

Conservation Significance of —Tejon Ranch—

A biogeographic crossroads



August 2003



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The Conservation Biology Institute provides scientific expertise to support conservation and recovery of biological diversity in its natural state through applied research, education, planning, and community service.



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Burrowing owl
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Executive Summary

Tejon Ranch is a precious and irreplaceable piece of California's natural heritage—a hotspot of biological diversity that lies at the confluence of four major biogeographic regions. It is a haven for rare and endemic species, ancient oak trees, endangered California condors, rare native vegetation communities, and intact watersheds and streams—and all so near the largest metropolitan area in California.

The time will undoubtedly come when the entire area of this noble valley will be tilled like a garden, when the fertilizing waters of the mountains, now flowing to the sea, will be distributed to every acre, giving rise to prosperous towns, wealth, arts, etc. Then, I suppose, there will be few left, even among botanists, to deplore the vanished primeval flora. In the mean time, the pure waste going on—the wanton destruction of the innocents—is a sad sight to see, and the sun may well be pitted in being compelled to look on.

— John Muir 1894

This report synthesizes available scientific information for the Tejon Ranch region to raise public awareness about its significance to the conservation of natural diversity and to encourage comprehensive, landscape-level planning to protect its unique values. We present this information in the hope it will inspire the Ranch's owners, the public, and governmental decision-makers to work together to protect this unspoiled natural treasure.

Since the early years of California statehood, Tejon Ranch has served as a natural laboratory for scientists studying natural history, biogeography, and the products and processes of evolution. Historic field studies here in the late 1850s significantly advanced scientific knowledge about the plants and animals of the West, and ongoing research in the region continues to further our understanding of how species and ecological communities evolve, function, and interact. Scientists have demonstrated how dramatic geological and climate changes have produced an amazing history for the Tejon Ranch region—a crucible of evolutionary innovation and species diversification.

The 270,000-acre Tejon Ranch lies at the crossroads of five geomorphic provinces and four floristic regions—circumstances unmatched anywhere else in California. This remarkable conjoining of diverse biological communities occurs within a global biodiversity hotspot known as the California Floristic Province. Tejon Ranch is emblematic of this diversity:

- It potentially supports as many as 20 state and federally listed species and over 60 other rare species, including many species or subspecies that occur nowhere else on earth!
- It supports 23 different vegetation communities, a high percentage of the total number of communities in the region, and over one-third of the oak species in California, including some of the largest individual oaks in the state!

The Ranch supports several habitat types that are rare and under-protected in the region, including grasslands, fir forests, and significant stands of valley and blue oak woodlands. The Ranch's grasslands, in particular, represent a final opportunity to preserve a connection between grasslands remaining on the western and eastern flanks of the San Joaquin Valley, which are otherwise becoming isolated into non-interacting and therefore diminished ecological communities. Moreover, substantial conservation of the Ranch is crucial to maintaining the viability of existing conservation investments in the region, such as the Sequoia and Los Padres



National Forests and Wind Wolves Preserve, which depend on unrestricted movement of the species they support.

Tejon Ranch's long history of use as a working ranch and haven for sportsmen has helped maintain its biological values in the face of California's rapid development and agricultural conversion. The Ranch is, so far, largely roadless and unfragmented by urbanization. It therefore supports something very rare in southern California—intact, healthy watersheds and streams. Tejon Ranch serves as a core biological resource area—large enough and pristine enough to support such wide-ranging species as mountain lions and sufficiently vast to accommodate large-scale ecological processes such as natural fire cycles. Conserving much of the Ranch in its existing state is essential to maintaining these characteristics and values.

State and local agencies and environmental organizations have already recognized the historical significance, unique biological characteristics, and important resource values of Tejon Ranch:

- Tejon Ranch meets nearly all of the *Priority Criteria for Conservation* established by the California Resources Agency.
- The California Wilderness Coalition named Tejon Ranch one of *California's Ten Most Threatened Wild Places*.
- Audubon California has identified the Tehachapi Mountains around Tejon as an *Important Bird Area*.
- Los Angeles County has designated *Significant Ecological Areas* on the Ranch and is considering expanding the area under this designation.
- The U.S. Fish and Wildlife Service designated a significant part of the Ranch as *Critical Habitat* for the endangered California condor and important for recovery of many other endangered San Joaquin Valley species.

Significant urbanization is proposed for the Ranch, threatening to fragment and degrade this remarkable natural area and the surrounding region. Decisions over the fate of Tejon Ranch, and implications to the region, should only be made via comprehensive, multi-jurisdictional planning at a regional scale. Such planning should occur in a public arena and should be guided by the best available science to balance economic development with protection of the Ranch's irreplaceable natural values.

California's heritage and future quality of life are at stake in the decisions that are being made today.



Introduction and Overview

In many respects, I would argue that this region is the single most important biogeographic component of California, since so many regional elements form a nexus here.

Dr. James L. Patton
Professor Emeritus
University of California, Berkeley

Tejon Ranch is one of California's most precious natural areas—a haven for rare and endangered species, a sanctuary for the soul of ancient California, a treasure that, through the years, has not escaped the wonderment of ranchers, hunters, wildlife enthusiasts, and scientists. This is a place through which thousands of people drive daily, but few have really seen; where one can visualize the dramatic geologic processes that shaped California's landscape and influenced the evolutionary history of

California's diverse flora and fauna. In this place, California condors still fly, centuries-old oaks still flourish, and streams are born. Perhaps most remarkably, virtues of this place have not yet been compromised by the urban sprawl that is rapidly devouring so much of California's natural landscape.

Tejon Ranch, 270,000 acres of southern Kern and northern Los Angeles counties, is the largest, contiguous, privately-owned property in California (Figure 1). Owners of the Ranch are currently planning large-scale residential and industrial developments in what is now a largely undeveloped and natural landscape. Concerned that these development plans might severely compromise the Ranch's ecological integrity before the public has had an opportunity to understand its significance, Environment Now and a coalition of environmental groups commissioned the Conservation Biology Institute to assess the regional and statewide value of Tejon Ranch for conservation of biological diversity. Through the course of this assessment, we have come to recognize what others have already suggested—that Tejon Ranch is truly one of California's most priceless natural areas, unparalleled in its diversity of natural resources and its importance to conservation, and meeting all of the State's criteria for a priority conservation target.



Figure 1. General location of Tejon Ranch

This report shares our synthesis of publicly available information—documenting the biogeographic importance of the Tejon Ranch region, revealing the values of the region's natural resources, and identifying factors that threaten these values. This report does not advocate any specific open space design, but rather it illuminates the extraordinary values and regionally under-protected resources of the Ranch so that the public and decision-makers are fully aware of their importance in future land planning decisions. We hope that this information will be used as a basis for comprehensive, rather than piecemeal, land use planning of Tejon Ranch.



Approach and limitations

Our approach was to characterize the relative significance of Tejon Ranch with respect to various conservation attributes. We used publicly available data supplemented with information from individuals having specific knowledge of the region's biological resources. No new data were collected for this study. To evaluate the Ranch within a larger geographic context, we mapped and analyzed biological and land use data within a circular area surrounding and including the Ranch (see Appendix A for discussion of data sources and methods). Although some of the available data are at a relatively coarse scale, we believe that the scale and thematic detail of information are adequate to support our conclusions. Our analysis was also limited by the dearth of recent biological resources data for Tejon Ranch itself. Many individuals who have conducted surveys on the Ranch are under confidentiality agreements to the Tejon Ranch Company and could not disclose their findings. We used historic occurrences of species in the vicinity of the Ranch, obtained from museum records, individuals with knowledge of the area, and the California Natural Diversity Database (CNDDDB), as indicators of the potential for species to occur on the Ranch. Comprehensive surveys of Tejon Ranch would likely reveal unique vegetation associations, new species distribution records, and as yet undescribed species.

Biogeographic Importance

The California Floristic Province: a global hotspot of biodiversity

Biogeography is the study of how plants and animals are distributed on earth and the factors that influence those distribution patterns. These geographic patterns are often organized into hierarchical categories that become increasingly distinct at each finer resolution. For example, the flora of California has been organized into a four-tiered hierarchy (Hickman 1996) consisting of provinces (e.g., California Floristic Province), regions (e.g., Southwestern California region), subregions (e.g., Transverse Ranges subregion), and districts (e.g., Western Transverse Ranges district). The biota present in any biogeographic category is an expression of its geology and soils, terrain, climate, and evolutionary history. Biogeographic regions can be excellent constructs against which to plan and implement conservation actions, because they contain distinct assemblages of natural communities and species (Olson et al. 2001). We can compare community representation and richness and species endemism on Tejon Ranch to the characteristics of biota in other locations by using a system of biogeographic categories.

Representation—including examples of species or habitats in nature reserves or other managed areas.

Richness—the number of species or communities within a particular geographic area.

Endemism—species restricted in distribution, occurring nowhere outside a defined geographic area.

Since the concept of identifying biodiversity hotspots was introduced in 1988 (Myers 1988), it has become a common tool for establishing global conservation priorities (Myers 1990, Mittermeier et al. 1998, Mittermeier et al. 1999). Biodiversity hotspots are areas supporting high concentrations of species, particularly endemic species. Conservation International has designated the California Floristic Province as one of the world's 25 biodiversity hotspots (Figure 2). Although these hotspots comprise less than 1.5% of the Earth's vegetated land



surface, they are estimated to contain over 70% of all vascular plant species. Moreover, as measured by species endemic to only a single hotspot, these 25 locations account for 44% of endemic plant species diversity, 35% of terrestrial vertebrate species, and 75% of all terrestrial animal species listed as threatened by IUCN-World Conservation Union (Mittermeier et al. 1998, Mittermeier et al. 1999).

Although biological resources outside of these hotspots also merit conservation, our point is to emphasize the richness of this region of California on a global scale. Tejon Ranch is located largely within the California Floristic Province (Hickman 1996). Thus, the Ranch represents a large and generally intact portion of the overall biodiversity for which the California Floristic Province is widely recognized (Mittermeier et al. 1998, Myers et al. 2000, Stein et al. 2000). In the following discussion, we examine the biogeographic factors that contribute to the exceptional biological richness of Tejon Ranch.

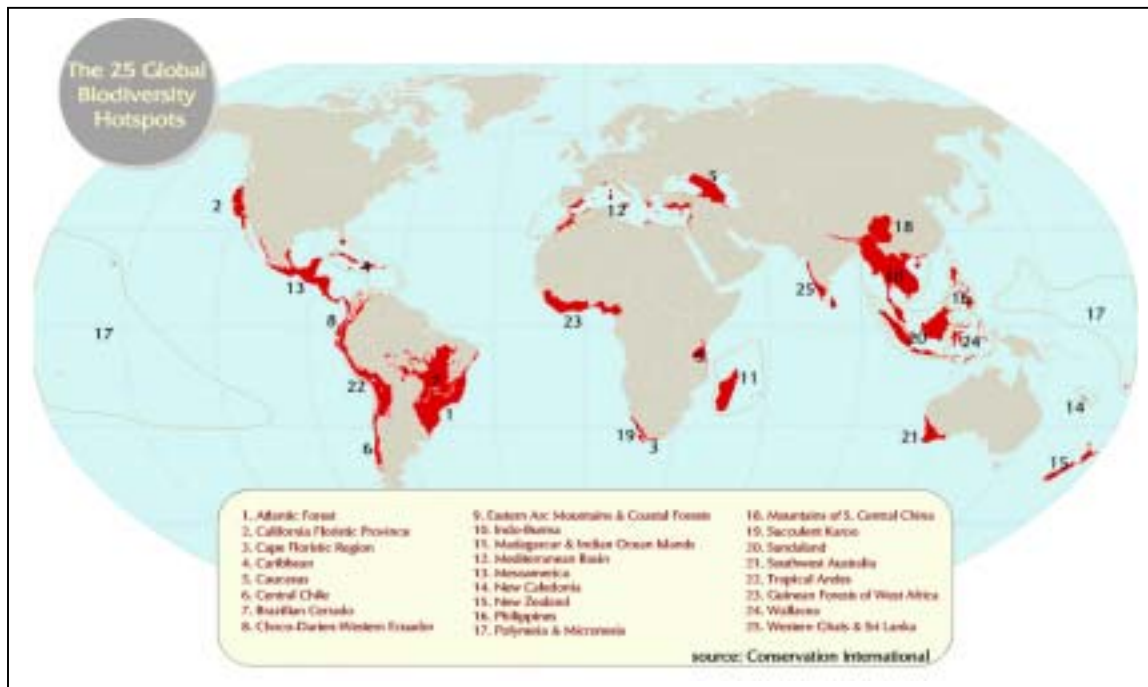


Figure 2. The 25 global biodiversity hotspots (Mittermeier et al. 1999).

A biogeographic crossroads

Tejon Ranch has played a historic role in our understanding of the biogeography of the Western U.S. From 1857 to 1859 John Xántus made extensive collections of specimens from his station at Fort Tejon (Zwinger 1986). These specimens were shipped to Spencer Baird, National Museum at the Smithsonian Institution, where they were used to dramatically increase our understanding of the biogeography of the flora and fauna of the West. Xántus' contribution to the natural history of the area is recognized not only by his voluminous collections at the Smithsonian and other institutions, but by the numerous taxa that were first collected in the vicinity of Fort Tejon.



The unique biota of Tejon Ranch reflects its position at a *biogeographic crossroads* (Spector 2002). The Ranch lies at the confluence of five geomorphic provinces (Sierra Nevada, Great Central Valley, Coast Ranges, Transverse Ranges, and Mojave Desert). Each province is geologically distinct, and the area of their conjunction is characterized by major fault systems, such as the San Andreas and Garlock faults, and a complex geologic history (Atwater 1989). Much of the uplifting of the Transverse and southern Coast Ranges has occurred in the last 2 million years, and the Tejon Ranch region escaped the extensive Pleistocene glaciations that shaped much of the Sierra Nevada. Thus, Tejon Ranch comprises a physical landscape of extreme dimensions that is still quite active geologically. One of the largest earthquakes recorded in California occurred at Fort Tejon in 1857, resulting in an estimated 35 feet of displacement along the San Andreas Fault (Schoenherr 1992).

This geologic turmoil has created a distinctively diverse terrain which, in turn, produces a differential climate pattern across the landscape of Tejon Ranch. The Tehachapi Mountains, located at the southern end of the Sierra Nevada geomorphic province, rise steeply to an elevation of over 6,500 feet from the gently sloping San Joaquin Valley to the north (at about 500 feet elevation) and the Mojave Desert to the south (at about 3,000 feet) (Figure 3). The climate is Mediterranean, with hot, dry summers and cool, wet winters, but the landscape within Tejon Ranch exhibits climate extremes. Annual precipitation varies from about 6-7 inches in the San Joaquin and Antelope valleys to around 30 inches at higher elevations of the Tehachapis, with nearly 20 inches of this falling as snow (Western Regional Climate Center 2003).

The geologic history of western North America and the climate dynamics associated with the evolving terrain were major factors shaping the biogeography we see in California today. Floristic regions of California tend to align with geomorphic provinces (Barbour and Major 1995, Hickman 1996). Tejon Ranch lies at the confluence of four major floristic regions (also referred to as Jepson ecoregions, Figure 4) and supports elements of each: the Sierra Nevada (Tehachapi subregion), Great Central Valley (San Joaquin Valley subregion), Southwestern California (Transverse Ranges subregion), and Mojave Desert (Hickman 1996).

The convergence of floristic elements from each of these ecoregions underlies the remarkable biodiversity of the Tejon region. Each ecoregion supports a unique flora, with low to moderate similarity with adjacent ecoregions (U.C. Berkeley, Jepson Herbarium unpubl.). Moreover, each ecoregion reaches its geographic extreme at Tejon Ranch (Figure 5), so the biological composition of these areas is unique relative to the larger ecoregion. For example, the flora of the Tehachapi subregion is relatively distinct from the remainder of the Sierra Nevada region (Hickman 1996; U.C. Berkeley, Jepson Herbarium unpubl.). Likewise, the flora of the Western Transverse Ranges district is somewhat unique relative to the remainder of the Transverse Ranges subregion (Hickman 1996; U.C. Berkeley, Jepson Herbarium unpubl.). The Tehachapi Mountains are further distinguished in that they harbor some of the largest oak trees in California (Block 1989, Williams 2002).

