13 Sierra Nevada and Cascades Region

Tim Palmer

Extending approximately 525 miles from north to south, the Sierra Nevada and Cascade ranges form the spine of the California landscape. The mostly volcanic southern Cascades stretch from north of the Oregon border southeastward, merging just south of Mt. Lassen with the northern reaches of the predominantly granitic Sierra Nevada. To the south, the Sierra Nevada range embraces the Mojave Desert to the east and curves south to link with the Tehachapi Mountains. The region includes the oak woodland foothills on the western slopes of the Sierra and Cascade ranges and, on the east, the Owens Valley and edges of the Great Basin.

On the west side, the slope of the Sierra Nevada and Cascades rises gradually from near sea level at the floor of the Central Valley to ridges ranging from 6,000 feet in the north to 14,000 feet in the south, then drops off sharply to the east. In contrast, the east side of the Cascades slopes gradually. As the Sierra elevation increases from west to east, life zones transition from chaparral and oak woodlands to lower-level montane forests of ponderosa and sugar pine to upper montane forests of firs, Jeffrey and lodgepole pine and, above timberline, to alpine plant communities.

Federal agencies manage about 61 percent of the Sierra Nevada and Cascades: 46 percent by the Forest Service, 8 percent by the National Park Service, and 7 percent by the Bureau of Land Management. About 2 million acres are wilderness areas, mostly in the eastern and southern Sierra, managed by the Forest Service. Lands managed by the National Park Service include Lassen Volcanic, Sequoia, Kings Canyon, and Yosemite national parks and Devils Postpile National Monument. State parks and wildlife areas account for 1 percent of the region, and the remaining, approximately 36 percent of the Sierra and Cascades, is privately owned. Most of the higher elevations and the eastern Sierra are public lands, whereas most of the oak woodlands and lower mixed conifer forests and rangelands below 3,000 feet on the western slope are in private ownership. There is a checkerboard ownership pattern of private and public lands in areas of the northern half of the Sierra that lie near historical railway routes (CRA 2004, SNEP 1996).

About 40 percent of the state's surface-water runoff flows to the Central Valley from the Sierra and Cascades. These flows are critical to meet California's hydropower demands and agricultural and drinking water needs. Much of the water is stored in reservoirs and is conveyed by aqueducts to irrigate agriculture from Redding to Bakersfield and to provide drinking water for most of urbanized California, including the San Francisco Bay Area and Southern California (DWR 1998).

The hundreds of creeks and streams of the western slope of the Sierra and Cascades drain via a dozen major river basins to merge with the Sacramento River in the north and the San Joaquin River in the south, eventually joining at the San Francisco Bay Delta. The southern forks of the Kings River and streams farther south drain into the Tulare basin. The streams east of the Sierra crest flow into the Great Basin via the Lahontan, Mono, and Owens drainages. Many of the springs and creeks of northeastern California drain via the Pit River, which winds through the Cascades and joins the Sacramento River at Lake Shasta. Maintaining and restoring the ecological health of these watersheds and aquatic systems is important to ensure clean water.

Bold topography, the large elevation gradient, and varied climatic conditions of the Sierra and Cascades support diverse plant communities. Fifty percent of California's 7,000 vascular plants are found in the region, and more than 400 plant species are endemic (Shevock 1996). The varied conditions and floristically and structurally diverse plant communities provide a large array of habitats important for maintaining California's wildlife diversity and abundance.

Several major stressors have altered aquatic ecosystems and transformed forest structure and habitats on both public and private lands. Dramatic human population growth and development in the western Sierra foothills, forest management practices, fire suppression, and livestock grazing have altered ecosystems and continue to affect wildlife habitats. Hydropower facilities and agricultural and municipal water diversions have disrupted natural river flow regimes. Eroding access roads in forested and other habitats and excessive livestock grazing have resulted in the conversion of wet meadows to drier lands and have degraded streams and aquatic habitat. The introduction of trout has caused declines in native species. In the central Sierra, historic mining severely altered watersheds and water courses, and those effects persist.

The altered forest ecosystems of the Sierra and Cascades largely lack the qualities of old-growth forests or late-**seral** stage forests (forests that are in the later stages of development with large-diameter trees, snags, and logs) that are important for diverse and abundant wildlife (Franklin and Fites-Kaufman 1996, USFS 2001b). Species that depend on old-growth or late-seral stage forest habitat, like the Pacific fisher, have been negatively affected. The degradation of mountain meadows and loss of willows and other riparian woody plants have affected the endangered willow flycatcher and other species that have similar habitat requirements.

New conservation challenges and opportunities will affect the Sierra and Cascade ranges in the next few decades. How new development is managed will determine the extent of wildlife habitat fragmentation. Changing global climate will alter depth and seasonality of snowpack, further modifying river flow regimes and ecosystems. The relicensing of hydropower projects provides an opportunity to change hydropower operations to reduce their effects on fish and wildlife.

Concerned about the decline of old forests and associated wildlife species of the region, Congress funded, in 1993, the Sierra Nevada Ecosystem Project (SNEP), based at UC Davis, for the "scientific review of the remaining old growth in the national forests of the Sierra Nevada in California, and for the study of the entire Sierra Nevada ecosystem by an independent panel of scientists, with expertise in diverse areas related to this issue." The forests of the Sierra, Cascades, and the Modoc Plateau were evaluated by a multidisciplinary team of scientists from many organizations. SNEP completed its work and published a three-volume report in 1996. Based on the work of dozens of scientists, the report analyzed the status of conifer forests, rangelands, meadow and riparian plant communities, and aquatic ecosystems, and suggested alternatives to restore ecosystems.

Aquatic and riparian systems are believed to be two of the most altered and impaired habitats of the Sierra Nevada. Among other critical findings, SNEP found that key causes of the decline of mammals, birds, and other vertebrates in the Sierra, Cascades, and Modoc regions include the loss and degradation of riparian areas, foothill woodlands, and diverse old forest habitats (including large trees, snags, fallen logs, and layered vegetative structure).

Meanwhile, a 1992 technical report by the Forest Service's Pacific Southwest Research Station highlighting at-risk California spotted owl populations triggered challenges and debate. That debate prompted the Forest Service to initiate a multiyear planning process that resulted in the Sierra Nevada Framework for Conservation and Collaboration (Sierra Framework), which evolved into the Sierra Nevada Forest Plan Amendment Final Environmental Impact Statement (SNFPA) covering the national forests of the Sierra, Cascades, and Modoc regions. In January 2001, Forest Service announced the SNFPA Record of Decision, describing chosen management options. In January 2004, the SNFPA was amended, reducing livestock-grazing and timber-harvest restrictions and giving the Forest Service greater management discretion.

Numerous watershed groups, private landowners, local conservancies, resource conservation districts, and state and federal programs are engaged in habitat conservation and restoration work on public and private lands throughout the region. The legislatively created Sierra Nevada Conservancy, established in January 2004, is a new collaborator and a potential source of funding for conservation and restoration of habitats for species at risk in the Sierra.

Species at Risk

The Plan development team updated vertebrate and invertebrate species information in the California Natural Diversity Database (CNDDB) during 2004–2005. The following regional summary of numbers of wildlife species, **endemic** species, and **species at risk** is derived from the updated CNDDB.

There are 572 vertebrate species that inhabit the Sierra Nevada and Cascades region at some point in their life cycle, including 293 birds, 135 mammals, 46 reptiles, 37 amphibians, and 61 fish. Of the total vertebrate species that inhabit this region, 83 bird **taxa**, 41 mammalian taxa, 12 reptilian taxa, 23 amphibian taxa, and 31 fish taxa are included on the **Special Animals List**. Of these, 26 are endemic to the Sierra Nevada and Cascades Region, two are endemic to California but introduced in this region, and 26 other species found here are endemic to California but not restricted to this region (Table 13.1).

Table 13.1: State-Endemic Special Status Vertebrates of the Sierra Nevada and Cascades Region

	Ambystoma californiense	California tiger salamander
	Ammospermophilus nelsoni	Nelson's antelope squirrel
+	*Archoplites interruptus*	Sacramento perch
	Batrachoseps campi	Inyo Mountains slender salamander
*	*Batrachoseps diabolicus*	Hell Hollow slender salamander
*	*Batrachoseps kawia*	Sequoia slender salamander
*	*Batrachoseps regius*	Kings River slender salamander
*	*Batrachoseps relictus (=pacificus)*	Relictual slender salamander
	Batrachoseps robustus	Kern Plateau salamander
*	*Batrachoseps simatus*	Kern Canyon slender salamander
*	*Batrachoseps sp. 1*	Breckenridge Mountain slender salamander
*	*Batrachoseps stebbinsi*	Tehachapi slender salamander
*	*Bufo canorus*	Yosemite toad
*	*Catostomus fumeiventris*	Owens sucker
	Charina umbratica	Southern rubber boa
	Cottus asperrimus	Rough sculpin
	Cottus klamathensis macrops	Bigeye marbled sculpin
+	*Cyprinodon nevadensis amargosae*	Amargosa pupfish
*	*Cyprinodon radiosus*	Owens pupfish
*	*Dendragapus obscurus howardi*	Mount Pinos blue grouse
	Diadophis punctatus modestus	San Bernardino ringneck snake
	Dipodomys heermanni dixoni	Merced kangaroo rat
	Dipodomys panamintinus argusensis	Argus Mountains kangaroo rat
	Elgaria (=Gerrhonotus) panamintinus	Panamint alligator lizard
	Ensatina eschscholtzii croceator	Yellow-blotched salamander
*	*Gila bicolor snyderi*	Owens tui chub
*	*Hydromantes brunus*	Limestone salamander
*	*Hydromantes platycephalus*	Mount Lyell salamander
	Hydromantes shastae	Shasta salamander
*	*Hydromantes sp. 1*	Owens Valley web-toed salamander
	Hysterocarpus traski traski	Sacramento-San Joaquin tule perch
	Lavinia symmetricus ssp. 1	San Joaquin roach
*	*Lavinia symmetricus ssp. 3*	Red Hills roach
	Microtus californicus vallicola	Owens Valley vole

	Mylopharodon conocephalus	Hardhead
*	*Oncorhynchus clarki seleniris*	Paiute cutthroat trout
*	*Oncorhynchus mykiss aguabonita*	Volcano Creek golden trout
*	*Oncorhynchus mykiss gilberti*	Kern River rainbow trout
*	*Oncorhynchus mykiss ssp. 2*	McCloud River redband trout
*	*Oncorhynchus mykiss whitei*	Little Kern golden trout
	Onychomys torridus tularensis	Tulare grasshopper mouse
	Perognathus alticolus inexpectatus	Tehachapi pocket mouse
	Perognathus inornatus inornatus	San Joaquin pocket mouse
*	*Perognathus longimembris tularensis*	No common name
	Perognathus parvus xanthonotus	Yellow-eared pocket mouse
	Rhinichthys osculus ssp. 2	Owens speckled dace
*	*Rhinichthys osculus ssp. 5*	Long Valley speckled dace
*	*Sorex lyelli*	Mount Lyell shrew
	Spermophilus mohavensis	Mohave ground squirrel
	Tamias speciosus speciosus	Lodgepole chipmunk
*	*Thomomys bottae operarius*	Owens Lake pocket gopher
*	*Xantusia vigilis sierrae*	Sierra night lizard

* denotes taxon is endemic to region
+ denotes taxon is endemic to California but introduced in this region

The number of arthropod species is so great, and they are so poorly known taxonomically, that it is presently impossible to accurately estimate the total number of invertebrate species occurring in the state. In the Sierra Nevada and Cascades Region, however, 96 invertebrate taxa are included on the Special Animals List, including 68 arthropod taxa and 28 mollusk taxa. Of these, 57 are endemic to the Sierra Nevada and Cascades Region, and 23 other taxa found here are endemic to California but not restricted to this region (Table 13.2).

