System Indicators

Land Conservation and Wildlife Habitat

SIERRA NEVADA CONSERVANCY

Final Draft Report

11/1/2011

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INTRODUCTION

For purposes of this report, "land conserved" is defined as public lands, private lands with conservation easements, or private lands acquired in fee title for purposes of conservation. A significant portion of the Sierra Nevada region is conserved in some way, which may not be surprising given that the Sierra Nevada Region is a primary source of critical resources for the state. It is ***the*** major source of water for the State, providing 65% of California's developed water supply and drinking water for 23 million Californians. The Sierra and its forests, agricultural lands and rangelands serve as habitat to 60% of California's animal and 50% of California's plant species, filtrate pollutants from the air and provide numerous economic and cultural benefits. While many private lands in the Region are managed in ways that protect and enhance these benefits, for purposes of this indicator only those private lands that have a conservation easement or are owned in fee title for conservation purposes are included.

In order to provide meaningful data and analysis on the environmental, economic, and social well-being of the Region, the Sierra Nevada Conservancy is undertaking a Sierra Nevada System Indicators Project, which encompasses the collection and analysis of nineteen indicators approved by the SNC Governing Board in March 2011. This report provides an overview of the acres of lands conserved in the Sierra Nevada and the status of natural areas in the Region. It is the second in a series of five reports that have or will cover: the Economy and Demographics; Water Quality, Air Quality, and Climate; Land Conservation and Habitat; Agriculture and Ranch Lands; and Forest Lands. All of the reports will be developed and presented to the Board by June 2012.

These reports establish a baseline for additional analysis over time. Information relative to each indicator will be available on the SNC Web site and will be updated periodically as the underlying data is updated, providing an opportunity to observe trends over time. We may also identify new sources of data over time, which will provide an opportunity to enhance this original analysis.

In addition to providing information relevant to the administration of the SNC's programs throughout the Sierra Nevada region, we hope that this information will also be useful to others located in or working in the Region as they develop and implement their own projects and programs. If you would like more detailed information regarding any of the indicators, some additional detail will be available on the SNC Web site and further detail may be available by contacting the SNC at the address and phone number provided on the last page of this report.

Challenges and Strategies

The acres of land conserved section is sourced from GreenInfo Network's California Protected Areas Database, which is constantly being updated to provide information about the ownership, location and acreage of privately held areas in fee title for conservation and all publicly managed lands for multiple land uses in California. As the public lands figures include lands for multiple land uses including conservation, these data cannot be analyzed to determine conservation-only acres. Data regarding the total acreage of conservation easements is a challenge to secure as no one State agency maintains consistent and up-to-date records of conservation easements statewide. The analysis in this report is based on GIS data collected

from the GreenInfo Network on conservation easements throughout California. GreenInfo received these data from land trust organizations and government agencies within California. The data set from GreenInfo Network did not include easements held by the Califonria Department of Fish and Game (DFG); DFG provided the acreage of easements for the portion of all twenty-two counties located within the Sierra Nevada region.

Measuring changes in wildlife habitat requires evaluating differences in plant communities using consistently mapped vegetation data over multiple time periods. Since these vegetation maps were not available over multiple time period for the entire Sierra, the Fish and Game and CalTrans California Essential Habitat Connectivity Project[1] were used to understand the location of small and large natural areas that provide plant communities and wildlife species populations with suitable habitat in the Sierra.

[1] Spencer et al. 2010

Report Highlights

Juvenile black bear in a Sierra meadow

The Sierra Nevada encompasses a rich diversity of plants and animals that inhabit many distinct ecoregions including the Northwestern Basin and Range, Modoc Plateau, Southern Cascades, Sierra Nevada Foothills, Sierra Nevada, Great Valley, Mojave Desert, Southeastern Great Basin, and Mono Sections. (See Appendix A, Map of Ecoregions in the SNC)[2].

Each of these ecoregions contains a number of different life zones that transition from west to east upwards in elevation and over the crest of the Sierra and southern Cascades into the eastern Sierra and Great Basin, and change from north to south due to temperature and precipitation differences. From west to east these life zones include foothill grasslands, oak savannahs and woodlands, chaparral, foothill woodland and conifer forests, low-level montane forests, upper montane forests, and alpine communities. In the northeast area of the SNC, high desert life zones such as shrub-steppe, grasslands, and woodlands are common in lower elevations while conifer forests dominate the upper elevations. In the southeast of the SNC, desert scrub is one of the dominant life zones. Forty-seven watersheds[3] are either partially or wholly within the SNC boundary and provide the Region with the water needed by fish, wildlife, and people to survive.

Each ecoregion of the Sierra varies significantly in the types of habitat and species supported as well as the acres of land protected. Likewise the level of risk for maintaining these benefits, as well as the specific threats, varies throughout the Region.

Here are some of the key findings from this report:

Acres of Land Conserved

16.4 million acres (64% of the total land in the Region) are conserved within the Region[4] with nearly 16.2 million acres (63%) in public ownership and primarily managed by three federal agencies: the US Forest Service (64.3% of the public lands within the Region), US Bureau of Land Management (19.3%) and National Park Service (10.6%).

[2] Barbour and Minnich 2000
[3] At the hydrologic scale
[4] California Protected Areas Database, GreenInfo Network, June 2010.

One percent of the area of the Region is conserved in private ownership: 178,246 acres of private lands have conservation easements and 41,872 acres are in private fee title ownership for conservation.

There is a large variance among subregions in the percentage of land conserved. The Central subregion has the lowest overall percentage of conserved land (47.2%), and the East subregion the highest (98.3%). The South Central subregion has the lowest percent of private lands conserved (0.5%), and the North Central sub region has the highest percent of private lands conserved (8.8%).

Public lands dominate above 3,000 and private lands dominate below. In the elevation band above 3,000 feet, about three-quarters of the land is in public management (74%) whereas about three-quarters (76.5%) of the land is in private ownership below 3,000 feet.

Change in Wildlife Habitat

There are 11.6 million acres (49% of the total land in the Region) of large, intact natural areas in the Sierra Nevada and the distribution of these large natural areas significantly increases with elevation within the Region.

Although 74% of the land between 3,000 and 6,000 is in public lands management, only 37% is identified as large, intact natural areas due to higher average road density than higher elevations. Despite low population figures, the mid-elevations of the Sierra have a growing rural development pattern, which reduces overall available habitat and fragments habitat for many wildlife species.[5]

The land below 3,000 feet on the west side of the Sierra has experienced the greatest degree of development, habitat conversion and fragmentation[6]. Road density is highest below 3,000 feet and the population is greatest. The lower elevations have the smallest area of land in conservation and the grasslands, oak woodland, and wetland ecosystems here have experienced reductions in size and degradation of habitat quality.

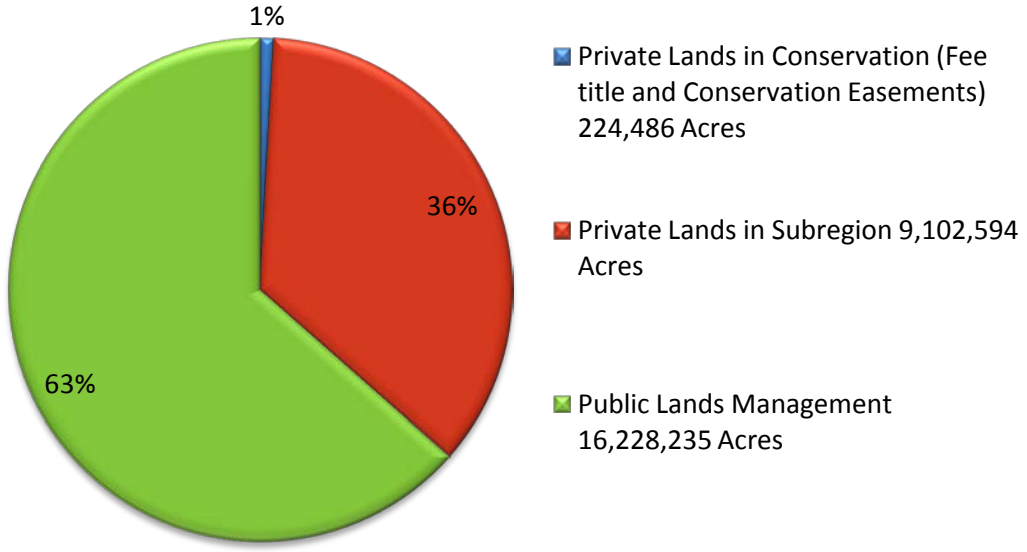
[5] Shilling and Givertz 2007, Laurance 2009, Terborgh 1974
[6] Sierra Nevada Ecosystem Project 1996

Acres Of Lands Conserved

The acres of land conserved section includes public lands preserved for natural resource values, which may also be used for recreation, mineral extraction, grazing, and timber production. It also includes the the number of acres of private lands in conservation ownership (fee title) and conservation easement that are protected from future residential and commercial development. These lands have been set aside from development to protect natural resource and agricultural values and provide a number of environmental benefits including habitat for fish and wildlife species, greenhouse gas storage, and air and water filtration.