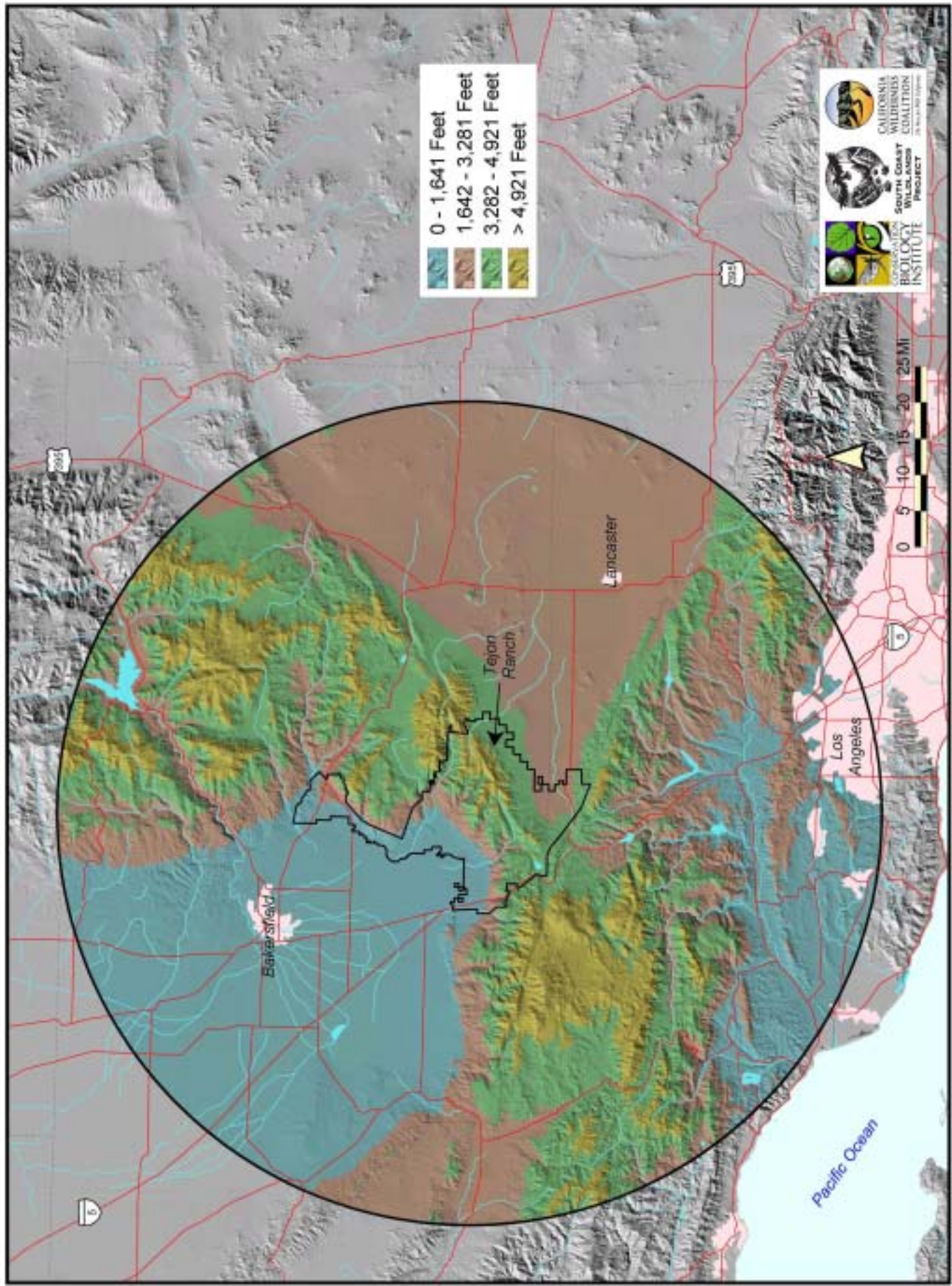


Figure 3. Elevation bands - regional extent.



Figure 4. Tejon Ranch in relation to four converging ecoregions - California extent.

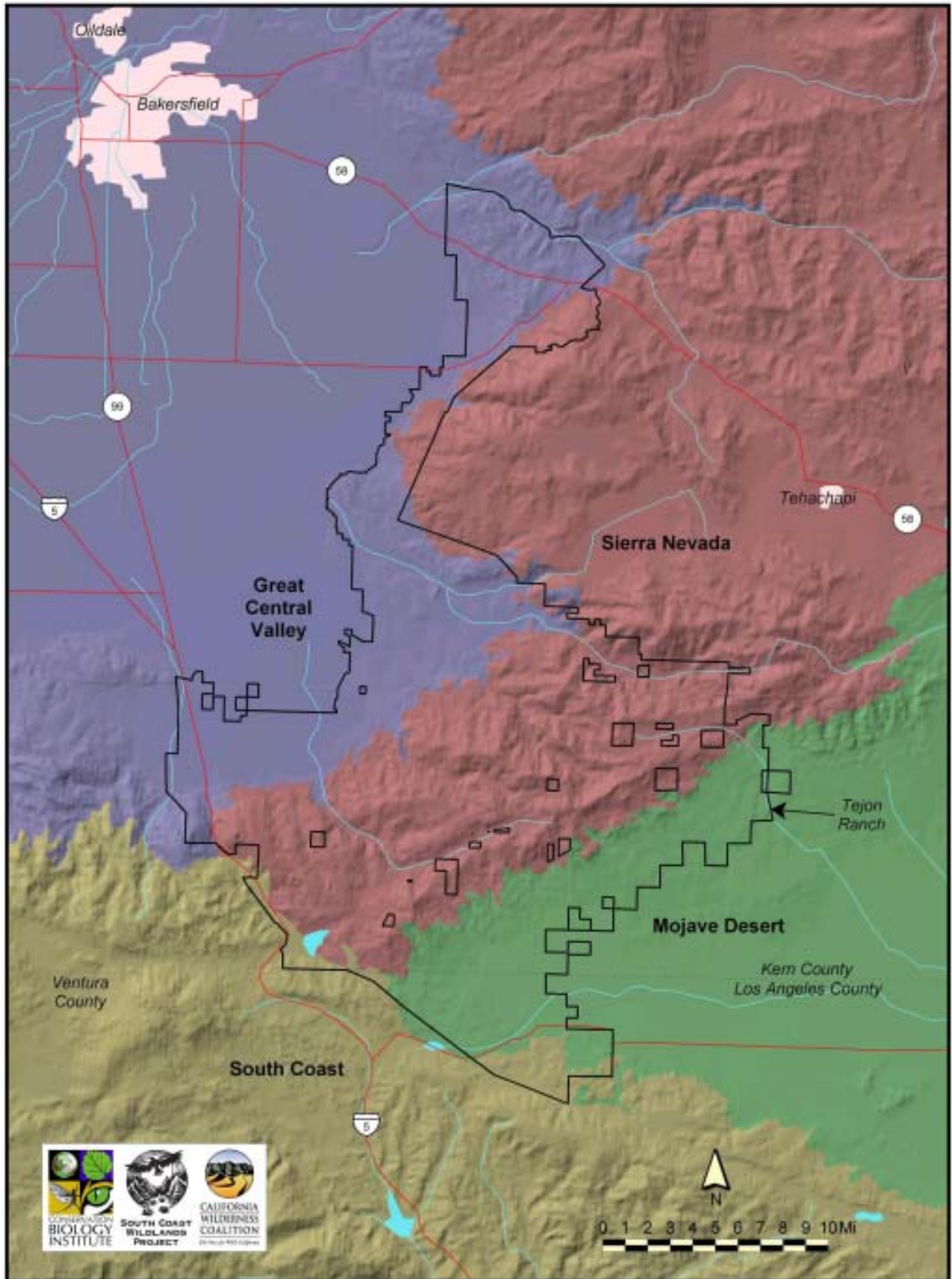


Figure 5. Tejon Ranch in relation to four converging ecoregions - Tejon Ranch extent.



The Tejon hotspot

By supporting a large number of biological communities from four distinct ecoregions in one contiguous area, the Tejon Ranch itself comprises a regional biodiversity hotspot. The Tejon Ranch region is defined in this report as the circular area shown in Figures 3, 6, 9, 10, 12, and 13—an area of approximately 6,500,000 acres. This region captures a segment of each of the four ecoregions and supports an impressive array of vegetation communities (Figures 6 and 7, Appendix B), including low-elevation grasslands, coniferous and hardwood forests at high elevations, and oak woodlands, pinyon-juniper forests, and chaparral at intermediate elevations. For example, at



Joshua trees and oaks on Tejon Ranch
A.M. Harvey 2003 www.visualjourneys.net

least four different oak communities occur on Tejon Ranch; valley oaks and Joshua trees are found side-by-side; and San Joaquin Valley grasslands join white fir forest on the same property! In fact, of the 38 unique vegetation communities within the 6.5 million-acre Tejon Ranch region (Figure 6 and Appendix B), 23 of these communities (61%) are found on Tejon Ranch itself (Table 1). Thus, Tejon Ranch, by virtue of its size and location, supports a huge diversity of regional vegetation types in a comparatively small area. It is these resource-rich hotspots that are typically prioritized for conservation, so as to get the greatest *bang for the buck* from limited conservation funds.

Table 1. Vegetation community richness by ecoregion¹

Ecoregion	# in Region	# on Tejon Ranch	% Represented on Tejon Ranch²
Sierra Nevada	27	21	78%
Southwestern California	29	16	55%
Great Central Valley	23	10	43%
Mojave Desert	21	11	52%
Total	38	23	61%

¹ Community richness is the number of vegetation communities found within a particular geographic area.

² Percentage of communities present on Tejon Ranch relative to the number of communities in the region within each respective ecoregion.

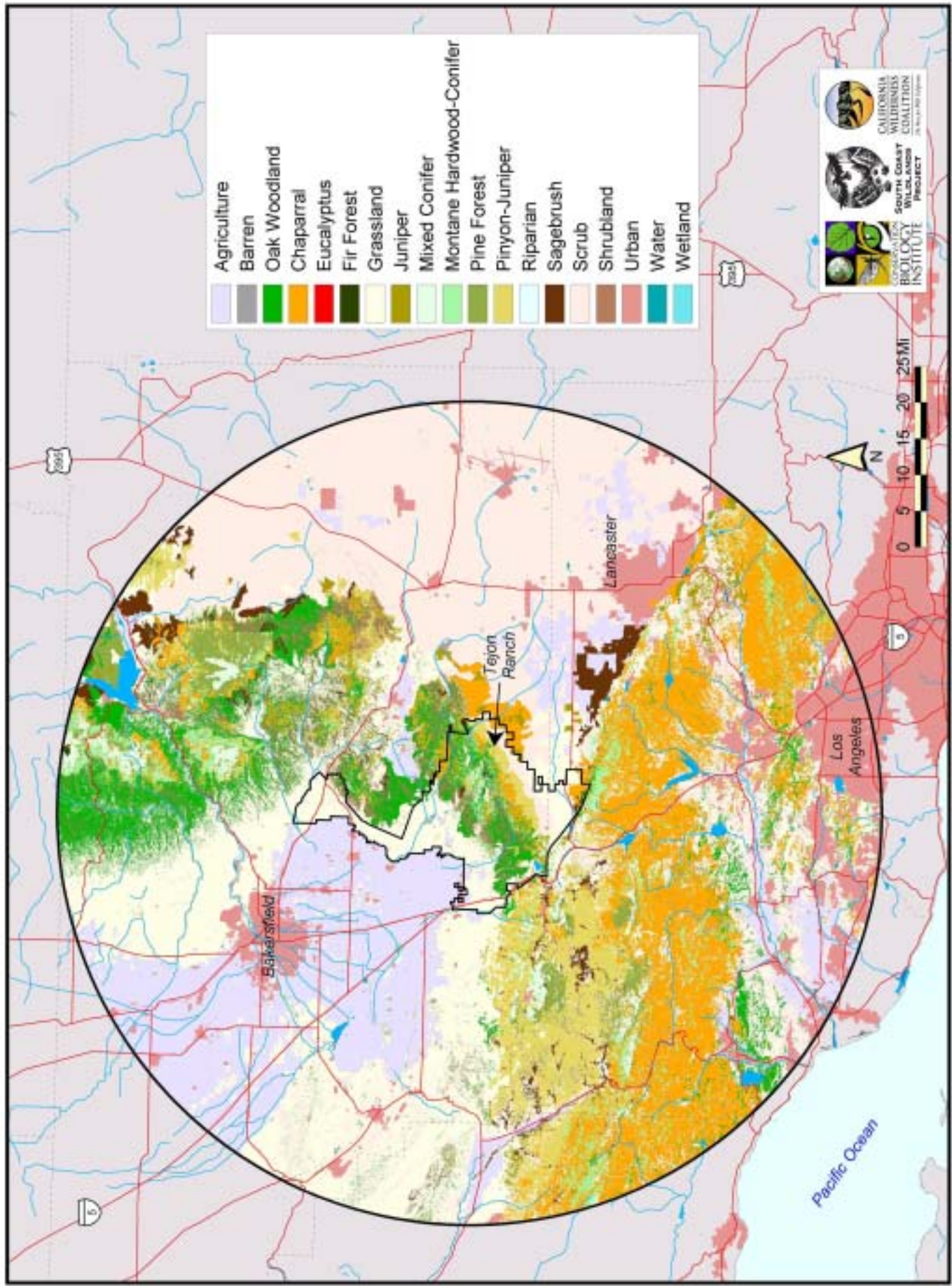


Figure 6. Land cover - regional extent.

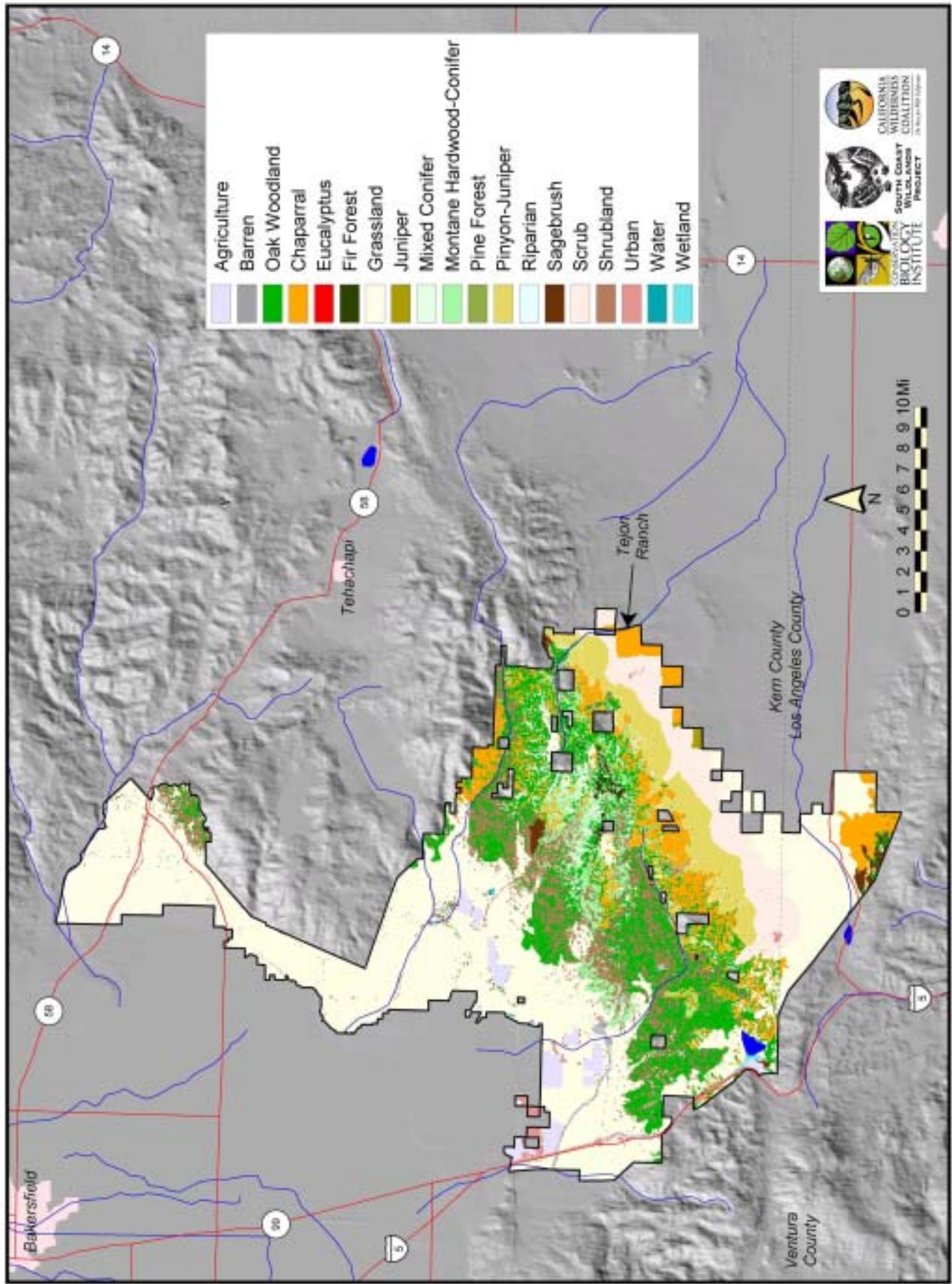


Figure 7. Land cover - Tejon Ranch extent.