Table 13.2: State-Endemic Special Status Invertebrates of the Sierra and Cascades Region

*	*Ammonitella yatesi*	Tight coin (=Yates' snail)
	Andrena blennospermatis	Vernal pool bee
	Andrena macswaini	An andrenid bee
	Andrena subapasta	An andrenid bee
*	*Aphrastochthonius grubbsi*	Grubbs' cave pseudoscorpion
*	*Argochrysis lassenae*	Lassen chrysidid wasp
*	*Artemia monica*	Mono brine shrimp
	Atractelmis wawona	Wawona riffle beetle

*	*Banksula californica*	California banksula harvestman
*	*Banksula galilei*	Galile's cave harvestman
*	*Banksula grubbsi*	Grubbs' cave harvestman
*	*Banksula martinorum*	Martins' cave harvestmen
*	*Banksula melones*	Melones Cave harvestman
*	*Banksula rudolphi*	Rudolph's cave harvestman
*	*Banksula tuolumne*	Tuolumne Cave harvestman
*	*Banksula tutankhamen*	King Tut Cave harvestman
	Branchinecta mesovallensis	Midvalley fairy shrimp
*	*Caecidotea sequoiae*	An isopod; no common name
*	*Calasellus longus*	An isopod; no common name
*	*Calicina cloughensis*	Clough Cave harvestman
*	*Calicina conifera*	A harvestman; no common name
*	*Calicina dimorphica*	A harvestman; no common name
*	*Calicina macula*	A harvestman; no common name
*	*Calicina mesaensis*	Table Mountain harvestman
*	*Calicina piedra*	Piedra harvestman
*	*Ceratochrysis gracilis*	A chrysidid wasp; no common name
	Colligyrus convexus	Canary duskysnail
*	*Cryptochia denningi*	Denning's cryptic caddisfly
*	*Cryptochia excella*	Kings Canyon cryptochian caddisfly
	Desmocerus californicus dimorphus	Valley elderberry longhorn beetle
*	*Desmona bethula*	Amphibious caddisfly
*	*Ecclisomyia bilera*	Kings Creek ecclysomyian caddisfly
*	*Euphilotes battoides comstocki*	Comstock's blue butterfly
*	*Euphydryas editha monoensis*	Mono checkerspot butterfly
*	*Euproserpinus euterpe*	Kern primrose sphinx moth
*	*Farula praelonga*	Long-tailed caddisfly
*	*Helminthoglypta allynsmithi*	Merced Canyon shoulderband
*	*Helminthoglypta concolor*	White fir shoulderband
	Hydrochara rickseckeri	Ricksecker's water scavenger beetle
*	*Hydroporus hirsutus*	Wooly hydroporus diving beetle
	Hydroporus leechi	Leech's skyline diving beetle
*	*Hygrotus fontinalis*	Travertine band-thigh diving beetle
*	*Juga occata*	Scalloped juga
	Lanx patelloides	Kneecap lanx
*	*Larca laceyi*	Lacey's cave pseudoscorpion
*	*Lepidostoma ermanae*	Cold Spring caddisfly
	Lepidurus packardi	Vernal pool tadpole shrimp

	Linderiella occidentalis	California linderiella
	Lytta moesta	Moestan blister beetle
	Lytta molesta	Molestan blister beetle
*	*Megaleuctra sierra*	Shirttail Creek stonefly
	Megomphix californicus	Natural Bridge megomphix
	Monadenia churchi	Klamath sideband
*	*Monadenia circumcarinata*	Keeled sideband
*	*Monadenia mormonum buttoni*	Button's Sierra sideband
*	*Monadenia mormonum hirsuta*	Hirsute Sierra sideband
	Monadenia troglodytes	Shasta sideband
*	*Monadenia tuolumneana*	Tuolumne sideband
*	*Monadenia yosemitensis*	Yosemite Mariposa sideband
*	*Nebria darlingtoni*	South Forks ground beetle
*	*Neothremma genella*	Golden-horned caddisfly
*	*Oravelia pege*	Dry Creek cliff strider bug
*	*Orobittacus obscurus*	Gold Rush hanging scorpionfly
	Pacifastacus fortis	Shasta crayfish
*	*Parapsyche extensa*	King's Creek parapsyche caddisfly
	Parnopes borregoensis	Borrego parnopes chrysidid wasp
*	*Philotiella speciosa bohartorum*	Bohart's blue butterfly
*	*Pseudogarypus orpheus*	Music Hall Cave pseudoscorpion
	Punctum hannai	Trinity spot
*	*Pyrgulopsis aardahli*	Benton Valley (=Aahrdahl's) springsnail
	Pyrgulopsis eremica	Smoke Creek pyrg
*	*Pyrgulopsis perturbata*	Fish Slough springsnail
*	*Pyrgulopsis rupinicola*	Sucker Springs pyrg
	Pyrgulopsis wongi	Wong's springsnail
*	*Rhyacophila spinata*	Spiny rhyacophilan caddisfly
*	*Stygobromus gradyi*	Grady's cave amphipod
*	*Stygobromus harai*	Hara's cave amphipod
*	*Stygobromus wengerorum*	Wengerors' cave amphipod
	Talanites moodyae	A gnaphosid spider; no common name
*	*Tetrix sierrana*	Sierra pygmy grasshopper

* denotes taxon is endemic to region

The Wildlife Species Matrix, including data on listing status, habitat association, and population trend for each vertebrate and invertebrate species included on the Special Animals List, is available on the Web at http://www.dfg.ca.gov/habitats/wdp/matrix_search.asp. For vertebrates, the matrix also includes links to species-level range maps. Additionally, a link to the California Department of Fish and Game's online Field Survey Form is available to assist in reporting positive sightings of species on the Special Animals List to the California Natural Diversity Database (CNDDB).

Three Species at Risk

Note: *The following discussion of three species at risk illustrates how stressors or threats affect species and highlights conservation challenges and opportunities. These species discussions are not intended to imply that conservation should have a single-species approach.*

Three species at risk are discussed here to illustrate the effects of stressors in the region on species and the opportunities for conservation. The Sierra willow flycatcher (two of the three subspecies of willow flycatcher) and other species have declined as mountain meadows and riparian habitats have been drained or degraded. The case of the Sierra willow flycatcher illustrates the result of habitat degradation and the challenge ahead to make the land-use changes necessary to restore meadow and riparian ecosystem health and wildlife populations.

The status of the Pacific fisher is one indicator of the status of forest conditions of the Sierra, particularly the old-growth component. The fisher requires specific features of mature forest, such as large trees with cavities for nesting, within a forest mosaic that contains areas of open canopy and layered groundcover supportive of squirrels and other prey species. Conservation of the Pacific fisher is dependent upon the approaches to and success of restoring healthy and diverse forest ecosystems along the Sierra range.

The mountain yellow-legged frog, once abundant in aquatic habitats throughout much of the Sierra, is absent from many areas of its historical range, and several stressors are implicated in its decline.

Sierra Willow Flycatcher


Will Richardson

The willow flycatcher (*Empidonax traillii*) has declined to low numbers and is still declining in the Sierra, where it occurs primarily on federally managed lands (Green et al. 2003). It is designated as endangered by the state. Two subspecies of the willow flycatcher, the little willow flycatcher (*E.t. brewsteri*) and the Great Basin willow flycatcher (*E.t. adastus*), are found in the Sierra Nevada, with combined total numbers estimated between 300 and 400 birds; *brewsteri* is found on the western slope, and *adastus* inhabits the east side. For the purposes of this discussion, these two subspecies are collectively referred to as Sierra willow flycatcher. One estimate is that since 1982, individual male territories of the Sierra willow flycatcher have declined 26 percent (Green et al. 2003). *E.t. brewsteri* was also historically prevalent in the Central Valley but has been **extirpated** there owing to habitat loss and cowbird nest parasitism.

The Sierra willow flycatcher is dependent on riparian thickets and wet mountain meadows skirted with willows and alders. For over a century, the browsing and grazing of vegetation by domestic sheep and cattle, combined with the carving of roads for timber and mining operations and ditches for diversion of water for various uses, have had an effect on the vegetation and caused drying of montane meadows (SNEP 1996, USFS 2001b). Livestock grazing has facilitated the invasion of the cowbird, a brood parasite that causes willow flycatcher nest failure. Cowbirds have a **commensal** association with livestock and have invaded the Sierra in the last 60 to 70 years; in the central Sierra, cowbird brood parasitism has been documented at several sites ranging from 8 percent to 47 percent of willow flycatchers' nests (Green et al. 2003). The drier conditions have led to increased nest predation of willow flycatchers by enabling the encroachment of trees and brush that, in turn, provide perches for predators, including squirrels, chipmunks, hawks, and ravens. Road building, water diversions, and inappropriate grazing continue to occur in some areas of willow flycatcher habitat.

The precarious condition of the Sierra willow flycatcher was highlighted in the Sierra Framework. The U.S. Forest Service described the willow flycatcher as the highest-priority land bird in the Sierra Nevada, because it had the highest probability of being extirpated there. The 2001 Record of Decision declared the intent of the Forest Service to produce a conservation assessment of the willow flycatcher in the Sierra. Completed in March 2003, the Assessment identifies the needs of the willow flycatcher and the urgent need to reduce or curtail land uses that negatively affect riparian and meadow habitats and the need to restore degraded habitats (Blankenship 2004 pers. comm., USFS 2001b).

The causes of the degradation of willow flycatcher habitat are now well-enough understood to enable actions that will contribute to the recovery of the species. The critical status of the willow flycatcher warrants reducing or excluding livestock grazing and other land uses adversely affecting montane meadows and riparian habitat, particularly where there are known flycatcher territories, unless new research can show the land uses have no detrimental effects on the flycatcher and other species (USFS 2001b). The Forest Service Conservation Assessment concludes that "regardless of causes, meadow condition must be improved." The species-recovery benefit of eliminating a stressor of riparian habitat is dramatically exhibited on Lee Vining and Rush creeks, tributaries to Mono Lake. Reestablished flows and restoration work on these creeks, which had dried up due to water diversions to Los Angeles, are credited with the return of willow flycatchers to the creeks (Heath 2004 pers. comm.).

Pacific Fisher

Pacific Biodiversity Institute

The fisher inhabits mountain forests across much of North America. In California, the Pacific subspecies lives in the Klamath region and the Sierra Nevada. Historically, in the Sierra Nevada, the Pacific fisher ranged from Lassen National Forest in the northern Sierra to Sequoia National Forest in the southern Sierra. Today, the only known fisher populations in the region are in the southern Sierra; surveys to date suggest they may be absent from 240 miles of their former range in the Sierra to the north. More surveys are needed to confirm the distribution status of the fisher (Campbell et al. 2000, USFWS 2004e, Zielinski et al. 1995).

The Pacific fisher is long-lived, has low reproductive rates, and occurs in low densities with large home ranges. With these life characteristics, the fisher is vulnerable to extirpation and will be slow to recover when conditions improve. The fisher requires specific habitat features associated with older conifer or hardwood-conifer forests and riparian forests (Campbell et al. 2000). Suitable habitat is well-shaded forest containing small areas of open canopy along with thick vegetative layers mixed with snags and fallen logs. Large-tree forests provide denning and resting habitat and an open canopy areas of herbs and shrubs to support prey of small mammals and birds. Our understanding of the broader home range is less well developed.

The fisher inhabits the lower and mid-elevations of the Sierra. These are also the areas where development pressures are greatest. The apparent extirpation of the fisher from the northern and central Sierra is attributed to the loss of forest complexity, itself attributable to logging of larger trees and older forests, forest management for even-aged forests (including tree farming), removal of fallen logs and snags, fire suppression, and the fragmentation of forest landscapes by roads and residential development (Campbell et al. 2000, USFS 2001b, USFWS 2004e).

Today, the fisher is a rare **species of special concern.** The U.S. Fish and Wildlife Service (USFWS) has been petitioned three times to list the West Coast population of the fisher as endangered or threatened. In 2004, USFWS concluded that listing was warranted. But due to a backlog of other species-listing issues, USFWS recognized Pacific fisher as a candidate species for listing, to be further considered at a later date (USFWS 2004e).

Restoring and managing preferred forest habitats throughout the Sierra are essential to conserve the fisher. Maintaining connectivity of habitats is important to enable the fisher to recolonize the central and northern Sierra from the fisher populations in the south. Conservation of the fisher also necessitates protecting and restoring the black oak woodlands component of mixed-conifer forest ecosystems, conserving large deformed trees, and reestablishing patches of lush layered ground vegetation, snags, and fallen logs to provide conditions for abundant prey.

The SNFPA highlighted the precarious status of the Pacific fisher in the Sierra, selecting it as a focal species for special protection as part of its old-forest ecosystems and associated species conservation strategy (USFS 2001b).

