)(A)(i) of the ESA states that, "to the maximum extent prudent and determinable," the USFWS: shall, concurrently with making a determination . . . that a species is an endangered species or threatened species, designate any habitat of such species which is then considered to be critical habitat . . . . 16 U.S.C. § 1533(a)(3)(A)(i); *see also id.* at § 1533(b)(6)(C). The ESA defines the term "critical habitat" to mean:

> i. the specific areas within the geographical area occupied by the species, at the time it is listed . . . , on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and ii. specific areas outside the geographical area occupied by the species at the time it is listed . . . , upon a determination by the Secretary that such areas are essential for the conservation of the species. *Id.* at § 1532(5)(A).

The petitioner expects that FWS will comply with this unambiguous mandate and designate critical habitat concurrently with the listing of the Sierra Nevada red fox. Sufficient critical habitat should be designated to support Sierra Nevada red fox dispersal throughout its historical range, including the southern Sierra Nevada Mountains northward through the Cascade Mountains of California and Oregon to the Columbia River.

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Literature Cited

Ables, E. D. 1975. Ecology of the red fox in North America. In: Fox, M. W., ed. The wild canids: their systematics, behavioral ecology and evolution. New York: Van Nostrand Reinhold Company; 216-236

Allison, I., N. L. Bindoff, R. A. Bindschadler, P. M. Cox, N. de Noblet, M. H. England, J. E. Francis, N. Gruber, A. M. Haywood, D. J. Karoly, G. Kaser, C. Le Quéré, T. M. Lenton, M. E. Mann, B. I. McNeil, A. J. Pitman, S. Rahmstorf, E. Rignot, H. J. Schellnhuber, S. H. Schneider, S. C. Sherwood, R. C. J. Somerville, K. Steffen, S. E.J., M. Visbeck, and A. J. Weaver. 2009. The Copenhagen Diagnosis, 2009: Updating the World on the Latest Climate Science. *in*. The University of New South Wales Climate Change Research Centre (CCRC), Sydney, Australia, 60pp.

Andreadis, K. M., and D. P. Lettenmaier. 2006. Trends in 20th century drought over the continental United States Geophysical Research Letters 33, L10403, doi:10.1029/2006GL025711.

Aubry, K. B. 1983. The Cascade red fox: Distribution, morphology, zoogeography and ecology. Seattle: University of Washington; 151 p. Ph.D. dissertation.

Aubry, K. B. 1997. The Sierra Nevada red fox (*Vulpes vulpes necator*). In: Harris, J. E.; Ogan, C. V., eds. Mesocarnivores of northern California: biology, management and survey techniques. 1997 August 12-17; Humboldt State University, Arcata, CA. The Wildlife Society, California North Coast Chapter; 47-53.

Aubry, K. B.; Statham, M. J.; Sacks, B. N.; Perrine, J. D.; Wisely, S. M.. 2009. Phylogeography of the North American red fox: vicariance in Pleistocene forest refugia. Molecular Ecology 18: 2668-2686.

Backer, D.M., Jensen, S.E., and G.R. McPherson. 2004. Impacts of fire suppression activities on natural communities. Conservation Biology 18(4): 937-946.

Baer, P., and T. Athanasiou. 2009. A 350 ppm Emergency Pathway. A Greenhouse Development Rights brief.

Baird, S. F. 1857. Mammals: General report upon the zoology of the several Pacific railroad routes. Washington, D.C.: Reports, explorations and surveys for railroad routes from the Mississippi to the Pacific Ocean; 121-133.

Baker, E. and Bithmann, E., 2005. Snowmobiling in the Adirondack Park: Environmental and Social Impacts. St. Lawrence University, Department of Biology.

Baker, J.P. and S.W. Christensen. 1991. Effects of acidification on biological communities. *In* D.F. Charles, ed., Acidic Deposition and Aquatic Ecosystems—Regional Case Studies. Springer Verlag. New York, New York USA.

Barnett, T. P., D. W. Pierce, H. G. Hidalgo, C. Bonfils, B. D. Santer, T. Das, G. Bala, A. W. Wood, T. Nozawa, A. A. Mirin, D. R. Cayan, and M. D. Dettinger. 2008. Human-induced changes in the hydrology of the western United States. Science 319:1080-1083.

Benson, J. F; Perrine, J. D.; Golightly, R. T.; Barrett, R. H. 2005. Use of cover and response to cover type edges by female Sierra Nevada red foxes. Western North American Naturalist 65: 127-130.

Baldwin, M.F. 1970. The off-road vehicle and environmental quality: A report on the social and environmental effects of off-road vehicles, particularly snowmobiles, with suggested policies for their control. Conservation Foundation. Washington, D.C., USA.

Bowyer, R. T., and V. C. Bleich. 1984. Effects of cattle grazing on selected habitats of southern mule deer. *California Fish and Game* 70(4): 240-247.

Brattstrom, B.H. and M.C. Bondello. 1983. Effects of off-road vehicle noise on desert vertebrates. Pages 167-206 *in:* R. H. Webb and H. G. Wilshire (eds.). Environmental effects of off-road vehicles: Impacts and management in arid regions. Springer-Verlag. New York.

Bonfils, C., P. B. Duffy, B. D. Santer, T. M. L. Wigley, D. B. Lobell, T. J. Phillips, and C. Doutriaux. 2008a. Identification of external influences on temperatures in California. Climatic Change 87 (Suppl 1):S43-S55.

Bonfils, C., B. D. Santer, D. W. Pierce, H. G. Hidalgo, G. Bala, T. Das, T. P. Barnett, D. Cayan, C. Doutriaux, A. W. Wood, A. Mirin, and T. Nozawa. 2008b. Detection and attribution of temperature changes in the mountainous western United States. Journal of Climate 21:6404-6424.

Brander, R.B., 1974. Ecological impacts of off-road recreation vehicles. General Technical Report NC-9. Outdoor recreation research: Applying the results. U.S. Department of Agriculture, U.S. Forest Service.

Burson, S., 2008. Natural Soundscape Monitoring in Yellowstone National Park December 2007-March 2008. Yellowstone Center for Resources. USGS.

Bury, R.L. 1978. Impacts of Snowmobiles on Wildlife. Transcript. 43rd North American Wildlife and Natural Resource Conference. WMI.

Buskirk, S. W. 1999. Mesocarnivores of Yellowstone. In: Clark, T. W.; Curlee, A. P.; Minta, S. C.; Karieva, P. M., eds. Carnivores in ecosystems: The Yellowstone experience. New Haven: Yale University Press; 165-187.

California Department of Parks and Recreation (2010), Draft and Final Environmental Impact Reports, Over Snow Vehicle Program, Program Years 2010 – 2020 (State Clearinghouse Number 2009042113), available at http://ohv.parks.ca.gov/?page_id=26379

Canadian Wildlife Federation. 1998. Below zero activities: snowmobile savvy. Wild Education. Wild programs www.wildeducation.org

Cayan, D., E. P. Maurer, M. D. Dettinger, M. Tyree, and K. Hayhoe. 2008. Climate change scenarios for the California region. Climatic Change 87 (Suppl 1):S21-S42.

CBD and 350.org. 2010. Not Just a Number: Achieving a CO_2 Concentration of 350 ppm or Less to Avoid Catastrophic Climate Impacts. Center for Biological Diversity and 350.org. Available http://www.biologicaldiversity.org/programs/climate_law_institute/350_or_bust/pdfs/Not_Just_a_Number-v3.pdf.

CDFG. 1987. Sierra Nevada red fox: Five-year status report. Sacramento: California Department of Fish and Game, Sacramento, California, USA

CDFG. 1996. The status of rare, threatened and endangered animals and plants of California. Sacramento: California Department of Fish and Game, Sacramento, California, USA.

CDFG. 2004. Status of rare, threatened, and endangered plants and animals of California, 2000-2004. California Department of Fish and Game, Sacramento, California, USA.

CDFG 2008. Letter and data in response to public records act request no. 07-10-218. California Department of Fish and Game, Sacramento, California, USA.

Christensen, J. H., B. Hewitson, B. A., A. Chen, X. Gao, I. Held, R. Jones, R. K. Kolli, W.-T. Kwon, R. Laprise, V. Magaña Rueda, L. Mearns, C. G. Menéndez, J. Räisänen, A. Rinke, A. Sarr, and P. Whetton. 2007. 2007: Regional Climate Projections. *in* S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, and G. H. Miller, editors. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Churcher, C. S. 1959. The specific status of the New World red fox. Journal of Mammalogy 40: 513-520.

Cordy, D.M. and J.R. Gorham. 1950. The pathology and etiology of salmon disease in the dog and fox. American Journal of Pathology, XXVI: 617-637.

Crabtree, R. L. 1993. Gray ghost of the Beartooth. Yellowstone Science. Spring: 13-16.

Das, T., H. G. Hidalgo, M. D. Dettinger, D. Cayan, D. W. Pierce, C. Bonfils, T. P. Barnett, G. Bala, and A. Mirin. 2009. Structure and detectability of trends in hydrological measures over the western United States. Journal of Climate 10:871-892.

Dekker, D. 1983. Denning and foraging habits of red foxes, *Vulpes vulpes*, and their interactions with coyotes, *Canis latrans*, in central Alberta, 1972-1981. Canadian Field-Naturalist 97: 303-306.

Desmarest, A. G. 1820. Mammalogie ou description des espèces de mammifères. Paris, France.

Environmental Protection Agency (EPA), 1971. Effects of Noise on Wildlife and Other Animals. Prepared by Memphis State University

Franklin, J.F., and J.A. Fites-Kaufmann. 1996. Assessment of late successional forests of the Sierra Nevada. Pages 627–61 *in*: Sierra Nevada Ecosystem Project: final report to Congress, vol. II, Assessments and scientific basis for management options. Wildlands Resources Center Report No. 37, Centers for Water and Wildlands Resources, University of California, Davis.

Fussel, H.-M. 2009. An updated assessment of the risks from climate change based on research published since the IPCC Fourth Assessment Report. Climatic Change 97:469-482.

Gershunov, A., and D. Cayan. 2008. Recent Increases in California Heat Waves: July 2006 and the Last Six Decades. California Energy Commission, PIER Energy-Related Environmental Research. CEC-500-2008-088.

Gorham, J. R.; Foreyt, W. J. 1990. Salmon poisoning disease. In: Greene, C. E., ed. Infectious diseases of the dog and cat. Philadelphia: W.B. Saunders; 397-403.

Gould, G. I. 1980. Status of the red fox in California. Sacramento: California Department of Fish and Game, Nongame Wildlife Investigations, Job I-8. 3 p.

Gray, R. L. 1975. Sacramento Valley red fox survey. Sacramento: California Department of Fish and Game, Nongame Wildlife Investigations, Job II-1.2; 5 p.

Graber, David M. 1996. Status of Terrestrial Vertebrates. In: Sierra Nevada Ecosystem Project Report, Final Report to Congress, Vol II: Assessments and Scientific Basis for Management Options. Davis: University of California, Centers for Water and Wildland Resources Report No.37

Grinnell, J.; Dixon, J.; Linsdale, L. 1937. Fur-bearing mammals of California. Berkeley: University of California Press; 777 p.