The Tejon region is also an area of high species endemism (Table 2), even relative to the endemic-rich California Floristic Province it lies within. Biologists have long recognized the high plant endemism of Southern California (Stebbins and Major 1965, Raven 1995). Recent records from the Jepson Herbarium confirm the high representation of California endemics within the native flora of the Tehachapi, San Joaquin Valley, and Transverse Ranges subregions (U.C. Berkeley, Jepson Herbarium unpubl.). Tejon Ranch sits at the junction of these floristic areas, and its flora reflects this endemism.

Endemic species (endemism)—species restricted in distribution, occurring nowhere outside a defined geographic area, such as a particular province or ecoregion.

Table 2. Examples of species and subspecies endemic to the Tejon region

Species	Reference
Vasek's clarkia (<i>Clarkia tembloriensis</i> ssp. <i>calientensis</i>)	USFWS 1998
Comanche Point layia (<i>Layia leucopappa</i>)	USFWS 1998
Bakersfield cactus (<i>Opuntia basilaris</i> var. <i>treleasei</i>)	USFWS 1998
Tejon poppy (<i>Eschscholzia lemmonii</i> ssp. <i>kernensis</i>)	USFWS 1998
Shoulderband snail (<i>Helminthoglypta uvasana</i>)	Roth and Hochberg 1992
Tehachapi slender salamander (<i>Batrachoseps stebbinsi</i>)	Jockusch and Wake 2002
Yellow-blotched salamander (<i>Ensatina eschscholtzii croceater</i>)	Wake 1997
Buena Vista Lake shrew (<i>Sorex ornatus relictus</i>)	USFWS 1998
Mount Pinos chipmunk (<i>Tamias speciosus callipeplus</i>)	Williams 1986
Yellow-eared pocket mouse (<i>Perognathus parvus xanthonotus</i>)	Williams et al. 1993
Tehachapi pocket mouse (<i>Perognathus alticola inexpectatus</i>)	Williams et al. 1993

Not surprisingly, the Tejon region also supports many threatened and endangered species and other species considered rare or sensitive because of their restricted distributions and substantial loss of habitat. At least 20 species listed as Threatened or Endangered and an additional 61 species otherwise designated as sensitive are known to occur or have the potential to occur in the vicinity of Tejon Ranch (Appendix C). Because of this concentration of listed species, the Recovery Plan for Upland Species of the San Joaquin Valley (USFWS 1998) targets the Tejon Hills, Bena Hills-Caliente Hills, and Comanche Point areas, which include areas of Tejon Ranch, as important for protection. In addition, Tejon Ranch is one of the last areas supporting populations of the endangered California condor in the wild. The Ranch is essential to ensuring the recovery of the condor, which requires huge, unfragmented, relatively open landscapes for foraging. In recognition of the Ranch's importance to the condor, the U.S. Fish and Wildlife Service has designated a significant part of the Ranch as Critical Habitat, i.e., containing *physical or biological features essential to the conservation of the species and which may require special management considerations or protection* (Section 3(5)(A) of the federal Endangered Species Act).



The importance of the Tejon region to California's biological diversity is illustrated by several other noteworthy facts:

- The CNDDDB lists several natural communities on Tejon Ranch and in the immediate vicinity of Tejon Ranch that are *rare and worthy of consideration*—valley needlegrass grassland, wildflower field, southern cottonwood willow riparian forest, and valley oak woodland. It is likely that other *rare and worthy* communities also are present on the Ranch, including arroyo willow riparian forest and scrub, California sycamore, Central California sycamore alluvial woodland, southern willow scrub, and Joshua tree tall shrub and open woodland (Anderson pers. comm.).
- The Tehachapi Mountains are estimated to support approximately 15% of California's breeding population of purple martins (Williams 1998), which nest in woodpecker cavities in the extensive oak woodlands on the Ranch. This is probably the largest natural nesting area for this species in North America (Grantham pers. comm.). Audubon-California consequently identified the oak woodlands in the Tehachapis as an Important Bird Area (Cooper in prep.). These oaks are some of the largest in California and have not been invaded by starlings, which displace native cavity-nesting birds (Block 1989, Williams 2002).
- Over one-third of all oak species in California occur in the Tejon region, making this area one of the highest in the state with respect to oak species richness. For example, of the 32 species in the oak family (Fagaceae) that occur in California, 11 of these species occur in the Tehachapi floristic subregion and 12 occur within the Western Transverse Ranges floristic district (U.C. Berkeley, Jepson Herbarium unpubl.).
- Tejon Ranch is part of an important migratory flyway used by Swainson's hawks and other raptors, white pelicans, and a variety of waterfowl and songbirds (Grantham pers. comm.). Jesse Grantham with National Audubon has counted as many as 175 Swainson's hawks at one time riding wind currents up Tunis Canyon through the Ranch and over the Tehachapis on their southward migration.
- The Ranch is notable for its diversity of intact watersheds supporting diverse aquatic and riparian habitats, which have become rare elsewhere in the state. The Ranch supports extensive stream systems, from their headwaters to lowland reaches, numerous springs, and regionally important wetlands and riparian habitats (Figure 8). These aquatic habitats historically have supported a variety of sensitive aquatic species, including pond turtles, foothill yellow-legged frogs, and red-legged frogs (Cooper pers. comm., Jennings pers. comm., U.C. Museum of Vertebrate Zoology unpubl.). The watersheds on the Ranch are still intact and may continue to support these species.



Oak in Bear Trap Canyon, Tejon Ranch
© A.M. Harvey 2003 www.visualjourneys.net

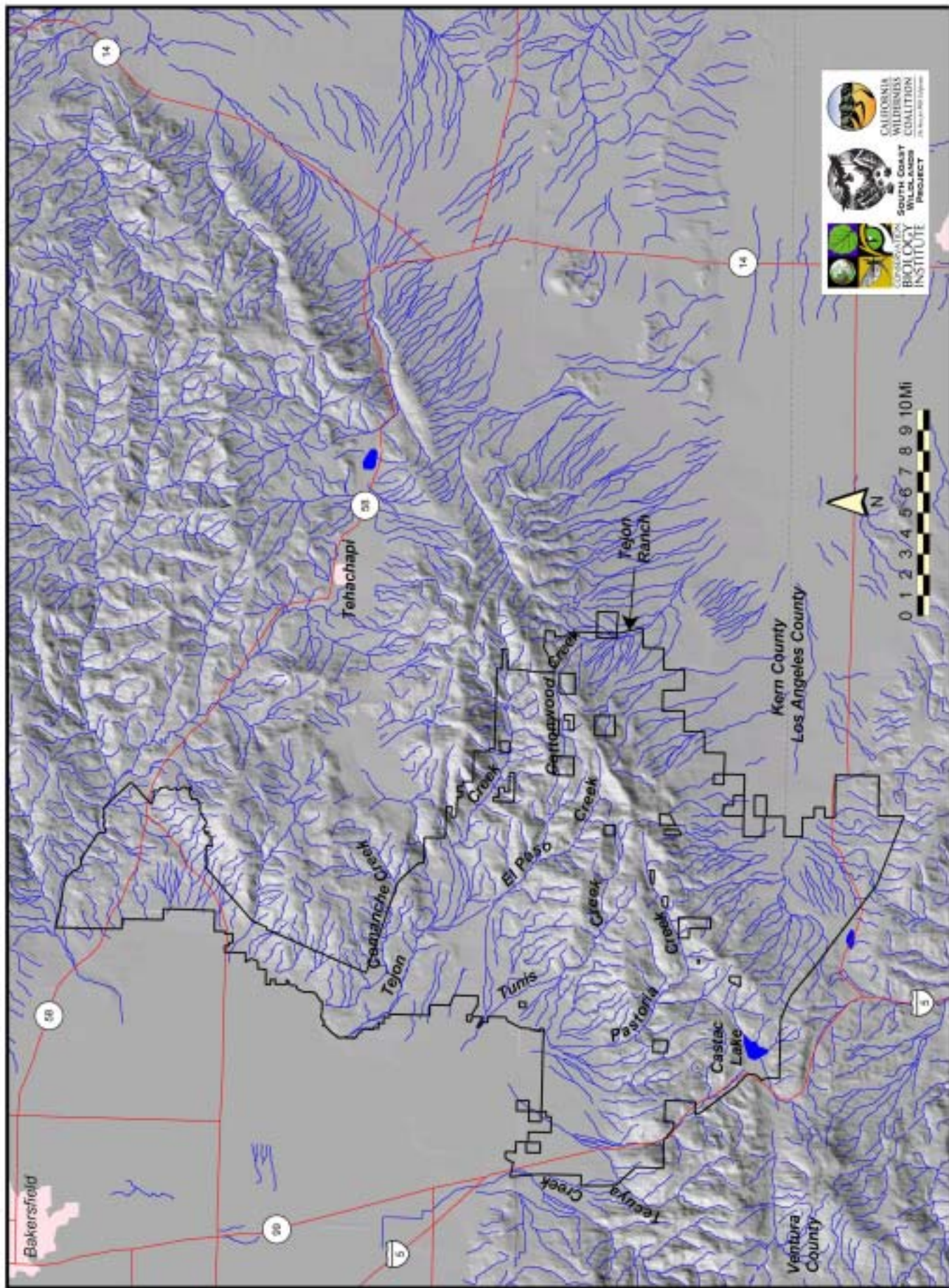


Figure 8. Streams of Tejon Ranch.



A crucible of evolution

Scientists are increasingly realizing that the overall goal of biological conservation should be to maintain not just species—the products of evolution—but the process of evolution itself (Erwin 1991, Brooks et al. 1992, Lesica and Allendorf 1995, Spector 2002). In the words of Craig Moritz, *The living world today is only a snapshot, but conservation biology should aim to preserve the whole unfolding saga of evolution* (Moritz, quoted in DeWeerd 2002). The only way to ensure that evolution can continue innovating, and keeping pace with climatic and other anthropogenic changes, is to conserve large, intact, and connected landscapes where evolutionary processes can continue at a grand scale, and especially to conserve known hotspots of evolutionary innovation. Tejon Ranch is demonstrably such an evolutionary hotspot—a crucible of evolutionary innovation. The dynamic geologic history of this place, which has alternately split and reconnected diverging lineages of species across many different taxa, along with its current remarkable confluence of four major ecoregions, have made this a region of dynamic evolutionary change.

The Tehachapi Mountains are widely recognized by evolutionary biologists as a region of evolutionary divergence and speciation for many taxa (Stebbins and Major 1965, Hafner 1979, Patton and Smith 1990, Roth and Hotchberg 1992, Wake 1997, Feldman 2000, Jockusch and Wake 2002, Patton and Alvarez-Castañeda in press). The slender salamanders (*Batrachoseps*) illustrate the fascinating evolutionary dynamics characteristic of this region of California (Yanev 1980, Wake and Jockusch 2000, Jockusch and Wake 2002). In the vicinity of Tejon Ranch, these evolutionary dynamics have produced the *Batrachoseps nigriventris* lineage, including *B. nigriventris*, *B. stebbinsi*, *B. gregarious*, and *B. simatus*. It is also likely that there is an undescribed species, distinct from *B. stebbinsi*, present on Tejon Ranch (Wake pers. comm.).



Tehachapi slender salamander
© T. Manolis 1992

Over evolutionary time, populations of slender salamanders that were periodically geographically isolated from one another became increasingly distinct genetically (Jockusch and Wake 2002). In zones of contact between salamander populations, genes from distinct lineages could be exchanged, unless the differences between them had become so great they prevented interbreeding (Jockusch and Wake 2002). There is still the potential for continued evolutionary dynamics within the *B. nigriventris* lineage in the Tejon Ranch area; however, dramatic changes in the landscape, such as urban development and habitat fragmentation, would alter the trajectory of evolution. The number of other taxa with contact zones in the vicinity of Tejon Ranch (Table 3) affirms the significance of the area from an evolutionary standpoint and its potential role as a *staging ground for evolution* (Jockusch and Wake 2002).



Table 3. Taxa with contact zones* in the vicinity of Tejon Ranch

Taxon	Species, subspecies, or clade	Reference
Shoulderband snail <i>Helminthoglypta</i> spp.	<i>H. tejonis</i> <i>H. uvasana</i> <i>H. unicolor</i>	Roth 1987 Roth and Hochberg 1988 Roth and Hochberg 1992
Slender salamander <i>Batrachoseps nigriventris</i> group	<i>B. nigriventris</i> <i>B. stebbinsi</i> <i>B. gregarious</i> <i>B. simatus</i>	Jockusch and Wake 2002
Western whiptail <i>Cnemidophorus tigris</i>	<i>C. t. tigris</i> <i>C. t. mundus</i> <i>C. t. stejnegeri</i>	Stebbins 2003
Ensatina salamander <i>Ensatina eschscholtzii</i>	<i>E. e. croceator</i> <i>E. e. eschscholtzii</i>	Wake 1997
Southern alligator lizard <i>Elgaria multicarinata</i>	<i>E. m. multicarinata</i> <i>E. m. webbii</i>	Feldman 2000
Leopard lizard <i>Gambelia</i> spp.	<i>G. sila</i> <i>G. wislizenii</i>	Stebbins 2003
Coachwhip <i>Masticophis flagellum</i>	<i>M. f. ruddocki</i> <i>M. f. piceus</i>	Jennings and Hayes 1984
Western patch-nosed snake <i>Salvadora hexalepis</i>	<i>S. h. virgultea</i> <i>S. h. mojavensis</i>	Stebbins 2003
California mountain kingsnake <i>Lampropeltis zonata</i>	<i>L. z. multicolor</i> <i>L. z. multifasciata</i>	Rodriguez-Robles et al. 1999
Horned lizard <i>Phrynosoma coronatum</i>	<i>P. c. frontale</i> <i>P. c. blainvillei</i>	Jennings and Hayes 1984
Garter snake <i>Thamnophis sirtalis</i>	<i>T. s. infernalis</i> <i>T. s. fitchi</i>	Stebbins 2003
Aquatic garter snake <i>Thamnophis</i> spp.	<i>T. couchii</i> <i>T. hammondi</i>	Stebbins 2003
Rattlesnake <i>Crotalus</i> spp.	<i>C. viridis oregonus</i> <i>C. v. helleri</i> <i>C. scutulatus</i>	Stebbins 2003
Rubber boa <i>Charina bottae</i>	<i>C. b. bottae</i> <i>C. b. umbricata</i>	Rodriguez-Robles et al. 2001
Pocket gopher <i>Thomomys bottae</i>	<i>T. b. bottae</i> <i>T. b. pascalis</i>	Patton and Smith 1990
Desert woodrat <i>Neotoma lepida</i>	Subclades 1B, 1C, 2A	Patton and Alvarez-Castañeda, in press
San Joaquin kangaroo rat <i>Dipodomys nitratoides</i>	<i>D. n. nitratoides</i> <i>D. n. brevinasus</i>	Hafner 1979

*Contact zones are areas where ranges of related taxa overlap.



Regional Conservation Value

In this section, we evaluate the conservation significance of Tejon Ranch relative to the extent and configuration of natural resources protection in the region, roadless areas, regional integrity of habitats and watersheds, and regional habitat connectivity. For the purposes of these analyses, the Tejon region is defined as a 6.5 million-acre circular area centered on Tejon Ranch.

Regional conservation patterns

Gap analysis (Scott et al. 1993) is a coarse-filter approach for prioritizing conservation efforts—it examines the regional ownership, protection, and management patterns of vegetation communities and other indicators of biodiversity to determine where there are gaps in their protection. We conducted a gap analysis to evaluate the potential role of Tejon Ranch in conserving the diversity of vegetation communities in the region.