Mountain Yellow-Legged Frog

William Flaxington

The mountain yellow-legged frog exists in two regions of the state, in the higher elevations of the Sierra and in the mountains of Southern California. Few frogs exist today where they were once common in the San Gabriel and San Jacinto mountains. In 2002, the Southern California population of mountain yellow-legged frog was federally listed as endangered. The mountain yellow-legged frog was widespread throughout the Sierra range above 4,500 feet and abundant in some areas, in lakes and slow-moving streams, until the 1960s (USFS 2001b). In the early 1990s, field studies found that mountain yellow-legged frog numbers had dramatically declined and were absent from more than 80 percent of their historical range. The mountain yellow-legged frog in the Sierra is a state and federal species of concern and a candidate for listing under the federal Endangered Species Act.

The mountain yellow-legged frog is a highly aquatic frog, found in lakes and larger streams. It seeks warmer nearshore areas for cover and reproduction during the short summer season and overwinters in deep lake waters and in deep crevices near shore. It moves short distances over land between aquatic habitats. The Sierra mountain yellow-legged frog evolved in historically fishless habitats and is very vulnerable to predation by introduced trout, because in higher elevations it has a multiple-year tadpole stage (Knapp 1996, Knapp and Mathews 2000). One study found that while the tadpole has a prey response to native predatory snakes, it shows no such response to predatory non-native fish.

The introduction of predatory non-native trout over the last 100 years is considered the primary cause of decline of the mountain yellow-legged frog in the Sierra. Exposure to pesticides from upwind agricultural applications and chytrid fungal infection are also considered contributing factors to their decline.

Field studies have found frogs to be extirpated from most lakes where trout exist. However, the frog has rapidly repopulated lakes following the removal of trout (Milliron 1999, 2005, Milliron et al. 2004). Fish and Game and the Pacific Southwest Research Station of the Forest Service have conducted extensive field surveys of trout and frogs throughout the high Sierra in recent years. The field studies identified sub-basins protected by natural trout barriers, such as waterfalls, where frogs are likely to recover and thrive after the removal of trout. Based on this work, Fish and Game has developed basin plans to restore mountain yellow-legged frogs and other aquatic species while maintaining quality trout fishing opportunities at selected lakes. (Basin plans have been prepared for the southern Sierra; the central and northern Sierra basin plans are not yet prepared).

While further studies are needed to understand all the significant stressors affecting native amphibians and other aquatic species in the Sierra, immediate restoration of mountain yellow-legged frog populations appears feasible through the establishment of trout-free sub-basins across the high Sierra.

Stressors Affecting Wildlife and Habitats

Stressors Affecting Upland Habitats

- Growth and land development
- Forest management conflicts
- Altered fire regimes
- Excessive livestock grazing
- Invasive plants
- Recreational pressures
- Climate change

Stressors Affecting Aquatic and Riparian Habitats

- Water diversions and dams
- Watershed fragmentation and fish barriers
- Hydropower project operations
- Excessive livestock grazing
- Water diversion from the Owens Valley
- Introduced non-native fish

Stressors Affecting Upland Habitats

Growth and Land Development

The Sierra Nevada underwent population growth of 130 percent between 1970 and 1990, compared to the state's average of 49 percent growth over the same period, and growth in the region is expected to continue at a pace exceeding the state average, adding about 175,000 new residents every decade (Duane 1998, SNEP 1996).

The greatest growth and development have occurred in the mostly privately owned western foothills, particularly in the watersheds of the Yuba, American, and San Joaquin rivers, in the Lake Tahoe Basin, and around Lake Almanor. Development pressure is strong in the foothills adjacent to the metropolitan centers of Redding, Sacramento, Stockton, Merced, Fresno, and Bakersfield, particularly along the foothill river corridors near these cities. (See Fig. 13.1, Development Along Highway Corridors.) On the Sierra Nevada's east side, growth pressure is greatest between Reno and Susanville and near Bishop.

Ranchette and residential communities are expanding from metropolitan areas of Reno and Redding along highways 395, 299, and 44 along the eastern foothills and across the northern Sierra and Cascades (Laudenslayer 2004 pers. comm., Rickman 2004 pers. comm.). New development along these highway corridors is displacing wildlife habitat and creating barriers in important wildlife migration areas. For example, development along Highway 395 south of Susanville hinders the seasonal migration of deer across the Bass Hill Wildlife Area. Key wildlife corridors in the region are crossed by highways. Highway 299 descends the Cascades between Mount Lassen and Mount Shasta and winds northeast across the Modoc Plateau (Penrod et al. 2000). As development expands on the private lands adjacent to Highway 299, migrating mule deer, elk, and antelope will be less able to move between seasonal ranges. Without conservation planning, future development along these corridors will likely have a significant impact on the region's wildlife.

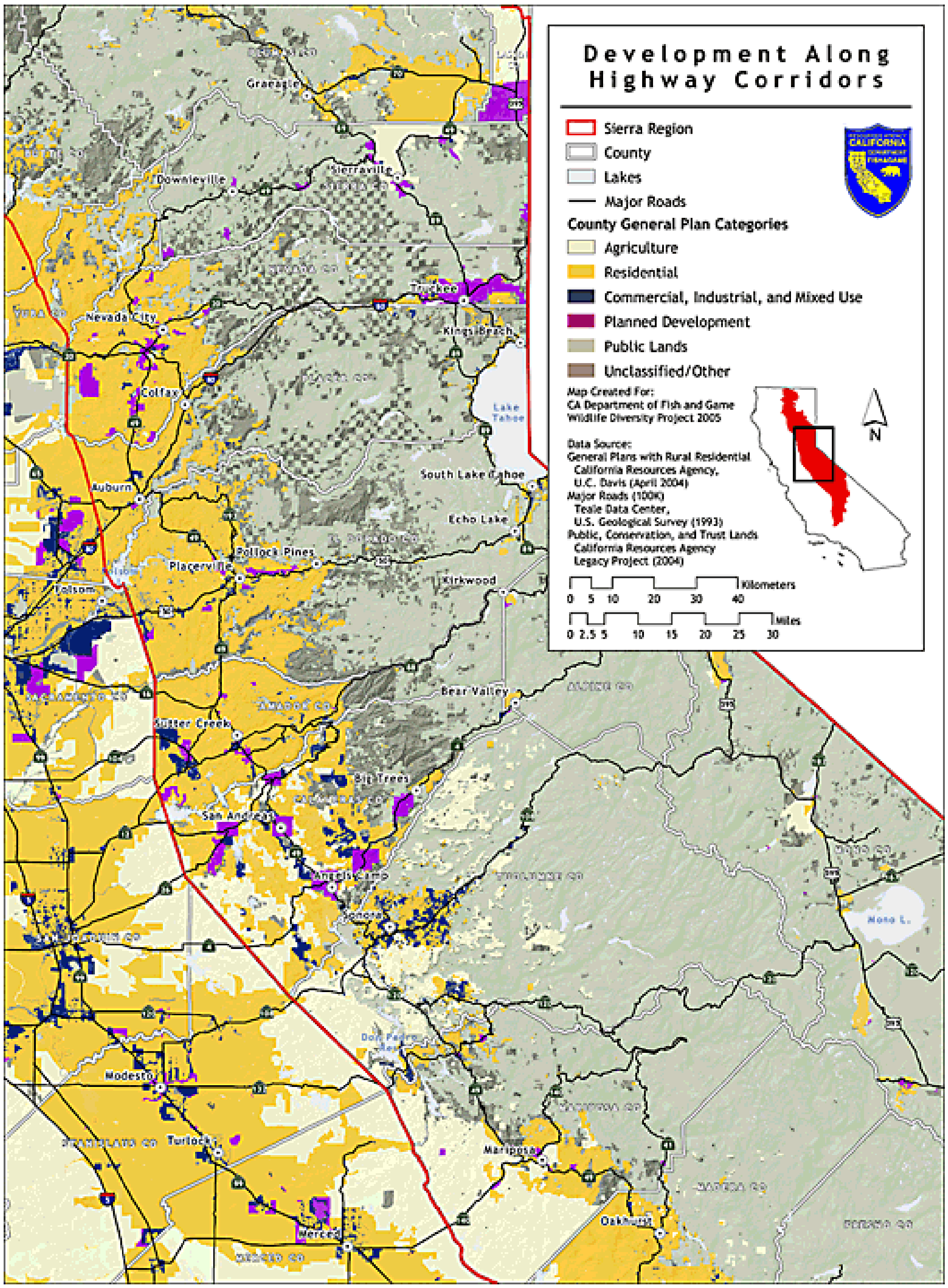


Fig. 13.1: Development Along Highway Corridors
Development pressure in the Sierra Nevada is anticipated to be particularly strong along highway corridors extending from urban centers in the Central Valley.

In the Sierra and Cascades, development is also expanding into the forest. New golf courses, scattered single-family homes, commercial properties, ski resorts, industrial sites, and new roads are replacing and fragmenting wildlife habitat. Where development occurs, fire is suppressed, preventing regeneration of fire-dependent vegetation and altering plant communities. Development also requires new water diversions and creates new sources of pollution. Mountain meadows, oak woodlands, and riparian streams are places of high wildlife diversity, and they are also preferred sites for development.

As seasons change, the survival of many mammal, bird, and fish species depends on their ability to migrate between higher and lower elevations in both the Sierra and Cascades. But opportunities to migrate successfully have been compromised by dams, reservoirs, highways, altered stream flows, residential community development, and predation by free-roaming domestic pets.

For 150 years, the west-slope foothills have been the most seriously affected area of the Sierra, with cattle ranching having the greatest presence. Western foothill development has fragmented riparian corridors and other habitats (Kattelman 2000). Much of the development on the western slope of the Sierra has degraded oak woodlands, lower mixed conifer forests, and similar habitats that support more wildlife diversity than other plant communities of the region. More than 350 species of birds, mammals, reptiles, and amphibians inhabit the oak woodlands (CalPIF 2002). The Sierra Nevada Ecosystem Project documented that 85 terrestrial vertebrate species require west-slope foothill savanna, woodland, chaparral, or riparian habitats to retain population viability, and 14 of these species are at risk of extinction.

Many early homestead settlements in the high Sierra clustered in level areas close to water, areas that are also particularly important for wildlife habitats, including meadows and along rivers and streams. While most higher-mountain habitats are public lands managed by federal agencies, these older settled areas remain largely in private ownership. Today, these private lands, surrounded by national forests, are prized for development.

Development in the Sierra over the last three decades has been primarily via incremental single-home and small commercial development, lacking the benefit of regional conservation planning. Low-density development has been the norm. Such development has resulted in greater fragmentation of the landscape and its corresponding negative consequences for wildlife. In many locations throughout the foothills, larger land holdings are being broken up into smaller parcels for single homes. In other areas, mountain meadows and pastures are being converted to golf courses and residential communities.

Development also exacerbates existing stresses on wildlife and habitats. **Invasive** plant species are often introduced along new roads and with new landscaping. Invasive species outcompete native species in development-disturbed lands. Additional domestic water use further reduces water available for aquatic ecosystems.

Growth has also increased the need to suppress fire, thereby expanding the conflict with efforts to restore more natural fire regimes in these fire-adapted ecosystems. Adding residents to the region will likely result in more citizen resistance to prescribed fire and more objections to the smoke it generates.

The severity of future development's effects on species at risk will depend on whether conservation planning is embraced and if growth allowed by counties is designed to account for fire, to protect ecosystems, and to minimize further fragmentation of habitats.

Forest Management Conflicts

[This discussion applies to the forests of the Sierra Nevada and Cascades Region and the Modoc Plateau Region.]

Using narrative descriptions by explorers and pioneers of the 1800s, in conjunction with the requirements of native forest species and what is known of land use activities over the past 150 years, scientists have developed descriptions of forests as they were before Euro-American settlement. The forests were a mosaic of stands of conifer trees with an understory of herbaceous plants and shrubs, open meadows, aspen stands, and riparian plant communities. Mixed conifer forests were patchy, with stands of trees in all stages of development, from recently burned areas yielding young saplings among shrubs and herbaceous vegetation to mature forests of scattered large trees several centuries old. Stands of middle-aged and older trees were broken up by natural disturbances like fire, disease, or avalanche, leaving areas of fallen trees where understory vegetation was abundant.