As shown in Chart 1, a total of 14.5 million acres of land are conserved within the Region or 56% of the total land area.[7] Sixty-three percent of the land area within the Region, or 16,228,235 acres, is primarily managed by three federal agencies: the US Forest Service (64.3% of the public lands within the Region), US Bureau of Land Management (19.3%) and National Park Service (10.6%) A total of 224,486 acres[8,9]are conserved in private ownership, which is one percent of the total land area of the Region. Of this amount, 182,614 acres of private lands have conservation easements that are managed by government agencies or nonprofit organizations. An additional 41,872 acres are in private fee title ownership for conservation.

Chart 1 Public, Private and Conservation Lands within the Sierra Nevada Conservancy



There are 25.5 million acres within the Region

[7] California Protected Areas Database, GreenInfo Network, June 2010.
[8] Lisa Ohara, GIS Analyst, Biogeographic Data Branch - Lands Program Department of Fish and Game, February, 2010 (32,792 acres).
[9] GreenInfo Network, February 2010.

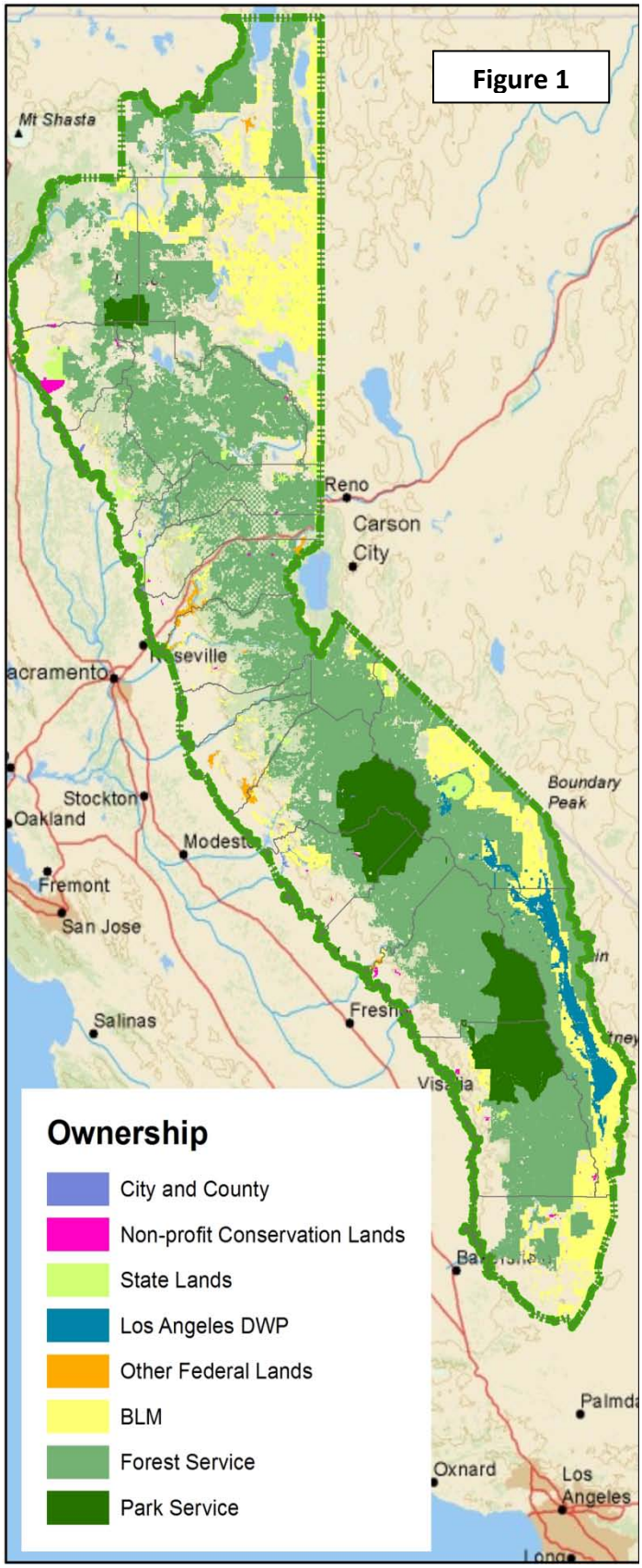
As shown in Table 1, the North Central subregion has the greatest percentage of private lands in conservation at 8.8% compared to the South Central subregion with 0.5% percent of the private lands in conservation. In the Central subregion, which has experienced the greatest conversion of land to development in the last thirty years, 1.6% of the private lands are conserved and 45.7% of lands are public, the lowest percentage of public lands among subregions. Compare that to the East subregion, which has by far the greatest percentage of public lands among the subregions with 94.2% or 3,598,991 acres. The East subregion also has the second highest percentage of private lands in conservation at 4.0% or 8,861acres.

Table 1 Acres of Land Conserved by Subregion and Ownership

Ownership Type	North Subregion	North Central Subregion	Central Subregion	South Central Subregion	East Subregion	South Subregion
Private Lands in Conservation*	27,082	130,958	21,947	7,044	8,861	28,594
Percentage of Private Lands in Conservation	0.9%	8.8%	1.6%	0.5%	4.0%	1.6%
Other Private Lands	2,903,747	1,364,017	1,377,113	1,505,559	211,493	1,740,665
Public Lands	3,406,501	2,128,914	1,176,078	1,829,812	3,598,991	4,087,940
Percentage of Subregion in Public Ownership	53.8%	58.7%	45.7%	54.7%	94.2%	69.8%
Total Acres	**6,337,330**	**3,630,741**	**2,575,138**	**3,342,414**	**3,819,345**	**5,857,199**

*Fee title and conservation easements

The majority of the public lands in the Sierra occupy the mid to upper elevations (see Figure 1.) In the elevation band above 3,000 feet, 74% or 15.1 million of the total 20.3 million acres is in public management. The lower elevation areas are dominated by private and tribal lands. Over 4 million of the 5.23 million acres (76.5%) of land in the elevation band below 3,000 feet in the SNC region is in private ownership. The majority of private conservation areas in this elevation band occur on the western side of the Sierra in the Sierra Nevada Foothills, since the bulk of land in the East Subregion is managed by public agencies.



The Sierra Nevada range has experienced a pattern of landscape change similar to many mountainous regions of the United States and the developed world. Development in the Sierra has been more widespread in the lower elevations of the Sierra closest to the productive farming environment and larger towns of the Central Valley.

Conservation easements are an important tool in preserving agricultural and ranching areas and the fish and wildlife habitat, air and water quality, economic, historical, and cultural benefits they provide to the Region and the State, especially where risk of development is greatest.

While not included under Acres of Land Conserved, another important tool in protecting ranches and agricultural lands in the Sierra Nevada is the Williamson Act, which provides an offset of property taxes for agricultural and ranch properties in exchange for ten or twenty year contracts to maintain livestock or agricultural production on the specified land. Appendix B addresses the current status of the Williamson Act in the Sierra Nevada with regards to land protection.

Wildlife Habitat

This system indicator addresses the distribution and abundance of natural areas important to fish and wildlife species in the Sierra. The results of the California Essential Habitat Connectivity Project (Connectivity Project) conducted by CalTrans and the California Department of Fish and Game[10] were used to understand the location of small and large natural areas that provide plant communities and wildlife species populations with suitable habitat in the Sierra. The Connectivity Project analysis produced the most up-to-date statewide distribution and location of natural areas in California through a multi-agency, cooperative effort. The Connectivity Project used a GIS analysis to select large, intact natural areas greater than 2,000 acres and smaller natural areas less than 2,000 throughout California. The degree of land conversion, residential housing impacts, road impacts and status of forest structure (the level of canopy closure related to forests being departed from their normal fire return interval) were used to identify the large and small natural areas.