Gupta, S., D. A. Tirpak, N. Burger, J. Gupta, N. Höhne, A. I. Boncheva, G. M. Kanoan, C. Kolstad, J. A. Kruger, A. Michaelowa, S. Murase, J. Pershing, T. Saijo, and A. Sari. 2007. 2007: Policies, Instruments and Co-operative Arrangements. *in* B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, and L. A. Meyer, editors. Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY USA.

Hall, E. R. 1981. Mammals of North America. New York: John Wiley and Sons. 1181 p.

Hamlet, A., P. W. Mote, M. P. Clark, and D. P. Lettenmaier. 2005. Effects of temperature and precipitation variability on snowpack trends in the western United States. 18.

Hamlet, A. F., P. W. Mote, M. P. Clark, and D. P. Lettenmaier. 2006. Twentieth-century trends in runoff, evapotranspiration, and soil moisture in the western United States. Journal of Climate 20.

Hanley, T. A., and J. L. Page. 1982. Differential effects of livestock use on habitat structure and rodent populations in Great Basin communities. *California Fish and Game* 68(3): 160-174.

Hansen, J., M. Sato, P. Kharecha, D. Beerling, V. Masson-Delmotte, M. Pagani, M. Raymo, D. L. Royer, and J. C. Zachos. 2008. Target atmospheric CO_2: Where should humanity aim? Open Atmospheric Science Journal 2:217-231.

Hanson, C. T. 2007. Post-fire management of snag forest habitat in the Sierra Nevada. PhD Dissertation. University of California, Davis.

Harvell, C. D., C. E. Mitchell, J. R. Ward, S. Altizer, A. P. Dobson, R. S. Ostfeld, and M. D. Samuel. 2002. Climate warming and disease risks for terrestrial and marine biota. Science 296:2158-2162.

Hayward, B., E. J. Heske, and C. W. Painter. 1997. Effects of livestock grazing on small mammals at a desert cienaga. *J. of Wildlife Management* 61: 123-29.

Heath, R. 1974., A look at snowmobile damage. ORV Monitor. Environmental Defense Fund, Berkeley, California, USA.

Hidalgo, H. G., T. Das, M. D. Dettinger, D. Cayan, D. W. Pierce, T. P. Barnett, G. Bala, A. Mirin, A. W. Wood, C. Bonfils, B. D. Santer, and T. Nozawa. 2009 Detection and attribution of streamflow timing changes to climate change in the western United States. Journal of Climate 22:3838-3855.

Huff, D.E. and P.J. Savage. 1972. A correlation of deer movements with snowmobile activity in Minnesota during winter. Proceedings of the Midwest Fish and Wildlife Conference. 34: 42-49.

IPCC. 2007. Climate Change 2007: Synthesis Report. An Assessment of the Intergovernmental Panel on Climate Change. Available at www.ipcc.ch.

Institute for Wildlife Studies. 2006. 2006 winter wolverine survey in Sequoia and Kings Canyon National Parks. Unpublished report, available at: http://www.iws.org

Janssen, R. 1978. Effects of noise on wildflife—noise and animals: perspective of government and public policy. Office of Noise Abatement and Control, U.S. Environmental Protection Agency, Washington, D.C.

Jarvinen, J.A., and Schmid, W.D., 1971. Snowmobile use and winter mortality of small mammals. *In* J. Chubb, editor. Proceedings of the snowmobile and off the road vehicle research symposium. College of Agriculture and Natural Resources, Department of Park and Recreation Resources, Recreation Resources and Planning Unit. Tech. Rep. 8. Michigan State University, East Lansing, Michigan, USA.

Jeske, C.W. 1985. Time and energy budgets of wintering ring-necked ducks Ayatha collaris (L.) in north-central Florida. Thesis. University of Florida, Gainesville, FL, USA.

Jones, C., J. Lowe, S. Liddicoat, and R. Betts. 2009. Committed terrestrial ecosystem changes due to climate change. Nature Geoscience 2:484-487.

Karl, T. R., J. M. Melillo, and T. C. Peterson, editors. 2009. *Global climate change impacts in the United States.* A State of Knowledge report from the U.S. Global Change Research Program. Cambridge University Press, Washington, D.C., USA.

Kauffman, J. B., and W. C. Krueger. 1984. Livestock impacts on riparian ecosystems and streamside management implications: a review. *J. of Range Manage.* 37(5): 430-438.

Kie, J. G. 1996. The effects of cattle grazing on optimal foraging in mule deer (*Odocoileus hemiounus*) . *Forest Ecology and Managment* 88: 131-38.

Knowles, N.; Dettinger, M. D.; Cayan, D. R. 2006. Trends in snowfall versus rainfall in the western United States. Journal of Climate 19: 4545-4559.

Kopischke, E.B., 1972. Effects of snowmobile activity on the distribution of white-tailed deer in South-Central Minnesota. Minnesota Department of Natural Resources, Game Research Project Quarterly Report. 32(3):139-142.

Larivière, S., and M. Pasitschniak-Arts. 1996. *Vulpes vulpes*. Mammalian Species 537: 1-11.

Lenton, T. M., H. Held, E. Kriegler, J. W. Hall, W. Lucht, S. Rahmstorf, and H. J. Schellnhuber. 2008. Tipping elements in the Earth's climate system. Proceedings of the National Academy of Sciences of the United States of America 105:1786-1793.

Lewis, J. C.; Sallee, K. L.; Golightly, R. T. 1993. Introduced red fox in California. Arcata, CA: Department of Wildlife, Humboldt State University. 70 p. California Department of Fish and Game, Nongame Bird and Mammal Report 93-10.

Leung, L. R., Y. Qian, X. D. Bian, W. M. Washington, J. G. Han, and J. O. Roads. 2004. Mid-century ensemble regional climate change scenarios for the western United States. Climatic Change 62:75-113.

Linnaeus, C. 1758. Systema naturae, 10th ed. Stockholm: Laurentii Salvii.

Loft, E. R, J. W. Menke, J. G. Kie, and R. C. Bertram. 1987. Influence of cattle stocking rate on the structural profile of deer hiding cover. *J. of Wildlife Management* 51(655-664).

Loft, E. R., J. G. Kie, and J. W. Menke. 1993. Grazing in the Sierra Nevada: home ranges and space use patterns of mule deer as influenced by cattle. *California Fish and Game* 79: 145-66.

Malaher, G.W. 1967. Improper use of snow vehicles for hunting. Proceedings of the Thirty-Second North American Wildlife Conference. Pgs. 429-433.

McDonald, K. A.; Brown, J. H. 1992. Using montane mammals to model extinctions due to global change. Conservation Biology 6: 409-415.

McMullen, C. P., and J. Jabbour. 2009. Climate Change Science Compendium 2009. United Nations Environment Porgramme, Nairobi, EarthPrint.

Merriam, C. H. 1900. Preliminary revision of the North American red foxes. Proceedings of the Washington Academy of Sciences 2: 661-676.

Millar, C. I. 1996. Sierra Nevada Ecosystem Project, Final Report to Congress, Vol. I, Assessment Summaries and Management Strategies, Centers for water and Wildland Resources, Report No. 36, University of California, Davis, California. Cooperative report of the PSW Research Station, PSW Region, USDA, for the Sierra Nevada Framework Project, Sacramento, CA.

Moen, J.; Aune, K.; Edenius, L.; Angerbjörn, A. 2004. Potential effects of climate change on treeline position in the Swedish mountains. Ecology and Society 9(1): 16.

Moritz, C., J. L. Patton, C. J. Conroy, J. L. Parra, G. C. White, and S. R. Beissinger. 2008. Impacts of a century of climate change on small-mammal communities in Yosemite National Park, USA. Science 321:261-264.

Mote, P. W. 2006. Climate-driven variability and trends in mountain snowpack in Western North America. Journal of Climate 19:6209-6220.

Mote, P. W., A. Hamlet, M. P. Clark, and D. P. Lettenmaier. 2005. Declining mountain snowpack in western North America. American Meteorological Society January 39-49.

Natureserve. 2010. Sierra Nevada red fox species account. Accessed 5 April 2011 at: http://www.natureserve.org/explorer/

Nei, M., T. Marayama, and R. Chakraborty. 1975. The bottleneck effect and genetic variability on populations. Evolution 29:1-10.

Nolin, A.W., and C. Daly, 2006. Mapping "At Risk" snow in the Pacific Northwest. J. Hydrometeor., 7, 1164–1171.

Neumann, P.W. and H.G. Merriam. 1972. Ecological effects of snowmobiles. The Canadian Field-Naturalist, 86: 207-212.

NDW. 2010. 2009-2010 fubearer seasons and limits. Nevada Department of Wildlife. Reno, NV.

Nowak, R. N. 1999. Walker's Mammals of the World (6th edition, vol. 1). Baltimore: Johns Hopkins University Press; 636-639.

ODFW 2010a. Oregon furbearer, trapping and hunting regulations. Oregon Department of Fish and Wildlife. Portland, Oregon. Accessed 4 April 2011 at: http://www.dfw.state.or.us/resources/hunting/small_game/regulations/docs/2010-2012_Furbearer_Regs.pdf

ODFW 2010b. 2010 trout stocking schedule. Oregon Department of Fish and Wildlife, Portland, Oregon. Accessed on 15 December 2010 at: http://www.dfw.state.or.us/resources/fishing/trout_stocking_schedules/2010.asp

Parmesan, C. 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology Evolution and Systematics 37:637-669.

Pierce, D. W., T. P. Barnett, H. G. Hidalgo, T. Das, C. Bonfils, B. D. Santer, G. Bala, M. D. Dettinger, D. Cayan, A. Mirin, A. W. Wood, and T. Nozawa. 2008. Attribution of declining western U.S. snowpack to human effects. 21.

Perrine, J. D. 2005. Ecology of red fox (*Vulpes vulpes*) in the Lassen Peak region of California, USA. Berkeley: University of California; 236 p. Ph.D. dissertation.

Perrine, J. D.; Pollinger, J. P.; Sacks, B. N.; Barrett, R. H.; Wayne, R. K. 2007. Genetic evidence for the persistence of the critically endangered Sierra Nevada red fox in California. Conservation Genetics 8: 1083-1095.

Perrine, J.D., Campbell, L.A., Green, G.A. 2010. Conservation assessment for the Sierra Nevada red fox (*Vulpes vulpes necator*). US Forest Service, Pacific Southwest Research Station.

Raupach, M. R., G. Marland, P. Ciais, C. Le Quéré, J. G. Canadell, G. Klepper, and C. B. Field. 2007. Global and regional drivers of accelerating CO_2 emissions. Proceedings of the National Academy of Sciences of the United States of America 104:10288-10293.

Rauscher, S. A., J. S. Pal, N. S. Diffenbaugh, and M. M. Benedetti. 2008. Future changes in snowmelt-driven runoff timing over the western US. Geophysical Research Letters 35, L16703, doi:10.1029/2008GL034424.