Tejon Ranch lies between protected areas associated with Los Padres National Forest and Wind Wolves Preserve, southwest of the Ranch, and Sequoia National Forest and Bureau of Land Management land northeast of the Ranch (Figure 9). These areas, in turn, are connected to other protected or public lands that form a virtually continuous swath of natural open space from the Pacific Ocean to the California-Nevada border. The Ranch supports several vegetation community types that are not well-represented within protected areas in the region, including valley oak woodland, grassland, and fir forest (Table 4). In particular, grassland and valley oak woodland are regionally under-represented within protected areas in the region, with less than 1% of valley oak woodland and only 16% of grassland currently protected. If these community types were completely conserved on Tejon Ranch, an additional 21,881 acres of valley oak woodland and 116,181 acres of grasslands would be conserved in the region. These community types provide habitat for many sensitive species (Appendix C). Blue oak woodland and coastal oak woodland are also not well-represented within protected areas in the region, and Tejon Ranch supports significant acreages of these community types (Table 4, Figures 10 and 11).

Within the 6.5 million-acre Tejon region, over 20% of natural habitats (>1,400,000 acres) have been converted to agriculture or urban land uses (Figure 6). These land cover changes have occurred primarily at lower elevations and, as a consequence, have disproportionately affected grassland, shrubland, and oak woodlands. Conversely, the vast majority (>75%) of protected areas in the region are at elevations above 3,500 feet, and less than 5% of protected areas are below 1,650 feet. This pattern of developing lowland areas and conserving higher elevation areas that are more difficult to develop is reflected throughout California and the nation (Scott et al. 2001). On Tejon Ranch, approximately 50% of the land lies below 3,500 feet, and more than 25% is below 1,650 feet. Thus, on Tejon Ranch, there is a significant opportunity to conserve lower elevation habitats that are currently under-protected in the region.

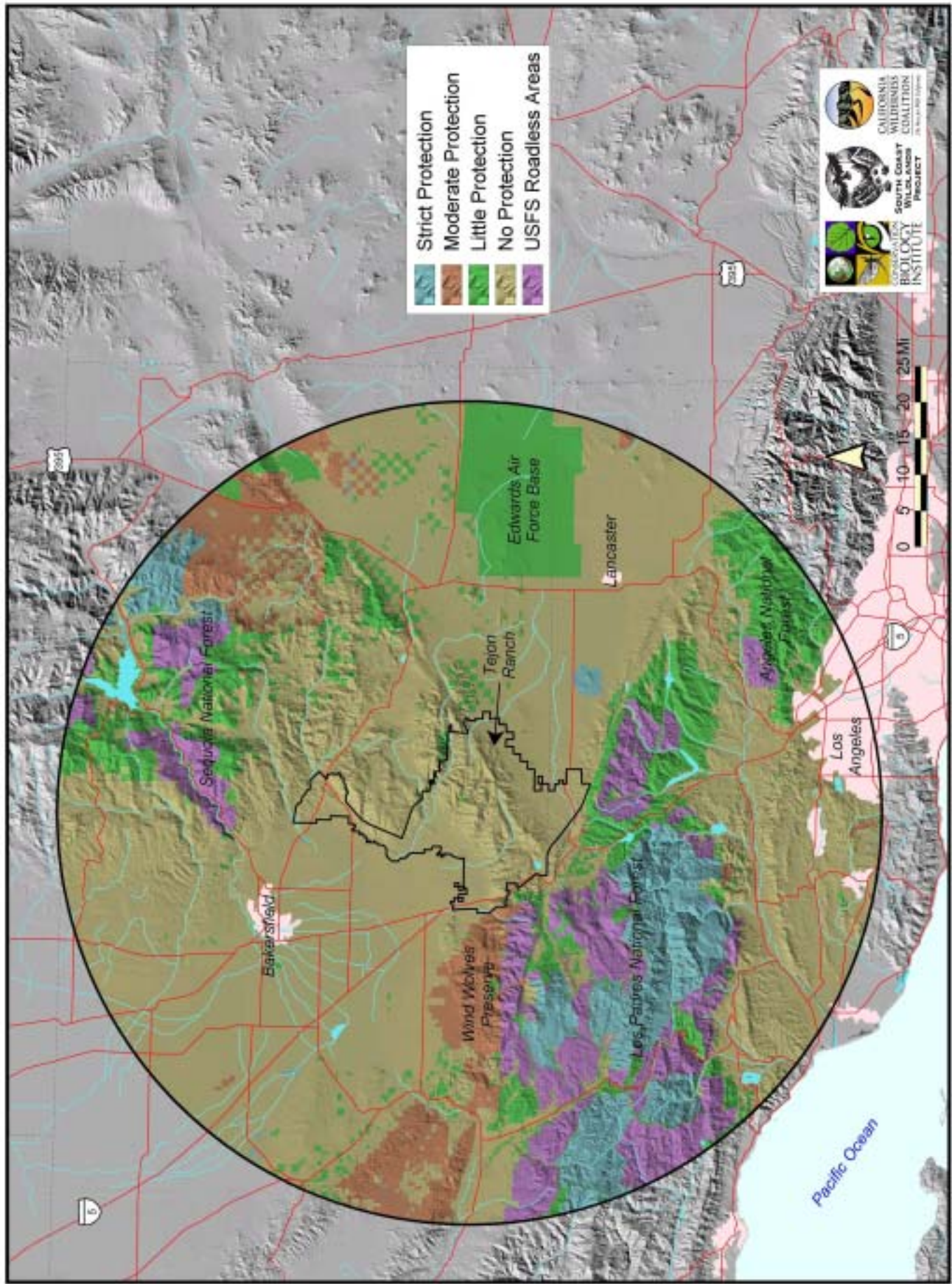


Figure 9. Protection status and Forest Service inventoried roadless areas.



Table 4. Conservation representation by vegetation community

Vegetation Community	Region (acres)	GAP 1&2* (acres)	Representation (%)	Tejon Ranch (acres)	Combined (%)	Increase
Blue oak woodland	238,876	30,315	13%	13,914	19%	6%
Blue oak-foothill pine	48,628	3,160	7%	729	8%	2%
Coastal oak woodland	69,323	9,990	14%	3,815	20%	6%
Valley oak woodland	35,358	237	<1%	21,881	63%	62%
Grassland	1,213,075	198,425	16%	116,181	26%	10%
Fir forest	1,707	114	7%	845	56%	49%
Riparian	23,836	7,851	33%	252	34%	1%
Wetland	3,793	1,156	30%	210	36%	6%
Juniper	40,201	2,627	7%	551	8%	1%
Mixed conifer	73,014	31,768	44%	4,154	49%	6%
Montane hardwood-conifer	156,877	71,944	46%	13,272	54%	8%
Pine forest	118,993	53,693	45%	114	45%	<1%
Pinyon-juniper	294,934	207,775	70%	14,562	75%	5%
Chaparral	894,320	436,478	49%	25,444	52%	3%
Sagebrush	100,035	31,229	31%	1,594	33%	2%
Scrub	1,608,659	264,508	16%	17,888	18%	1%
Other shrubland	145,547	8,330	6%	24,357	22%	17%

* GAP 1 = strict protection, GAP 2 = moderate protection; see Figure 9.

See Appendix A for data sources and methods.

Vegetation communities highlighted in yellow are under-represented in protected open space in the Tejon region.

Roadless areas

Roads and road maintenance affect terrestrial and aquatic environments in many ways—increased erosion, air and water pollution, spread of invasive exotics, road mortality, alteration of movement patterns, and habitat fragmentation (Spellerberg 1998,

On National Forest lands, the Forest Service inventoried **roadless areas** (minimum mapping unit of 5,000 acres, or 1,000 acres adjacent to existing Wilderness Areas) to determine which areas should be considered for wilderness designation as a result of the Wilderness Act of 1964 (Croswell and Cutler 1983). For this report, we mapped lands with natural cover >500 acres, without roads, on both public and private lands (Figure 12).

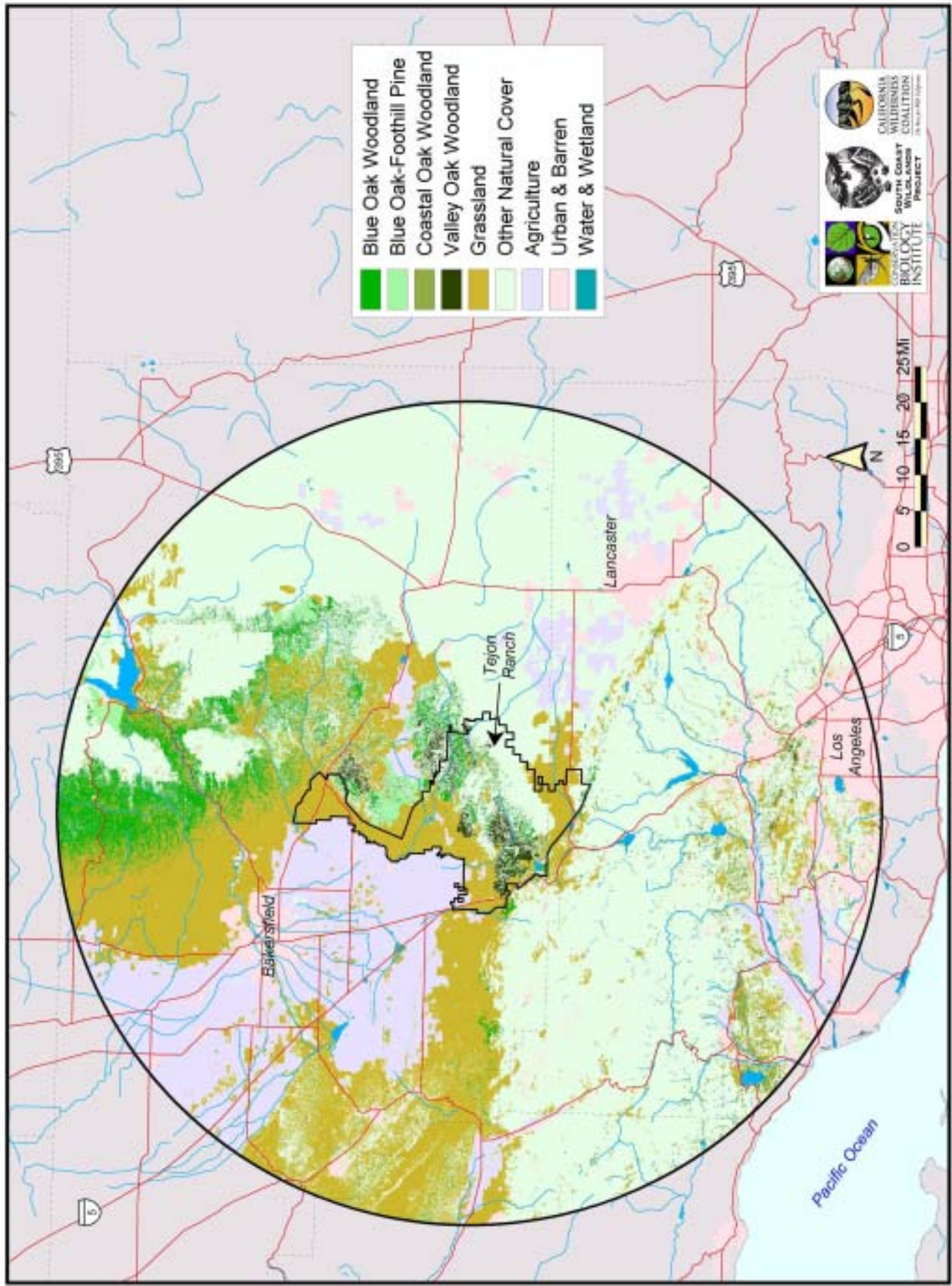


Figure 10. Land cover emphasizing oak woodlands and grasslands - regional extent.

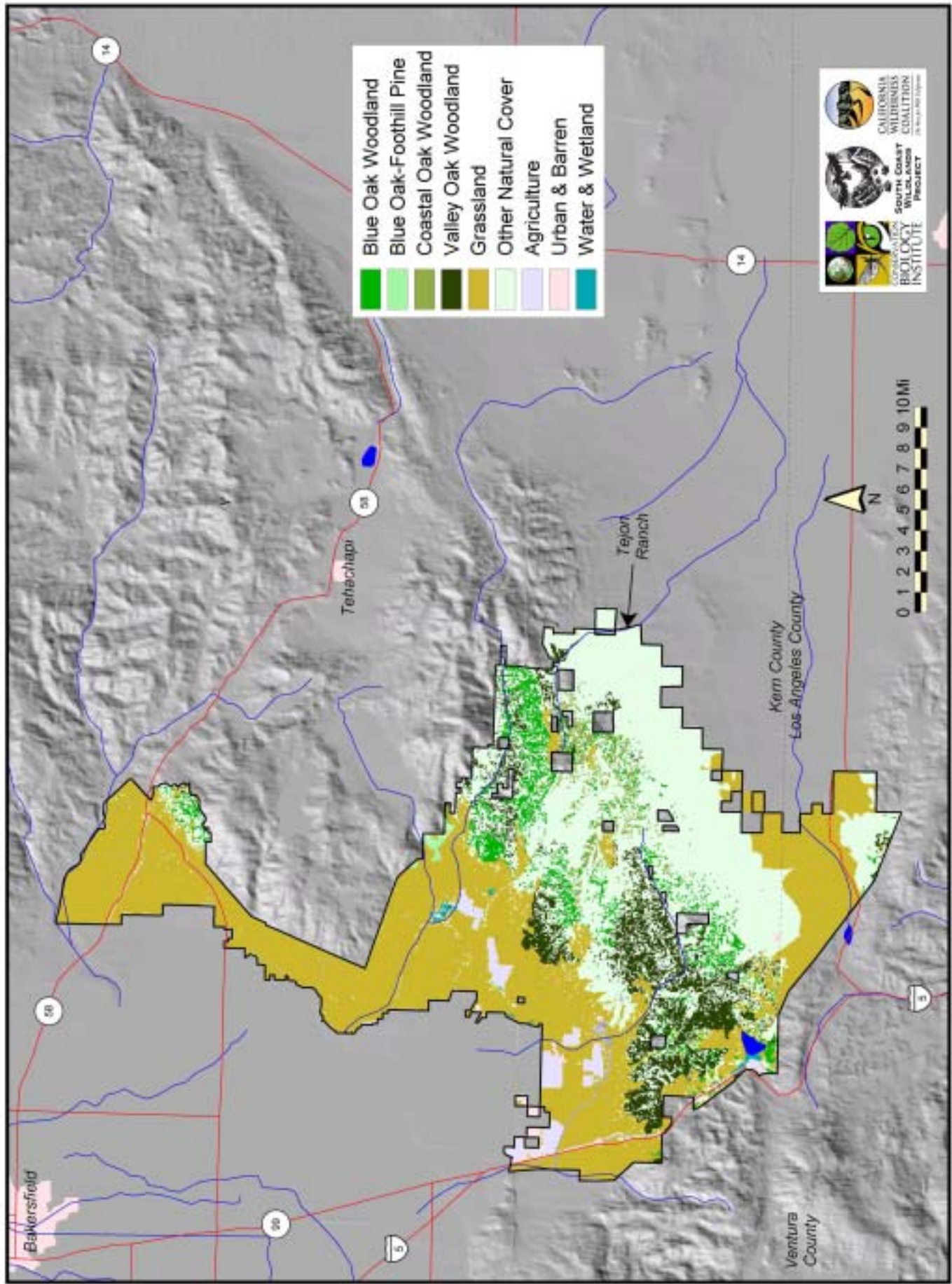


Figure 11. Land cover emphasizing oak woodlands and grasslands - Tejon Ranch extent.



Strittholt et al. 2000, Trombulak and Frissell 2000, Jones et al. 2000, Czech et al. 2001, Paul and Meyer 2001). Roads not only fragment natural ecosystems (Reed et al. 1996), but they also provide human access to areas for logging, mining, agriculture, and development, leading to additional loss of habitat and degradation of ecosystem integrity. We therefore mapped roadless areas (Figure 12) within the Tejon region to gauge the extent of habitat fragmentation.