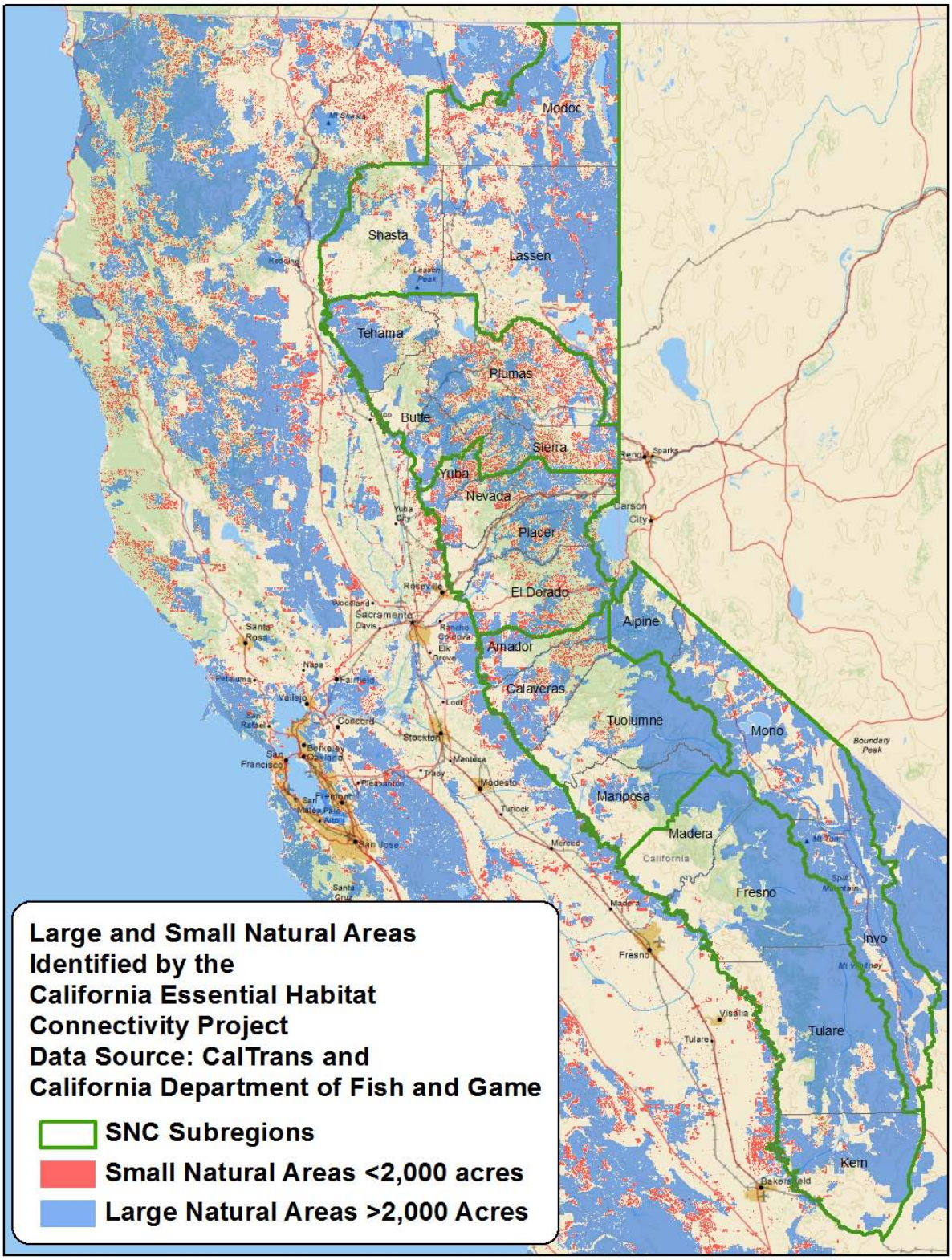
Large, intact natural areas were identified by the Connectivity Project as being the least developed and provide habitat for a variety of wildlife species including large predators such as mountain lions. Small natural areas are particularly important habitat for many smaller mammal species, birds, reptiles and amphibians. Large and small natural areas are surrounded by a matrix of land uses that can vary in the amount of wildlife habitat available and how permeable they are for wildlife to live in or move through. Areas not identified as large or small natural areas in the analysis include areas that are important to many wildlife species that are typically generalist species more adapted to the presence of humans such as the raccoon, coyote, wild turkey, mule deer, common raven and brown headed cowbirds.

The map of natural areas within the SNC boundary shows the distribution of large and small natural areas (Figure 2). In the entire 25 million acres within the Sierra Nevada, there are 11.6 million acres (49%) of large, intact natural areas. Not surprisingly based on the prior discussion of acres of land conserved, the distribution of these large natural areas significantly increases with elevation within the Region. In the elevation band below 3,000 feet, approximately 1.4 million out of a total of 5.3 million (26%) acres are identified as large natural areas (see Chart 2). Between 3,000 and 6,000 feet, there are about 4.3 million acres of large natural areas out of 11.7 million acres (37%). Above 6,000 feet, over 5.9 million of the 8.6 million total acres are large natural areas (69%). From Alpine County south to Kern County, the land above 6,000 feet is virtually a continuous, large natural area according to the Connectivity Project. This large natural area persists because 97% of the land above 6,000 feet is in public lands management, with a large majority in wilderness designation. The highest elevation areas of the Sierra are steep, rugged areas that are significantly less impacted by roads and development than lower elevation areas in the Region. Although high elevation areas represent the largest, most intact natural areas, the higher elevations typically provide habitat for fewer wildlife species and have less plant diversity and overall productivity.

A key factor in whether large intact natural areas exist is road density. Examining road density data for the Region provides insight to understand some of the results of the Connectivity

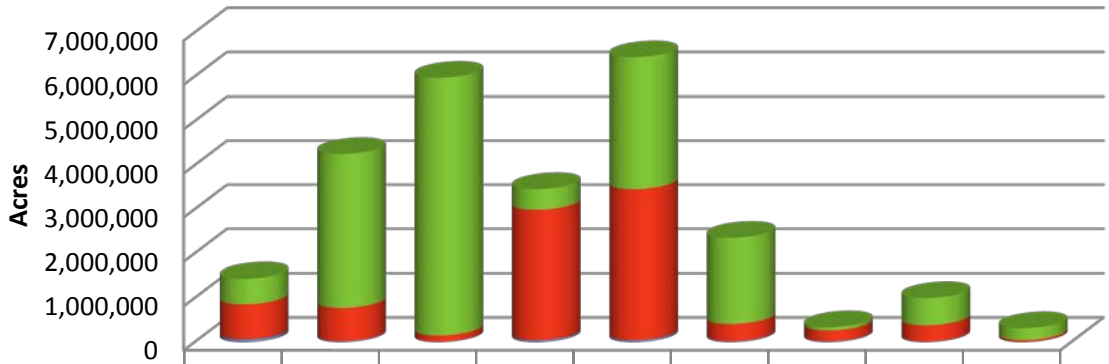
[10] Spencer et al. 2010

Figure 2: Map of large and small natural areas within the SNC



Project as it relates to large, intact natural areas. For example, although 74% of the land between 3,000 and 6,000 is in public lands management, only 37% is identified as large, intact natural areas as the majority of the region is traversed by roads. Although less than 200,000 people inhabit this part of the Sierra, this area has a higher average road density than higher elevations: 2.3 miles/square mile compared to 1.47 miles/square mile above 6,000 feet. The greater road density at this elevation band leads to increased habitat fragmentation, which is significant as the majority of the Sierra's mixed conifer forest occurs within the 3,000 to 6,000 foot elevation band.[11] In the Sierra, forest fragmentation is exacerbated by the condition of the majority of mixed conifer forests, which are significantly departed from their normal fire return interval and impacted by forests pests and climate change.[12] Because of the higher road density, fragmentation, and departure from the normal fire return interval, the majority of lands at this elevation band are not identified as large, intact natural areas by the Connectivity Project analysis. This is particularly evident when viewing Figure 1 on the west side of the Sierra in the central and southern Sierra. Despite the low population figures overall, the mid-elevations of the Sierra have a growing rural development pattern, which reduces overall available habitat and fragments habitat for many wildlife species.[13] In addition, new development in the wildland-urban interface introduces a number of threats to wildlife persistence such as vehicular collisions, domesticated animals, disease transmission, and non-native species invasions that reduce available forage.

Chart 2 Natural Areas by Ownership and Elevation



	Large Natural Areas			Not Identified as Large or Small Natural Areas			Small Natural Areas		
	0 to 3,000 Feet	3,000 to 6,000 Feet	6,000 Feet and Above	0 to 3,000 Feet	3,000 to 6,000 Feet	6,000 Feet and Above	0 to 3,000 Feet	3,000 to 6,000 Feet	6,000 Feet and Above
Public	576,788	3,480,7	5,822,1	470,712	2,980,4	1,941,8	70,971	617,354	269,567
Private	799,259	763,136	147,761	2,951,3	3,419,4	400,708	256,097	377,605	46,023
Easement	60,000	13,232	3,345	38,967	38,605	12,202	11,046	4,531	686

[11] Barbour et al. 1991, Barbour and Minnich 2000
[12] North et al. 2009, Guarin and Taylor 2005, Beaty and Taylor 2007
[13] Shilling and Givertz 2007, Laurance 2009, Terborgh 1974

As shown in Chart 2 the 3,000 to 6,000 foot elevation band has the majority of small natural areas in the Sierra; small natural areas make up over 8% of the total land area or under 1 million acres. As discussed in the previous paragraph, this percentage of small natural areas is likely associated with greater fragmentation and departure from the normal fire return interval than compared with lands above 6,000 feet. Above 6,000 feet, small natural areas make up just over 3% of the total area or 316,000 acres. Below 3,000 feet, the areas not identified as small or large natural areas make up the majority of the area at 66% or over 3.4 million acres out of a total of over 5.2 million acres, as the land below 3,000 feet on the west side of the Sierra has experienced the greatest degree of development, habitat conversion and fragmentation[14].

Overall, the grasslands, oak woodland, and wetland ecosystems have experienced reductions in size and degradation of habitat quality, and are at risk of continued ecosystem health declines due to temperature and precipitation fluctuations associated with climatic change. This elevation band will also be disproportionately affected by the loss of subvention payments for Williamson Act contracts to preserve agricultural and grazing lands, which support many wildlife species, as the majority of these contracts are located below 3,000 feet.

Appendix C summarizes research related to changes in distribution and abundance of fish and wildlife species that occurred in the Sierra over the last hundred years.