Rich, A., Lisius, S.K., Statham, M.J., and B.N. Sacks. 2011. Discovery of a remnant population of Sierra Nevada red fox (*Vulpes vulpes necator)* in the southern Sierra Nevada. Presentation at the Annual Conference of the western section of The Wildlife Society on 9 February 2011 in Pinecrest, CA.

Richardson, K., W. Steffen, H. J. Schellnhuber, J. Alcamo, T. Barker, R. Leemans, D. Liverman, M. Munasinghe, B. Osman-Elasha, N. Stern, and O. Waever. 2009. Synthesis Report from Climate Change: Global Risks, Challenges and Decisions, Copenhagen 2009, 10-12 March, www.climatecongresss.ku.dk.

Rikihisa, Y., Stills, H., Zimmerman G. 1991. Isolation and continuous culture of *Neorickettsia helminthoeca* in a macrophage cell line. Journal of Clinical Microbiology. 29(9): 1928-1933.

Roest, A. I. 1977. Taxonomic status of the red fox in California. San Luis Obispo: California Polytechnic State University. Available from California Department of Fish and Game, Job II-1.3.

Rogelj, J., J. Nabel, C. Chen, W. Hare, K. Markman, and M. Meinshausen. 2010. Copenhagen Accord pledges are paltry. Nature 464:1126-1128.

Rongstad, O.J., 1980. Research needs on environmental impacts of snowmobiles. In R.N.L. Andrews and P. Nowak, editors. Off-road vehicle use: A management challenge. U.S. Department of Agriculture, Office of Environmental Quality, Washington, D.C.

Sacks, B.N., Statham, M.J., Perrine, J.D., Wisely, S.M., and K.B. Aubry. 2010. North American montane red foxes: expansion, fragmentation, and the origin of the Sacramento Valley red fox. Conservation Genetics 11: 1523-1539.

Samuel, D. E.; Nelson, B. B. 1982. Foxes. In: Chapman, J. A.; Feldhamer, G. A., eds. Wild mammals of North America: biology, management and economics. Baltimore: Johns Hopkins Univ. Press; 475-489.

Schempf, P. F.; White, M. 1977. Status of six furbearer populations in the mountains of northern California. Berkeley: Department of Forestry and Conservation, and Museum of Vertebrate Zoology, University of California. 51 p. Published by the U. S. Department of Agriculture, Forest Service, California Region.

Seton, E. T. 1929. Lives of game animals. Volume I, Part 2: Cats, wolves, and foxes. Garden City, NY: Doubleday, Doran and Company; 467-552.

Smith, J. B., S. H. Schneider, M. Oppenheimer, G. W. Yohe, W. Hare, M. D. Mastrandrea, A. Patwardhan, I. Burton, J. Corfee-Morlot, C. H. D. Magadza, H.-M. Fussel, A. B. Pittock, A. Rahman, A. Suarez, and J.-P. van Ypersele. 2009. Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC) "reasons for concern". Proceedings of the National Academy of Sciences of the United States of America 106:4133-4137.

Snyder, M. A., J. L. Bell, L. C. Sloan, P. B. Duffy, and B. Govindasamy. 2002. Climate responses to a doubling of atmospheric carbon dioxide for a climatically vulnerable region. Geophysical Research Letters 29.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2004. Changes in snowmelt runoff timing in western North America under a 'Business as Usual' climate change scenario. Climatic Change 62: 217-232.

Strittholt, J. R., D. A. DellaSala, and H. Jiang. 2006. Status of mature and old-growth forests in the Pacific Northwest. Conservation Biology 20:363–374.

Tjernberg, M. 1981. Diet of the golden eagle *Aquila chrysaetos* during the breeding season in Sweden. Holarctic Ecology 4: 12-19.

Tripati, A. K., C. D. Roberts, and R. A. Eagle. 2009. Coupling of CO_2 and ice sheet stability over major climate transitions of the last 20 million years. Science 326:1394-1397.

USDA Forest Service. 2001. Sierra Nevada Forest Plan Amendment Final Environmental Impact Statement and Record of Decision. Vallejo, CA: Pacific Southwest and Intermountain Regions, Forest Service, US Department of Agriculture.

USDA Forest Service. 2004. Sierra Nevada Forest Plan Amendment Final Supplemental Environmental Impact Statement and Record of Decision. Vallejo, CA: Pacific Southwest and Intermountain Regions, Forest Service, US Department of Agriculture.

USDA Forest Service. 2010. Forest carnivore surveys in the Pacific states carnivore survey database. Accessed December 15 2010 at: http://maps.fs.fed.us/carnivore//Modules/application/home.html

USDA Forest Service. 2007. Aerial application of fire retardant environmental assessment. Forest Service Fire and Aviation Management. Washington, D.C.

USDA Forest Service; USDI. 1994a. Final supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl [Northwest Forest Plan]. Portland, OR. 2 vol.

USDA Forest Service; USDI. 1994b. Record of decision on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl [Northwest Forest Plan]. Portland, OR.

USDA Forest Service and CFGD. 2010. Rare Sierra Nevada red fox “population” re-discovered. Joint news release of the USDA Forest Service Pacific Southwest Region and CFGD California State Office. December 3rd 2010, Vallejo, CA.

USDA Forest Service. 2011. Bridgeport Ranger District, Humboldt-Toiyabe National Forest, Environmental Assessment, Pacific Crest National Scenic Trail Crossing, available at http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5283814.pdf

USDI US Fish and Wildlife Service. 2008. Biological opinion on the USDA Forest Service application of fire retardants on national forest system lands. USDI US Fish and Wildlife Service. Washington, D.C.

USGCRP. 2009. Global Climate Change Impacts in the United States. U.S. Global Change Research Program. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

UNEP. 2010. The Emissions Gap Report: Are the Copenhagen Accord Pledges Sufficient to Limit Global Warming to 2C or 1.5C? Available at http://www.unep.org/publications/ebooks/emissionsgapreport/pdfs/GAP_REPORT_SUNDAY_SINGLES_LOWRES.pdf.

Vicuna, S., and J. A. Dracup. 2007. The evolution of climate change impact studies on hydrology and water resources in California. Climatic Change 82:327-350.

Voigt, D. R. 1987. Red fox. In: Novak, M.; Baker, J. A.; Obbare, M. E., eds. Wild furbearer management and conservation in North America. Ontario: Ontario Ministry of Natural Resources; 379-392.

Vos, D.K., Ryder, R.A., and Graul, W.D. 1985. Response of breeding great blue herons (Ardea Herodias) to human disturbance in north-central Colorado. Colonial Waterbirds, 8(1): 13-22.

Warren, R. 2006. Impacts of global climate change at different annual mean global temperature increases. Pages 93-132 *in* H. J. Schellnhuber, editor. Avoiding Dangerous Climate Change. Cambridge University Press, Cambridge, UK.

Weinstein, M., 1978. Impact of Off-Road Vehicles on the Avifauna of Afton Canyon, California. Bureau of Land Management. Department of the Interior. Final Report #CA-060-CT7-2734.

Wettersten, R. 1971. Environmental impacts of snowmobiling. Pages E-10 - E-13 *in* R.W. Butler, P.S. Elder, H.N. Janish, and B.M. Petrie, eds. Conference on Snowmobiles and All-terrain Vehicles. Univesity of Ontario, London, Ontario, Canada.

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

APPENDIX 1: Livestock Grazing Allotments Intersecting Approximate Historical and Current Known Range of Sierra Nevada Red Fox

Allotments Intersecting Approximate Historical Range

Agency	State	Name
BLM	California	Alabama Hills
BLM	California	Barron
BLM	California	Bucks Bay
BLM	California	Burnt Point
BLM	California	Case Mountain
BLM	California	Coffin
BLM	California	Coonrod
BLM	California	Copper Mountain
BLM	California	Cottonwood
BLM	California	Dog Creek
BLM	California	Four Corners
BLM	California	George Creek
BLM	California	Green Creek
BLM	California	Jacks Valley
BLM	California	Kennedy Lamont
BLM	California	Mello Canyon
BLM	California	Milk Ranch Peak
BLM	California	Mono Settlement
BLM	California	North Fork River
BLM	California	North Horse Lake
BLM	California	Oak Grove
BLM	California	Rancheria Gulch
BLM	California	Rice Canyon
BLM	California	Round Valley
BLM	California	Salt Springs
BLM	California	Slate Creek
BLM	California	South Horse Lake
BLM	California	Stone
BLM	California	Ulch

BLM	California	Walsh Mountain
BLM	California	Wells Meadow
BLM	California	Willow Creek
BLM	California	Wood
BLM	Oregon	BROWN
BLM	Oregon	CLIFF
USFS	California	77 Corral
USFS	California	A. Brown
USFS	California	Alabama Hills
USFS	California	Alger Lake
USFS	California	American Hill
USFS	California	Antelope
USFS	California	Ash Creek
USFS	California	Baldwin
USFS	California	Ball Mountain
USFS	California	Bartle
USFS	California	Battle Canyon
USFS	California	Beach
USFS	California	Bear
USFS	California	Bear Creek
USFS	California	Bear River
USFS	California	Bear Valley
USFS	California	Beasore
USFS	California	Beckwourth
USFS	California	Beckwourth Peak
USFS	California	Bell Meadow-Bear Lake
USFS	California	Benner Creek
USFS	California	Bickford
USFS	California	Big Flat
USFS	California	Big Hill
USFS	California	Black Cap
USFS	California	Black Mountain
USFS	California	Blasingame
USFS	California	Bloody Canyon
USFS	California	Blue Canyon
USFS	California	Boca
USFS	California	Bogus
USFS	California	Bray
USFS	California	Bridge Creek
USFS	California	Bryan Meadow
USFS	California	Buck Rock
USFS	California	Bull Creek

USFS	California	Bull Hill
USFS	California	Burnt Country
USFS	California	Butt Creek
USFS	California	Butte Meadows
USFS	California	Buttermilk
USFS	California	Caldor
USFS	California	Cannell
USFS	California	Canyon Creek
USFS	California	Carter Meadows
USFS	California	Cassidy
USFS	California	Castle Peak
USFS	California	Cat Creek
USFS	California	Cayton
USFS	California	Central Camp
USFS	California	Champs Flat
USFS	California	Chico
USFS	California	Chipmunk
USFS	California	Chips Creek
USFS	California	Chiquito
USFS	California	Chowchilla
USFS	California	Clark Fork
USFS	California	Clover Valley
USFS	California	Cody Meadow
USFS	California	Cold Creek
USFS	California	Collins
USFS	California	Converse/hoist
USFS	California	Coon Hollow
USFS	California	Cooper
USFS	California	Corral Flat
USFS	California	Cow Mountain
USFS	California	Coyote
USFS	California	Coyote Springs
USFS	California	Crown Valley
USFS	California	Curtin
USFS	California	Deadwood
USFS	California	Deer Creek
USFS	California	Deer Mountain
USFS	California	Delilah
USFS	California	Devils Peak
USFS	California	Dike Creek
USFS	California	Dinkey
USFS	California	Dry Lake