Roadless areas are virtually absent from the relatively level terrains in the San Joaquin, Antelope, Tehachapi, and Cummings valleys. While roads have affected grassland habitats in the San Joaquin Valley, the majority of Tejon Ranch is roadless. In fact, the Ranch represents the only contiguous block of roadless habitats connecting the adjacent roadless areas of the Los Padres and Sequoia National Forests. The western edge and central portion of Tejon Ranch support roadless areas >10,000 acres in size, and roadless areas of 5,000-10,000 acres lie at the southern end and north-central portion of the Ranch (Figure 12). Much of the matrix land around these large roadless areas supports roadless habitat patches of 1,000-5,000 acres (Figure 12). The absence of roads across this landscape is critical to maintaining its wildland values.

Land cover changes and habitat integrity

To assess the extent of both road development and other land use changes (e.g., agricultural conversion and urbanization) in the Tejon region, we modeled habitat integrity based on road density and the magnitude and reversibility of negative effects associated with specific land uses. For example, urban land uses generally have greater negative effects on biological resources and are less reversible than agricultural uses and, thus, received a higher *score* in the model. Likewise, row crops received a higher score than orchards, because they tend to have less value for wildlife species as a result of greater frequency and intensity of human disturbance. Scores for road density and land use were summed, and areas with the lowest scores (least negatively affected) were assigned the highest integrity values. We did not factor grazing into this analysis, which is likely to have caused some degradation of habitats in the region. However, the effects of grazing generally are more reversible than the land uses evaluated in the model, and grazing can be managed to the benefit of some native species and, in some instances, may be necessary for some native species.

Habitat integrity—the ideal state of an ecosystem or block of habitat that is whole, undiminished, unimpaired, fully functional, healthy, and unconstrained by human activities.

The majority of Tejon Ranch ranks as having high or medium-high habitat integrity (Figure 13). Moreover, the Ranch connects adjacent areas of high habitat integrity in Sequoia and Los Padres National Forests. The high physical integrity of habitats and watersheds on Tejon Ranch also implies functional ecosystem processes. The pattern of urban development has left a swath of relatively intact habitat spanning from the Sierra Nevada to the Transverse and Coast Ranges and includes Tejon Ranch. These remaining habitat areas are becoming increasingly degraded and fragmented by roads and the encroachment of urban centers in the southern San Joaquin Valley,

Fragmentation—the process by which a relatively continuous habitat area is subdivided into smaller and more isolated pieces, usually resulting in the loss of species and ecosystem integrity.

western Mojave Desert, greater Los Angeles area, the Simi Valley–Ventura–Oxnard corridor, and, to a lesser degree, the Tehachapi Valley (Figure 13). Thus, Tejon Ranch represents a roadless, intact core area between already protected core areas in a region where urban land uses have eliminated or fragmented the remaining natural habitats.

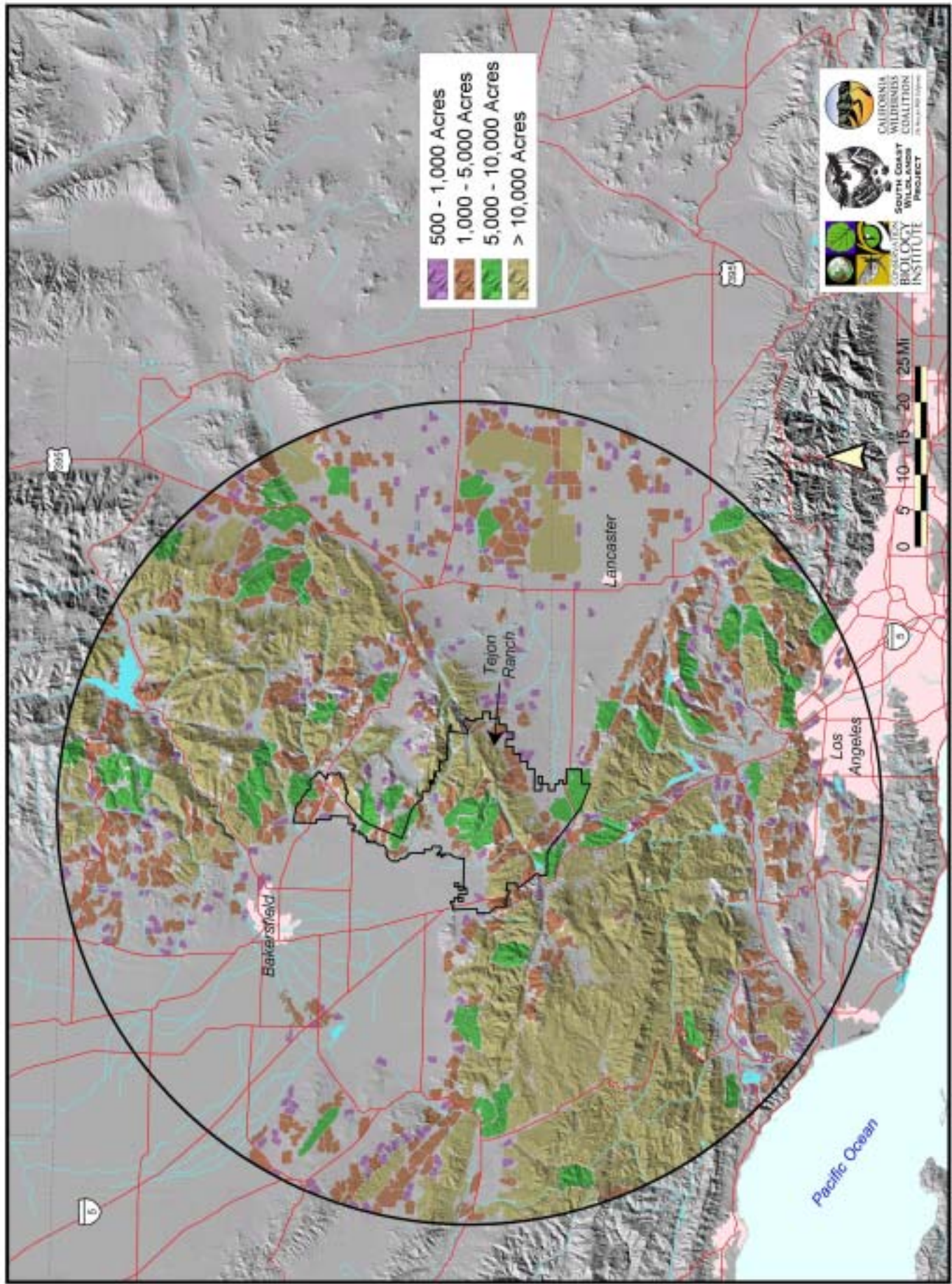


Figure 12. Uninventoried roadless areas.

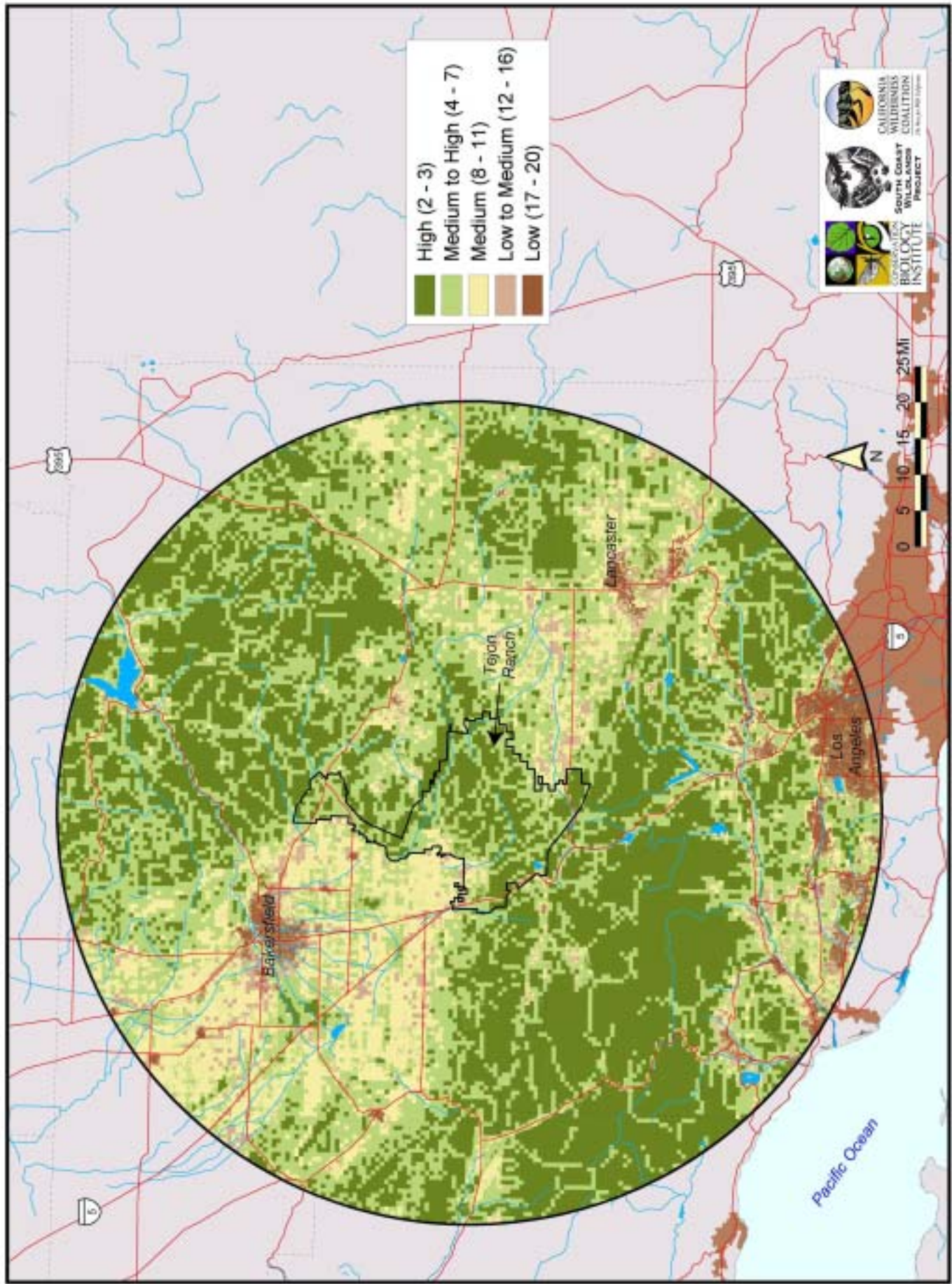


Figure 13. Regional ecosystem integrity.



Habitat connectivity

Connectivity of natural open space is widely regarded as essential to functional landscapes (e.g., Noss 1987, Noss 1991, Saunders et al. 1991, Beier and Noss 1998, Crooks 2002). In fact, providing for connectivity of conserved lands is a fundamental principle of conservation planning (Noss et al. 1997, CDFG 1993, California Natural Community Conservation Planning Act 2002). Significant conservation investments have been made in the vicinity of Tejon Ranch by federal, state, and private entities, and the Ranch represents the last remaining, intact landscape between these protected areas (Figure 9). The value of these existing conservation investments relies on maintaining the lands' integrity and intact ecosystem functions by buffering them from development and maintaining connections to other intact areas.

Historic stewardship efforts have kept Tejon Ranch relatively roadless, thus helping to maintain high habitat integrity (Figures 12 and 13). The Ranch provides landscape linkages for large, mobile species (e.g., mountain lion and mule deer), as well as smaller, less mobile species (e.g., invertebrates, amphibians, reptiles, rodents) that require multiple generations to disperse across the landscape. For species that won't cross the Central Valley because of their habitat requirements, this is the only habitat linkage between the Sierras and the Coast Ranges south of Redding. Moreover, Tejon Ranch represents the last remaining grassland between the western and eastern portions of the southern San Joaquin Valley (Figure 6). The valley floor portion of Tejon Ranch is part of the linkage *Southwest, Southern, and Southeastern Valley edge, McKittrick south to Maricopa, east and north to Kern River* that must be maintained for recovery of San Joaquin Valley species (USFWS 1998, Recovery Task #5.3.8). Severing this grassland connection at Tejon Ranch would result in permanent isolation of grassland communities on opposite sides of the valley and preclude genetic exchange between grassland species.

The South Coast Wildlands Project (SCWP) is conducting planning-level conservation assessments for 15 priority habitat linkages throughout the South Coast Ecoregion (SCWP in prep.). The landscape linkage represented by Tejon Ranch, between core protected areas in the Los Padres and Sequoia National Forests, is ranked as one of these priority linkages, based on its size, biological irreplaceability, vulnerability to threats, and existing conservation investments. Preliminary results of SCWP's analyses demonstrate the importance of Tejon Ranch for maintaining habitat connectivity for a wide variety of species, at all elevations, from the floor of the San Joaquin Valley, to the high-elevation pine and fir forests, to the Mojave Desert. For example, grassland specialists such as the kit fox and American badger rely on the last remaining grassland linkage through Tejon Ranch for regional habitat connectivity. Tejon Ranch is one of the last remaining contact zones for Tipton's and short-nosed kangaroo rats. Mountain lions and deer rely on shrubland and woodland habitats along the slopes and valleys of the Tehachapi Mountains for movement and long-range dispersal. Fir forests on Tejon Ranch form part of an archipelago of high elevation islands linking the San Emigdio and Piute Mountains and associated species. These habitats serve as critical *stepping-stones* for dispersal of species such as the blue grouse, which is currently absent from the San Emigdios but could recolonize this historic portion of its range from occupied habitats in the Sierra Nevada (Bland pers. comm.). Finally, some species rely on connectivity within the foothill transition into the Mojave Desert, such as the narrow endemic Tehachapi pocket mouse, which survives in a restricted habitat zone where the desert butts against the base of the Tehachapis and northern San Gabriel Mountains.



Analysis of Threats and Vulnerability

Habitat fragmentation and roads

The loss and fragmentation of habitats is considered the single greatest threat to biodiversity at global and regional scales (Myers 1997, Noss and Csuti 1997, Brooks et al. 2002). Over 80% of imperiled or federally listed species in the U.S. are at risk from habitat degradation and loss (Wilcove et al. 2000). It has been estimated that 32% of California's diverse flora and vertebrate fauna are at risk (Stein et al. 2000). Urban sprawl, defined as encroachment of low-density, automobile-dependent development into the natural areas outside of cities and towns, imperils



San Joaquin kit fox
© L.G. Ingles 1999 Cal. Acad. Sciences

65% of the species listed as Threatened or Endangered in California (Czech et al. 2000). Within the southern portions of the Sierra Nevada, Coast Range, San Joaquin Valley, and western South Coast region, the most commonly cited endangerment factors are residential and industrial development, introduction of exotic species, agricultural development, and heavy equipment (Flather et al. 1998).

Remaining natural areas in the Tejon region are at risk from this trend. Road construction and conversion of land to agricultural and urban land uses have fragmented natural habitats. The remaining habitat fragments, lying within a matrix of altered land cover, experience edge effects in the form of altered physical conditions (Saunders et al. 1991, Pickett et al. 2001) and fire regimes (Keeley and Fotheringham 2001), increased invasions by exotic plant and animal species (Suarez et al. 1998, Brothers and Spingarn 1992), changes in vegetation structure (Pickett et al. 2001), loss of top predators and changes in interspecific interactions (Bolger et al. 1991, Crooks 2002), and altered population dynamics (Soulé et al. 1992). Roads have even broader geographic impacts, such as serving as sources of pollution, altering hydrologic patterns, disrupting migration patterns, and causing direct mortality via road kill (Beier 1995, Trombulak and Frissell 2000).

Modifications to watershed processes

Poff et al. (1997) discussed the concept of the *natural flow regime* of riverine systems as the critical determinant of their biological composition. The natural flow regime can be described by five key characteristics: magnitude, frequency, duration, timing, and rate of change of discharge (Poff et al. 1997). Because urbanization can modify the natural flow regime of stream systems, aquatic and riparian communities that depend on a natural flow regime are ultimately affected. Urbanization increases the area of impervious surfaces (Paul and Meyer 2001), which increases storm runoff, peak discharges, and flood magnitudes downstream (Dunne and Leopold 1978, Gordon et al. 1992, Leopold 1994). Importing water into an urban watershed for landscape irrigation may also increase dry-season base flows and can cause intermittent streams to become perennially flowing, thereby altering the composition of riparian vegetation communities (White and Greer unpubl. MS). Urbanization produces other adverse changes to



watersheds and stream systems, including increasing nutrient and contaminant loads, elevating water temperatures, facilitating invasion by non-native aquatic species, and, ultimately, reducing the abundance of native aquatic and riparian species (Paul and Meyer 2001). Therefore, protecting intact watersheds on Tejon Ranch, and the aquatic, wetland, and riparian systems they support, should be a high conservation priority.