[14] Sierra Nevada Ecosystem Project 1996

Contact Information

For more detailed information on the individual Indicators or explanation of their development, please contact:

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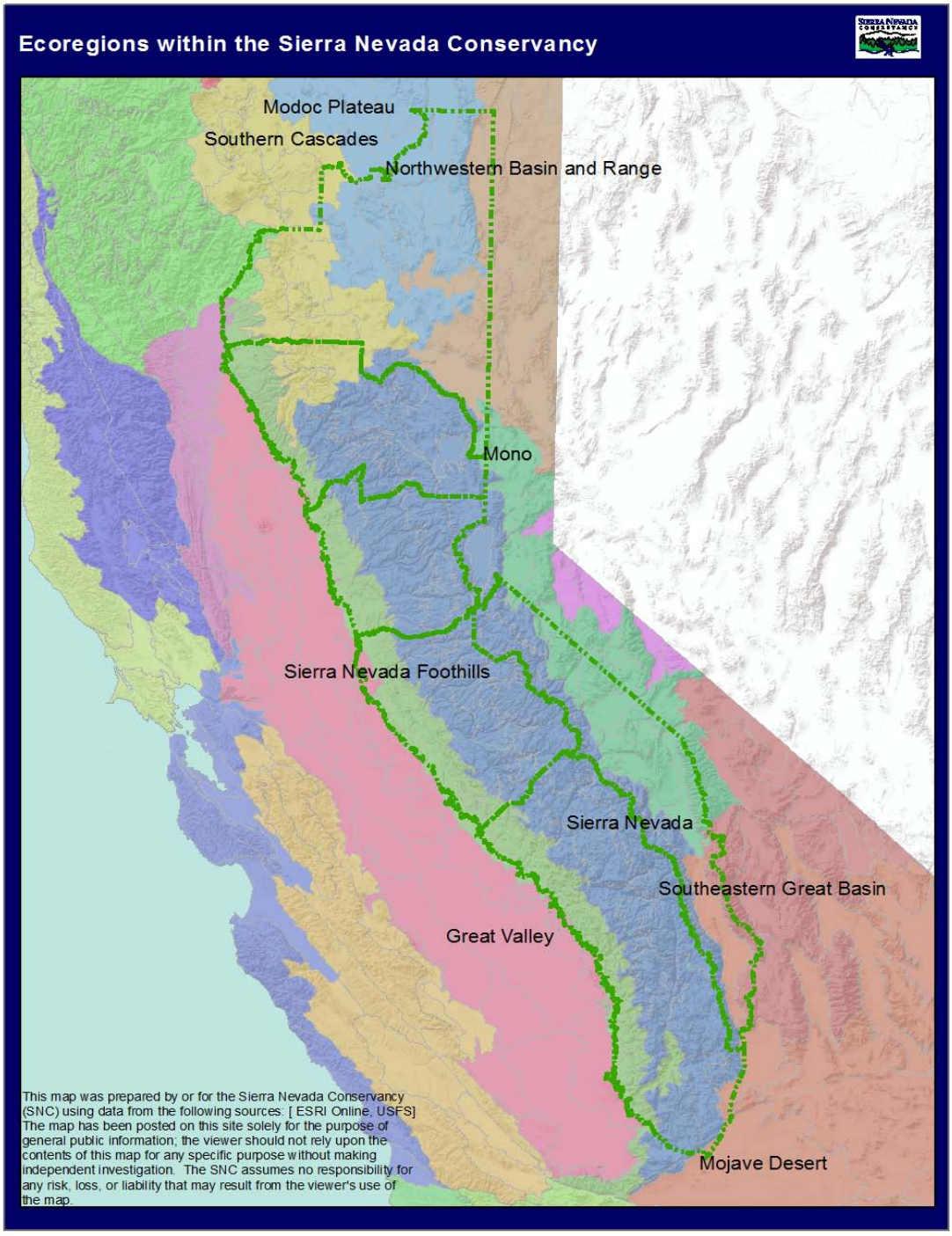
Appendix A: Ecoregions of the Sierra Nevada



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[15] Cleland, D.T., Freeouf, J.A., Keys, J.E., Jr., Nowacki, G.J., Carpenter, C, McNab, W.H. 2007. Ecological Subregions: Sections and Subsections of the Conterminous United States [1:3,500,000] [CD-ROM]. Sloan, A.M., cartog. Gen. Tech. Report WO-76. Washington, DC: U.S. Department of Agriculture, Forest Service.

Appendix B: Williamson Act & Land Protection

Due to the State budget crisis, funding provided to counties to offset the loss of property tax revenues associated with the Williamson Act were eliminatde state-wide in the 2009-2010 fiscal year.

As of the most recent Department of Conservation data, over 180,000 acres of agricultural land is in Williamson Act contracts (see Table 2) and more than 1.4 million acres of rangeland is in contracts in the 22 counties partially or wholly within the SNC region. With the loss of the State funding, however, some counties do not have the financial resources to support the Williamson Act contracts. As of September 2011, the County of Fresno voted to halt subvention payments to land owners in Williamson Act contracts in Fresno County, which affects private property owners managing 190,000 acres of land within the SNC portion of the County. In October 2010, UC Davis researchers published a policy brief detailing interviews with 700 ranchers in rangeland Williamson Act contracts throughout the State. Twenty-three percent of the respondents said that the loss of the Williamson Act would result in the ranchers ending their ranching enterprises. In 2009, 70% of the survey respondents made less than $10,000, which makes ranching a vulnerable industry to the loss of an important conservation program that protects ranching, wildlife habitat and other environmental benefits.[16]

[16] Myhe, S., I. Lacher, W. Wetzel, D. Manning, and D. Swezey. 2010. UC Davis Policy Brief: California Ranching Without the Williamon Act. http://reach.ucdavis.edu/programs/williamsonact.html

Table 2 Acres of Land in Williamson Act Contracts

County	Williamson Act Prime Agricultural Acres	Williamson Act Non-prime (Rangeland) Acres
Modoc County	41,003 WA, 8,607 in prime	76,654
Shasta County	86,790	127,252
Lassen County	14,472	282,488
Tehama County	3,567	227,142
Plumas County	4,544	68,756
Butte County	311	56,722
Sierra County	1,622	34,159
Yuba County	N/A	0
Nevada County	2,397 Ag Easement, 964 Mixed prime-non-prime, and 3,258 prime	0
Placer County	10799 mixed prime and non prime	2,185
El Dorado County	5,673	26,796
Alpine County	N/A	0
Amador County	324 prime acres, 14,657 mixed ag and rangeland	0
Calaveras County	4,565	N/A
Tuolumne County	12,541 unspecified	76,520
Mono County	13,165	118,974
Mariposa County	0	106,963
Madera County	27	205,492
Fresno County	3,850	168,012
Inyo County	N/A	186,646
Tulare County	8,190 prime, 680 HS, 62 HS non-renewal	367,975
Kern County	1,150 prime, 1,073 mixed prime/non-prime	312,917
Totals	**173,806 (includes some Non-prime/Rangeland acreage)**	**2,445,653**

Appendix C: Detailed Discussion of Wildlife Status

IntroductionThe natural history of the Sierra is intertwined with human history, the plants and animals of the Sierra Nevada's foothills, oak savannahs, woodlands, wetlands and conifer forests have been a vital food source and economic base of humans for thousands of years. Native Americans carefully managed the foothills and conifer forests for their resource needs through controlled burning for over 10,000 years.[17] Significant changes to the Sierra landscape and the plant and animal populations dependent on this region began to occur with the arrival of the Spanish missionaries in the mid 1500s. The missionaries brought annual grassland species from Mediterranean Europe that quickly colonized the coastal areas, central valley and Sierra foothills of California. These invasive grassland species are believed to have displaced an herbaceous plant cover that was dominated by wildflowers and blanketed the hills of the coast, central valley and Sierra foothills .[18] Many wildlife species that were dependent upon the native flora of the foothills likely declined following the invasion of the non-native, annual grasses.

Resource extraction in the Sierra grew exponentially in the mid 1800s with the initiation of the Gold Rush. Timber operations, trapping, mining, grazing, road and small community development were common in the Sierra, particularly intense on the western slope in the central Sierra, during the Gold Rush era until the 1920s .[19] Naturalists such as John Muir started documenting the presence of plants and animals in various parts of the Sierra Nevada in the 1860s, but these studies were not quantitative in nature. Quantitative records that describe the presence and distribution of vegetation communities and wildlife species prior to then do not exist.

The Sierra Nevada is home to over 570 species of fish and wildlife, and many of these species are endemic (native to the Sierra Nevada and southern Cascades)[20]. Understanding the current status of Sierra fish and wildlife species requires a look into the past to evaluate the many factors that have affected the Sierra environment. Comprehensive surveys of the vegetation communities[21] and wildlife presence[22] in the Sierra Nevada began in the 1910s after the Sierra environment had already been greatly modified by resource extraction, the introduction of non-native species, and development. Therefore, when comparing the changes to vegetation communities and wildlife habitat between historic and modern surveys, consideration must be given that the baseline natural conditions had already shifted significantly by the early twentieth century when the comprehensive surveys began. Since the historic surveys of the early twentieth century, wildlife and plant communities in the Sierra have been impacted by a set of stressors including: expansion of human development, particularly in the foothills; fire suppression in the conifer forests; the spread of invasive plant, pest and animal species; air pollution; stream diversions; and climate change.