Wildlife species evolved to make use of the diverse forest landscape. Some species use the older tree stands for nesting or resting but require forage in the more open areas of the forest mosaic, where the herbaceous vegetation supports prey species. For example, raptors such as the northern goshawk and the California spotted owl nest in mature forests but hunt for prey in open areas near their nest sites. Fisher and marten select older trees for den sites, but some of their prey are more abundant where the tree canopy is open, fallen logs are common, and shrubs and herbs carpet the ground. Aspen stands dispersed along streams and meadows provide habitat for many mammals, birds, reptiles, and amphibians. Mule deer use the cover in which to hide, and songbirds often use nest sites provided by the shrubs and trees of aspen stands.

For the last century, forest management practices have adversely affected wildlife and plant communities of the Sierra Nevada, Cascades, and the Modoc Plateau regions. The cumulative effects of even-aged timber-harvest practices, elimination of older trees, snags and brush, logging-road construction, and fire suppression have changed forest plant communities. While some of these stressors have been reduced in recent years, they all continue to affect the forests' ecosystems and wildlife.

The SNEP project found that old-forest conditions (old-growth and late-seral forest) exist on 17 percent of national forest lands and on 47 percent of national park lands. On national forest lands outside of wilderness areas, remaining old-growth forest is likely less than 8 percent (Franklin and Fites-Kaufman 1996, USFS 2001b). Old-forest conditions exist primarily as small patches. Large areas of old forest are uncommon in national forests, and only remnant areas of old-forest conditions exist on private lands. Fire-tolerant old forests, often with open canopies, have been replaced by dense, even-aged forests that lack diverse wildlife habitat features and are prone to devastating wildfires.

Maintaining diverse wildlife requires forests that contain, in adequate distribution, all sizes and ages of trees, areas of open and closed canopies, and a varied landscape shaped by natural disturbance. Conserving biological diversity also requires maintaining connections between diverse habitats, ecosystem functions (e.g., energy cycling, food webs, and fire regimes), and the integrity of aquatic ecosystems (Franklin 2005 pers. comm., Lindenmayer and Franklin 2002, Moyle 1996a, Rickman 2004 pers. comm., Smith 2001). Protecting the remnant stands of old-growth and late-seral forests and generally conserving older, larger trees are important components of maintaining forest diversity in the Sierra, Cascades, and Modoc regions. Nevertheless, the harvesting of large trees continues.

Much of the Sierra Nevada, Cascades, and Modoc mixed-conifer forests needs to be thinned to restore complex forest structure, improve conditions for wildlife, and reduce the risk of catastrophic fires (Rickman 2004 pers. comm., Smith 2001). The design of forest thinning projects requires input from wildlife biologists and forest ecologists to ensure that the forest treatments contribute to wildlife habitat restoration.

Tremendous volumes of small and medium trees must be harvested over the next several decades to appropriately thin Sierra, Cascades, and Modoc forests. Currently, California does not have adequate wood-product processing infrastructure to handle these volumes of timber.

Thus, the economic feasibility of thinning forests is dependent on development of new forest products and processing facilities.

In addition to treatments of forest stands, regeneration practices following timber harvests or fire are very important in shaping the future forest structure. While timber harvest strategies on public lands are beginning to incorporate wildlife and habitat needs, regeneration practices have generally not made similar changes (Franklin 2005 pers. comm.). In some national forests, regeneration treatments clear shrubs and herbaceous vegetation to promote growth of tree species (Britting 2004 pers. comm., Buckley 2005 pers. comm.). Yet shrubs and herbaceous vegetation are particularly important for wildlife. These kinds of post-harvest treatments are more common on private forest lands. The National Forest Management Act and federal regulations prescribe the method and speed of reestablishing the next generation of trees on federal lands (Tappeiner and McDonald 1996). State Forest Practice Rules have similar prescriptions for private forest lands. These regeneration prescriptions are generally designed to enhance timber production and do not generally support regeneration practices specifically to benefit wildlife and restore diverse native plant communities. For example, if a land owner wishes to restore aspen stands following the removal of conifers, to do so may be in conflict with regeneration rules.

The rules governing forest management decisions, and the processes for arriving at those decisions, are different depending on the forest jurisdiction. Within the Sierra-Cascades and Modoc Plateau regions, the U.S. Forest Service manages the 11 national forests, the National Park Service manages forested national park lands, and BLM manages a very limited area of forested lands in the northern Sierra and Modoc regions. Timber harvest on private lands is governed by State Forest Practice Rules, and timber harvest plans are reviewed and approved by the State Board of Forestry.

Altered Fire Regimes

Most of California's forest ecosystems have evolved with recurring fire, and each plant community of the Sierra and Cascades has evolved with some range of frequency of wildfire. The plant communities, topography, elevation, and climatic conditions influence the "fire regime," the frequency and intensity of fire for a specific plant community (McKelvey et al. 1996). In turn, the extent and intensity of fire influence ecological processes, shape plant communities, and affect wildlife.

Declining Aspen

Quaking aspen are scattered across the Sierra Nevada, the southern Cascades, and the Warner Mountains of the Modoc National Forest, usually in stands of fewer than five acres and usually adjacent to streams, springs, lake shores, and meadows. Aspen is found within a wide range of elevation in the Sierra, from the lower elevations of western juniper on the east side to higher zones of fir and lodgepole pine, generally along creeks or meadows. Like other riparian communities, aspen communities comprise only a small portion of the landscape but provide habitat for many species. The multilayered herbaceous vegetation and shrubs that thrive beneath aspen canopy provide nesting, denning, and foraging habitat for insects, birds, amphibians, and mammals. The fruits produced by this diverse plant life and the insects that are abundant in the moist aspen environment provide food for a wide variety of birds. Northern goshawks, owls, and other raptors rest in the upper canopy and hunt adjacent habitats. Cavity-nesting songbirds make use of all layers of the canopy and brush of aspen stands. Large mammals also use aspen stands. Deer forage and hide in the layers of vegetation; black bears forage on the berry bushes. Rabbits, voles, and other small animals thrive here, too (Burton 2002, Loft et al. 1987, Romsos 2000).

Across the West, including in the Sierra Nevada and Modoc Plateau, aspen are in decline. Heavy livestock grazing, reduced fire frequency, historically high numbers of foraging deer in the 1950s and 1960s, the drying of meadows, and conifer encroachment have all contributed to the decline of aspen stands. Less-frequent fire over the past century has limited the regeneration of aspen trees. Aspen regenerate primarily by clonal production of suckers. Fire reduces conifer encroachment, opens up the canopy, removes shrub cover, and stimulates sucker release. Historic grazing consumed vegetation around aspen stands, reducing fuel available for fire. Also, under conditions of moderate-to-heavy livestock grazing, both livestock and wildlife graze more heavily on vegetation in aspen stands, including any emerging aspen shoots. The soil water tapped by conifers has contributed to the drying of meadows, reducing water available for aspen. Pine and fir trees eventually tower over the aspen stands, shading them from sunlight.

The U.S. Forest Service and Fish and Game have launched programs to inventory, restore, and conserve aspen plant communities. Aspen conservation efforts involve prescribed fire, removal of encroaching conifers, and restoration of meadow and riparian wet conditions.

A continuum of fire regimes has evolved in the various forest types. For example, historically, ponderosa pine-dominated mixed conifer forests of the Sierra had a fire regime of frequent, low- to moderate-intensity fires. Before fire suppression, such a fire regime along with other conditions maintained a plant community of large, well-spaced trees. At higher elevations, lodgepole pine communities evolved with less-frequent but more-severe fires (McKelvey et al. 1996). Wildfire is such an influential ecological element that the regeneration of some plant communities and the survival of many plant species require fire (Kilgore 1973). Coupled with selective harvest of large trees, road building, and intensive grazing, suppression of fire over the last 100 years has affected fire frequency and intensity and thus dramatically reshaped forest structure and altered ecosystems throughout the region.

In the early 1900s, the nature and role of wildfire was not understood and was generally viewed as damaging to forests. As a result, state and national policy for the last century has been to aggressively suppress forest fires and to put them out quickly, minimizing fire on the landscape of the West (van Wagtendonk 1995). The Forest Service's "Smokey Bear" campaign was highly successful, training generations of Americans that wildfire was synonymous with waste and destruction and that it was everyone's duty to prevent forest fires (Dombeck et al. 2004, Kaufman 2004).

To restore native plant communities, forest ecologists generally agree that fire needs to be returned to forests at intervals consistent with historical fire regimes. But a century of fire suppression has created an enormous backlog of forest acreage with dense tree stands and high fuel loads (Husari and McKelvey 1996). The 1964 federal Wilderness Act recognized the ecological role of fire and established a policy allowing natural fires to burn in national parks. The National Park Service has implemented prescribed fires for many years. However, most of the forests needing fire are lower in elevation than most of the wilderness areas. In 1971, Forest Service policy was amended to allow prescribed fires on national forest lands, as well (Caprio and Swetnam 1993, Chang 1996, Kilgore 1973, Skinner and Chang 1996). The results of prescribed fires in the Sierra have shown excellent ecological benefits (Keifer et al. 2000). Yet, while prescribed fire is considered a necessary tool to restore ecosystems and reduce the risk of catastrophic wildfire, and its use is increasing, it is currently applied to very few forested acres of the Sierra.

Returning fire to the forests presents great challenges. The fire threat to people and expanding communities in the forests, excessive fuel loads created by fire suppression and past forest management practices, effects on air quality and conflicts with clean-air laws, and liability all impose difficult constraints on the increased use of prescribed fire and allowing natural fires to burn. Even with the best efforts to reduce fire conflicts and risks, in many areas, reintroducing fire will not be practical or politically possible, at least as a first treatment. Certainly in some locations, selective timber harvest may have to serve as the surrogate for natural fire to begin the process of restoring ecological diversity to forests. Mechanical thinning, however, will not provide all of fire's ecological benefits.

Excessive Livestock Grazing

The effects of grazing on wildlife vary from beneficial to detrimental, depending upon how grazing is managed, including the seasonality and duration of grazing and the type and number of livestock. These effects also depend on the relative sensitivities of individual wildlife species, since not all species respond the same way to grazing. Well-managed livestock grazing can benefit sensitive plant and animal species, particularly by controlling annual grasses and invasive plants where these have become established. These working lands are an essential part of the solution to conserving the state's wildlife.

While recognizing the values of appropriate grazing practices, this plan is required to focus on stressors affecting wildlife species at risk. Thus, the following discussion describes those situations where excessive grazing practices stress those species. Excessive grazing, as used here, refers to livestock grazing at a frequency or intensity that causes degradation of native plant communities, reduces habitat values for native wildlife species, degrades aquatic or other ecosystems, or impairs ecosystem functions. (The term "overgrazing" has a different meaning; it is usually used in referring to the productivity of the forage crop and range condition).

Over the past 150 years, grazing on forests, shrublands, and grasslands of the Sierra Nevada, the southern Cascades, and Modoc Plateau has been characterized as excessive and unsustainable, destroying native vegetation and degrading meadows and streams (Menke et al. 1996). At one time, millions of sheep and cattle grazed throughout the Sierra, Cascades, and Modoc forests, on private and public lands of oak woodlands of the western foothills to high mountain meadows and the east-side high-desert slopes. Sheep and cattle grazing were unregulated on public lands until after the establishment of the Forest Service in 1905, and livestock numbers continued to exceed sustainable levels and reduce forage quality as late as the 1960s. On the western foothills and on higher forest lands, shrubs were often cleared with fire or herbicides to expand rangelands or to respond to brush encroachment on overgrazed lands (Burcham 1982, Menke et al. 1996).

Today, livestock numbers have been lowered to levels that are more sustainable for forage for livestock production (Kondolf et al. 1996, Menke et al. 1996). However, grazing continues to have negative consequences for forage, cover, and nest sites for dozens of wildlife species throughout much of the Sierra and Cascades Region. Plant communities and ecosystems that are particularly important for sustaining wildlife diversity, including riparian, aspen, meadow, aquatic, and oak woodland habitats, continue to be subject to livestock grazing.