USFS	California	Dry Meadow
USFS	California	Duck Lake
USFS	California	Duckwall
USFS	California	Duncan Sailor
USFS	California	Eagle Creek
USFS	California	East Bear Creek
USFS	California	East Fork
USFS	California	East Red Rock
USFS	California	Eddy Creek
USFS	California	English
USFS	California	Euer Valley
USFS	California	Feather River
USFS	California	Fish Creek
USFS	California	Florence
USFS	California	Fredonyer
USFS	California	Garden Gulch
USFS	California	George Creek
USFS	California	Gold Valley
USFS	California	Granite Fox
USFS	California	Grays Valley
USFS	California	Grouse Creek
USFS	California	Haight Mountain
USFS	California	Harding Point
USFS	California	Harvey Valley
USFS	California	Haskell
USFS	California	Haskell Peak
USFS	California	Haslett
USFS	California	Hat Creek
USFS	California	Haypress
USFS	California	Helms
USFS	California	Herring Creek
USFS	California	Highland Lakes
USFS	California	Horse Corral
USFS	California	Horse Meadow
USFS	California	Horsethief
USFS	California	Hot Creek
USFS	California	Hot Springs
USFS	California	Howard Creek
USFS	California	Independence
USFS	California	Indian Valley
USFS	California	Iron Creek
USFS	California	Jawbone

USFS	California	Jose
USFS	California	June Lake
USFS	California	June Lake (Closed to sheep grazing)
USFS	California	Kaiser
USFS	California	Kennedy Lake
USFS	California	Kyburz
USFS	California	Leek Springs
USFS	California	Lincoln Valley
USFS	California	Little Crane
USFS	California	Little Kern
USFS	California	Long Ridge
USFS	California	Long Valley - Eagle Meadow
USFS	California	Lower Blue
USFS	California	Lower Hull
USFS	California	Lower Pine Creek
USFS	California	Lyonsville
USFS	California	Markwood
USFS	California	Martin
USFS	California	Mattley
USFS	California	Mccloud/hambone
USFS	California	McGee
USFS	California	Meiss
USFS	California	Middle Fork
USFS	California	Middle Tule
USFS	California	Middle Yuba
USFS	California	Mill Creek
USFS	California	Minnow
USFS	California	Mokelumne
USFS	California	Monache
USFS	California	Mono
USFS	California	Morgan Springs
USFS	California	Morrison
USFS	California	Mosquito
USFS	California	Mount Hebron
USFS	California	Mountain Meadows
USFS	California	Mt Haskell
USFS	California	Mt Tom
USFS	California	Mugler
USFS	California	Mulkey
USFS	California	Mumbo
USFS	California	Murphy Hill
USFS	California	Nevada Point

USFS	California	Nichols Canyon
USFS	California	North Battle Creek
USFS	California	North Eagle Lake
USFS	California	North Hot Springs
USFS	California	North Jackass
USFS	California	Oat Mountain/lef
USFS	California	Olancha
USFS	California	Old Pino
USFS	California	Our House
USFS	California	Pacific Valley
USFS	California	Panther Creek
USFS	California	Pardoe
USFS	California	Pass Creek
USFS	California	Patterson Bnd
USFS	California	Patterson Mtn
USFS	California	Payen
USFS	California	Pearl Lake
USFS	California	Perazzo Meadows
USFS	California	Pinoche
USFS	California	Piute
USFS	California	Poison Lake
USFS	California	Post Corral
USFS	California	Prather
USFS	California	Pyramid
USFS	California	Rancheria
USFS	California	Red Mountain
USFS	California	Red Peak
USFS	California	Red Rock
USFS	California	Rice Creek
USFS	California	Robbers Creek
USFS	California	Rock Creek
USFS	California	Rodgers Ridge
USFS	California	Rodoni
USFS	California	Rosasco
USFS	California	Rushing
USFS	California	Sampson
USFS	California	Sherman
USFS	California	Sherwin/Deadman
USFS	California	Silver Lake
USFS	California	Soda Creek - North Butte
USFS	California	Soldier Creek
USFS	California	Soldier Meadows

USFS	California	Soquel
USFS	California	South Eagle Lake
USFS	California	South Fork Saloon
USFS	California	South Grouse
USFS	California	South Jackass
USFS	California	South Russian
USFS	California	Southgrove-Smoothwire
USFS	California	Stanislaus Meadow
USFS	California	Steely Creek
USFS	California	Sugar Pine
USFS	California	Sugarloaf
USFS	California	Summit
USFS	California	Susan River
USFS	California	Sycamore
USFS	California	Tehama
USFS	California	Tells Peak
USFS	California	Templeton
USFS	California	Thompson
USFS	California	Three Sisters
USFS	California	Toad Mtn
USFS	California	Tobacco Flat
USFS	California	Trout Creek
USFS	California	Upper Hull
USFS	California	Upper Mono
USFS	California	Upper Pine Creek
USFS	California	Volcano
USFS	California	Webber Lake
USFS	California	West Humbug
USFS	California	West Parks Creek
USFS	California	Westside
USFS	California	Wheats
USFS	California	White Deer
USFS	California	Whitney
USFS	California	Woodchuck
USFS	California	Wrights Lake
USFS	Oregon	ABBOT
USFS	Oregon	BIG MARSH
USFS	Oregon	CACHE MOUNTAIN
USFS	Oregon	CRESCENT BUTTE
USFS	Oregon	CRESCENT CREEK
USFS	Oregon	DAVIS LAKE
USFS	Oregon	FREMONT SIDING

USFS	Oregon	FUELBREAKS
USFS	Oregon	GARRISON BUTTE
USFS	Oregon	GILCHRIST
USFS	Oregon	GLAZE MEADOW
USFS	Oregon	HOLZMAN
USFS	Oregon	INDIAN FORD
USFS	Oregon	LITTLE DESCHUTES
USFS	Oregon	LITTLE DESCHUTES ON-OFF
USFS	Oregon	MOWICH
USFS	Oregon	RYAN RANCH
USFS	Oregon	SPARKS LAKE
USFS	Oregon	SQUAW CREEK
USFS	Oregon	TETHEROW MEADOW

Allotments Intersecting Approximate Current Known Range

Agency	State	Name
USFS	California	Benner Creek
USFS	California	Deer Creek
USFS	California	Clover Valley
USFS	California	Feather River
USFS	California	Grays Valley
USFS	California	Harvey Valley
USFS	California	Lower Pine Creek
USFS	California	Martin
USFS	California	Morgan Springs
USFS	California	Poison Lake
USFS	California	Robbers Creek
USFS	California	Silver Lake
USFS	California	Soldier Meadows
USFS	California	Tehama
USFS	California	Collins
USFS	California	Lyonsville
USFS	California	Rice Creek
USFS	California	Coyote Springs
USFS	California	Hat Creek
USFS	California	North Battle Creek
USFS	California	Clark Fork
USFS	California	Kennedy Lake
USFS	California	Red Peak
USFS	California	Bridge Creek

USFS	California	Duck Lake
USFS	California	Upper Pine Creek

APPENDIX 2: Trout-stocked Water-bodies (2002-2006) in California Intersecting Approximate Historical and Current Known Range of Sierra Nevada Red Fox

Trout-stocked Water-bodies (2002-2006) Intersecting Approximate Historical Range

YEAR_	HATCHERY	COUNTY	METHOD	RELEASE DATE	FISH SPECIES	RELEASE WATER BODY
2002	MSH	Siskiyou	Air Plant	6/24/2002	BK	West Park Lake Middle
2002	MSH	Siskiyou	Air Plant	6/24/2002	BK	West Park Lake Lower
2003	MSH	Siskiyou	Air Plant	7/14/2003	RT	Crater Lake Big, China Mountain
2003	MSH	Siskiyou	Air Plant	7/21/2003	BK	Caldwell Lake #2
2003	MSH	Siskiyou	Air Plant	7/21/2003	BK	Caldwell Lake Middle
2003	MSH	Siskiyou	Air Plant	7/14/2003	RT	Cabin Meadow Lake
2003	MSH	Siskiyou	Air Plant	7/29/2003	RT	Dobkins Lake
2002	MSH	Siskiyou		6/10/2002	RT	Lily Pad Lake
2002	MSH	Siskiyou		6/10/2002	RT	Kangaroo Lake
2003	MSH	Siskiyou	Air Plant	7/14/2003	BK	Rock Fence Lake
2006	MSH	Trinity	Air Plant	7/6/2006	RT	Bull Lake
2003	MSH	Siskiyou	Air Plant	7/25/2003	ELT	Deadfall Lake, Lower
2003	MSH	Siskiyou		7/25/2003	ELT	Deadfall Lake, Middle
2003	MSH	Trinity	Air Plant	7/14/2003	RT	Slide Lake
2005	MSH	Siskiyou	Truck	6/17/2005	RT	Browns Lake
2002	CLH	Siskiyou		7/11/2002	ELT	Siskiyou Lake
2003	MSH	Siskiyou	Horse/Mule	7/17/2003	RT	Toad Lake
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Waterdog Lake
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Russian Lake Upper
2003	MSH	Siskiyou	Air Plant	7/25/2003	RT	Syphon Lake
2003	MSH	Siskiyou	Air Plant	7/14/2003	RT	Mill Creek Lake West
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Boulder Lake East
2006	MSH	Trinity	Air Plant	7/5/2006	RT	Marshy Lake Big, Salmon Scott
2002	MSH	Siskiyou		5/17/2002	RT	Castle Lake
2006	MSH	Trinity	Air Plant	7/5/2006	RT	Marshy Lake Little, Salmon Scott
2003	MSH	Siskiyou	Air Plant	7/14/2003	RT	Boulder Lake Middle
2002	MSH	Siskiyou	Air Plant	6/24/2002	BK	Hidden Lake