Climate change

Conservation scientists are concerned with the implications of global climate change for native biodiversity (Peters and Darling 1985, Kareiva et al. 1992, Malcomb et al. 2001). Climate models suggest that Southern California will experience increased winter precipitation, hotter and drier summers, and more severe El Niño events (Field et al. 1999). One consequence of these changes will likely be shifts in the distribution of vegetation communities and species ranges. The availability of contiguous habitat areas with broad elevational and other environmental gradients is critical to accommodating these shifts in species distributions. It has been suggested that areas with high physical heterogeneity will allow species greater *choices* in the face of changing conditions (Meffe and Carroll 1997). Thus, areas such as Tejon Ranch, that are located at geomorphic and biogeographic crossroads, may serve as species refugia during climate change.

Proposed developments

The Tejon Ranch Company is currently planning development of Tejon Ranch. Presently disclosed development projects include the Tejon Industrial Complex, Centennial Project, and Mountain Village Project, all located along the western margin of the Tejon Ranch property, along the Interstate-5 corridor (Figure 14). These industrial and residential development projects will introduce significant additional urbanization to one of the last remaining areas of open space in a region that has experienced considerable land use changes, particularly along Interstate-5 and within developable valley areas (e.g., Tehachapi, Cummings, San Joaquin, and Antelope valleys). The Tejon Ranch developments are proposed for areas that support regionally under-protected resources such as grassland and oak woodlands, which provide habitat for numerous listed or sensitive species. The location of these developments has the potential to significantly compromise habitat connectivity between adjacent protected areas. Moreover, the creation of a major urban area within the relatively intact Tejon Ranch will have profound consequences for the natural resources of the area by internally fragmenting the core habitat area of the Ranch.

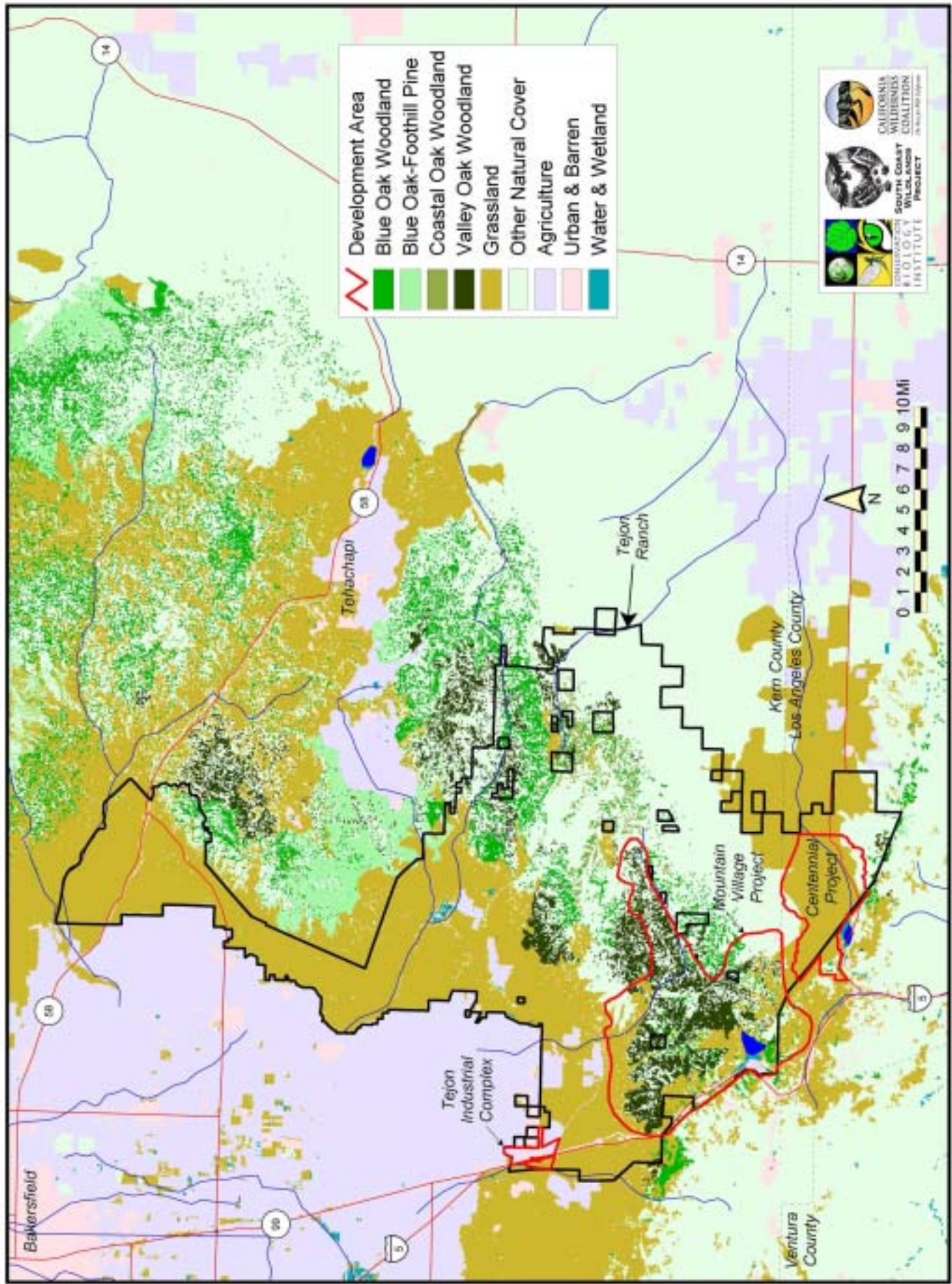


Figure 14. Proposed development areas for Tejon Ranch.



Summary and Recommendations

The Tejon region is an irreplaceable piece of California whose future deserves careful consideration. It lies at the biogeographic crossroads of five geomorphic provinces and four floristic regions, all within the global hotspot recognized by scientists as the California Floristic Province. Within this hotspot, the 270,000-acre Tejon Ranch supports 23 different vegetation communities (60% of the vegetation communities in the region), Critical Habitat for the endangered California condor, and potential habitat for 20 state and federally listed species and 61 other rare and endemic species, all within about 40 miles of the largest population center of California. Tejon Ranch provides a unique opportunity to conserve low-elevation grasslands and oak woodlands that are under-protected in the region.



Tejon poppy
© D.W. Taylor 1987

Tejon Ranch is a largely roadless, biological core area with high habitat integrity and intact, functioning watersheds. It is one of the California Wilderness Coalition's ten most threatened wild places in California (CWC 2003). Los Angeles County has designated portions of the Ranch as Significant Ecological Areas (SEA) and is considering expanding the area under this designation (PCR Services Corp. 2000). The Ranch meets virtually all of the state Resources Agency priority criteria for conservation (Table 5). Significant conservation on the Ranch is crucial to ensuring that existing conservation investments remain intact and to linking the Sequoia National Forest with the Los Padres National Forest.

Table 5. California Department of Fish and Game priority criteria for conservation

Local or Statewide Significance

- Critical wintering, breeding, or migratory habitat
- Extremely rare species/habitats
- Representative examples of species and habitats
- Essential habitat linkages
- Critical buffer zones
- Species/habitats declining throughout the state
- Critical for maintaining ecosystem functions
- Critical habitat for species important to the Department
- Lands critical for successfully implementing regional conservation plans

Site Viability and Habitat Conditions

- Large area of natural vegetation or areas adjacent to large protected areas
- Robust populations of species
- Few, if any, immediate or near-term threats
- Relatively undisturbed watersheds upstream of the site
- Potential for multi-species protection

Site Diversity

- High number of species/habitats present
- Populations of native species that exhibit important subspecies or genetic varieties
- Populations of species/habitats that inhabit special/unusual environments
- Representative examples of functional diversity
- Natural landscapes that support representative examples of important ecological functions

Source: California Legacy Project 2002



The future of the Tejon region deserves immediate attention from the public and decision-makers at municipal, state, and federal levels of government. The full significance of this pivotal landscape can be understood only within a regional or statewide context. Therefore, our recommendations call for an extraordinary effort to protect an extraordinary place:

- Review all biological survey data for this area, including data collected under state and federal endangered species permits and scientific collecting permits, and assess where there are data gaps or additional studies needed.
- Develop a comprehensive, multi-jurisdictional plan for protection and development of this region, using principles of *smart growth*, conservation planning and reserve design, and sustainable working landscapes.
- Evaluate the cumulative effects of conservation and development on quality of life for all citizens of the state.



Striped adobe lily
© Br. A. Brousseau, St. Mary's College

The resources of Tejon Ranch, and their significance to conservation and California's heritage, are irreplaceable.

References

- Anderson, I. 2003. Personal communication with Michael White, July 9.
- Atwater, T. 1989. Plate tectonic history of the northeast Pacific and western North America. Chapter 4 in Winterer, E.L., D.M. Hussong, and R.W. Decker (eds.), *The geology of North America, Vol. N: the eastern Pacific Ocean and Hawaii*. The Geological Society of America, Boulder, CO.
- Barbour, M.G., and J. Major. 1995. 4th ed. *Terrestrial vegetation of California*. California Native Plant Society, Special Publication Number 9. Sacramento, CA.
- Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitat. *Journal of Wildlife Management* 59:228-237.
- Beier, P., and R.F. Noss. 1998. Do habitat corridors provide connectivity? *Conservation Biology* 12:1241-1252.
- Bland, J. 2003. Personal communication with Alison Sterling Nichols, March 26.
- Block, W.M. 1989. Spatial and temporal patterns of resource use by birds in California oak woodlands. Ph.D. dissertation. University of California, Berkeley, CA.
- Bolger, D.T., A.C. Alberts, and M.E. Soulé. 1991. Occurrence patterns of bird species in habitat fragments: sampling, extinction, and nested species subsets. *American Naturalist* 137:155-166.
- Brooks, D.R., R.L. Mayden, and D.A. McLennan. 1992. Phylogeny and biodiversity: conserving our evolutionary legacy. *Trends in Ecology & Evolution* 7:55-59.
- Brooks, T.M., R.A. Mittermeier, C.G. Mittermeier, G.A.B. da Fonseca, A.B. Rylands, W.R. Konstant, P. Flick, J. Pilgrim, S. Oldfield, G. Magin, and C. Hilton-Taylor. 2002. Habitat loss and extinction in the hotspots of biodiversity. *Conservation Biology* 16:909-923.
- Brothers, T.S., and A. Spingarn. 1992. Forest fragmentation and alien plant invasion of central Indiana old-growth forests. *Conservation Biology* 6(1):91-100.
- Brown, T. 2003. Personal communication with Michael White, July 16.



- California Department of Fish and Game. 1993. Southern California coastal sage scrub NCCP conservation guidelines. Revised November 1993.
- California Legacy Project. 2002. First annual conservation priorities report. The Resources Agency.
- California Native Plant Society (CNPS). 2001. 6th ed. Inventory of rare and endangered plants of California. Rare Plant Scientific Advisory Committee, Tibor, D.P. (ed.), CNPS, Sacramento, CA. 388 pp.
- California Natural Community Conservation Planning Act. 2002. California Fish and Game Code Section 2800-2835. Repealed and added by statutes 2002.
- California Wilderness Coalition. 2003. California's 10 most threatened wild places. California Wilderness Coalition, Davis, CA. <http://www.calwild.org/resources/pubs/10most.php>
- Cooper, D.S. In preparation. Important bird areas of California. Audubon-California.
- Cooper, D.S. 2003. Personal communication with Michael White, June 4.
- Crooks, K.R. 2002. Relative sensitivities of mammalian carnivores to habitat fragmentation. *Conservation Biology* 16:488-502.
- Croswell, J.B., and M.R. Cutler. 1983. Roadless lands in limbo. *American Forests*. March:12-13, 61-63.
- Cypher, B. 2003. Personal communication with Michael White, July 20.
- Cypher, E. 2003. Personal communication with Michael White, July 8.
- Czech, B., K. Doyle, J. Kostyack, B. McNitt, G. Sugameli, C. Whitaker, K. Whitcomb-Blylock, J. Byrd, and G. Stall. 2001. Paving paradise: sprawl's impact on wildlife and wild places in California. Unpublished report, National Wildlife Federation.
- DeWeerd, S. 2002. What really is an evolutionarily significant unit? *Conservation Biology in Practice* 3:10-17.
- Dunne, T., and L.B. Leopold. 1978. *Water in environmental planning*. W.H. Freeman Co., San Francisco, CA.
- Erwin, T.L. 1991. An evolutionary basis for conservation strategies. *Science* 253:750-752.
- Feldman, C.R. 2000. Comparative phylogeography of three California reptiles: *Contia tenuis*, *Diadophis punctatus*, *Elgaria multicarinata*. MA thesis. San Francisco State University, San Francisco, CA.
- Field, C.B., G.C. Daily, F.W. Davis, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller. 1999. *Confronting climate change in California: ecological impacts on the Golden State*. Union of Concerned Scientists, Cambridge, MA and Ecological Society of America, Washington, DC.
- Flather, C.H., M.S. Knowles, and I.A. Kendall. 1998. Threatened and endangered species geography. *BioScience* 48:365-376.
- Gordon, N.D., T.A. McMahon, and B.L. Finlayson. 1992. *Stream hydrology: an introduction for ecologists*. John Wiley & Sons Ltd., Baffins Lane, Chichester, West Sussex, England.
- Grantham, J. 2003. Personal communication with Alison Sterling Nichols, March 12, and Michael White, July 12.
- Hafner, M.S. 1979. Density, distribution, and taxonomic status of *Dipodomys nitratooides nitratooides* Merriam, 1994 (Rodentia - Heteromyidae). California Department of Fish and Game, Nongame Wildlife Investigations, Draft Final Report. 17 pp.
- Hickman, J.C. (ed.). 1996. *The Jepson manual. Higher plants of California*. University of California Press, Berkeley, CA. 1400 pp.
- Holland, R.F. 1986. Preliminary descriptions of the terrestrial natural communities of California. The Resources Agency, Department of Fish and Game. 156 pp.



- Jennings, M.R., and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. Final report to the California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, CA. Contract 8023. iii + 255 pp.
- Jennings, M.R. 2003. Personal communication with Alison Sterling Nichols, March 3.
- Jockusch, E.L., and D.B. Wake. 2002. Falling apart and merging: diversification of the slender salamanders (Plethodontidae: Batrachoseps) in the American West. *Biological Journal of the Linnean Society* 76:361-391.
- Jones, J.A., F.J. Swanson, B.C. Wemple, and K. Synder. 2000. Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. *Conservation Biology* 14:76-85.
- Kareiva, P.M., J.G. Kingsolver, and R.B. Huey (eds). 1992. *Biotic interactions and global change*. Sinauer and Associates, Sunderland, MA.
- Keeley, J.E., and C.J. Fotheringham. 2001. The historical role of fire in California shrublands. *Conservation Biology* 15:1536-1548.
- Leopold, L.B. 1994. *A view of the river*. Harvard University Press, Cambridge, MA.
- Lesica, P., and F.W. Allendorf. 1995. When are peripheral populations valuable for conservation? *Conservation Biology* 9:753-760.
- Malcolm, J.R., A. Markham, and R.P. Neilson. 2001. Can species keep up with global climate change? *Conservation Biology in Practice* 2(2):24-25.
- Meffe, G.K., and C.R. Carroll. 1997. 2nd ed. Conservation reserves in heterogeneous landscapes. Chapter 10 *in* Meffe, G.K., and C.R. Carroll (eds.), *Principles of conservation biology*. Sinauer Associates, Inc. Sunderland, MA.
- Mittermeier, R.A., N. Myers, J.B. Thomsen, G.A.B. da Fonseca, and S. Olivieri. 1998. Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. *Conservation Biology* 12(3):516-520.
- Mittermeier, R.A., N. Myers, P.R. Gil, and C.G. Mittermeier. 1999. Hotspots: Earth's biologically richest and most endangered terrestrial ecoregions. Conservation International.
- Muir, J. 1894. *The mountains of California*. The Modern Library, New York, NY. 284 pp.
- Myers, N. 1988. Threatened biotas: hotspots in tropical forests. *The Environmentalist* 8:178-208.
- Myers, N. 1990. The biodiversity challenge: expanded hotspots analysis. *The Environmentalist* 10:243-256.
- Myers, N. 1997. 2nd ed. Global biodiversity II: losses and threats. Chapter 5 *in* Meffe, G.K., and C.R. Carroll (eds.), *Principles of conservation biology*. Sinauer Associates, Inc. Sunderland, MA.
- Myers, N., R. Mittermeier, G.A.B. da Fonseca, and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853-858.
- Noss, R.F. 1987. Corridors in real landscapes: a reply to Simberloff and Cox. *Conservation Biology* 1:159-164.
- Noss, R.F. 1991. Landscape connectivity: different functions at different scales. Pages 91-104 *in* W.E. Hudson (ed.), *Landscape linkages and biodiversity*. Island Press, Washington, DC.
- Noss, R.F., and B. Csuti. 1997. 2nd ed. Habitat fragmentation. Chapter 9 *in* Meffe, G.K., and C.R. Carroll (eds.), *Principles of conservation biology*. Sinauer Associates, Inc. Sunderland, MA.
- Noss, R.F., M.A. O'Connell, and D.D. Murphy. 1997. *The science of conservation planning: habitat conservation under the Endangered Species Act*. Island Press, Washington, DC.