The 1996 Sierra Nevada Ecosystem Project (SNEP) found that "over-grazing in mountain meadows is a threat to many rare species that are restricted to these habitats." Sierra and Cascades high mountain meadows and plant communities evolved without the kind of grazing pressure caused by livestock. Yet, as described by the Forest Service, "the riparian and meadow systems are the key livestock forage areas within allotments above 4,000-foot elevations. Studies have shown that 50 percent to 80 percent of the herbage used comes from these meadow systems, which constitute a small percentage (generally less than 5 percent) of the allotment area. In the Sierra Nevada forests, the meadow systems cover an estimated 2 percent of the allotment areas" (USFS 2001b).

The SNEP and the SNFPA also found that aquatic and riparian habitats are particularly affected by livestock grazing. Cattle are attracted to the lush forage, water, and shade of riparian habitat. In late summer and fall, especially when upland habitats have dried out, cattle can decimate riparian plant communities, grazing and trampling meadows, converting meandering meadow streams into eroded channels, and stripping forage and cover needed by wildlife. The erosion increases sediment runoff, degrading aquatic ecosystems.

Livestock grazing is affecting the composition of plant communities important for wildlife diversity. Where livestock grazing is excessive, forage often becomes scarce, and both livestock and deer consume young aspen shoots, hindering the regeneration of aspen stands. Excessive grazing is a factor in reducing the regeneration of blue oak and many other plant species throughout the predominantly privately owned foothill region (McCreary 2001, Mitchell 2005 pers. comm.). Livestock compact soils and remove leaf litter, making conditions less than optimal for germination of acorns and new growth. Livestock also consume acorns and young oak saplings.

Several aquatic, riparian, and meadow-dependent species are at risk in the Sierra region (USFS 2001b). Half of the occupied willow flycatcher nest sites in meadow and riparian areas in the Sierra Nevada continue to be grazed by cattle or sheep. Wet meadow and stream areas for the Yosemite toad, a species of special concern, are also grazed (USFS 2004b). The SNEP project concluded that "livestock grazing has been implicated in plant compositional and structural changes in foothill community types, meadows, and riparian systems, and grazing is the primary negative factor affecting the viability of native Sierran land bird populations" (SNEP 1996).

Livestock grazing also negatively affects native species by transmitting diseases to wild animals. *Pastuerella*, a bacteria transmitted from domestic sheep, has had a devastating effect on bighorn sheep in the Sierra, Cascades, and Modoc regions. Efforts to reintroduce bighorn sheep to the Lava Beds National Monument and the Warner Mountains have failed as a result of disease transmission (Bleich et al. 1996, NCBSIAG 1991).

For the last decade, a major multiagency effort has implemented a recovery program for the Sierra Nevada bighorn sheep. Currently, there are 300–350 bighorn sheep in seven herds along the steep terrain of the eastern Sierra. The greatest threat to the survival of these endangered bighorn sheep is domestic sheep grazing nearby on public and private lands. (See Fig. 13.2, showing proximity of bighorn sheep to domestic sheep.) The domestic sheep are still permitted to graze on allotments within the range of the wild bighorn sheep. If the California bighorn are exposed to these domestic sheep, pastuerellosis could wipe out the contacted wild sheep population within a few weeks (Boyce 2005 pers. comm.).

Invasive Plants

Invasive plants have transformed plant communities and contributed to the decline of native species in ecosystems of the Sierra and Cascades. Foothill oak woodlands and riparian plant communities, so important for maintaining wildlife diversity, have been particularly affected by invasions of exotic grasses and shrubs. High desert shrublands on the Sierra and Cascades' east side have also been altered by invasive grasses. Sub-alpine and alpine plant communities, however, are relatively intact, with few invasive plants (Schwartz et al. 1996).

The understory of foothill woodlands of blue oak, interior live oak, valley oak, and gray pine are now dominated by wild oats, fescue, cheatgrass, and other invasive non-native grasses. Scotch broom and yellow starthistle have also degraded the Sierra Nevada and Cascades foothills (Bossard et al. 2000, DiTomaso and Gerlach 2000). Both weed species displace native species and are toxic to grazing wildlife. Saltcedar, Russian olive, giant reed, eucalyptus, and English ivy are among the invasive plants that have intruded into low- and mid-elevation riparian habitats. On the east side of the Sierra and Cascades, the combined effects of invasive cheatgrass, which outcompetes native perennial and annual grasses, and livestock grazing have contributed to changes in fire regimes and transformed desert scrub and grassland communities.

Generally, invasive plants that replace native plants degrade habitat quality for native species. Some wildlife species are dependent on specific native plants. Other animal species become stressed when the invasive plants offer inferior nutrition or nesting or prey habitat.

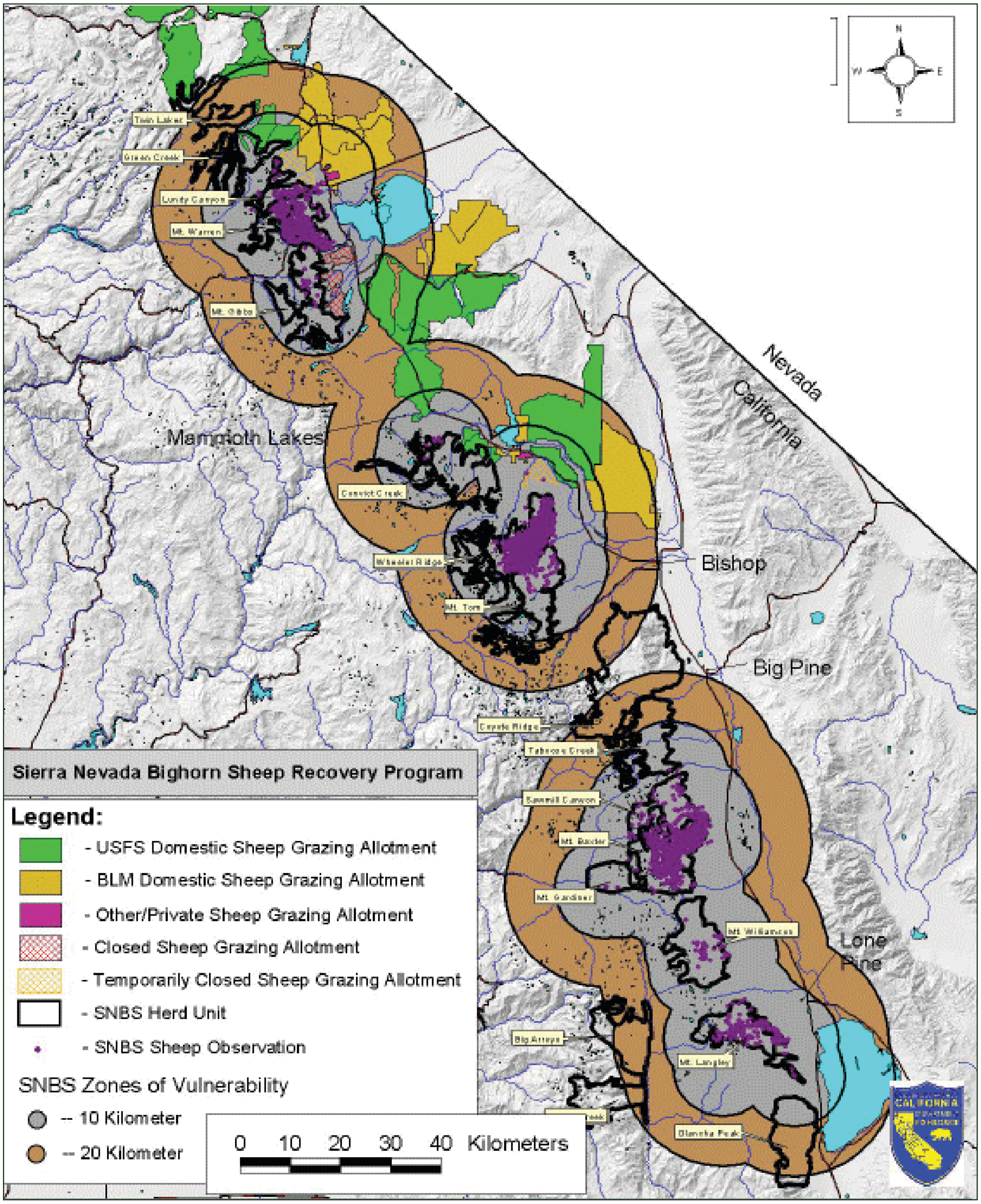


Fig 13.2: Sierra Nevada Bighorn Sheep Recovery Program

Sheep grazing allotments overlap the ranges of endangered Sierra Nevada bighorn sheep, potentially exposing the bighorn sheep to a deadly disease that is transmitted from domestic sheep. (Locations as of May 2005.)

In some areas, invasive annual grasses make for greater fuel loads compared to native vegetation, which increases the intensity of fires and causes further ecological changes.

Recreational Pressures

The mountains and wildlands of the Sierra and Cascades are very popular recreation destinations. National parks, wilderness areas, and wildlife areas provide recreational opportunities while also providing greater protection for wildlife. The public develops a better understanding and appreciation for wildlife by visiting these natural areas.

Recreational activities are diverse, from traditional ones like fishing, hiking, and backpacking to those requiring more infrastructure and visitor services, such as fixed camps, ski resorts, golf courses, and off-road vehicle areas. Some types of recreation have grown significantly in the last few decades, such as mountain biking and off-road vehicle use; the numbers of off-road vehicle users have risen several-fold over the past 30 years.

Accordingly, the effects of recreation on wildlife and ecosystems are diverse and are increasing in many areas. Ski-resort runs and infrastructure crisscross steep mountains, and golf courses have replaced some mountain meadows. Vegetation is removed and soils are eroded along creeks in popular camping areas, and more land is cleared for recreation infrastructure. Recreation technologies, such as all-terrain vehicles, snowmobiles, and lighter, warmer, and waterproof camping gear and clothing, have allowed people to drive, mountain bike, ski, camp, and hunt in wild areas that years ago were natural refuges, too remote to be affected by recreation activities.

Recreation has consequences for soils, vegetation, wildlife, and aquatic resources. Soils become compacted or eroded, and habitat is cleared in areas that are heavily used by motorized vehicles, packhorses, and campers. A number of recreation activities inadvertently cause nest- or den abandonment, displace wildlife from important foraging or watering sites, and interfere with migratory corridors (Leung and Marion 2000).

Providing more recreational opportunities while protecting wildlife habitats and aquatic ecosystems requires that sufficient resources be devoted to planning, management, and enforcement. Federal and state land agencies construct parking lots and restrooms, establish information kiosks, build and sign roads and trails, and manage garbage and sewage to accommodate recreational visitors. And there is an increased need for wildlife agencies to provide wildlife education to keep visitors safe and minimize their effects on species at risk.

Climate Change

While climate change will undoubtedly affect all regions of the state, the consequences for vegetation, wildlife, and water resources will likely be most dramatic in the Sierra Nevada. Depending on the model and assumptions, scientists project the average annual temperature in California to rise between 4 and 10.5 degrees F above the current average temperature by the end of the century (Hayhoe et al. 2004, Schneider and Kuntz-Duriseti 2002, Turman 2002). Within 50 years, average wintertime temperatures are expected to rise between 2 and 2.5 degrees. A rise in this range would substantially reduce annual snowpack and increase fire frequency and intensity. By mid-century, the Sierra snowpack could be reduced by 25 percent to 40 percent and by as much as 70 percent at the end of the century (duVair 2003). Snow season would be shortened, starting later and melting sooner, while fire season would be longer and hotter. The reduction of snowpack and more extreme fire conditions would have cascading effects on water resources, plant communities, and wildlife.

The average annual Sierra snowpack is roughly equal to half the storage capacity of the state's reservoirs, holding water until the melt in late spring and early summer. Rising temperature would reduce the total snowpack and melt it earlier in the year, further shifting stream- and river flow regimes throughout the Sierra (Stewart et al 2004, Vanrheenen et al. 2004). As the runoff comes earlier, spring and summer stream flow is projected to decline by 10 percent to 25 percent by 2050 and decline by potentially as much as 40 percent to 55 percent by the end of the century (duVair 2003). The changing flow regimes will alter riparian and aquatic ecosystems. Streams may be reshaped by different timing and intensity of flood conditions, while some perennial streams may dry up and transition to ephemeral streams no longer supportive of many aquatic species (Turman 2002). One strategy to alleviate these effects would rely on maintaining and restoring healthy mountain meadows, which act like sponges and would help to hold water later into the dry season.