2002	MSH	Siskiyou	Air Plant	6/24/2002	BN	Fox Creek Lake
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Telephone Lake
2003	MSH	Siskiyou	Air Plant	7/10/2003	BK	Mavis Lake
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Virginia Lake
2003	MSH	Trinity	Air Plant	7/25/2003	ELT	Tangle Blue Lake
2002	MSH	Siskiyou		5/23/2002	RT	Gumboot Lake Lower
2002	MSH	Trinity	Air Plant	7/29/2002	RT	Big Bear Lake
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Trail Gulch Lake
2002	MSH	Trinity	Air Plant	6/24/2002	BK	Mumbo Lake Lower, Trinity Divide
2002	MSH	Siskiyou	Air Plant	6/24/2002	RT	Seven Lake Lower
2002	MSH	Shasta	Air Plant	6/24/2002	RT	Helen Lake
2002	CLH	Shasta		4/24/2002	RT	McCloud Reservoir
2002	MSH	Trinity	Air Plant	7/29/2002	RT	Stoddard Lake
2002	MSH	Trinity	Air Plant	7/29/2002	RT	McDonald Lake
2002	MSH	Trinity	Air Plant	7/29/2002	RT	Adams Lake
2002	MSH	Shasta	Air Plant	6/24/2002	BK	Grey Rock Lake
2003	MSH	Trinity	Air Plant	7/15/2003	RT	Twin Lake Lower
2004	MSH	Trinity		7/7/2004	RT	Tamarack Lake
2003	MSH	Trinity	Air Plant	7/15/2003	RT	Highland Lake
2003	MSH	Trinity	Air Plant	7/14/2003	RT	Sugar Pine Lake
2002	CLH	Trinity		3/6/2002	BN	Trinity Lake
2002	MSH	Trinity		4/24/2002	RT	Carrville Pond
2002	MSH	Trinity	Air Plant	7/26/2002	RT	Boulder Lake Big
2004	MSH	Trinity		7/6/2004	RT	Foster Lake
2002	MSH	Trinity	Air Plant	7/29/2002	RT	Boulder Lake Little
2003	MSH	Trinity	Air Plant	7/25/2003	ELT	Union Lake
2002	CLH	Shasta		4/25/2002	RT	Iron Canyon Reservoir
2003	MSH	Trinity	Air Plant	7/26/2003	RT	Landers Lake
2002	MSH	Trinity	Air Plant	7/30/2002	RT	Shimmy Lake, Trinity Alps
2003	MSH	Trinity		7/26/2003	RT	Ward Lake
2003	MSH	Trinity	Air Plant	7/26/2003	RT	Horseshoe Lake
2002	MSH	Trinity	Air Plant	7/30/2002	RT	Eleanor Lake
2003	MSH	Trinity	Air Plant	7/14/2003	RT	Granite Lake
2002	DSH	Shasta		5/22/2002	RT	Buckhorn Lake
2002	CLH	Shasta		4/22/2002	RT	McCumber Reservoir
2002	CLH	Plumas		5/17/2002	ELT	Lake Almanor
2002	ARH	Nevada		2/7/2002	RT	Scotts Flat Reservoir Upper
2002	ARH	Nevada		7/10/2002	RT	Scotts Flat Reservoir Lower
2002	ARH	Nevada		2/7/2002	RT	Rollins Reservoir
2002	ARH	El Dorado		4/24/2002	RT	El Dorado Forebay
2002	SJH	Madera	Air Plant	7/9/2002	RT	Joe Crane Lake

2002	SJH	Fresno	Air Plant	7/9/2002	RT	Pearl Lake
2002	CLH	Siskiyou		6/19/2002	BK	Medicine Lake Little
2002	CLH	Siskiyou		6/11/2002	BK	Medicine Lake
2002	CLH	Siskiyou		6/21/2002	RT	Bullseye Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Eiler Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Barrett Lake
2002	MSH	Shasta	Air Plant	6/25/2002	ELT	Durbin Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Everett Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Hufford Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Magee Lake
2002	CLH	Lassen		6/12/2002	ELT	Crater Lake
2002	CLH	Shasta		6/12/2002	RT	North Battle Creek Reservoir
2002	MSH	Lassen	Air Plant	6/25/2002	ELT	Triangle Lake
2002	MSH	Lassen		7/18/2002	ELT	Snag Lake
2002	MSH	Lassen	Air Plant	6/25/2002	ELT	Twin Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Turnaround Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Bimber Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Eleanor Lake
2002	MSH	Lassen	Air Plant	6/25/2002	ELT	Black Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Jewel Lake
2002	CLH	Lassen		6/10/2002	RT	Caribou Lake
2002	MSH	Lassen	Air Plant	6/25/2002	RT	Gem Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hourglass Lake
2002	CLH	Lassen		6/7/2002	BN	Silver Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Emerald Lake
2002	MSH	Lassen		6/25/2002	BK	Rim Lake
2002	MSH	Lassen		6/25/2002	RT	Betty Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Cypress Lake
2002	CLH	Lassen		6/12/2002	ELT	Shotoverin Lake
2002	CLH	Lassen		5/6/2002	BN	McCoy Flat Reservoir
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Trail Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Long Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Posey Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #2
2002	MSH	Lassen	Air Plant	6/25/2002	RT	Beauty Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #1
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #3
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #4
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #5
2002	MSH	Lassen	Air Plant	6/25/2002	RT	Evelyn Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Heart Lake

2003	CLH	Plumas		6/19/2003	BK	Echo Lake
2002	MSH	Tehama	Air Plant	6/25/2002	BK	Twin Meadows Lake, Mt. Lassen
2003	MSH	Tehama	Air Plant	7/15/2003	BK	Rocky Peak Lake
2002	MSH	Tehama	Air Plant	6/25/2002	BK	Diamond Lake, Turner Mountain
2002	ARH	Butte		7/11/2002	RT	Philbrook Reservoir
2002	CLH	Sierra		6/19/2002	BK	Gold Lake
2006	ARH	Sierra	Air Plant	7/13/2006	RT	Snake Lake
2006	ARH	Sierra	Air Plant	7/13/2006	RT	Deer Lake Little
2006	ARH	Sierra	Truck	8/28/2006	RT	Snag Lake
2002	ARH	Sierra		5/30/2002	RT	Salmon Lake Upper
2006	ARH	Sierra	Air Plant	7/13/2006	RT	Smith Lake
2006	ARH	Sierra	Air Plant	7/13/2006	RT	Deer Lake Big
2002	ARH	Sierra		5/30/2002	RT	Packer Lake
2002	ARH	Sierra		5/30/2002	RT	Sardine Lake Lower
2004	ARH	Sierra	Air Plant	7/2/2004	RT	Sardine Lake Upper
2002	ARH	Nevada		5/28/2002	RT	Jackson Meadows Reservoir
2002	ARH	Sierra		4/24/2002	RT	Stampede Reservoir
2002	ARH	Nevada		5/29/2002	RT	Weaver Lake
2002	ARH	Nevada		5/27/2002	KOK	Bowman Reservoir
2002	ARH	Nevada		4/24/2002	RT	Boca Reservoir
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Sawmill Lake
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Rock Lake Upper
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Rock Lake Lower
2002	ARH	Nevada		7/11/2002	BN	Faucherie Lake
2002	ARH	Nevada	Air Plant	6/28/2002	RT	French Lake
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Culbertson Lake
2006	HCH	Nevada	Air Plant	9/20/2006	CT	Penner Lake
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Lindsey Lake Lower
2006	ARH	Nevada	Truck	7/11/2006	RT	Lindsey Lake Lower
2006	HCH	Nevada	Air Plant	9/20/2006	CT	Eileen Lake
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Island Lake Big
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Long Lake, Grouse Ridge
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Island Lake Little
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Fordyce Lake
2006	ARH	Nevada	Air Plant	7/13/2006	RT	Milk Lake
2002	ARH	Nevada		4/24/2002	RT	Prosser Reservoir
2002	SFB	Nevada	Truck	5/16/2002	CHIN	Spaulding Reservoir
2002	ARH	Nevada		5/24/2002	RT	Fuller Lake
2002	ARH	Nevada		4/22/2002	RT	Donner Lake

2002	ARH	Nevada		6/12/2002	CT	Martis Creek Reservoir
2003	ARH	Nevada		6/12/2003	RT	Kilborn Lake
2005	ARH	Nevada	Truck	7/14/2005	RT	Coldstream Pond, Donner Lake Park
2002	ARH	Placer		9/30/2002	RT	Lake Valley Reservoir
2002	ARH	Placer		6/3/2002	RT	French Meadows Reservoir
2002	ARH	Placer		4/24/2002	KOK	Hellhole Reservoir
2002	ARH	El Dorado		5/20/2002	RT	Loon Lake
2002	HCH	El Dorado	Air Plant	9/9/2002	CT	Hidden Lake
2002	ARH	El Dorado	Air Plant	6/28/2002	RT	Winifred Lake
2002	ARH	El Dorado	Air Plant	6/28/2002	RT	Rockbound Lake
2006	HCH	El Dorado	Air Plant	9/21/2006	CT	Francis Lake
2002	ARH	El Dorado	Air Plant	6/28/2002	RT	Rubicon Reservoir
2002	MCH	El Dorado		7/8/2002	BK	Shadow Lake
2002	ARH	El Dorado	Air Plant	6/28/2002	RT	Hidden Lake, Crag
2002	ARH	El Dorado	Air Plant	6/28/2002	RT	Stoney Ridge Lake
2002	HCH	El Dorado	Air Plant	9/9/2002	GT	Number 3 Lake
2003	MOK	El Dorado		8/12/2003	CT	Fallen Leaf Lake
2002	HCH	El Dorado	Air Plant	9/9/2002	GT	Kalmia Lake
2002	ARH	El Dorado		4/25/2002	RT	Stumpy Meadows Reservoir
2002	ARH	El Dorado	Air Plant	6/28/2002	RT	Gilmore Lake
2002	ARH	El Dorado		4/2/2002	KOK	Union Valley Reservoir
2003	ARH	El Dorado	Air Plant	7/10/2003	BK	Angora Lake Lower
2004	MCH	El Dorado		7/12/2004	CT	Angora Lake Upper
2002	ARH	El Dorado		6/13/2002	RT	Wrights Lake
2002	ARH	El Dorado		6/13/2002	RT	Dark Lake
2002	ARH	El Dorado		5/23/2002	CT	Echo Lake Lower
2002	ARH	El Dorado		4/24/2002	RT	Icehouse Reservoir
2006	HCH	Alpine	Air Plant	9/20/2006	CT	Scotts Lake
2004	MCH	El Dorado		8/27/2004	CT	Round Lake
2002	HCH	El Dorado	Air Plant	9/9/2002	CT	Four Lake Upper
2004	MCH	El Dorado		8/27/2004	CT	Shower Lake
2002	HCH	El Dorado	Air Plant	9/9/2002	CT	Four Lake Middle
2002	ARH	Alpine		6/12/2002	RT	Burnside Lake
2002	ARH	Alpine		5/22/2002	RT	Caples Lake
2002	ARH	El Dorado		6/20/2002	RT	Kirkwood Lake
2002	ARH	Alpine		5/23/2002	CT	Red Lake
2002	ARH	Alpine		6/20/2002	RT	Woods Lake
2002	ARH	Amador		5/22/2002	RT	Silver Lake
2006	HCH	Alpine	Air Plant	9/20/2006	CT	Round Top Lake
2002	ARH	Alpine		6/21/2002	RT	Blue Lake Upper