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[17] Storer et al. 2004
[18] Minnich 2008
[19] Storer et al. 2004
[20] Bunn et al. 2007
[21] Comprehensive vegetation surveys of the Sierra were initiated in the 1920s by Albert Wieslander
[22] Joseph Grinnell and his team from the Museum of Vertebrate Biology, UC Berkeley

Evaluating the changes in fish and wildlife species habitat over the modern era is limited by a lack of Sierra-wide data for multiple time periods. Therefore, the historic and modern Grinnell surveys were analyzed for birds and mammals[23] in the Yosemite and Lassen areas as well as the 1999 Sierra-wide bird surveys by the Point Reyes Bird Observatory[24]. For fish, amphibians, and reptiles, peer reviewed, scientific journal articles were cited to document changes in species abundance and habitat.The ability of a population of a species to persist over multiple generations in response to habitat loss and fragmentation is dependent upon many factors including the extent of the habitat loss, fragmentation, and the life history of the species. Species with specialist life histories that are dependent on particular habitat types and distinct prey sources are often more sensitive to human presence[25] and are more susceptible to population size reductions[26] and extinction compared to colonizing and invasive species that are generalists.

Wildlife species that are more sensitive to human presence, intensive land uses, stream diversions, climate change, hunting and trapping and the stressors associated with them have experienced population declines in the Sierra[27]. Many species began disappearing from the Sierra in the 1800s and into the early 1900s and include the grizzly bear, wolverine, Sierra Nevada red fox, marten and fisher[28] . In the last century, a number of species such as the willow flycatcher, spotted owl, Stellar's jay, band tailed pigeon, dark-eyed junco, olive-sided flycatcher, the two species of mountain yellow-legged frog, foothill yellow-legged frog, red-legged frog, Cascade frog, and native salmon and trout fish species including Chinook salmon, steelhead, Pacific lamprey, rainbow trout (including golden trout) and cutthroat trout have significantly declined throughout the Sierra.[29]

Fish, Amphibians and Reptiles

Significant declines in the abundance and distribution of native fish and amphibians in the Sierra are well documented[30] These declines are a result of multiple factors, but the primary causes for many of these declines are aquatic habitat loss and fragmentation including stream channelization, diversions, and degradation of wetland habitats; and the introduction of non-native species that compete with or are predatory to native species.[31]. Air pollution, specifically pesticide,[32] and mercury deposition[33] from past mining practices, along with disease outbreaks have exacerbated population declines. Scientists continue to monitor and explore the mechanisms responsible for the decline of many native, endemic species that are dependent upon freshwater habitats.

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[23] Moritz 2008, Perrine et al. 2007, and Zielinkski et al. 2005
[24] Siegel and Desante 1999.
[25] Morrison et al. 2011
[26] Terborgh 1974, Laurance 2009.
[27] Zielinski 2005, Storer 2004, Laurance 2009
[28] Zielinski 2005
[29] Siegel and DeSante 1999, Knapp and Matthews 2001, Lawler et al. 1999, Moyle and Randall 1998
[30] Moyle and Nichols 1974, Moyle and Randall 1998, Knapp and Matthews 2001, and Briggs et al 2005
[31] SNEP 1996
[32] Davidson et al. 2007
[33] Sakai et al. 2010

Of the forty native fish in the Sierra, 19 species have stable populations (Table 1).[34] The remaining 21 species are either federal or state listed species (endangered or threatened) and/or the species are identified by various conservation and fish and wildlife agencies or organizations as species of concern. Anadromous species (e.g. salmon) that move from the ocean to mountain streams to reproduce have suffered significant declines in population size as well as endemic fish species of the Sierra such as the Little Kern golden trout, the Lahontan cutthroat trout and the Paiute cutthroat trout. Native fish of the foothill streams have also declined.

Mountain yellow-legged frog, credit: mylf.info

All of the native "true frogs" or Ranid frogs in the Sierra have declined significantly (Table 2).[35]. The over 90% population declines of both species of the mountain yellow-legged frog in the Sierra were primarily associated with predation by stocked, non-native trout in previously fishless high elevation lakes followed by a further reduction in population sizes by the Chytridiomycosis fungal infection.[36] The Yosemite toad is an endemic high elevation species of the Sierra with a narrow range whose population numbers have declined up to 50% since the 1970s; scientists are trying to better understand the factors involved in the declines.

The Sierra is home to a number of rare, endemic salamander species that are vulnerable to extinction if significant habitat loss and fragmentation occur in the foothills. Two reptile species have also declined in the Sierra. The mountain garter snake numbers dwindled due to the decline of its main prey source, mountain yellow-legged frogs.[37] Western pond turtles have been in decline due to the loss and degradation of upland habitat[38] and mortality from vehicle collisions as turtles move between aquatic habitats and upland areas.

Native aquatic species have faced significant declines in abundance and range throughout the Sierra, so much so that Viers and Rheinheimer (2009) called for the development of freshwater conservation planning in the Sierra that includes climate change forecasts on a watershed catchment scale. Table 1 provides a summary of the status of native fish species in the Sierra Nevada (SNEP 1996, CNDDB 2011, and IUCN 2011). Table 2 lists the status of amphibians and reptiles in decline throughout the Sierra.

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[34] California Natural Diversity Database, January 2011. International Union for Conservation of Nature Red List of Threatened Species, 2011,
[35] Knapp and Matthews 2001, Briggs et al 2005
[36] Knapp and Matthews 2001, Briggs et al 2005
[37] Knapp 2005
[38] Spinks et al, 2003, Jennings and Hayes 1994

Table 1 Declining/Special Status Native Fish of the Sierra Nevada

Common Name	Drainage	Habitat	CNDDB Status, January 2011*	IUCN**
Kern brook lamprey (*Lampetra hubbsia*)	Sacramento–San Joaquin	Lowlands	AFS:TH DFG:SSC	Near threatened
Pacific lamprey (*Lampetra tridentata*)	Sacramento–San Joaquin Anadromous	Anadromous, foothills, lowlands	AFS:VU	No status
Chinook salmon (*Oncorhynchus tshawytscha*)-Spring run	Sacramento–San Joaquin	Anadromous, foothills, lowlands	Federal Threatened, State Threatened, AFS:TH	No status
Chinook salmon (*Oncorhynchus tshawytscha*)-Winter run	Sacramento–San Joaquin	Anadromous, foothills, lowlands	Federal Endangered, State Endangered, AFS:EN	No status
Chinook salmon (*Oncorhynchus tshawytscha*)-Fall run	Sacramento–San Joaquin	Anadromous, lowlands	AFS:VU DFG:SSC NMFS:SC	No status
Chinook salmon (*Oncorhynchus tshawytscha*)-Late fall run	Sacramento–San Joaquin	Anadromous, foothills, lowlands	AFS:VU DFG:SSC NMFS:SC	No status
Rainbow trout (*Oncorhynchus mykiss irideus*)-Winter steelhead	Sacramento–San Joaquin Foothills	Anadromous, foothills, lowlands	Federal Threatened, AFS:TH	No status
Rainbow trout (*Oncorhynchus mykiss aguilarum*) Eagle Lake rainbow trout	Eagle Lake	Foothills, high elevations	AFS:TH DFG:SSC USFS:S	No status
Rainbow trout (*Oncorhynchus mykiss gilbertia*) Kern River rainbow trout	Sacramento–San Joaquin	High elevations	AFS:TH DFG:SSC	No status
Rainbow trout (*Oncorhynchus mykiss whitei*) Little Kern golden trout	Sacramento–San Joaquin	High elevations	Federal Threatened, AFS:EN	No status

Rainbow trout (*Oncorhynchus mykiss aquabonita*) California golden trout	Sacramento–San Joaquin	High elevations	AFS:TH DFG:SSC	No status
Cutthroat trout (Oncorhnychus clarki henshawi) Lahontan cutthroat trout	Lahontan	Foothills, high elevations	Federal Threatened; AFS:TH	No status
Cutthroat trout (*Oncorhnychus clarki selenerisa*) Paiute cutthroat trout	Lahontan	High elevations	Federal Threatened, AFS:EN	No status
Tui chub (*Siphateles bicolor pectinifer*) Lahontan lake tui chub	Lahontan	Lowlands, foothills, high elevations	DFG:SSC USFS:S	No status
Tui chub (*Siphateles bicolor snyderia*) Owens tui chub	Owens River	Lowlands, foothills	Federal Endangered, State Endangered, AFS:EN	No status
Tui chub (*Siphateles bicolor ssp.*) Eagle Lake tui chub	Eagle Lake	Foothills	DFG:SSC	No status
Sacramento hitch (*Lavinia exilicauda exilicauda*)	Sacramento–San Joaquin Lowlands	Lowlands, foothills	No status	No status
California roach (*Lavinia symmetricus ssp.*) San Joaquin roach	Sacramento–San Joaquin Foothills	Foothills	DFG:SSC	No status
California roach (*Lavinia symmetricus ssp.)* Red Hills roach (*Lavinia symmetricus)*	Sacramento–San Joaquin Foothills	Foothills	AFS:VU BLM:S DFG:SSC	No status
Hardhead (*Mylopharodon conocephalus*)	Sacramento–San Joaquin	Lowlands, foothills	DFG:SSC USFS:S	No status
Speckled dace (*Rhinichthys osculus ssp.*) Owens speckled dace	Owens River	Lowlands	AFS:TH DFG:SSC	No status

Owens pupfish (*Cyprinodon radiosusa*)	Owens River	Lowlands	Federal endangered, State Endangered, AFS:EN, DFG:FP	Endangered
*Please see http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf for description of species status **International Union for the Conservation of Nature: Red List of Threatened Species				