Average annual temperature is a key element that determines plant communities found across the elevation gradient of the Sierra Nevada and Cascades. As temperature rises, alpine and sub-alpine plant communities will shrink as mixed conifer forest expands higher in the range. Alpine and sub-alpine plant communities may decline by 40 percent to 50 percent by mid-century. Oak woodlands may move higher, replacing pine and fir forest. At the lower elevations, the longer, warmer dry season could lead to increased fire frequency, likely converting some shrub communities to grasslands (du Vair 2003, Turman 2002). The expected changes in fire regimes will likely alter the abundance and distribution of plant communities, affecting habitats for wildlife (McKenzie et al. 2004, Miller and Urban 1999).

As climate change shifts annual average temperatures along the elevation gradient, as fire reshapes plant communities, and as stream flow regimes change, habitats and wildlife populations will be substantially affected. So far, very little research has evaluated the consequences of projected climate change on species at risk in the Sierra and Cascades.

Stressors Affecting Aquatic and Riparian Habitats

The Sierra Nevada Ecosystem Project and the Sierra Framework highlighted aquatic and riparian ecosystems as vital to the sustenance of wildlife diversity. Aquatic and riparian ecosystems provide diverse and rich habitats for wildlife in the Sierra and Cascades (Moyle 1996a). There are 67 aquatic habitat types in the region. Major riparian habitats include valley foothill riparian, montane riparian, wetland meadow, and aspen. Numerous invertebrate and vertebrate species are associated with these moist habitats. Other wildlife species, including some raptors and numerous songbirds, live in drier plant communities and rely on nearby aquatic and riparian habitats for hunting, foraging, cover, and resting.

SNEP concluded that aquatic and riparian systems are the most altered and impaired habitats of the Sierra. Of the 67 aquatic habitat types, nearly two-thirds are in decline. Ecosystem functions have been disrupted in thousands of riparian areas, particularly in mountain meadows (Kattelman and Embury 1996). Riparian corridors are fragmented, and more than 600 miles of river habitat have been submerged under reservoirs.

Deterioration of the aquatic and riparian habitats has contributed to the decline of native fish and amphibians. Wildlife species that depend on these habitats, including the Sierra willow flycatcher, foothill- and mountain yellow-legged frog, California red-legged frog, Cascade frog, Northern leopard frog, and Yosemite toad, are at risk of extinction (USFS 2001). In the Sierra, of the 83 terrestrial species dependent on riparian habitat, 24 percent are at risk (Graber 1996). Aquatic insects and other invertebrates, important prey for fish and amphibians, have also been affected by habitat changes. Six of the 40 native fish of the Sierra are listed as threatened or endangered. Only half of the 40 species have secure populations (Moyle et al. 1996). Among the fish species at risk in the region are several of California's native trout, including the Little Kern golden trout and Lahontan and Paiute cutthroat trout. Half of the 29 native amphibian populations of the region are at risk of extinction (Jennings 1996).

Multiple stressors have negatively affected rivers, streams, and wet meadows in the region. Dams and water diversions throughout the region have profoundly altered stream-flow patterns, increased water temperatures, and degraded aquatic ecosystems. Dams and reservoirs have also blocked animal migration routes. Livestock grazing, eroding forest roads, timber harvest activities, development, and recreational activities have also contributed to the fragmentation of riparian habitats, caused bank erosion, and increased sediment and nutrient runoff into aquatic ecosystems. (See Fig. 13.3).

Water Diversions and Dams

Among the 24 major river systems of the Sierra and Cascades, all but a few rivers have multiple dams or diversions. Flows are managed for hydropower generation, for water for irrigation and domestic uses, and for flood control (DWR 1998). A few small dams were developed and are still maintained for instream flow protection and management downstream, and/or for wet meadow habitat maintenance. Others were constructed by fisheries managers to provide barriers between sensitive native fish populations and introduced fishes with capability to interbreed or prey upon the native species. The unnatural managed flows disrupt and degrade aquatic and riparian ecosystems. Below dams, river flows are ramped up and down and water temperatures are changed, often creating lethal conditions for aquatic species. Dams and diversions of the rivers that flow into the Sacramento and San Joaquin drainages have been particularly detrimental to **anadromous** chinook salmon, steelhead trout, and Pacific lamprey. Each of these species historically spawned in Sierra mountain rivers and streams, their young swimming to the sea and returning a few years later as adult fish to spawn. The construction of dams and water diversions blocked fish passage, causing dramatic declines in salmon and steelhead populations of the Sacramento and San Joaquin drainages. Fewer anadromous fish also means fewer eggs, young fish, and fish carcasses that provide nutrients for numerous other aquatic species. Historically, 1 million to 3 million chinook salmon spawned each year in the western Sierra. Today, dams block salmon access to upstream spawning habitat in all but a few creeks. Late fall, winter, and spring runs of salmon have collapsed. Steelhead and the winter and spring runs of salmon are endangered, and the late fall run salmon are taxa of special concern. The hatchery-supported fall run of salmon ranges between 100,000 to 200,000 fish and continues to support a commercial and sport fishery. Many other aquatic species also are affected by the migration impediments imposed by dams and their associated reservoirs.

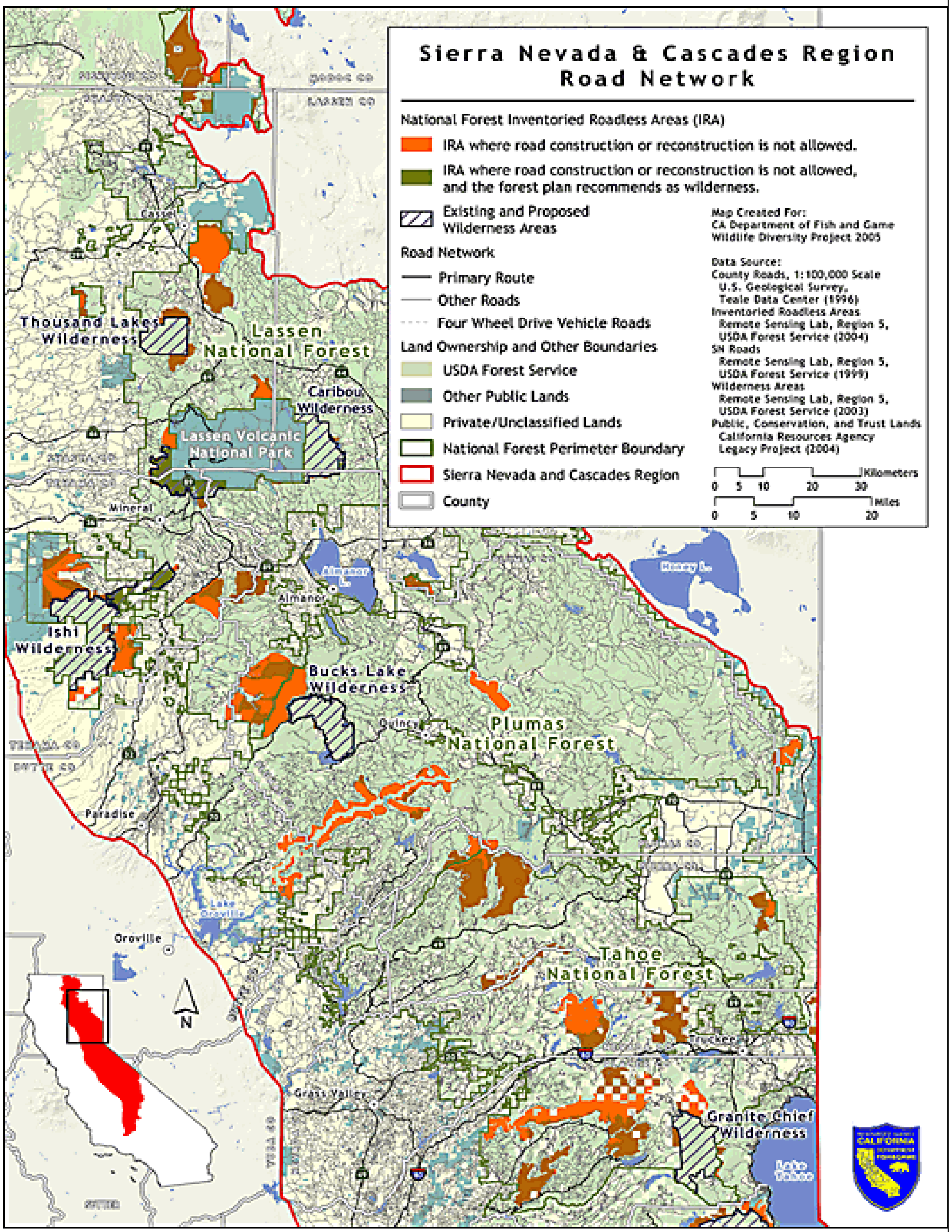


Fig. 13.3: Forest Road Density
One of the major effects of forest management practices on wildlands and aquatic ecosystems is the erosion and runoff associated with forest roads.

Native Fish of the Sierra Nevada and Cascades Region

The native fish of the region evolved in four hydrologically separated areas: the west side Sacramento–San Joaquin drainage; Lahontan drainage, consisting of the Susan, Truckee, Carson and Walker Rivers; Eagle Lake drainage; and the Owens drainage (Moyle et al. 1996). Diverse assemblages of native fish inhabited the rivers and creeks of the western slope of the Sierra and Cascades, which flowed into the Sacramento–San Joaquin system. These assemblages included 22 native taxa of fish, including abundant runs of Chinook salmon, steelhead, and Pacific lamprey. Ten native fish species were abundant in the low- to middle elevations in the Lahontan rivers and lakes. Lahontan cutthroat trout was so abundant that in the 1800s it had supported commercial fisheries in Lake Tahoe and Pyramid Lake, Nev. Five native fish resided in Eagle Lake, including the endemic Eagle Lake rainbow trout. Four unique fish species are found in the Owens Valley: the Owens pupfish, Owens tui chub, Owens sucker, and Owens speckled dace (Moyle 2002).

In the foothills, residential development continues to add “river wells” located directly on stream aquifers. Increased water drafting has turned some year-round streams into seasonal creeks and dried up other streams (Mitchell 2005 pers. comm.). Native fish (such as hitch and hardhead), amphibians, and native invertebrate populations are adversely affected where streams have receded. Similarly, the development of springs for domestic water supply on private and public lands has degraded riparian habitats for native amphibians and invertebrates.

Watershed Fragmentation and Fish Barriers

Aquatic species depend upon the ability to move within watersheds as a way to survive temperature changes and catastrophic events and to access different habitats at different stages in their lives. Upstream tributary habitats offer breeding and rearing grounds, and downstream habitats usually provide expanded nurseries with an abundance of nutrients. This annual mixing and migration allows recolonization of tributary or downstream habitats following catastrophic events such as floods or fires. Aquatic connectivity is an important part of overall watershed function, one that has been disrupted by many activities. Present populations of numerous fish species are confined below or above dams or separated by other fish barriers such as poorly designed culverts. These artificial barriers prevent genetic mixing between populations and block recolonization of areas within the watershed. Within the fragmented watersheds, native minnows and other fish and amphibian populations are listed either as threatened or endangered or as species of special concern.

Hydropower Project Operations

Dams and reservoir levels are operated to meet their primary purposes: generating hydropower, storing water for domestic or agricultural uses, and providing flood protection. California hydropower projects generate about 15 percent of the electricity used in the state, and they provide critical peaking capacity, giving the electrical system flexibility. However, hydropower project operations have major consequences for rivers and riverine ecosystems of the Sierra Nevada and Cascades, contributing to the decline of endangered salmon, steelhead, and other fish populations. Similar to the barriers mentioned above, hydropower operations affect water from rivers and streams, changing natural flow regimes of rivers, altering water temperature, and blocking fish passage and migration (McKinney 2003).

The daily fluctuation in river water levels caused by hydropower operations affects fish, reptiles, amphibians, invertebrates, and plants. Rapid changes in water flows strand spawning salmon and trap young salmon in pools on their journey to the sea. Thousands of miles of rivers and streams no longer support salmon and steelhead because migration is blocked by hydropower dams. Radical stream flow fluctuations and higher-than-normal flows from peaking hydropower projects can drown deer and other animals if high-flow releases are improperly timed with migratory or reproductive seasons.