2002	ARH	Alpine		6/21/2002	RT	Blue Lake Lower
2004	MCH	Alpine		7/12/2004	CT	Granite Lake
2004	MCH	Alpine		7/12/2004	CT	Evergreen Lake
2004	SJH	Alpine		9/2/2004	GT	Raymond Lake
2002	HCH	Alpine	Air Plant	9/9/2002	CT	Twin Lake
2003	ARH	Alpine	Air Plant	7/10/2003	BK	Wet Meadows Reservoir
2002	HCH	Alpine	Air Plant	9/9/2002	CT	Meadow Lake
2002	ARH	Amador		6/25/2002	RT	Bear River Reservoir Upper
2002	ARH	Amador		5/9/2002	RT	Bear River Reservoir Lower
2002	HCH	Alpine		6/14/2002	RT	Kinney Reservoir
2004	MCH	Alpine		5/27/2004	RT	Mosquito Lake Lower
2002	MCH	Alpine		5/28/2002	ELT	Mosquito Lake Upper
2002	MCH	Alpine		5/24/2002	ELT	Alpine Lake
2003	MCH	Alpine		9/9/2003	CT	Tamarack Lake
2002	MCH	Alpine		7/2/2002	ELT	Union Reservoir
2002	MCH	Mono		6/12/2002	BK	Kirmen Lake
2002	HCH	Mono	Air Plant	7/2/2002	RT	Millie Lake
2002	HCH	Mono		5/16/2002	RT	Junction Reservoir
2002	HCH	Mono	Air Plant	7/2/2002	RT	Poore Lake
2005	HCH	Mono	Air Plant	7/26/2005	RT	Secret Lake
2004	SJH	Tuolumne	Air Plant	9/15/2004	GT	Blue Canyon Lake
2002	HCH	Mono	Air Plant	9/9/2002	CT	Roosevelt Lake
2005	HCH	Mono	Air Plant	7/26/2005	RT	Emma Lake
2006	MCH	Tuolumne	Truck	7/14/2006	RT	Relief Lake, North
2002	HCH	Mono		#########	RT	Leavitt Lake
2003	MCH	Mono		7/21/2003	RT	Fremont Lake
2002	MCH	Tuolumne		6/5/2002	ELT	Herring Creek Reservoir
2002	MCH	Tuolumne		4/23/2002	RT	Beardsley Reservoir
2004	SJH	Tuolumne	Air Plant	9/15/2004	GT	Iceland Lake
2002	HCH	Mono	Air Plant	7/2/2002	RT	Harding Lake (Lower Long Lake)
2005	HCH	Mono	Air Plant	7/26/2005	RT	Upper Long Lake
2004	MCH	Tuolumne		7/12/2004	RT	Waterhouse Lake
2004	SJH	Tuolumne	Air Plant	9/15/2004	GT	Ridge Lake
2006	HCH	Mono	Air Plant	9/21/2006	GT	Anna Lake
2004	SJH	Tuolumne	Air Plant	9/15/2004	GT	Blackhawk Lake
2004	SJH	Tuolumne	Air Plant	9/15/2004	GT	Mosquito Lake
2002	MCH	Tuolumne		4/25/2002	RT	Pinecrest Lake
2002	MCH	Tuolumne		7/8/2002	RT	Grizzley Peak Lake West
2002	MCH	Tuolumne		7/8/2002	RT	Grizzley Peak Lake East
2002	MCH	Tuolumne		7/8/2002	RT	Toejam Lake
2002	HCH	Mono	Air Plant	7/2/2002	RT	Harriet Lake

2002	MCH	Tuolumne		7/8/2002	RT	Granite Lake
2002	MCH	Tuolumne		7/8/2002	RT	Long Lake
2003	MCH	Tuolumne		7/21/2003	RT	Snow Lake
2002	FSH	Mono		4/22/2002	RT	Twin Lake Lower, Bridgeport
2002	MCH	Tuolumne		7/8/2002	RT	Buck Lake Upper
2003	MCH	Tuolumne		7/21/2003	RT	Camp Lake
2002	MCH	Tuolumne		7/8/2002	RT	Jewelry Lake
2002	MCH	Tuolumne		7/8/2002	RT	Gem Lake
2004	MCH	Tuolumne		7/12/2004	RT	Piute Lake
2002	MCH	Tuolumne		7/8/2002	RT	Buck Lake Lower
2002	MCH	Tuolumne		7/8/2002	RT	Bigelow Lake
2002	FSH	Mono		4/23/2002	RT	Twin Lake Upper, Bridgeport
2002	MCH	Tuolumne		7/8/2002	RT	Black Bear Lake
2003	MCH	Tuolumne		7/21/2003	RT	Grouse Lake
2003	MCH	Tuolumne		7/21/2003	RT	Red Can Lake
2004	MCH	Tuolumne		7/12/2004	RT	Dutch Lake
2003	MCH	Tuolumne		7/21/2003	RT	Roasasco Lake
2003	MSH	Mono	Air Plant	7/15/2003	RT	Tamarack Lake
2006	MCH	Tuolumne	Truck	7/14/2006	RT	Clear Lake
2003	MCH	Tuolumne		7/21/2003	RT	Big Lake
2003	MCH	Tuolumne		7/21/2003	RT	Hyatt Lake
2003	MCH	Tuolumne		7/21/2003	RT	Yellowhammer Lake
2002	MCH	Tuolumne		5/3/2002	RT	Lyons Reservoir
2003	MCH	Mono		7/21/2003	RT	East Lake
2002	HCH	Mono		6/19/2002	RT	Trumble Lake
2002	HCH	Mono		6/19/2002	RT	Virginia Lake Lower
2002	HCH	Mono		6/19/2002	RT	Virginia Lake Upper
2006	HCH	Mono	Air Plant	7/19/2006	RT	Red Lake
2002	HCH	Mono		4/25/2002	RT	Lundy Lake
2002	MCH	Tuolumne		4/24/2002	RT	Cherry Valley Reservoir
2005	HCH	Mono	Air Plant	9/27/2005	CT	Steelhead Lake, Mill Creek
2002	HCH	Mono		6/20/2002	RT	Saddlebag Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Geraldine Lake Upper
2005	HCH	Inyo	Air Plant	7/26/2005	RT	Sawmill Lake
2002	SJH	Fresno	Truck	4/24/2002	ELT	Hume Lake
2003	SJH	Tulare	Air Plant	7/18/2003	RT	Weaver Lake
2002	SJH	Tulare	Air Plant	7/9/2002	RT	Jennie Lake
2005	HCH	Inyo	Air Plant	7/26/2005	RT	Lone Pine Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Mirror Lake
2006	HCH	Inyo	Air Plant	7/18/2006	RT	Consultation Lake

2002	SJH	Tulare	Truck	5/23/2002	ELT	Hedrick Pond (Redwood Lake)
2002	ARH	Alpine		7/9/2002	RT	Spicer Meadows Reservoir
2005	HCH	Alpine	Air Plant	9/27/2005	CT	Tamarack Lake, Sunset
2002	SJH	Tulare	Truck	5/23/2002	ELT	Balch Park Lake Upper
2002	SJH	Tulare	Truck	5/23/2002	ELT	Balch Park Lake Lower
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Golden Trout Lake #1
2006	MSH	Trinity	Air Plant	7/5/2006	RT	Seven Up Lake
2004	MSH	Trinity		7/29/2004	ELT	Stoddard Lake Upper, Salmon Scott
2004	MSH	Siskiyou		7/9/2004	RT	Caldwell Lake Lower
2003	MSH	Trinity	Air Plant	7/25/2003	ELT	Deadfall Lake, Upper
2004	SFB	Placer	Truck	4/5/2004	KOK	Lake Tahoe
2002	CLH	Lassen		5/8/2002	BK	Long Lake, Highway 44
2002	HCH	Mono	Air Plant	9/9/2002	CT	Lane Lake
2002	ARH	Placer		3/19/2002	RT	Sugar Pine Reservoir
2002	CLH	Lassen		7/29/2002	ELT	Eagle Lake
2004	MSH	Trinity		7/7/2004	RT	Tamarack Lake Lower
2002	ARH	Placer		5/10/2002	CT	Coldstream Creek Pond
2002	ARH	El Dorado		2/4/2002	RT	Jenkinson Lake
2002	HCH	Mono		6/19/2002	RT	Ellery Lake
2002	HCH	Mono		6/18/2002	RT	Tioga Lake
2004	HCH	Mono		4/22/2004	RT	Little Walker Lake
2002	FSH	Mono		4/17/2002	ELT	Grant Lake
2002	FSH	Mono		4/19/2002	ELT	June Lake
2002	FSH	Mono		4/17/2002	ELT	Silver Lake
2002	FSH	Mono		4/17/2002	ELT	Gull Lake
2003	MCH	Mono		7/21/2003	RT	Gem Lake
2003	MCH	Mono		7/21/2003	RT	Agnew Lake
2005	HCH	Madera	Air Plant	7/26/2005	RT	Thousand Island Lake
2003	SJH	Madera	Air Plant	7/18/2003	RT	Ruby Lake
2003	SJH	Madera	Air Plant	7/18/2003	RT	Garnet Lake
2003	SJH	Madera	Air Plant	7/18/2003	RT	Altha Lake
2002	HCH	Madera	Air Plant	7/2/2002	RT	Shadow Lake
2004	SJH	Madera	Air Plant	9/15/2004	GT	Twin Island Lake North
2002	HCH	Madera	Air Plant	7/2/2002	RT	Olaine Lake
2002	HCH	Madera	Air Plant	7/2/2002	RT	Rosalie Lake
2002	HCH	Madera	Air Plant	7/2/2002	RT	Ediza Lake
2002	HCH	Madera	Air Plant	9/9/2002	GT	Cabin Lake
2002	HCH	Madera	Air Plant	7/2/2002	RT	Gladys Lake
2004	SJH	Madera	Air Plant	9/15/2004	GT	Blue Lake
2002	HCH	Madera	Air Plant	7/2/2002	RT	Emily Lake