- Olson, D.M., E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'Amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W. Wettengel, P. Hedao, and K.R. Kassem. 2001. Terrestrial ecoregions of the world: a new map of life on Earth. *BioScience* 51(11):933-938.
- Patton, J.L. Personal communication with Michael White, June 5.
- Patton, J.L., and S.T. Alvarez-Castañeda. In press. Phylogeography of the desert woodrat, *Neotoma lepida*, with comments on systematics and biogeographic history.
- Patton, J.L., and M.F. Smith. 1990. The evolutionary dynamics of the pocket gopher *Thomomys bottae*, with emphasis on California populations. A Contribution from the Museum of Vertebrate Zoology. University of California Press, Berkeley, CA. 161 pp.
- Paul, M.J., and J.L. Meyer. 2001. Streams in the urban landscape. *Annual Review of Ecology and Systematics* 32:333-365.
- PCR Services Corporation. 2000. Los Angeles County Significant Ecological Area Update Study 2000. Background Report. Prepared for Los Angeles County Department of Regional Planning. November.
- Peters, R.L., and J.D.S. Darling. 1985. The greenhouse effect and nature reserves. *BioScience* 35:707-717.
- Peyton, G. 1998. *Dipodomys nitratoides* Merriam 1894. Pages 76-78 in Hafner, D.J., E. Yensen, and G.L. Kirkland, Jr. (eds.), Status survey and conservation action plan: North American rodents. IUCN/SSC Rodent Specialist Group. The IUCN World Conservation Union, Cambridge, UK.
- Pickett, S.T.A., M.L. Casenasso, J.M. Grove, C.H. Nilon, R.V. Pouyat, W.C. Zipperer, and R. Costanza. 2001. Urban ecological systems: linking terrestrial ecological, physical, and socioeconomic components of metropolitan areas. *Annual Review of Ecology and Systematics* 32:127-157.
- Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegard, B.D. Richter, R.E. Sparks, and J.C. Stromberg. 1997. The natural flow regime: a paradigm for river conservation and restoration. *BioScience* 47:769-784.
- Raven, P.H. 1995. The California flora. Chapter 4 in Barbour, M.G., and J. Major (eds.), Terrestrial vegetation of California. California Native Plant Society, Special Publication Number 9. Sacramento, CA. 4th ed.
- Reed, A.R., J. Johnson-Barnard, and W.L. Baker. 1996. Contribution of roads to forest fragmentation in the Rocky Mountains. *Conservation Biology* 10:1098-1106.
- Rodriguez-Robles, J.A., D.F. Denardo, and R.E. Staub. 1999. Phylogeography of the California mountain kingsnake, *Lampropeltis zonata* (Colubridae). *Molecular Ecology* 8:1923-1934.
- Rodriguez-Robles, J.A., G.R. Stewart, and T.J. Papenfuss. 2001. Mitochondrial DNA-based phylogeography of North American rubber boas, *Charina bottae* (Serpentes: Boidae). *Molecular Phylogenetics and Evolution* 18(2):227-237.
- Roth, B. 1987. A new and polytypic species of *Helminthoglypta* (Gastropoda: Pulmonata) from Southern California with comments on the subgenus *Charodotes* Pilsbry. *The Veliger* 30:184-189.
- Roth, B., and F.G. Hochberg, Jr. 1988. A new species of *Helminthoglypta* (Coyote) (Gastropoda: Pulmonata) from the Tehachapi Mountains, California. *The Veliger* 31:258-261.
- Roth, B., and F.G. Hochberg. 1992. Two new species of *Helminthoglypta* (Gastropoda: Pulmonata) from Southern California, with comments on the subgenus *Charodotes* Pilsbry. *The Veliger* 35(4):338-346.
- Saunders, D.N., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentation: a review. *Conservation Biology* 5:18-32.
- Sawyer, J.O., and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society. 471 pp.



- Schoenherr, A.A. 1992. A natural history of California. California Natural History Guides 56. University of California Press, Berkeley, CA. 772 pp.
- Scott, J.M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T.C. Edwards, Jr., J. Ulliman, and R.G. Wright. 1993. Gap analysis: a geographic approach to protection of biological diversity. Wildlife Monographs No. 123. Supplement to the Journal of Wildlife Management 57(1).
- Scott, J.M., F.W. Davis, R.G. McGhie, R.G. Wright, C. Groves, and J. Estes. 2001. Nature reserves: do they capture the full range of America's biological diversity? Ecological Applications 11(4): 999-1007.
- Soulé, M.E., D.T. Bolger, A.C. Alberts, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitat islands. Conservation Biology 2:75-92.
- South Coast Wildlands Project (SCWP). In preparation. South Coast Missing Linkages Project.
- Spector, S. 2002. Biogeographic crossroads as priority areas for biodiversity conservation. Conservation Biology 16:1480-1487.
- Spellerburg, I.F. 1998. Ecological effects of roads and traffic: a literature review. Global Ecology and Biogeography Letters 7:317-333.
- Stebbins, G.L., and J. Major. 1965. Endemism and speciation in the California flora. Ecological Monographs 35(1):1-35.
- Stebbins, R.C. 2003. A field guide to western reptiles and amphibians. 3rd ed. Houghton Mifflin Company, Boston, MA. 533 pp.
- Stein, B.A., L.S. Kutner, and J.S. Adams (eds.). 2000. Precious heritage: the status of biodiversity in the United States. Oxford University Press, New York, NY.
- Stein, B.A., L.S. Kutner, G.A. Hammerson, L.L. Master, and L.E. Morse. 2000. State of the states: geographic patterns of diversity, rarity, and endemism. Chapter 5 in Stein, B.A., L.S. Kutner, and J.S. Adams (eds.), Precious heritage: the status of biodiversity in the United States. Oxford University Press, New York, NY.
- Strittholt, J.R., N.L. Stauss, and M.D. White. 2000. Importance of Bureau of Land Management roadless areas in the Western U.S.A. Prepared for the National Bureau of Land Management Wilderness Campaign by the Conservation Biology Institute. March.
- Suarez, A.V., D.T. Bolger, and T.J. Case. 1998. Effects of fragmentation and invasion on native ant communities in coastal Southern California. Ecology 79(6):2,041-2,056.
- Trombulak, S.C., and C.A. Frissell. 2000. Review of the ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.
- University of California, Berkeley, Jepson Herbarium. Unpublished data provided by Bruce Baldwin.
- University of California, Berkeley, Museum of Vertebrate Zoology. Unpublished data.
- U.S. Fish and Wildlife Service (USFWS). 1998. Recovery plan for upland species of the San Joaquin Valley, California. Region 1, Portland, OR. 319 pp.
- Wake, D.B. 2003. Personal communication with Michael White. July 29.



- Wake, D.B. 1997. Incipient species formation in salamanders of the *Ensatina* complex. *Proc. Natl. Acad. Sci.* 94:7761-7767.
- Wake, D.B., and E.L. Jockusch. 2000. Detecting species borders using diverse data sets. Examples from Plethodontid salamanders in California. Pages 95-119 in Bruce et al., *The biology of Plethodontid salamanders*. Kluwer Academic/Plenum Publishers, New York, NY.
- Western Regional Climate Center. 2003. California climate summaries. <http://www.wrcc.dri.edu/summary>
- White, M.D., and K.A. Greer. in MS. The effects of watershed urbanization of stream hydrologic characteristics and riparian vegetation of Los Peñasquitos Creek, California. Submitted to *Wetlands*.
- Wilcove, D.S., D. Rothstein, J. Subow, A. Philips, and E. Losos. 2000. Leading threats to biodiversity: What's imperiling U.S. species? Chapter 8 in Stein, B.A., L.S. Kutner, and J.S. Adams (eds.), *Precious heritage: the status of biodiversity in the United States*. Oxford University Press, New York, NY.
- Williams, B.D.C. 1998. Distribution, habitat associations, and conservation of Purple Martins breeding in California. M.S. thesis, California State University, Sacramento, CA.
- Williams, B.D.C. 2002. Purple martins in oak woodlands. USDA Forest Service General Technical Report PSW-GTR-184.
- Williams, D.F. 1986. Mammalian species of special concern in California. Wildlife Management Division Administrative Report 86-1. CDFG. 112 pp.
- Williams, D.F., H.H. Genoways, and J.K. Braun. 1993. Taxonomy. In Genoways, H.H., and J.H. Brown (eds.), *Biology of the heteromyidae*. American Society of Mammalogists, Special Publication No. 10:8-196.
- Yanev, K.P. 1980. Biogeography and distribution of three parapatric salamander species in coastal and borderland California. In Power, D.M. (ed.), *The California Islands: proceedings of a multidisciplinary symposium*. Santa Barbara Museum of Natural History, Santa Barbara, CA.
- Zwinger, A.H. 1986. John Xántus: The Fort Tejon letters. The University of Arizona Press, Tucson, AZ.



Appendix A

Data Sources and Methods

Data Sources

Geographic Information System (GIS) Data Layers

Name	Data Type	Scale	Date	Source
Cities	Polygon	1:250,000	2000	ESRI
Counties	Polygon	1:100,000	2000	U.S. Bureau of the Census
TIGER roads	Line	1:100,000	2000	U.S. Bureau of the Census
Ownership/protected lands	Polygon	1:100,000	2001	CBI Protected Areas Data Base
Tejon Ranch boundary	Polygon	1:24,000	1994	Modified from GreenInfo Network
Rivers and streams	Line	1:100,000	Varies	USGS EROS Data Center
Lakes	Polygon	1:100,000	Varies	USGS EROS Data Center
Elevation - digital elevation model	Raster	92.6 m	Varies	USGS EROS Data Center
Vegetation	Raster	100 m	2002	Cal. Dept. Forestry and Fire Protection (FRAP)
National Land Cover Database	Raster	30 m	1992	USGS EROS Data Center
Ecoregional boundaries	Polygon	1:100,000	1998	California Gap Analysis Project
CNDDDB point and region locations of species and communities	Point/region	Varies	2002	CNDDDB
Inventoried roadless areas	Polygon	1:100,000	2000	Forest Service

Other Data Sources

California Department of Fish and Game. California Interagency Task Group. 2002. California Wildlife Habitat Relationships (CWHR) version 8.0 personal computer program, Sacramento, CA.

California Native Plant Society. 2002. Inventory of Rare and Endangered Plants. Version 6. <http://www.northcoast.com/~cnps/cgi-bin/cnps/sensinv.cgi>

University of California Berkeley Museum of Vertebrate Zoology. 2003. <http://www.mip.berkeley.edu/mvz/>

University of California Berkeley and Jepson Herbarium. 2003. <http://ucjeps.berkeley.edu/>



Methods

GAP Analysis

We used FRAP vegetation data and an updated version of CBI's Protected Areas Database (or PAD) to determine the representation of vegetation types within protected areas in the region. The PAD utilizes data from the California Gap Analysis Program (GAP) and places land into one of four management categories (Scott et al. 1993):

Management Status 1 (GAP 1)—an area with an active management plan in operation that is maintained in its natural state and within which natural disturbance events are either allowed to proceed without interference or are mimicked through management (Strictly Protected).

Management Status 2 (GAP 2)—an area that is generally managed for its natural values, but which may receive use that degrades the quality of natural communities (Moderately Protected).

Management Status 3 (GAP 3)—most non-designated public lands, including USFS, BLM, and state park lands. Legal mandates prevent permanent conversion to anthropogenic habitat types (with some exceptions, such as tree plantations) and confer protection to populations of federally listed endangered, threatened, and/or candidate species (Little Protected).

Management Status 4 (GAP 4)—private or public land without an existing easement or irrevocable management agreement that maintains native species and natural communities and which is managed primarily or exclusively for intensive human activity. Urban, residential and agricultural lands, public buildings and grounds, and transportation corridors are included in this class (Not Protected).

One addition was made to the PAD—the Wind Wolves Preserve was added and assigned a GAP status category of 2. Inventoried roadless areas, obtained from the Forest Service, were also included in the analysis.

In our analysis, all lands that had a GAP status of 1 or 2, or were USFS inventoried roadless areas, were considered "protected." We used these data to calculate the acreages of the FRAP vegetation communities and elevational zones falling within protected areas.

Roadless Areas

Roadless areas were mapped using the steps outlined below:

1. Convert TIGER/Line 2000 road data to a raster (or GRID) file with a spatial resolution of 30m x 30m.
2. Using the raster road file (30m x 30m resolution), generate a grid file denoting the distance in meters away from each road, using the Find Distance function in ArcView.
3. Run a neighborhood statistics function on the results using the following settings:
 - Statistic type: mean
 - Neighborhood: rectangle
 - Neighborhood settings
 - Height: 3
 - Width: 3
 - Units: cells
 - Output resolution: 30 meters
4. Recode results from the neighborhood statistics as follows:
 - 0 = 0-500
 - 1 = 500- max distance
5. Perform a region group function, which assigns a unique ID to all cell clusters (value = 1) larger than 500 pixels.
6. Convert roadless grid file into a polygon file and buffer 400 meters. Convert back to grid file.



7. Create a grid file from the National Land Cover Database, assigning urban and agricultural land classes as "1" and all natural land classes as "0." Erase human-dominated land cover classes from the region group roadless grid.
8. Delete all roadless areas < 500 acres.

Road Density

Using TIGER/Line 2000 road data, road density was calculated and mapped using ArcGIS 8.x (ArcView) and the public domain extension "Fishnet" and procedure created by Robert Nicholas. The .dll is available at <http://arcscrips.esri.com>. The basic steps are as follows.

1. Create a fishnet polygon feature—Load the .dll to an ArcMap session. Use the dialog to create the geometry of the fishnet and select whether you want a polygon or polyline fishnet. Use the dimensions of the spatial extent of your linear features (i.e., roads). Each output cell contains a unique "Col_Row" field.
2. Intersect line networks with fishnet—Using the GeoProcessing Wizard, intersect the road network with the fishnet. Each line feature (i.e., road) will be assigned a "Col_Row" identity.
3. Re-calculate length of line segments in each cell—Create a field named "Leng_m". Use the following VB script to re-calculate the length of each line segment as these are not updated after performing the Intersect module in Step 2. The script calculates the length based on the units of the data set. The code can be copied and pasted to the "Pre-Logic VBA Script Code" section of the Field Calculator dialog.

```
Dim dblLength As Double
Dim pCurve As ICurve
Set pCurve = [shape]
dblLength = pCurve.Length
Return dblLength
```
4. Convert to kilometers—Add a new column called "Leng_km" to the shapefile. Use the Field Calculator to divide the Length by 1000; existing numbers are in meters.
5. Export a .dbf of total length (km) per cell (square km)—Open the attribute table of the roads shapefile. Summarize the Col_Row field by the Length field (choose SUM). Export this summary as a .dbf. This table contains a length value associated to each unique "Col_Row" code.
6. Join .dbf to fishnet polygon feature—Use Join based on the "Col_Row" as the common field. Each polygon cell has a total road length associated with it. The length per square kilometer grid is the density.
7. Convert to Raster (or GRID)—Use Convert Feature to Raster module. Road density (km/sq km) is now attached to each grid cell. In this case, we used a 1km x 1km resolution.
8. To smooth the results, take the 1km x1km resolution road density results and run the Neighborhood Statistics function in ArcView using the following parameters:
 - Statistic type: mean
 - Neighborhood: rectangle
 - Neighborhood settings:
 - Height: 3
 - Width: 3
 - Units: cells
 - Output resolution: 1,000 meters



Habitat Integrity

In general, integrity was modeled with two inputs—road density and land cover. Each input was re-classed on a common scale from 1 to 10. The model assumes that road density and land cover have an equal influence on integrity; thus, they are simply added together. Areas with highest integrity equal 1, and areas with lowest integrity equal 20. The road density input has been prepared to express length of road per square kilometer. All road types were treated equal. The TIGER/Line 2000 data was used for this input.