Table 2 Declining Species of Concern of Native Amphibians and Reptiles in the Sierra Nevada

Common Name	**Habitat**	**Threats**	**CNDDB Status, January 2011***	**IUCN****
Foothill yellow-legged frog (*Rana boylii*)	Pool and riffle complexes in streams, with shallow, slow moving water for breeding. Foothill species.	Stream diversions (Habitat fragmentation), non-native predatory species.	BLM:S DFG:SSC USFS:S	Near Threatened
Cascades frog (*Rana cascadae*)	Open wetlands such as meadows, ephemeral and permanent ponds at high elevations. May be found along streams in lower elevations. Mt Lassen area species.	Habitat conversion. See Fellers and Drost (1993)	DFG:SSC USFS:S	Near Threatened
California red-legged frog (*Rana draytonii*)	Ephemeral and permanent ponds and wetland habitats with still water. Central Valley and Foothill species.	Stream diversions (Habitat fragmentation), non-native predatory species. See Jennings and Hayes (1985).	Federal Threatened, DFG:SSC	Vulnerable to Extinction
Southern mountain yellow-legged frog (*Rana muscosa*)	High elevation ponds, lakes, meadows, springs, and streams. High elevation species found in South Central and South Subregions.	Introduction of non-native fish in fishless habitat, Chytrid disease, pesticide exposure.	Federal Endangered, State Candidate Endangered, DFG:SSC, USFS:S	Endangered

Sierra Nevada yellow-legged frog (*Rana sierrae*)	High elevation ponds, lakes, meadows, springs, and streams. High elevation species found in North Central Subregion south to the South Subregion.	Introduction of non-native fish in fishless habitat, Chytrid disease, pesticide exposure.	Federal Endangered, State Candidate Endangered, DFG:SSC, USFS:S	Endangered
Yosemite toad (*Bufo canorus*)	Wet meadows species in high elevations > 4,800'	Increase in predators such as common raven, pesticide exposure, other factors unknown.	Federal Candidate, DFG:SSC	Endangered
California tiger salamander (Ambystoma californiense)	Vernal pools and surrounding habitat in foothills < 3,000 ft.	Habitat loss and fragmentation in the foothills.	Federal Threatened, State Threatened, DFG:SSC	Vulnerable to Extinction
Sierra newt (*Taricha torosa sierrae*)	Rivers and streams with pool, rift complexes. Foothill to Mid Elevation Species	Population size unknown	DFG:SSC	No Status
Sequoia slender salamander (*Batrachoseps kawia*)	Deciduous woodlands of the Kaweah watershed.	Small population sizes and small range.	No Status	Definitely Declining
Inyo Mountain Slender Salamander (*Batrachoseps campi*)	Riparian areas within the arid mountains of Inyo County.	Loss of desert riparian habitat, stream diversions, mining	BLM:S DFG:SSC USFS:S	Endangered
Hell Hollow slender salamander (*Batrachoseps diabolicus*)	North facing riparian zones in chaparral and pine-oak woodland. Mariposa County.	Small population sizes, susceptible to population decline.	No Status	Definitely Declining
Gregarious slender salamander (*Batrachoseps gregarious*)	Low to mid elevation species that inhabits oak woodlands of the South Subregion.	Habitat conversion could pose future decline.	No Status	Least Concern

Kings River slender salamander (*Batrachoseps regius*)	Leaf litter and talus in foothill habitats in the Kings River and Kaweah Watersheds in Fresno and Tulare Counties.	Vulnerable to habitat alteration due to extremely small range. And, environmental contaminants at higher elevations.	No Status	Vulnerable to Extinction
Upper Kern slender salamander (proposed *Batrachoseps ssp.* Of Kern Plateau slender salamander)	North facing riparian zones in chaparral and pine-oak woodland. Kern County. Foothill species. Kern County	Development of water storage facilities could pose future threat to habitat.	State Threatened, USFS:S	Vulnerable to Extinction
Kern Canyon slender salamander (*Batrachoseps simatus*)	North facing riparian zones in chaparral and pine-oak woodland. Kern County. Foothill species. Kern County	Development of water storage facilities could pose future threat to habitat.	State Threatened, USFS:S	Vulnerable to Extinction
Kern Plateau slender salamander (*Batrachoseps robustus*)	Inhabits moist forest floor areas close to water, endemic to the Kern Plateau. Kern County	Vulnerable to habitat alteration due to extremely small range.	USFS:S	Near Threatened
Relictual slender salamander (*Batrachoseps relictus*)	Within Kern Canyon, prefers seeps and springs within forested areas above 1,000 ft. Kern County.	Believed to be extirpated in the lower Kern River Canyon.	DFG:SSC	Definitely Declining
Limestone salamander (*Hydromantes brunus*)	Limestone crevices, talus, and abandoned mines. Endemic to the Merced Watershed, Mariposa County.	Small range.	State Threatened, DFG:FP	Vulnerable to Extinction
Yellow-blotched salamander (*Ensatina eschscholtzii croceater*)	Moist evergreen and deciduous forests with coarse woody debris near riparian areas. Kern County, Tehachapi Mountains.	Population size unknown	BLM:S DFG:SSC USFS:S	No Status

Large-blotched salamander (*Ensatina eschscholtzii klauberi*)	Moist evergreen and deciduous forests with coarse woody debris. Species present in mid elevations of western slope of the Sierra.	Population size unknown	DFG:SSC USFS:S	No Status
Mount Lyell salamander (*Hydromantes platycephalus*)	Granite talus with water seeping through in mid to higher elevations in central and southern Sierra.	Population size unknown	DFG:SSC	Least Concern
Owens valley web-toed salamander (*Hydromantes platycephalus ssp*.)	Granite talus with water seeping through in eastern Sierra.	Population size unknown	DFG:SSC	No Status
Sierra night lizard (*Xantusia sierrae*)	Rocky outcrops around granite station in oak woodlands and chaparral in Kern County.	Habitat conversion could pose future decline.	DFG:SSC USFS:S	No Status
Panamint alligator lizard (*Elegaria panamintina*)	Riparian areas in rocky talus areas of Inyo county.	Limited habitat may be impacted by mining, livestock grazing, and off-road vehicle use.	BLM:S DFG:SSC USFS:S	Vulnerable to Extinction
Southern rubber boa (*Charian umbratica*)	Interior live oak and mixed conifer forests between 5,000 to 8,000 feet.	Habitat conversion could pose future decline.	State Threatened, USFS:S	No Status
Western pond turtle (*Actinemys marmorata*)	Streams and adjacent habitat in foothill region throughout Sierra.	Habitat fragmentation, degradation, non-native predator species, and pesticide impacts.	BLM:S DFG:SSC USFS:S	Vulnerable to Extinction

*Please see http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf for description of species status.

**International Union for the Conservation of Nature: Red List of Threatened Species.

Grinnell Historic and Modern Resurveys in the Sierra for Birds and Mammals

In 1908, Joseph Grinnell and his students at the University of California, Berkeley began wildlife surveys in California, including a cross section of the central Sierra from the floor of Yosemite Valley eastward over the crest of the Sierra and into the Great Basin near Mono Lake that covered 1,547 square miles an area near. Another survey was conducted in the Mt. Lassen area, a 3,125 square mile area that extended from the Sacramento River to the Nevada border. In 2003, scientists initiated the Grinnell re-surveys.

These resurveys have provided valuable data to measure the differences in bird and mammal presence and habitat use over a century. Table 3 shows the significant increasing or decreasing trends of birds in the Yosemite transect, across elevations, between the historic and modern surveys and also provides the recorded recent trends in population size changes as recorded in the 1999 Sierra-wide bird assessment[39] , which was conducted by the Point Reyes Bird Observatory using multiple years of Monitoring Avian Productivity and Survivorship (MAPS) data to evaluate changes in species abundance. Table 4 provides the significant increasing or decreasing trends of birds in the Lassen transect compared with the Yosemite surveys at Low, Mid and High Elevations and the Sierra-wide bird surveys.[40]

The Grinnell animal resurveys along the Lassen and Yosemite transects found patterns of bird and mammal migration to upper elevations in response to climate change[41] as well as other factors such as habitat loss, habitat fragmentation and predation. The pattern of species change observed in the historic versus the modern wildlife surveys indicates that specialist bird and mammal species are becoming less frequently detected than generalist species who are more accustomed to human presence.[42]

<u>Birds</u>

Bird species have very mixed patterns of increases and decreases in the Sierra over time. Many bird species in the Sierra are migratory, and factors affecting their increase or decrease are tied to their wintering habitat that is outside of the Sierra. In the Region, modern surveys have shown there are 9 bird species definitely declining, three species that are definitely increasing, and 170 birds that show trends on the decline or increase (Table 3).[43] Of the species definitely decreasing, several species are sensitive to land use changes and the associated stressors that accompany these changes such as being parasitized by the brown headed cowbirds and predation by species associated with human presence such as cats, dogs, and raccoons.[44]
Two species that definitely declined throughout the Sierra showed local increases within the Yosemite area such as the Stellar's jay and the American robin; therefore, local changes in species abundance may be very different from what happens within the Region overall.