The Federal Energy Regulatory Commission (FERC) licenses 119 of California's hydropower projects, accounting for 85 percent of the state's hydroelectric capacity. FERC licenses generally have terms from 30 to 50 years. Thirty-seven percent of the state's hydropower system is up for relicensing by 2015. (See Fig. 13.4.) Most of these projects were first licensed before 1970 and typically do not reflect today's generally accepted environmental considerations and standards. FERC relicensing of so many of California's hydropower projects presents a prime opportunity to reduce the consequences of hydropower operations on fish and wildlife. The full engagement of state biologists and enforcement officials in the FERC relicensing processes over the next decade would likely yield major benefits for river and stream ecosystems of the Sierra Nevada and Cascades.

The consideration of improvements for flow regimes and aquatic connectivity through the FERC relicensing process has had a project-by-project approach. Consideration of aquatic systems conservation across watersheds may yield greater restoration benefits for ecosystems

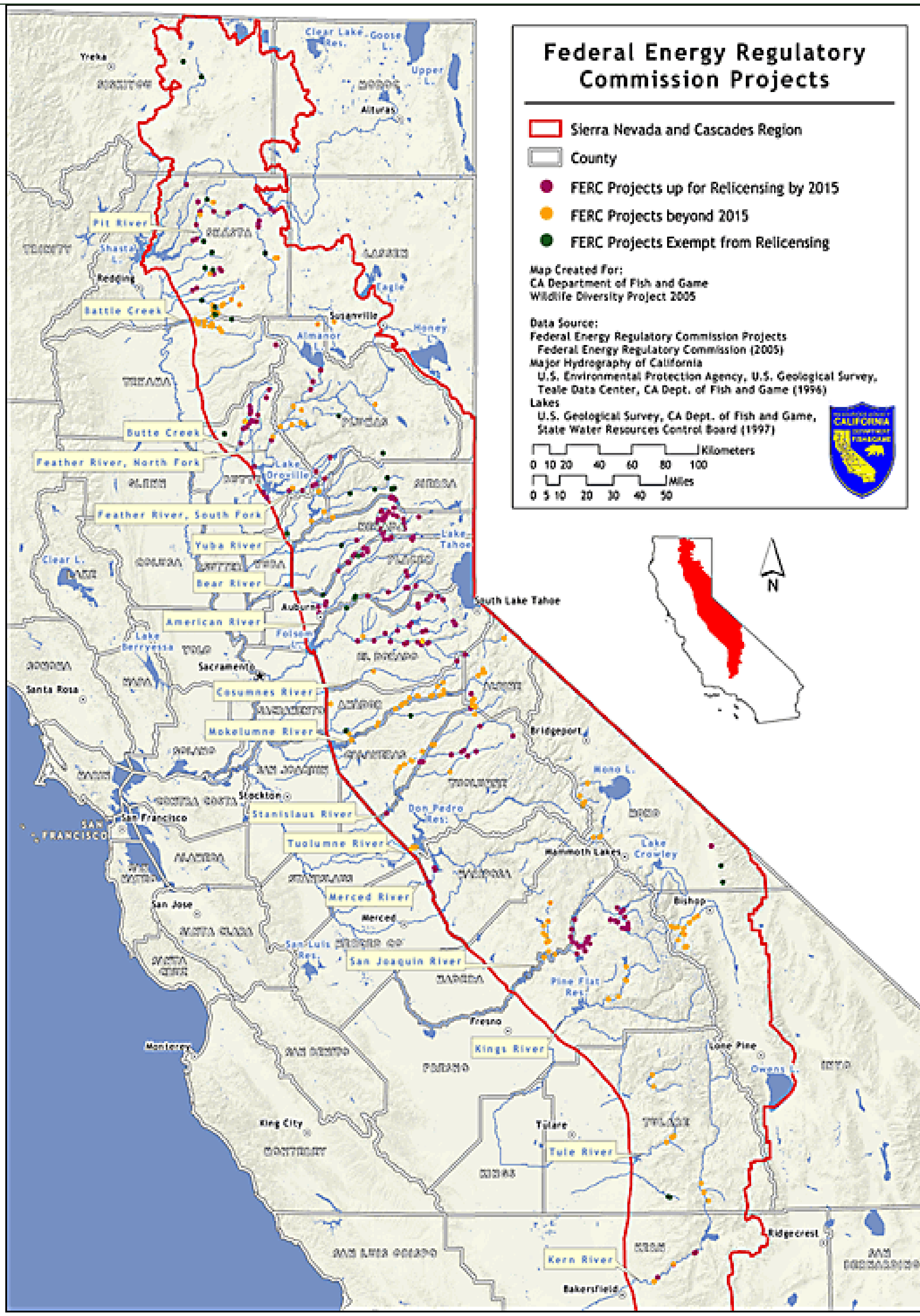


Fig. 13.4 Federal Energy Regulatory Commission Projects
Dozens of hydropower projects affect rivers and aquatic ecosystems throughout the Sierra Nevada and Cascades. The relicensing of these projects is an opportunity to make hydropower-project operational changes that benefit wildlife resources.

and wildlife. For example, projects that generate little power but greatly affect salmon and steelhead and other aquatic resources should be considered for decommissioning. The decommissioning could be negotiated as a mitigation trade for hydropower operation impacts in adjacent watersheds.

Water Diversion from the Owens Valley

The Owens Valley is the ecological beneficiary of the cold mountain creeks draining watersheds east of the Sierra crest and of the dozens of artesian springs that bubble up in the valley. These waters commingled in the Owens Basin and as wetlands and pools and the Owens River flowing south to Owens Lake. Historically, these wetlands and springs, the miles of lush riparian habitat, and the alkaline, shallow lake and mud flats supported tens of thousands of shorebirds, waterfowl, and neotropical migratory birds.

The city of Los Angeles diverts creek water that flows to Owens Valley into two aqueducts. Along with diverting creek flows, Los Angeles has relied on pumping groundwater in the Owens Valley. The environmental consequences of the increased groundwater pumping led Inyo County to file suit against the city of Los Angeles in 1972. The county and the city contended in the courts for a dozen years before jointly conducting research on groundwater, soils, and the effects of groundwater pumping on native vegetation, which served as background for the Environmental Impact Report completed in 1991. Inyo County, the city of Los Angeles, Fish and Game, the California State Lands Commission, the Sierra Club, and the Owens Valley Committee executed an MOU resolving disputes and proposing the Lower Owens River Project (LORP) as compensatory mitigation for the effects of groundwater pumping. The LORP would return water flows to and restore riverine and riparian habitat along 62 miles of river and restore wetlands and other wildlife habitats. Implementation of the LORP has been delayed, however, and the rewatering of the lower Owens River has yet to occur.

The diversion of water from the Owens Valley also turned Owens Lake into a dry lakebed, with a salty, powdery surface, creating an air pollution problem for the valley. Pursuant to the federal Clean Air Act, in 2000, Los Angeles was ordered to reduce the blowing dust from the dry lake surface. Three options were considered—shallow flooding, revegetation, or covering the surface with gravel. To date, Los Angeles has shallow-flooded the lake bed to control dust. Shallow flooding has restored some of the wet ecosystems, providing brine shrimp and other invertebrates for feeding shorebirds and other species, and bird numbers in the valley have increased. These ecological improvements are contingent upon continuing to shallow-flood Owens Lake lakebed year after year.

Introduced Non-Native Fish

The introduction of non-native fish to lakes and streams has significantly affected the aquatic life of the region, particularly in the sub-alpine and alpine ecosystems and in the Owens Valley. Decades of stocking fish for recreational fishing have contributed to the decline of native fish and frog species in the region. Stocking of trout into historically fishless high mountain lakes has contributed to the extirpation of native amphibians in some basins, with particularly severe consequences for the once-common mountain yellow-legged frog (Knapp 1996, Milliron 1999, Milliron et al. 2004, Vredenburg 2004). By consuming the native amphibians and aquatic insects, the predatory trout also are negatively affecting the western terrestrial garter snake and some birds and bats that depend on these prey species (Knapp 2005 pers. comm., Mathews et al. 2001, Milliron 2005 pers. comm.).

Stocking non-native rainbow trout (hatchery-raised or not native to a particular watershed), brook trout, and brown trout into native trout waters has degraded native trout populations through predation and interbreeding. The introduced eastern brook trout outcompetes the native Lahontan cutthroat trout. Introduced rainbow trout have interbred with and altered the genetics of golden trout and Little Kern golden trout in portions of their historical ranges. Along the eastern Sierra in the Owens Valley, the endangered Owens pupfish and Owens tui chub have been extirpated from the river, creeks, and pools where non-native largemouth bass are present (USFWS 1998b). In western foothill streams, introductions of non-native sunfishes and other exotic species have seriously threatened the continued existence of native minnow and amphibian populations. Many of these are now either listed as threatened or as species of special concern (Mitchell 2005 pers. comm.)

Fish and Game recently conducted a Sierra-wide field study of amphibians, trout, and other fauna in the high mountain lakes. The multiyear project, begun in 1998, has collected data on three-quarters of the Sierra's 10,000 high-mountain lakes. The results of the study are serving to inform Aquatic Biodiversity Management Plans that are being prepared for the high mountain watersheds of the Sierra. The goal of these plans is to protect and restore native amphibians and other fauna while maintaining thriving recreational fisheries. The results of the field studies have yielded information needed to design management plans that will achieve both of these goals. Lakes isolated by fish barriers and where exotic trout reproduction is absent have been identified for restoring native fauna. Lakes identified as popular with anglers or where reproduction of exotic trout is uncontrollable will be managed to improve their fisheries. Implementation of the completed aquatic biodiversity management plans and the completion of additional plans are contingent upon future funding and staffing.

In the Owens Valley, Fish and Game has conducted numerous projects over the last two decades to restore populations of pupfish and tui chub. Eliminating non-native predatory fish from the river and streams and pools of the Owens Valley is unlikely. Thus, the best strategy for the long-term conservation and restoration of Owens pupfish and tui chub is to introduce them to numerous small springs and creeks of the valley that do not have largemouth bass and other predators (Parmenter 2005 pers. comm.). However, introducing endangered fish to springs and waters that currently have none creates land management challenges for the landowners, in this case the Los Angeles Department of Water and Power. The long-term survival of these two Owens Valley native fish may well depend on a special agreement that permits LADWP to continue normal canal clearing and maintenance, even if such activities kill some fish. In exchange, the endangered fish would be introduced to numerous isolated waters, where it is expected they will flourish, free of predatory non-native species.

Conservation Actions to Restore and Conserve Wildlife

In addition to the recommended regional actions described below, see the recommended statewide conservation actions as given in Chapter 4.

a. The state should provide scientific and planning assistance and financial incentives to local governments to develop and implement regional multispecies conservation plans for all of the rapidly developing areas of the Sierra Nevada and Cascades.

The western foothills, the Lake Tahoe Basin, and the highway corridors of the Sierra Nevada are experiencing rapid development without the conservation planning necessary to minimize its negative consequences for wildlife and plant communities. Key wildlife habitats will be unnecessarily destroyed, degraded, and fragmented unless conservation planning is supported by the state and fully embraced by cities and counties.

The state should increase conservation science and planning assistance and economic incentives to counties to develop regional multispecies conservation plans and to incorporate conservation plans into county and city General Plans.

b. The Sierra Nevada Conservancy should develop a program, closely coordinated with federal, state, and local wildlife conservation planning efforts, that prioritizes areas for acquisition and easements based on the needs of wildlife.

- The Sierra Nevada Conservancy should consult with state and federal wildlife experts and wildlife conservation nongovernmental organizations to identify priority areas for acquisition and easements.
- The Sierra Nevada Conservancy should be a key funder for the implementation of conservation plans. Developing Natural Community Conservation Plans for the Sierra will depend on capital funding from, among other sources, the Sierra Nevada Conservancy, to be used for conservation easements and acquisitions of habitat reserves.

c. In areas where substantial development is projected, the state and federal land management and wildlife agencies should identify and protect from development those critical wildlife migration or dispersal corridors that cross ownership boundaries and county jurisdictions.