2004	SJH	Madera	Air Plant	9/15/2004	GT	Rockbound Lake
2002	FSH	Madera		8/23/2002	ELT	Starkweather Lake
2002	HCH	Madera	Air Plant	9/9/2002	GT	Isberg Lake Lower
2002	SJH	Madera	Air Plant	7/9/2002	RT	Sadler Lake
2003	SJH	Madera	Air Plant	7/18/2003	RT	Reds Lake
2002	FSH	Madera		8/23/2002	ELT	Sotcher Lake
2002	FSH	Mono		8/23/2002	ELT	Twin Lakes, Mammoth
2002	FSH	Mono		8/23/2002	ELT	Mamie Lake
2005	HCH	Mono	Air Plant	9/27/2005	CT	McCleod Lake
2002	FSH	Mono		8/23/2002	ELT	Mary Lake
2002	FSH	Mono		8/23/2002	ELT	George Lake
2003	SJH	Madera	Air Plant	7/17/2003	RT	Anne Lake
2003	SJH	Madera	Air Plant	7/17/2003	RT	Rutherford Lake
2002	FSH	Mono		4/19/2002	ELT	Convict Lake
2004	SJH	Madera	Air Plant	7/14/2004	RT	Cora Lake
2002	HCH	Mono	Air Plant	9/9/2002	GT	Laurel Lake #1
2003	SJH	Madera	Air Plant	7/17/2003	RT	Fernandez Lake Middle
2002	HCH	Mono	Air Plant	9/9/2002	GT	Laurel Lake #2
2006	SJH	Madera	Air Plant	7/11/2006	RT	Monument Lake
2006	SJH	Madera	Air Plant	7/11/2006	RT	Rainbow Lake
2005	HCH	Mono	Air Plant	7/26/2005	RT	Wood Lake
2002	SJH	Madera	Air Plant	7/9/2002	RT	Lillian Lake
2005	HCH	Fresno	Air Plant	7/26/2005	RT	Duck Lake
2003	SJH	Madera	Air Plant	7/17/2003	RT	Staniford Lake Lower
2002	HCH	Mono	Air Plant	7/2/2002	RT	Dorothy Lake
2003	SJH	Madera	Air Plant	7/17/2003	RT	Vandeberg Lake
2002	SJH	Madera	Air Plant	7/9/2002	RT	Lady Lake
2003	SJH	Fresno	Air Plant	7/18/2003	RT	Purple Lake
2003	SJH	Madera	Air Plant	7/17/2003	RT	Jackass Lake Upper
2003	SJH	Madera	Air Plant	7/17/2003	RT	Jackass Lake Lower
2003	SJH	Madera	Air Plant	7/17/2003	RT	Norris Lake
2003	SJH	Madera	Air Plant	7/17/2003	RT	Jackass Lake Middle
2006	HCH	Fresno	Air Plant	9/21/2006	GT	Amy Lake
2006	SJH	Fresno	Air Plant	7/11/2006	RT	Scoop Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Virginia Lake
2002	HCH	Mono	Air Plant	7/2/2002	RT	Hilton Lake #1, Davis
2005	HCH	Mono	Air Plant	7/26/2005	RT	Steelhead Lake, Owens Drainage
2002	HCH	Mono	Air Plant	9/9/2002	GT	Stanford Lake
2006	SJH	Madera	Air Plant	7/11/2006	RT	Junction Lake
2005	HCH	Mono	Air Plant	7/26/2005	RT	McGee Lake Lower
2004	SJH	Fresno	Air Plant	7/14/2004	RT	Brave Lake

2002	HCH	Mono	Air Plant	7/2/2002	RT	Hilton Lake #3
2004	SJH	Madera	Air Plant	7/14/2004	RT	Grizzly Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Sedge Lake, Margaret
2004	SJH	Fresno	Air Plant	9/15/2004	GT	Bighorn Lake
2006	SJH	Fresno	Air Plant	7/11/2006	RT	Minnie Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Coyote Lake, Margaret
2006	SJH	Fresno	Air Plant	7/11/2006	RT	Anne Lake
2002	FSH	Inyo		5/9/2002	ELT	Rock Creek Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Frog Lake, Margaret
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Graveyard Lake Upper
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Phantom Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Spook Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Ghost Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Murder Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Vengeance Lake
2006	HCH	Fresno	Air Plant	9/21/2006	GT	Needle Lake
2002	HCH	Inyo	Air Plant	9/9/2002	CT	Francis Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Devils Bathtub Lake
2006	SJH	Fresno	Air Plant	7/11/2006	RT	Shelf Lake
2006	SJH	Fresno	Air Plant	7/11/2006	RT	Arrowhead Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Big Fish Lake
2002	SJH	Fresno	Truck	9/4/2002	RT	Edison Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Chickenfoot Lake
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Treasure Lake #4
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Treasure Lake #1
2002	SJH	Madera	Truck	6/11/2002	RT	Mammoth Pool Lake
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Treasure Lake #3
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Morgan Lake Upper
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Treasure Lake #2
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Spire Lake
2003	SJH	Inyo	Air Plant	9/8/2003	GT	Split Lake
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Italy Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Doris lake
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Apollo Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Royce Lake #5
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Royce Lake #4
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Orchid Lake
2002	SJH	Madera	Truck	1/9/2002	RT	Bass Lake
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Vee Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Royce Lake #3
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Royce Lake #2
2002	SJH	Fresno	Truck	5/28/2002	ELT	Portal Forebay

2006	SJH	Fresno	Air Plant	7/12/2006	RT	Pryor Lake
2006	SJH	Fresno	Air Plant	7/12/2006	RT	Avalanche Lake
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Marie Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Gordon Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Royce Lake #1
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Harvey Lake
2006	HCH	Fresno	Air Plant	9/21/2006	GT	Steelhead Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Hooper Lake
2002	SJH	Fresno	Truck	5/20/2002	ELT	Ward Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Walling Lake
2004	SJH	Fresno	Air Plant	9/15/2004	GT	Three Island Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Twin Lake Upper, Kaiser
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Campfire Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Twin Lake Lower, Kaiser
2004	SJH	Fresno	Air Plant	7/14/2004	RT	Corbett Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	George Lake
2006	HCH	Fresno	Air Plant	9/21/2006	GT	Star Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Puppet Lake
2004	SJH	Fresno	Air Plant	7/14/2004	RT	Deer Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Nellie Lake
2004	SJH	Fresno	Air Plant	7/14/2004	RT	Mallard Lake
2002	SJH	Fresno	Truck	4/24/2002	ELT	Huntington Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Dutch Lake
2002	MWH	Inyo	Truck	4/19/2002	RT	Bishop Creek, Intake II
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Crater Lake
2002	SJH	Madera	Truck	4/26/2002	ELT	Manzanita Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Hidden Lake
2006	HCH	Fresno	Air Plant	9/21/2006	GT	Paine Lake
2002	MWH	Inyo	Truck	5/23/2002	RT	North Lake
2003	FSH	Inyo		10/1/2003	BN	Loch Leven Lake
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Lower Goethe Lake
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Upper Goethe Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Lamarck Lake Upper
2002	MWH	Inyo	Truck	5/15/2002	RT	Lake Sabrina
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Ershim Lake
2006	HCH	Inyo	Air Plant	7/18/2006	RT	Rocky Bottom Lake
2006	HCH	Inyo	Air Plant	7/18/2006	RT	Funnel Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Strawberry Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Granite Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	West Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Red Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Blue Lake

2002	HCH	Inyo	Air Plant	9/9/2002	GT	Schober Hole Lake #3
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Emerald Lake #2
2003	FSH	Inyo		10/1/2003	BN	DingleBerry Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Tyee Lake #5
2003	SJH	Inyo	Air Plant	7/18/2003	RT	Tyee Lake #6
2005	SJH	Fresno	Air Plant	7/19/2005	RT	East Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Beryl Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Topsy Turvy Lake
2002	MWH	Inyo	Truck	6/18/2002	RT	South Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Green Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Brown Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Davis Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Tocher Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Brewer Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Hungry Packer Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Diamond X Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Mystery Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	South Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Swede Lake
2002	SJH	Madera	Truck	4/26/2002	ELT	Corrine Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Dinkey Lake Second
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Dale Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Rae Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Long Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Rock Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Rainbow Lake, Dinkey
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Island Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Echo Lake
2002	SJH	Fresno	Truck	4/23/2002	ELT	Shaver Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Fleming Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Bullfrog Lake
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Chagrin Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Ruwau Lake
2002	HCH	Inyo	Air Plant	9/9/2002	GT	Summit Lake
2003	FSH	Inyo		10/1/2003	BN	Black Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Timberline Lake #2
2003	SJH	Inyo	Air Plant	7/18/2003	RT	Big Pine Lake #5
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Timberline Lake #1
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Horseshoe Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Big Pine Lake #4
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Saddlerock Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Hobler Lake

2002	HCH	Inyo	Air Plant	7/2/2002	RT	Phyllis Lake (Ledge Lake)
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Big Pine Lake #1
2003	SJH	Fresno	Air Plant	7/17/2003	RT	Blackrock Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Big Pine Lake #2
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Devils Punchbowl Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Swamp Lake
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Bishop Lake
2002	SJH	Fresno	Truck	5/24/2002	ELT	Courtright Reservoir
2002	HCH	Inyo	Air Plant	7/2/2002	RT	Big Pine Lake #3
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Nelson Lake Lower
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Twin Buck Lake, East
2002	HCH	Fresno	Air Plant	9/9/2002	GT	Nelson Lake Upper
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Twin Buck Lake, West
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Sportsman Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Hatch Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Little Joe Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Rainbow Lake, Blackcap
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Valor Lake
2005	HCH	Inyo	Air Plant	9/27/2005	CT	Birch Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Division Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Old Pipe Lake
2003	SJH	Fresno	Air Plant	9/8/2003	GT	Woodchuck Lake
2002	SJH	Fresno	Truck	4/23/2002	ELT	Wishon Reservoir
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Crown Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Scepter Lake
2005	SJH	Fresno	Air Plant	7/19/2005	RT	Chimney Lake
2003	MCH	Fresno		7/21/2003	RT	Chain Lake Upper
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Spanish Lake Big
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Spanish Lake Little
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Twin Round Lake
2002	SJH	Fresno	Air Plant	7/9/2002	RT	Geraldine Lake Lower
2002	SFB	Fresno	Truck	3/28/2002	CHIN	Pine Flat Reservoir
2002	ARH	El Dorado		7/5/2002	RT	Sawmill Pond
2002	ARH	Nevada		5/9/2002	RT	Blair Lake
2002	DSH	Tehama		7/31/2002	ELT	Camp Tehama Pond
2002	DSH	Shasta		6/11/2002	RT	Lassen Pines Pond
2002	MSH	Siskiyou		6/10/2002	RT	Eden Ponds
2002	MSH	Siskiyou		6/4/2002	RT	Hatchery Ponds
2002	ARH	El Dorado		4/25/2002	RT	American River Silver Fork
2002	ARH	El Dorado		4/24/2002	RT	American River South Fork, Riverton
2002	MSH	Siskiyou		4/25/2002	RT	Antelope Creek