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[39] Siegel and DeSante 1999
[40] Siegel and DeSante 1999
[41] Moritz 2008, Perrine et al. 2007, and Zielinski et al. 2005
[42] Zielinski et al. 2005, Moritz 2008
[43] Siegel and DeSante 1999
[44] Gates and Gysel 1979, Wilcove et al. 1986, and Askins 1995

The comparison of historic to the modern surveys of birds in the Yosemite area found that the highest elevation sites experienced the greatest increase in the number of species. These results would suggest that the large, intact natural areas above 6,000 feet are becoming refuges for species migrating to higher elevations in response to climate change. However, the change in species abundance and range (the geographic area that a species occupies) paints a more complicated picture. On average, 46% of the species observed per site were present in both the historic and modern surveys.[45] Low elevation sites experienced significant increases in species abundance while high elevation sites typically displayed a decrease in species abundance, even though these areas saw an overall increase in the numbers of species. Changes in species abundance were associated with specific habitat types. Overall, species abundance increases were observed in riparian (vegetation communities found along stream and river corridors). In conifer habitats, site specific increases and decreases were observed, and the decreases may be attributable to a lack of fire, particularly in conifers with drought tolerant shrubs. In conifer only habitats, increases in species abundance were observed.

Table 3 provides the change in population trends between the historic and modern Grinnell surveys for Yosemite and the Sierra-wide population trends for over a hundred bird species, and Table 4 in Appendix A details the trends in the Lassen area with the Yosemite and the Sierra-wide survey. One of the striking patterns of change is in land bird (non-aquatic) species[46] in the Sierra that inhabit the foothills and mid-elevation areas, many of these species have shown significant declines in both the Sierra wide survey as well as the Yosemite area (with the exception of the Stellar's jay and American robin). Several of these species are resident birds, and a few are migratory (Tables 3 & 4). Table 3 also identifies three birds that have greatly increased in the Sierra; two of the three species are highly correlated with human presence.

The Sierra-wide bird survey[47] assessed the status of 147 species, and 42 of these birds identified are likely declining for multiple reasons: habitat loss, degradation and fragmentation; parasitism by the Brown-headed cowbird; predation by animal species such as dogs, cats and raccoons found near human habitation; competition from non-native species, a decline in their prey base, and climate change[48] The factors responsible with the declines of many bird species are detailed in Tables 3 & 4.

[45] Moritz 2008
[46] Perrine et al. 2007
[47] Siegel and DeSante 1999
[48] Siegel and DeSante 1999

Table 3 Significant Increases and Decreases in Bird Species in the Sierra and within the Yosemite transect at Lower, Middle and High Elevations

SPECIES	Low	Mid	High	IUCN Status*	CNDDB Special Animals**	Population Trend in Sierra (Siegel and DeSante 1999)	Notes
American robin (*Turdus migratorius*)	IS	DSYL	IS	Least Concern	No status	Definitely decreasing throughout the Sierra-PRBO	Resident species. Requires moist, tree-margined meadows, pastures, or lawns. The reason for the decline throughout the Sierra is not known.
Band-tailed pigeon (*Columba fasciata*)	IS	DSYL	I	Least Concern	No status	Populations declining significantly throughout the Sierra-PRBO	Resident species. Winter food supply (primarily acorns) may be declining.
Dark-eyed junco (*Junco hyemalis*)	DS	ISYL	DS	Least Concern	No status	Definitely decreasing throughout the Sierra-PRBO	Resident species. A forest floor species that may be affected by brown-headed cowbird parasitism, but the parasitism rate is unknown. Ground nester. Adult survivorship appears to be low, may not survive well in higher elevations with colder temperatures.
Lesser goldfinch (*Carduelis psaltria*)	IS	DSYL	NT	Least Concern	No status	Definitely decreasing throughout the Sierra-PRBO	Migratory species. This species is dependent upon oak woodland and is a highly adaptable foothill species. The declines may be due to the Brown Headed Cowbird as well as a loss of habitat in the Sierra and in the winter habitat.

Mountain chickadee (*Parus gambeli*)	ND	ND	ND	Least Concern	No status	Definitely decreasing throughout the Sierra-PRBO.	Resident species. Found in all conifer species except foothill pines on the west slope; somewhat less common in pinyon and juniper pines. Cavity nester. The decline is thought to be associated with the removal of large snags and a reduction in large conifers.
Olive-sided flycatcher (*Contopus borealis*)	D	I	DS	Near Threatened	ABC:WLBCC DFG:SSC IUCN:NT USFWS:BCC	Definitely decreasing throughout the Sierra-PRBO.	Migratory species. The preferred habitat is forest edges and burned forests, found along openings such as meadows and ponds. Prefers very tall conifers. It's winter range in central and South America is being converted.
Stellar's jay (*Cyanocitta stelleri*)	IS	ISYL	IS	Least Concern	No status	Definitely decreasing throughout the Sierra-PRBO.	Resident species. Like other resident Sierra foothill species such as Mountain Chickadee and Acorn Woodpecker, this species is also showing a decline. It is dependent on acorn and pine nuts in the winter.
Western wood-pewee (*Contopus sordidulus*)	DS	NT	DS	Least Concern	No status	Definitely decreasing throughout the Sierra-PRBO.	Migratory species. Declining throughout the range; is sensitive to destruction of tropical forest wintering grounds.

Willow flycatcher (*Empidonax traillii*)	DS	DSYL	ND	Least Concern	State Endangered, ABC:WLBCC IUCN:LC USFS:S USFWS:BCC	Definitely decreasing throughout the Sierra-PRBO.	Migratory species. Parasitized by brown-headed cowbird, larval fly and other predators associated with human presence. Population sizes have declined in California. Population decline in the Sierra is implicated with decline of meadow thickets associated with grazing in meadows, which provides opportunities for predation.
<u>Increasing Species</u>							
Common raven (*Corvus corax*)	IS	ISYL	I	Least Concern	No status	Increasing tendency throughout the Sierra-PRBO	Widespread in the Sierra, prefers areas of human habitation and activity.
European starling (*Sturnus vulgaris*)	IS	ND	ND	Least Concern	No status	Increasing tendency throughout the Sierra-PRBO	Invasive
Song sparrow (*Melospiza melodia*)	IS	ISYS	IS	Least Concern	No status	Increasing tendency throughout the Sierra-PRBO	Found in many open habitats. Can be parasitized by BHC. PRBO Sierra Species Accounts: Increasing significantly along the western Slope of the Sierra. Should be monitored although the population appears stable. Has declined in the Central Valley, may be displacing Lincoln's sparrow. Prefers riparian habitats.

*Please see http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf for description of species status**International Union for the Conservation of Nature: Red List of Threatened Species
KEY: IS-Increase Significant, DS-Declining Significantly, ISYV-Increase Significant Yosemite Valley, DSYV Decrease Significant Yosemite Valley, I-Increase, D-Decrease, ND-Not Detected, and NT-No Trend

Table 4 Lassen Bird Species Present in Historic surveys and absent in Modern Surveys compared with the Yosemite surveys at Low, Mid and High Elevations and Sierra-wide bird surveys by Point Reyes Bird Observatory.

SPECIES	Low	Mid	High	IUCN Status*	CNDDB Special Animals**	Population Trend in Sierra (Siegel and DeSante 1999)
Bell's vireo (*Vireo bellii*)	DS	ND	ND	Near Threatened	No status	Not included in the PRBO survey data.
Burrowing owl (*Speotyto cunicularia*)	D	ND	ND	Least Concern	BLM:S DFG:SSC IUCN:LC USFWS:BCC	Not included in the PRBO survey data.
Golden-crowned sparrow (*Zonotrichia atricapilla*)	I	ND	ND	Least Concern	No status	Not included in the PRBO survey data.
Great horned owl (*Bubo virginianus*)	ND	ND	ND	Least Concern	No status	Population trends unknown throughout the Sierra-Monitoring needed-PRBO
Least sandpiper (*Calidris minutilla*)	ND	ND	ND	Least Concern	No status	Not included in the PRBO survey data.
Loggerhead shrike (*Lanius ludovicianus*)	DS	ND	ND	Least Concern	DFG:SSC IUCN:LC USFWS:BCC	Population trends unknown throughout the Sierra-Monitoring needed-PRBO
Ruby-crowned kinglet (*Regulus calendula*)	ND	ND	ND	Least Concern	No status	Decreasing trend throughout Sierra-PRBO
Sage sparrow (*Amphispia belli*)	IS	ND	ND	Least Concern	No status	Population trends unknown throughout the Sierra-Monitoring needed-PRBO
Solitary sandpiper (*Tringa solitaria*)	ND	ND	ND	Least Concern	No status	Not included in the PRBO survey data.
Spotted owl (*Strix occidentalis*)	ND	ND	ND	Near Threatened	USFWS: Candidate Threatened; DFG:SSC	Populations under study.