See Statewide Action d, Chapter 4.

Knowledge of important wildlife migration or dispersal corridors will help conservation planners and local governments prevent fragmentation of wildlife habitat and avoid creating barriers to wildlife movements, thereby maintaining conditions for the long-term survival of some species.

d. Public forest lands should be managed to maintain healthy ecosystems and wildlife diversity, including thinning to restore diverse habitats and reducing the risk of catastrophic wildfire. State and federal forest managers and wildlife agencies should work cooperatively to develop a vision for the future forest condition.

Watersheds, or a group of adjacent watersheds, may be the appropriate organizing unit for collaborative forest management.

Management of national forests and other public forest lands should incorporate the following principles:

- Retention of the remaining old-growth and late-successional forest stands
- Restoration of vegetative communities historically present within forest landscapes
- Restoration and maintenance of connectivity in the forest landscape
- Restoration and maintenance of habitat diversity across the forest landscape
- Restoration and maintenance of structural complexity in forest stands, including dead trees, snags, and fallen logs
- Restoration and maintenance of the integrity of riparian and aquatic ecosystems

e. On public lands, post-fire and post-harvest treatments and forest management should be designed to achieve the principles listed in Action d, above.

For example, natural regeneration or tree-stocking following fires, timber harvest, and other forest disturbances should be determined based on what will contribute to achieving the principles in Action d.

f. State and federal forest managers and state and federal wildlife managers should cooperatively develop timber-harvest cumulative-impact standards for each watershed or group of adjacent watersheds of the Sierra, Cascades, and Modoc regions to protect aquatic ecosystems and conserve wildlife habitat.

Using the best-available science, forest and wildlife managers should determine the extent, pattern, and pace for timber-harvest in a forest watershed or cluster of watersheds. Ecologically based standards or limits should be set for timber-harvest. State and federal forest managers should coordinate to ensure that cumulative effects of timber-harvest plans for public and private lands meet the standards for each watershed.

Federal forest managers and state and federal wildlife biologists should also work cooperatively to design forest-thinning and prescribed-fire treatments.

g. The California Resources Agency should coordinate the development of a model ordinance and building codes for new or expanding communities in fire-adapted landscapes to make those communities more fire compatible and reduce the state's liability for fire suppression.

Counties need to consider adopting development restrictions requiring planning and accommodation for wildfire consistent with the local historical fire regime, and such measures should be incorporated into the public-safety elements of the county General Plans. In addition, specific ordinances should be adopted:

- The model ordinances should address the design of new development to ensure new communities are safer and compatible with natural forest fires.
- The model ordinances should address maintenance of existing residential and commercial areas to ensure firebreaks are maintained to improve compatibility with forest fires.
- Model building codes should specify that all new construction employ materials and design features to make them more fire resistant.
- The California Resources Agency should encourage adoption of the model fire ordinances and building codes by cities and counties in forested areas.

h. Federal, state, and local agencies and fire-safe councils should work cooperatively to expand the use of prescribed fire and natural-burn programs.

- Prescribed fire should be based on criteria for protecting watersheds, aquatic ecosystems, water quality, and achieving the principles in Action d.
- Limited resources available to implement prescribed fire dictate that, where feasible, programs should be designed to prioritize reintroduced fire according to areas of greatest ecological need.
- State and federal agencies should implement a coordinated campaign to educate the public about the ecological benefits of fire and to promote prescribed fire.

i. State and federal wildlife agencies and federal land managers should jointly develop and implement grazing strategies for the Sierra Nevada and Cascades Region to reduce or eliminate livestock grazing on sensitive habitats to restore the condition of meadow, riparian, aspen, and aquatic habitats.

Restoring and protecting meadow, riparian, aspen, and aquatic ecosystems habitats is essential to protect wildlife diversity.

In areas where livestock grazing is maintained, wildlife- and land-management agencies should encourage or require practices to reduce negative ecological consequences.

Actions to reduce or eliminate livestock grazing on important habitats for at-risk wildlife species should include strategies or programs to reduce the economic impact on grazing allotment permit-holders affected by new restrictions.

j. Federal, state, and local agencies should provide greater resources and coordinate efforts to eradicate or control existing occurrences of invasive species and to prevent new introductions.

See Statewide Action f, Chapter 4.

k. In their conservation planning and ecosystem restoration work, state and federal wildlife agencies and land managers should consider the most current projections of the effects of global warming.

Global warming is expected to have major consequences for the Sierra and Cascades' snowpack and aquatic ecosystems. Projected changes are important factors to consider when planning long-term conservation or restoration projects.

l. Fish and Game should be allocated the resources to monitor and enforce the distribution of sensitive fish and other aquatic species populations and to engage effectively in water-rights decision processes, water diversion issues, land-management planning, and conservation planning actions to restore and enhance aquatic systems.

m. Through the FERC relicensing process, the state should pursue changes in operations of hydropower projects that will provide more water for wildlife, mandate that water flows be managed as close to natural flow regimes as possible, and ensure that the new license agreements provide the best possible conditions for ecosystems and wildlife.

- Over the next decade, Fish and Game should be staffed adequately to be a full partner in all FERC proceedings affecting river systems and aquatic species of the Sierra Nevada and Cascades.
- Partnering with the State Water Resource Control Board, Fish and Game should seek provisions in the new license agreements that provide the best possible conditions for aquatic ecosystems and wildlife.
- The state should consider an alternative hydropower-project relicensing strategy that trades mitigation credits across watersheds. Under this strategy, the state would identify those systems most important for hydropower and those systems most important for aquatic resources. Rather than making only marginal improvements to all major river systems, some systems would focus on hydropower generation, while diversions would be eliminated on other systems, making dramatic improvements for salmon, steelhead, and other aquatic resources.
- All hydropower projects up for relicensing should be evaluated for the costs and benefits of decommissioning. The amount of energy generated versus environmental-impact costs and benefits should be thoroughly reviewed. Where appropriate, the state should seek decommissioning of hydropower projects.

n. The state, Inyo County, and the city of Los Angeles should fully implement the Lower Owens River Project (LORP), restoring riparian and aquatic habitat along 62 miles of the lower Owens River.

o. The city of Los Angeles should reach long-term agreement with Inyo County and the state to use shallow flooding to control dust on the Owens Lake lakebed.

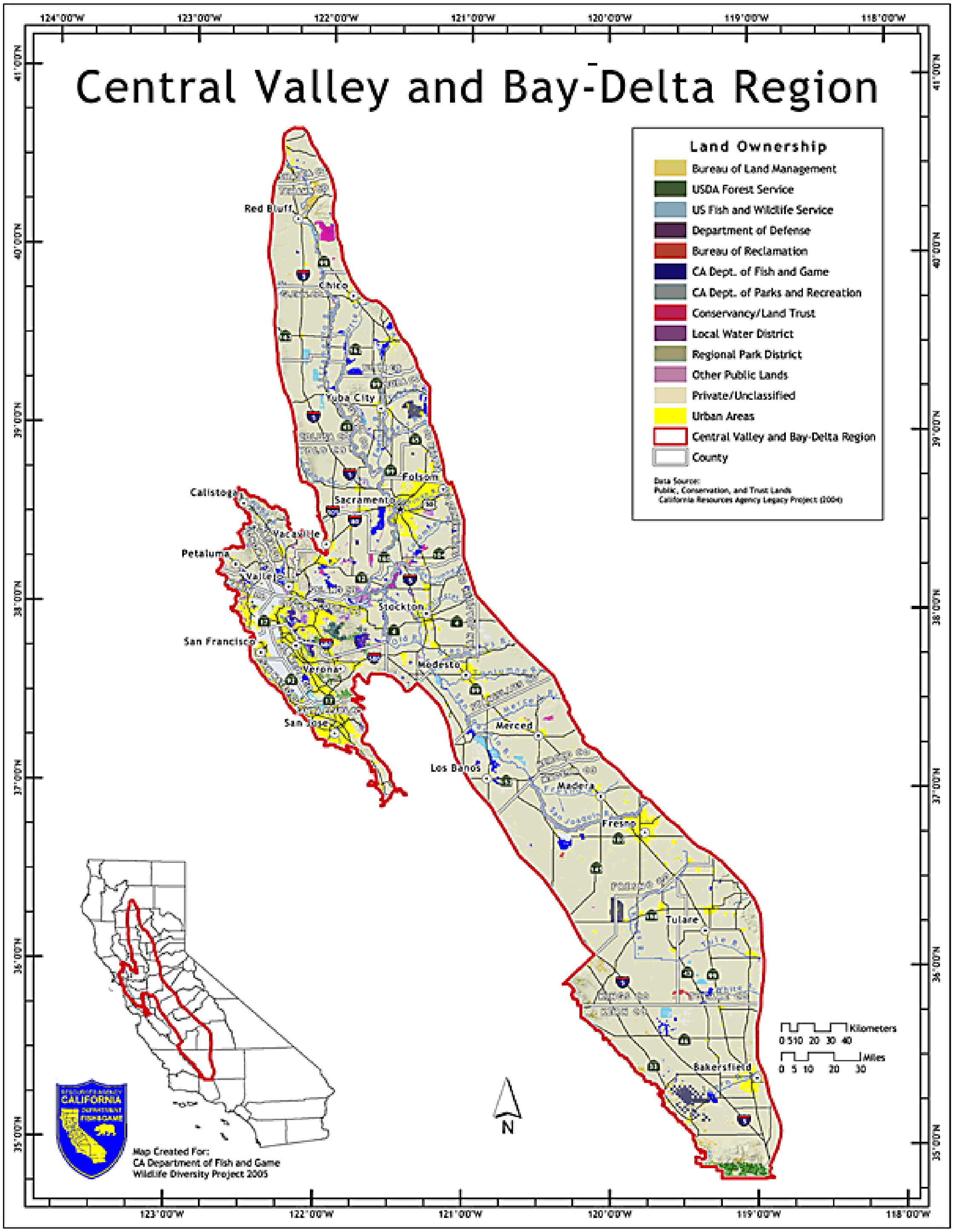
In addition to controlling dust, the shallow flooding has restored aquatic and mudflat habitat on Owens Lake, benefiting tens of thousands of shorebirds and other species.

p. Fish and Game and the U.S. Fish and Wildlife Service should seek an agreement with the Los Angeles Department of Water and Power (LADWP) to establish Owens pupfish and Owens tui chub in springs and creeks of the Owens Valley on LADWP lands as part of a strategy to recover these two endangered fish and ensure their long-term survival.

An agreement to establish new populations of the two endangered fish on LADWP lands will require provisions that allow LADWP to continue its normal operations and maintenance of canals and ponds.

q. Fish and Game should establish trout-free sub-basins and lakes across the high Sierra and Cascades to restore amphibians and other native species while concurrently improving trout fisheries in other lakes.

Introduced non-native trout are a major stressor of aquatic ecosystems in high mountain lakes of the Sierra and Cascades, and some native amphibians have recovered where trout were removed. The six completed Aquatic Biodiversity Management Plans, prepared by Fish and Game, provide good guidance for where conditions for native species can be restored and where trout fisheries may be improved.


Central Valley and Bay-Delta Region
Land Ownership
Bureau of Land Management
USDA Forest Service
US Fish and Wildlife Service
Department of Defense
Bureau of Reclamation
CA Dept. of Fish and Game
CA Dept. of Parks and Recreation
Conservancy/Land Trust
Local Water District
Regional Park District
Other Public Lands
Private/Unclassified
Urban Areas
Central Valley and Bay-Delta Region
County
Data Source:
Public, Conservation, and Trust Lands
California Resources Agency Legacy Project (2004)
Red Bluff
Chico
Yuba City
Folsom
Sacramento
Calistoga
Vacaville
Petaluma
Vallejo
Stockton
San Francisco
Modesto
Verona
San Jose
Merced
Los Banos
Madera
Fresno
Tulare
Bakersfield
Kilometers
0 5 10 20 30 40
Miles
0 5 10 20 30
N
Map Created For:
CA Department of Fish and Game
Wildlife Diversity Project 2005
124°0'0"W
123°0'0"W
122°0'0"W
121°0'0"W
120°0'0"W
119°0'0"W
118°0'0"W
41°0'0"N
40°0'0"N
39°0'0"N
38°0'0"N
37°0'0"N
36°0'0"N
35°0'0"N