1. The 22 classes in the National Land Cover Database file were assigned scores from 1 (natural) to 10 (most converted) as outlined below.

<u>Land Use/Land Cover Type</u>	<u>CBI Score</u>
Open Water	8
Perennial Ice/Snow	1
Low Intensity Residential	9
High Intensity Residential	10
Commercial/Industrial/Transportation	10
Bare Rock/Sand/Clay	1
Quarries/Strip Mines/Gravel Pits	7
Transitional	6
Deciduous Forest	1
Evergreen Forest	1
Mixed Forest	1
Shrubland	1
Orchards/Vineyards/Other	4
Grasslands/Herbaceous	1
Pasture/Hay	4
Row Crops	5
Small Grains	5
Fallow	3
Urban/Recreational	7
Woody Wetland	1
Emergent Herbaceous Wetlands	1

2. The resolution of the 1km x 1km road density file was changed to 30m x 30m to match the NLCD file. Road density was scored using the table below.

<u>Road Density</u>	<u>CBI Score</u>
0 to 0.5 km/sq. km	1
0.5 to 1 km/sq. km	2
1 to 2 km/sq. km	3
2 to 4 km/sq. km	5
4 to 6 km/sq. km	9
Greater than 6 km	10

3. The CBI Scores in the two input grid files were then added together to generate the final result. Land Cover (nlcd_reclass) + Road Density (rdens_rsmpl) = Integrity (integ_raw1).
4. The equation assumes that road density and land cover have an equal influence on integrity. The output will yield values between 1 and 20, with 20 having the least integrity.
5. The integrity raster was then smoothed using a 3x3 cell neighborhood (mean).



Appendix B

Vegetation Communities Within the Tejon Ranch Region and Tejon Ranch

Vegetation Communities (source: FRAP vegetation data)	Tejon Ranch Region				Tejon Ranch			
	Sierra Nevada	Central Valley	Mojave Desert	South Coast	Sierra Nevada	Central Valley	Mojave Desert	South Coast
Montane riparian	X			X				
Montane chaparral	X	X		X	X			
Montane hardwood	X	X	X	X	X	X	X	X
Montane hardwood-conifer	X		X	X	X			X
Subalpine conifer				X				
Sierran mixed conifer	X	X		X	X			
Lodgepole pine	X							
Ponderosa pine	X			X	X			
Jeffrey pine	X	X		X				
Closed cone pine-cypress				X				
Eastside pine				X				
White fir	X				X			
Red fir	X							
Unknown conifer type	X	X			X			
Juniper	X	X	X	X	X		X	X
Pinyon-juniper	X	X	X	X	X		X	X
Perennial grassland		X						
Annual grassland	X	X	X	X	X	X	X	X
Coastal oak woodland	X	X		X	X	X		
Blue oak-foothill pine	X	X	X	X	X	X		X
Blue oak woodland	X	X	X	X	X	X	X	X
Valley oak woodland	X	X	X	X	X	X	X	X
Valley foothill riparian	X	X	X	X		X		X
Wet meadow	X			X	X			X
Lacustrine	X	X	X					
Freshwater emergent wetland		X		X				
Riverine		X						
Mixed chaparral	X	X	X	X	X	X	X	X
Chamise-redshank chaparral	X		X	X	X		X	X
Unknown shrub type	X	X	X	X	X	X	X	X
Coastal scrub		X	X	X				X
Sagebrush	X	X	X	X	X	X	X	X
Alkali desert scrub		X	X	X				
Desert scrub	X	X	X	X	X		X	X
Desert riparian			X					
Desert wash			X	X				
Bitterbrush	X		X		X			
Joshua tree woodland			X	X				
Total	27	23	21	29	21	10	11	16



Appendix C Rare and Endangered Species Known or Potentially Occurring in the Vicinity of Tejon Ranch

COMMON NAME	SCIENTIFIC NAME	STATUS	NOTES
Plants			
California jewel-flower	<i>Caulanthus californicus</i>	FE, CE, CNPS 1B	Historic records near Hwy 58; valley and foothill grassland, pinyon-juniper, scrub
Vasek's clarkia	<i>Clarkia tembloriensis</i> ssp. <i>calientensis</i>	S1.1, CNPS 1B	Valley and foothill grassland; recorded on Tejon Ranch
Hoover's woolly-star	<i>Eriastrum hooveri</i>	FT	Valley and foothill grassland, pinyon-juniper, scrub
Fort Tejon woolly sunflower	<i>Eriophyllum lanatum</i> var. <i>hallii</i>	S1.1, CNPS 1B	Chaparral, cismontane woodland
Round-leaved filaree	<i>Erodium macrophyllum</i>	S2.1, CNPS 2	Valley and foothill grassland, cismontane woodland
Tejon poppy	<i>Eschscholzia lemmonii</i> ssp. <i>kernensis</i>	S1.1, CNPS 1B	Valley and foothill grassland, scrub; recorded on Tejon Ranch
Striped adobe lily	<i>Fritillaria striata</i>	CT, CNPS 1B	Widespread; valley and foothill grassland, cismontane woodland; recorded on Tejon Ranch
Delicate bluecup	<i>Githopsis tenella</i>	S2.3, CNPS 1B	Chaparral, cismontane woodland
Pale yellow layia	<i>Layia heterotricha</i>	S1.1, CNPS 1B	Valley and foothill grassland, cismontane woodland, pinyon-juniper
Comanche Point layia	<i>Layia leucopappa</i>	S1.1, CNPS 1B	Valley and foothill grassland, scrub; recorded on Tejon Ranch
Calico monkeyflower	<i>Mimulus pictus</i>	S2.2, CNPS 1B	Cismontane woodland, broadleaved upland forest; recorded on Tejon Ranch
Flax-like monardella	<i>Monardella linoidea</i> ssp. <i>oblonga</i>	S2.2, CNPS 1B	Coniferous forest, pinyon-juniper
San Joaquin woollythreads	<i>Monolopia congdonii</i>	FE, S3.2, CNPS 1B	Valley and foothill grassland, scrub
Piute Mountains navarretia	<i>Navarretia setiloba</i>	S1.1, CNPS 1B	Valley and foothill grassland, pinyon-juniper, cismontane woodland; recorded on Tejon Ranch
Bakersfield cactus	<i>Opuntia basilaris</i> var. <i>treleasei</i>	FE, CE	Valley/foothill grassland, scrub, cismontane woodland; recorded on Tejon Ranch
San Joaquin adobe sunburst	<i>Pseudobahia peirsonii</i>	FT, CE, CNPS 1B	Potential—associated with <i>F. striata</i> ; valley and foothill grassland, cismontane woodland
Grey-leaved violet	<i>Viola pinetorum</i> ssp. <i>grisea</i>	S1.3, CNPS 1B	Meadows and seeps, upper montane and alpine coniferous forest



Appendix C Rare and Endangered Species Known or Potentially Occurring in the Vicinity of Tejon Ranch

COMMON NAME	SCIENTIFIC NAME	STATUS	NOTES
Invertebrates			
Valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>	FT	Recorded on Tejon Ranch
Amphibians			
Yellow-blotched salamander	<i>Ensatina eschscholtzii croceater</i>	FSC, CSC	Endemic to Tehachapi and San Emigdio Mountains; recorded on Tejon Ranch
Kern Canyon slender salamander	<i>Batrachoseps simatus</i>	FSC, CT	Range may extend to northern edge of Ranch
Tehachapi slender salamander	<i>Batrachoseps stebbinsi</i>	FSC, CT	Endemic to Tehachapi and Piute Mountains; recorded on Tejon Ranch
Western spadefoot	<i>Scaphiopus hammondi</i>	FSC, CSC	
California red-legged frog	<i>Rana aurora draytonii</i>	FT, CSC	Potential sightings
Foothill yellow-legged frog	<i>Rana boylei</i>	FSC, CSC	Historic records
Reptiles			
Southwestern pond turtle	<i>Clemmys marmorata pallida</i>	FSC, CSC	Sighted in ponds, Old Gorman Post Rd.
Blunt-nosed leopard lizard	<i>Gambelia sila</i>	FE, CE, CFP	Recorded on San Joaquin Valley side of Ranch
California horned lizard	<i>Phrynosoma coronatum frontale</i>	FSC, CSC	
San Diego horned lizard	<i>Phrynosoma coronatum blainvillii</i>	FSC, CSC	
California legless lizard	<i>Anniella pulchra</i>	FSC, CSC	
Rosy boa	<i>Charina trivirgata</i>	FSC, CSC	Edge of range of desert subspecies
San Joaquin whipsnake	<i>Masticophis flagellum ruddocki</i>	FSC, CSC	Contact zone with red racer (<i>M. f. piceus</i>)
Two-striped garter snake	<i>Thamnophis hammondi</i>	CSC	Contact zone with Sierra garter snake (<i>T. couchii</i>)



Appendix C Rare and Endangered Species Known or Potentially Occurring in the Vicinity of Tejon Ranch

COMMON NAME	SCIENTIFIC NAME	STATUS	NOTES
Birds			
American bittern	<i>Botaurus lentiginosus</i>	FSC, CSC	Possibly resident in marshes (e.g., Castac Lake)
Least bittern	<i>Ixobrychus exilis</i>	CSC	Probably local summer resident in marshes (e.g., Castac Lake)
California condor	<i>Gymnogyps californianus</i>	FE, CE, CFP	Designated Critical Habitat; recorded on Tejon Ranch
Black-shouldered kite	<i>Elanus leucurus</i>	FSC	Uncommon resident
Bald eagle	<i>Haliaeetus leucocephalus</i>	FT, CSC, CFP	Winter roosts
Northern harrier	<i>Circus cyaneus</i>	CSC	
Sharp-shinned hawk	<i>Accipiter striatus</i>	CSC	
Cooper's hawk	<i>Accipiter cooperi</i>	CSC	Nesting
Northern goshawk	<i>Accipiter gentilis</i>	FSC, CSC	Known to breed at Mt. Pinos and possibly Tehachapi Mountains
Swainson's hawk	<i>Buteo swainsoni</i>	CT	Crucial area for migration, nesting; recorded on Tejon Ranch
Ferruginous hawk	<i>Buteo regalis</i>	FSC	Common winter visitor
Golden eagle	<i>Aquila chrysaetos</i>	CSC, CFP	Nesting
Merlin	<i>Falco columbarius</i>	CSC	
Prairie falcon	<i>Falco mexicanus</i>	CSC	Foraging
Mountain plover	<i>Charadrius montanus</i>	FPT, CSC	Winters in extreme west Antelope Valley and San Joaquin Valley, possibly Tejon Ranch
Flammulated owl	<i>Otus flammeolus</i>	FSC	Potential summer resident
Burrowing owl	<i>Athene cunicularia</i>	FSC, CSC	Recorded on Tejon Ranch
California spotted owl	<i>Strix occidentalis occidentalis</i>	FT, CSC	Habitat connection between Sequoia and Los Padres National Forests



Appendix C

Rare and Endangered Species Known or Potentially Occurring in the Vicinity of Tejon Ranch

COMMON NAME	SCIENTIFIC NAME	STATUS	NOTES
Long-eared owl	<i>Asio otus</i>	CSC	Recorded on Tejon Ranch, breeding season
Black swift	<i>Cypseloides niger</i>	FSC, CSC	May breed at Tejon Ranch
Costa's hummingbird	<i>Calypte costae</i>	FSC	Common summer resident; breeds in scrub/chaparral
Lewis' woodpecker	<i>Melanerpes lewis</i>	FSC	Wintering and breeding season
Nuttall's woodpecker	<i>Picoides nuttallii</i>	SLC	Abundant resident
White-headed woodpecker	<i>Picoides albolarvatus</i>	FSC	Probably resident in coniferous forest
Olive-sided flycatcher	<i>Contopus cooperi</i>	FSC	Breeding season
Southwestern willow flycatcher	<i>Empidonax traillii eximius</i>	FE, CE	
California horned lark	<i>Eremophila alpestris acitia</i>	CSC	
Purple martin	<i>Progne subis</i>	CSC	Largest natural breeding colony? Audubon Important Bird Area
Oak titmouse	<i>Baeolophus inornatus</i>	SLC	Abundant resident
American dipper	<i>Cinclus mexicanus</i>	SLC	May be resident
Swainson's thrush	<i>Catharus ustulatus</i>	CSC	Possibly summer resident (widely extirpated throughout range)
California thrasher	<i>Toxostoma redivivum</i>	FSC	
San Joaquin LeConte's thrasher	<i>Toxostoma lecontei macmillanorum</i>	FSC, CSC	Potentially occurs on floor of San Joaquin Valley. Tejon Ranch lies between the 2 major races.
Loggerhead shrike	<i>Lanius ludovicianus</i>	CSC	Breeding season
California yellow warbler	<i>Dendroica petechia brewsteri</i>	CSC	
Yellow-breasted chat	<i>Icteria virens</i>	CSC	Probably locally common summer resident
Summer tanager	<i>Piranga rubra</i>	CSC	Uncommon summer resident in riparian habitats



Appendix C Rare and Endangered Species Known or Potentially Occurring in the Vicinity of Tejon Ranch

COMMON NAME	SCIENTIFIC NAME	STATUS	NOTES
Black-chinned sparrow	<i>Spizella atrogularis</i>	FSC	Common summer resident in chaparral
Tricolored blackbird	<i>Agelaius tricolor</i>	FSC, CSC	
Yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>	CSC	Probably local summer resident in marshes (e.g., Castac Lake)
Lawrence's goldfinch	<i>Carduelis lawrencei</i>	FSC	Common resident
Mammals			
Buena Vista Lake shrew	<i>Sorex ornatus relictus</i>	FE, CSC	At edge of documented range
San Joaquin antelope squirrel	<i>Ammospermophilus nelsoni</i>	FSC, CT	At edge of documented range; recorded on Tejon Ranch
San Joaquin pocket mouse	<i>Perognathus inornatus inornatus</i>	FSC	Recorded on Tejon Ranch; probably common on San Joaquin Valley side of Ranch
Tehachapi pocket mouse	<i>Perognathus alticola inexpectatus</i>	CSC	Extremely narrow geographic range in desert transition zone on Mojave side of the Tehachapis
Short-nosed kangaroo rat	<i>Dipodomys niritoides brevinasus</i>	FSC, CSC	Potential contact zone with Tipton kangaroo rat on San Joaquin Valley side of Ranch
Tipton kangaroo rat	<i>Dipodomys niritoides niritoides</i>	FE, CE	Potential contact zone with short-nosed kangaroo rat on San Joaquin Valley side of Ranch
Tulare grasshopper mouse	<i>Onychomys torridus tularensis</i>	FSC, CSC	Potential on San Joaquin Valley side of Ranch
San Joaquin kit fox	<i>Vulpes macrotis mutica</i>	FE, CT	Recorded on San Joaquin Valley side of Ranch

Source: CNDDDB, Wildlife Habitat Relationships, museum records, and data from individuals having specific knowledge of the region's biological resources.

Status Codes (federally and state-listed species are in bold-face type)

- FE Federally listed as Endangered
- FT Federally listed as Threatened
- FPT Federally proposed as Threatened
- FSC Federal Species of Concern
- SLC Species of Local Concern
- CE State-listed as Endangered
- CT State-listed as Threatened
- CSC California Special Concern species
- CFP California Fully Protected species
- S1 CNDDDB: Extremely endangered
- S2 CNDDDB: Endangered
- S3 CNDDDB: Restricted range, rare
- S4 CNDDDB: Apparently secure, some factors exist to cause some concern
- S5 CNDDDB: Demonstrably secure
- CNPS List 1B: Rare, threatened, or endangered in California and elsewhere
- CNPS List 2: Rare, threatened or endangered in California, but more common elsewhere (CNPS 2001)