Swainson's thrush (*Cartharus ustulatus*)	DS	DSYL	ND	Least Concern	No status	Decreasing trend throughout Sierra-PRBO
Swainson's hawk (*Buteo swainsoni*)	D	ND	ND	Least Concern	State Threatened	Population trends unknown throughout the Sierra-Monitoring needed-PRBO
Virginia rail (*Rallus limicola*)	I	ND	ND	Least Concern	No status	Not included in the PRBO survey data.
Western screech owl (*Otus kennicottii*)	ND	ND	ND	Least Concern	No status	Population trends unknown throughout the Sierra-Monitoring needed-PRBO
White-crowned sparrow (*Zonotrichia leucophrys*)	DS	ND	DS	Least Concern	No status	Decreasing trend throughout Sierra-PRBO
White-throated swift (*Aeronautes saxatalis*)	DS	ISYL	I	Least Concern	No status	Decreasing trend throughout Sierra-PRBO

*Please see http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf for description of species status
**International Union for the Conservation of Nature: Red List of Threatened Species
KEY: IS-Increase Significant, DS-Declining Significantly, ISYV-Increase Significant Yosemite Valley, DSYV Decrease Significant Yosemite Valley, I-Increase, D-Decrease, ND-Not Detected, and NT-No Trend

The decline of many bird species is related to multiple factors, many of which are correlated and additive. The Brown-headed cowbird dramatically increased in the Sierra in the last century as it is associated with livestock and horse corrals, which became more widespread in the Sierra in the last century[49] . Non-native species such as the European starling dramatically increased in population in the Sierra between the historic and modern surveys,[50] and they compete for resources with many resident and migratory birds of the Sierra.

The factors responsible for bird declines are numerous and highly variable. Some species have declined due to consuming poisons associated with farming and rangeland areas (e.g. Brewer's blackbird); eating lead shot (e.g. Mourning dove); or because their prey based declined (e.g. White tailed kite, White-throated swift, and Barn owl). Others have declined due to the fragmentation of their habitat and nesting areas and because of human presence such as the Northern Goshawk.[51] Owls are particularly susceptible to higher mortality due to vehicle

[49] Moritz 2008
[50] Moritz 2008, Siegel and DeSante 1999
[51] Morrison et al 2008

collisions.[52] Changes in precipitation and temperature will only exacerbate the survival of many species that have already declined significantly throughout the Sierra.

The Lassen area bird surveys were compared with the Yosemite area and Sierra-wide survey data. Table 4 shows the bird species in the Lassen area that were detected in the historic surveys but were absent from all locations in the modern survey. Table 7 compares the status of these bird species that were absent from the modern Lassen survey with the Yosemite data at all three elevations and the Sierra-wide bird survey data. Overall, the birds that were not found in the Lassen survey in the modern surveys also show a declining trend in the Yosemite area and in the Sierra or throughout the range of the species. An exception is the Golden crowned sparrow, which is a winter migrant to the Sierra that is fairly common; it utilizes shrub habitat in foothill environments of the Sierra.

Mammals and Carnivores

Mammal species in the Yosemite area showed overall declines in species ranges between the historic and modern surveys. Seventeen out of 50 species showed range contractions: 9 species had a contraction of their lower elevation range; three species experienced contractions in the upper elevation limits of their range and; four species experienced contractions of their ranges at both upper and lower elevation limits. Range contractions outnumbered expansions 2.5 to 1. The contractions were especially severe for upper elevation species. The majority of the range expansions included a movement of historically lower elevation species to mid to higher elevation areas. Two species, the Shadow chipmunk and the Bushy-tailed woodrat were abundant during the historic survey and highly detectable. However, the modern survey had limited success in detecting either species across their ranges. These survey results underscore that although large, intact natural areas are vital for the persistence of large and small wildlife species, healthy natural areas of significant size and the corridors connecting these areas must be present at all elevation ranges for wildlife to live in and move through.

With regard to carnivores, two species that were documented in the historic records were not found in the modern survey, the Sierra Nevada red fox and the wolverine[53]. Both species are habitat specialists and are sensitive to human presence. The Sierra red fox and the wolverine were already declining in the early 1900s due to trapping and habitat fragmentation; the fox was only observed in the high elevations of the Sierra in the historic survey and the wolverine was primarily detected in the southern Sierra. Martens were found in the modern surveys in old growth forested areas. They were not found in areas that have been most impacted by human presence such as near roads and areas under recent timber harvest. The marten presence was highly correlated to the level of conservation protection; national parks and wilderness areas were found to have a presence of marten.

The habitat generalists such as gray fox, spotted skunk, black bear, ringtail, striped skunk, and the non-native opossum changed little between the historic and modern surveys. All of these species were detected at low and mid elevations where human presence is greater, but these habitats also tend to be more productive and less-seasonal than upper elevations. Generalist

[52] Jacobson 2005 and Forman et al. 2003
[53] Zielinski 2005

species may become increasingly more common in the Sierra as the development footprint expands in the Sierra and as populations of specialist species decline. Climate change may provide greater opportunities for generalist species to become more common and may allow invasive species a greater foothold in the Sierra.

A 2011 study by Villepique et al. evaluated the diet of cougars following a decline of mule deer to less than 25% of their former population size in the eastern Sierra. This studey found that even. after the mule deer population declined, there was no evidence that cougars switched to alternate prey sources[54]. Cougars are the keystone predator in the Sierra Nevada, and this study suggests that they may be susceptible to population declines due to a lack of prey switching, similar to other habitat specialists.

Table 5 Mammal Species Range Changes and Conservation Status in the Yosemite Survey

SPECIES	Range Change	IUCN Status*	CNDDB Special Animals**
California pocket mouse (*Chaetodipus californicus*)	Range Expansion	Least Concern	No status
California vole (*Microtus californicus)*	Range Expansion	Least Concern	No status
Southern marsh harvest mouse (*Reithrodontomys megalotis)*	Range Expansion	Least Concern	No status
Pinyon mouse (*Peromyscus truei)*	Range Expansion, Western and Eastern Sierra	Least Concern	No status
Montane shrew (*Sorex monticolus)*	Range Expansion, Western Sierra	Least Concern	No status
Ornate shrew (*Sorex ornatus*)	Range Expansion	Least Concern	No status
Heermann's kangaroo rat (*Dipodomys heermanni)*	Range Contraction	Least Concern	No status
Great Basin pocket mouse (*Perognathus parvus)*	Range Contraction	Least Concern	No status

[54] Villepique et al. 2001

Woodrat (*Neotoma cinerea)*	Range Contraction, Western and Eastern Sierra	Least Concern	No status
Long-tailed vole *(Microtus longicaudus)*	Range Contraction, Western Sierra	Least Concern	No status
American pika (*Ochotona princeps)*	Range Contraction, Western and Eastern Sierra	Least Concern	No status
American water shrew (*Sorex palustris)*	Range Contraction, Western Sierra	Least Concern	No status
California ground squirrel *(Spermophilus beecheyi)*	Range Contraction, Western Sierra	Least Concern	No status
Belding's ground squirrel (*Spermophilus beldingi)*	Range Contraction, Western and Eastern Sierra	Least Concern	No status
Golden-mantled ground squirrel (*Spermophilus lateralis)*	Range Contraction, Western Sierra	Least Concern	No status
Least chipmunk (*Tamias minimus)*	Range contraction	Least Concern	No status
Allen's chipmunk (*Tamias senex)*	Range contraction	Least Concern	No status
Alpine chipmunk (*Tamias alpines)*	Range Contraction, Western and Eastern Sierra (not found in the Eastern Sierra in the modern survey)	Least Concern	No status
Western jumping mouse (*Zapus princeps)*	Range Contraction, Western Sierra	Least Concern	No status
Pantamint kangaroo rat (*Dipodomys panamintinus)*	No Change	Least Concern	No status

Northern flying squirrel (*Glaucomys sabrinus)*	No Change	Least Concern	No status
Long-tailed vole *(Microtus longicaudus)*	No Change, Eastern Sierra	Least Concern	No status
Montane vole (*Microtus montanus)*	No Change, Western and Eastern Sierra	Least Concern	No status
Brush mouse (*Peromyscus boylii)*	No Change	Least Concern	No status
Deer mouse (*Peromyscus maniculatus)*	No Change, Western and Eastern Sierra	Least Concern	No status
Western heather mole (*Phenacomys intermedius)*	No Change	Least Concern	No status
Mount Lyell shrew (*Sorex lyelli)*	No Change	Least concern	DFG:SSC
Montane shrew (*Sorex monticolus)*	No Change, Eastern Sierra	Least Concern	No status
American water shrew (*Sorex palustris)*	No Change, Eastern Sierra	Least Concern	No status
Trowbridge's shrew (*Sorex trowbridgii)*	No Change	Least Concern	No status
Belding's ground squirrel (*Spermophilus beldingi)*	No Change, Eastern Sierra	Least Concern	No status
Golden-mantled ground squirrel (*Spermophilus lateralis)*	No Change, Eastern Sierra	Least Concern	No status
Yellow-pine chipmunk (*Tamias amoenus)*	No Change	Least Concern	No status
Merriam's chipmunk (*Tamias merriami)*	No Change	Least Concern	No status
Long-eared chipmunk (*Tamias quadrimaculatus)*	No Change	Least Concern	No status

Lodgepole chipmunk (*Tamias speciosus)*	No Change, Western and Eastern Sierra	Least Concern	No status
Douglas squirrel (*Tamiasciurus douglasii)*	No Change, Western and Eastern Sierra	Least Concern	No status
Botta's pocket gopher (*Thomomys bottae)*	No Change, Western Sierra	Least Concern	No status
Mountain pocket gopher (*Thomomys monticola)*	No Change	Least Concern	No status
Western jumping mouse (*Zapus princeps)*	No Change, Eastern Sierra	Least Concern	No status

*Please see http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf for description of species status**International Union for the Conservation of Nature: Red List of Threatened Species

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