2002	DSH	Shasta		5/29/2002	RT	Bailey Creek Upper
2002	DSH	Tehama		4/23/2002	RT	Battle Creek South Fork
2002	CLH	Siskiyou		5/24/2002	RT	Bear Creek Lower
2002	CLH	Siskiyou		4/25/2002	RT	Bear Creek Upper
2002	ARH	Nevada		7/18/2002	RT	Bear River, Bear Valley
2003	SJH	Fresno	Truck	6/11/2003	RT	Bearskin Creek
2002	MCH	Tuolumne		4/24/2002	RT	Beaver Creek
2002	SJH	Fresno	Truck	4/24/2002	ELT	Big Creek, Huntington
2002	SJH	Fresno	Truck	4/23/2002	ELT	Big Creek, Kings
2002	SJH	Madera	Truck	4/23/2002	ELT	Big Creek, Madera
2002	SJH	Tulare	Truck	5/29/2002	ELT	Big Meadows Creek
2002	MWH	Inyo	Truck	4/24/2002	RT	Big Pine Creek
2002	MWH	Inyo	Truck	4/18/2002	RT	Bishop Creek Middle Fork
2002	MWH	Inyo	Truck	4/19/2002	RT	Bishop Creek South Fork
2002	KRPB	Tulare	Truck	4/25/2002	ELT	Bone Creek
2002	HCH	Mono		5/16/2002	RT	Buckeye Creek
2002	CLH	Shasta		4/25/2002	RT	Burney Creek Upper
2002	DSH	Butte		5/2/2002	RT	Butte Creek, Big
2002	ARH	Alpine		6/18/2002	RT	Carson River East Fork
2002	ARH	Alpine		5/13/2002	CT	Carson River West Fork
2002	SJH	Madera	Truck	4/25/2002	ELT	Chiquito Creek West Fork
2002	SJH	Madera	Truck	4/25/2002	ELT	Chiquito Creek, Lower
2002	DSH	Lassen		5/22/2002	RT	Clear Creek
2002	MSH	Trinity		4/23/2002	RT	Coffee Creek
2002	MSH	Siskiyou		4/25/2002	RT	Cold Creek
2002	ARH	Sierra		5/14/2002	RT	Coldstream Creek
2002	HCH	Mono		6/20/2002	RT	Convict Creek
2002	FSH	Mono		5/2/2002	ELT	Deadman Creek
2002	DSH	Tehama	Truck	4/23/2002	RT	Deer Creek
2002	SJH	Fresno	Truck	4/23/2002	ELT	Dinkey Creek
2003	SJH	Fresno	Air Plant	7/18/2003	RT	Dinkey Creek Second
2002	KRPB	Tulare	Truck	4/25/2002	ELT	Dry Meadow Creek
2002	DSH	Plumas		5/22/2002	RT	Feather River North Fork, Almanor
2002	SJH	Madera	Truck	4/25/2002	ELT	Fish Creek
2002	KRPB	Tulare	Truck	5/20/2002	ELT	Freeman Creek
2002	FSH	Mono		5/2/2002	ELT	Glass Creek
2002	SJH	Madera	Truck	5/23/2002	ELT	Granite Creek
2002	HCH	Mono		5/16/2002	RT	Green Creek
2002	DSH	Tehama		4/23/2002	RT	Gurnsey Creek
2002	DSH	Plumas		5/22/2002	RT	Hamilton Branch Creek
2002	CLH	Shasta		4/26/2002	RT	Hat Creek Upper

2002	MCH	Tuolumne		6/5/2002	ELT	Herring Creek
2002	MWH	Inyo	Truck	3/1/2002	RT	Independence Creek
2002	KRPB	Tulare	Truck	4/26/2002	ELT	Kern River South Fork
2002	KRPB	Tulare	Truck	3/8/2002	RT	Kern River, Section 5
2002	KRPB	Tulare	Truck	3/8/2002	RT	Kern River, Section 6
2005	SJH	Fresno	Direct	10/7/2005	RT	Kings River, Upper
2002	HCH	Mono		4/24/2002	RT	Lee Vining Creek
2002	HCH	Mono		6/7/2002	RT	Lee Vining Creek South Fork
2002	SJH	Madera	Truck	4/23/2002	ELT	Lewis Creek
2006	ARH	Sierra	Truck	6/13/2006	RT	Little Truckee River Hwy 89
2002	HCH	Mono		4/17/2002	RT	Little Walker River
2002	MWH	Inyo	Truck	3/1/2002	RT	Lone Pine Creek
2002	HCH	Mono		7/12/2002	RT	Lost Cannon Creek
2002	HCH	Mono		4/25/2002	RT	Mammoth Creek
2002	ARH	Alpine		7/17/2002	RT	Markleeville Creek
2002	MSH	Siskiyou		4/24/2002	RT	McCloud River
2002	MSH	Siskiyou		4/26/2002	BK	McCloud River, Lakin Dam
2002	HCH	Mono		4/25/2002	RT	Mcgee Creek
2002	MCH	Mariposa		4/22/2002	RT	Merced River, Section II
2002	HCH	Mono		4/25/2002	RT	Mill Creek
2002	MCH	Alpine		5/28/2002	ELT	Mokelumne River North Fork
2002	SJH	Fresno	Truck	5/28/2002	ELT	Mono Creek
2002	SJH	Madera	Truck	4/22/2002	ELT	Nelder Creek
2002	KRPB	Tulare	Truck	4/25/2002	ELT	Nobe Young Creek
2002	KRPB	Tulare	Truck	4/24/2002	ELT	Peppermint Creek
2002	FSH	Inyo		5/2/2002	ELT	Pine Creek
2002	SJH	Fresno	Truck	4/24/2002	ELT	Rancheria Creek
2002	HCH	Mono		4/23/2002	RT	Reversed Creek
2002	FSH	Mono		4/23/2002	RT	Robinson Creek
2002	SJH	Madera	Truck	4/25/2002	ELT	Rock Creek
2002	FSH	Mono		4/15/2002	ELT	Rock Creek, Section 2
2002	FSH	Inyo		5/15/2002	ELT	Rock Creek, Section 3
2002	HCH	Mono		4/23/2002	RT	Rush Creek
2002	MSH	Shasta		4/22/2002	RT	Sacramento River
2002	MSH	Siskiyou		4/23/2002	RT	Sacramento River South Fork
2002	HCH	Mono		6/19/2002	RT	Saddlebag Creek
2005	MCH	Sierra	Truck	7/6/2005	CT	Sagehen Creek
2002	FSH	Madera		8/23/2002	ELT	San Joaquin River Middle Fork
2002	SJH	Fresno	Truck	5/20/2002	ELT	San Joaquin River South

						Fork
2002	MWH	Inyo	Truck	3/1/2002	RT	Sheperds Creek
2002	HCH	Mono		4/25/2002	RT	Sherwin Creek
2002	ARH	Alpine		7/31/2002	RT	Silver Creek
2002	MSH	Siskiyou		4/24/2002	RT	Squaw Creek
2002	MCH	Tuolumne		4/26/2002	RT	Stanislaus River Clarks Fork
2002	MCH	Tuolumne		4/24/2002	RT	Stanislaus River Middle Fork
2004	MCH	Tuolumne		4/23/2004	RT	Stanislaus River North Fork
2002	MCH	Tuolumne		4/25/2002	RT	Stanislaus River South Fork
2002	SJH	Tulare	Truck	5/22/2002	ELT	Stoney Creek
2002	CLH	Lassen		4/18/2002	RT	Susan River Lower
2002	CLH	Lassen		6/7/2002	BN	Susan River Middle
2002	CLH	Lassen		5/22/2002	RT	Susan River Upper
2002	MWH	Inyo	Truck	3/1/2002	RT	Symmes Creek
2002	SJH	Fresno	Truck	4/24/2002	ELT	Tamarack Creek
2002	ARH	El Dorado		5/6/2002	KOK	Taylor Creek
2002	SJH	Fresno	Truck	4/26/2002	ELT	Tenmile Creek, Upper
2002	MSH	Trinity		4/23/2002	RT	Trinity River
2003	MOK	Placer		#########	CT	Truckee River
2002	KRPB	Tulare	Truck	4/24/2002	ELT	Tule River North Fork, Middle Fork #1
2002	KRPB	Tulare	Truck	4/10/2002	RT	Tule River South Fork, Middle Fork #2
2002	KRPB	Tulare	Truck	4/24/2002	ELT	Tule River South Fork, Middle Fork #3
2002	MCH	Tuolumne		4/23/2002	RT	Tuolumne River Middle Fork
2002	MCH	Tuolumne		4/23/2002	RT	Tuolumne River North Fork
2002	MCH	Tuolumne		4/23/2002	RT	Tuolumne River South Fork
2002	HCH	Mono		6/18/2002	RT	Virginia Creek
2002	MSH	Siskiyou		4/25/2002	RT	Wagon Creek
2002	DSH	Plumas		5/22/2002	RT	Warner Creek
2002	HCH	Mono		4/16/2002	RT	West Walker River, Section 2
2002	HCH	Mono		4/16/2002	RT	West Walker River, Section 3
2002	SJH	Madera	Truck	4/22/2002	ELT	Willow Creek North Fork
2002	ARH	Sierra		4/22/2002	RT	Yuba River North Fork
2002	ARH	Nevada		6/6/2002	RT	Yuba River South Fork, Highway 80
2002	MCH	Tuolumne		5/23/2002	RT	Deadman Creek
2002	CLH	Lassen		5/17/2002	ELT	Pine Creek

2002	MSH	Siskiyou		4/22/2002	RT	Sacramento River

Trout-stocked Water-bodies (2002-2006) Intersecting Approximate Known Current Range

YEAR_	HATCHERY	COUNTY	METHOD	DATE	FISH SPECIES	RELEASE WATERS
2002	CLH	Plumas		5/17/2002	ELT	Lake Almanor
2002	CLH	Lassen		6/12/2002	ELT	Crater Lake
2002	MSH	Lassen	Air Plant	6/25/2002	ELT	Triangle Lake
2002	MSH	Lassen		7/18/2002	ELT	Snag Lake
2002	MSH	Lassen	Air Plant	6/25/2002	ELT	Twin Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Turnaround Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Bimber Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Eleanor Lake
2002	MSH	Lassen	Air Plant	6/25/2002	ELT	Black Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Jewel Lake
2002	CLH	Lassen		6/10/2002	RT	Caribou Lake
2002	MSH	Lassen	Air Plant	6/25/2002	RT	Gem Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hourglass Lake
2002	CLH	Lassen		6/7/2002	BN	Silver Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Emerald Lake
2002	MSH	Lassen		6/25/2002	BK	Rim Lake
2002	MSH	Lassen		6/25/2002	RT	Betty Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Cypress Lake
2002	CLH	Lassen		6/12/2002	ELT	Shotoverin Lake
2002	CLH	Lassen		5/6/2002	BN	McCoy Flat Reservoir
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Trail Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Long Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Posey Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #2
2002	MSH	Lassen	Air Plant	6/25/2002	RT	Beauty Lake
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #1
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #3
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #4
2002	MSH	Lassen	Air Plant	6/25/2002	BK	Hidden Lake #5
2002	MSH	Lassen	Air Plant	6/25/2002	RT	Evelyn Lake
2002	MSH	Shasta	Air Plant	6/25/2002	BK	Heart Lake
2003	CLH	Plumas		6/19/2003	BK	Echo Lake
2002	MSH	Tehama	Air Plant	6/25/2002	BK	Twin Meadows Lake, Mt. Lassen

2003	MSH	Tehama	Air Plant	7/15/2003	BK	Rocky Peak Lake
2002	MSH	Tehama	Air Plant	6/25/2002	BK	Diamond Lake, Turner Mountain
2004	SJH	Tuolumne	Air Plant	9/15/2004	GT	Blue Canyon Lake
2002	HCH	Mono		#########	RT	Leavitt Lake
2002	CLH	Lassen		5/8/2002	BK	Long Lake, Highway 44
2002	DSH	Tehama		7/31/2002	ELT	Camp Tehama Pond
2002	DSH	Shasta		5/29/2002	RT	Bailey Creek Upper
2002	DSH	Tehama		4/23/2002	RT	Battle Creek South Fork
2002	DSH	Tehama	Truck	4/23/2002	RT	Deer Creek
2002	DSH	Plumas		5/22/2002	RT	Feather River North Fork, Almanor
2002	DSH	Tehama		4/23/2002	RT	Gurnsey Creek
2002	CLH	Shasta		4/26/2002	RT	Hat Creek Upper
2002	DSH	Plumas		5/22/2002	RT	Warner Creek
2002	CLH	Lassen		5/17/2002	ELT	Pine Creek