A Guide To

Wildlands Conservation in the Central Coast Region of California

A Project of the California Wilderness Coalition

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Wildlands Conservation in the Central Coast Region of California

CALIFORNIA WILDERNESS COALITION

JULY 2002

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CALIFORNIA WILDERNESS COALITION

A Voice for Wild California

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Acknowledgments

The California Wilderness Coalition (CWC) sponsored the creation of this report to fill the need for a public document that addresses some of the regional conservation needs of the central coast of California. This document would not be possible without the generous financial support of the Foundation for Deep Ecology, the Columbia Foundation, the Packard Foundation, the Gabilan Foundation, and the Compton Foundation. This report is the result of a collaborative effort between environmental groups and individuals who have been active in conservation in the central coast region. We would like to acknowledge the considerable contributions of Joe Rigney, Michele Korpos, Rick Hopkins, and Tom Lupo in supplying information used in the writing and analysis of the report. We thank Drs. Paul Beier and Jim Quinn for their reviews of the methodology. Most data in the analysis were publicly available with the exception of a steelhead database supplied by Verna Jigour and Tom Lupo, and biodiversity hotspot information supplied by the Nature Conservancy (TNC). Thanks are also due to our reviewers Kathy Daly, Dr. Paul Beier and Dr. Ed Grumbine. Listed individuals provided input or information for this report; they do not necessarily endorse its findings.

About the California Wilderness Coalition

The California Wilderness Coalition (CWC) works to defend the pristine landscapes that make California unique, provide a home to our wildlife, and preserve a place for spiritual renewal. We protect wilderness for its own sake, for ourselves, and for generations yet to come. We identify and protect the habitat necessary for the long-term survival of California's plants and animals, and through our advocacy and public education, we enlist the support of citizens and policy-makers in our efforts to protect California's wildlands.

Design & Layout, *ImagePoint Design*

Artwork, *Peg Edwards*, *Sierra Nature Prints*

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Section 1

EXECUTIVE SUMMARY

Monterey Pine — *Pinus radiata*

Executive Summary

Regional conservation planning in California has made significant advances in recent years. Throughout the state, there is much support for the preservation of open space, biodiversity, and endangered species. Many conservation organizations, grassroots citizen groups, and concerned individuals are involved in developing conservation visions locally, regionally, and statewide. This report will assist those in the central coast region of California in making their visions a reality.

The *Guide to Conservation for the Central Coast Region of California*, presented by the California Wilderness Coalition through its California Wildlands Project, provides a framework for the protection and maintenance of biodiversity within the central coast region from which local efforts can be initiated and successfully implemented.

The *Guide* presents a Mammal Network of core habitat areas and habitat linkages that form the connective backbone of the regional Wildlands Conservation Plan (WCP). The development of the Mammal Network and the WCP was based on the principles of conservation biology and is displayed cartographically using Geographic Information Systems (GIS).

Priorities for immediate protection of remaining habitat and habitat linkages for three wildlife species, mountain lion, San Joaquin kit fox, and pronghorn antelope are identified. Strategies for long-term restoration of steelhead populations are also presented.

The species used in this conservation planning effort are termed Focal species. Focal species are classified based on their response to habitat conditions (e.g., fragmented habitat as a result of development), dependency on food resources, or as representing an essential ecological function such as migration, habitat alteration (e.g., beavers), or prey regulation (Noss 1992, Lambeck 1997).

The steps in the process of identifying conservation priorities include:

1. Develop a conservation "network" based on area requirements for three mammal species that, together, use a majority of habitat types in the region;
2. Assess how conservation and restoration of steelhead habitat would overlap with the above network;
3. Evaluate how the Mammal Network overlaps with, or represents, elements of biodiversity in the region, including: oaks, important bird habitats, Nature Conservancy portfolio sites, serpentine geology, old-growth redwoods, and California red-legged frog and tiger salamander populations;
4. Classify watersheds in the region based on their degree of impact from roads and on suitability for mountain lion, San Joaquin kit fox, and pronghorn antelope.

The results of our analysis suggest that 68% of the region is identified for potential inclusion in the Mammal Network, although we recognize this represents the maximum extent of suitable habitat for the three terrestrial focal species. The network contains greater than 68% of the extent of known locations for: oak communities (75-92% for five species), Nature Conservancy portfolio sites (73%), serpentine rock (82%), old-growth redwoods (91%), coastal sage chapparal (92%), and non-native grasslands (77%). The network contained less than proportional representation of known populations of red-legged frogs (50%) and California tiger salamanders (53%).

Conservation planning should be viewed as an iterative process with adaptive, local implementation strategies developed within the framework of this regional vision. As additional information becomes available, we recommend that it be incorporated into the plan. The *Guide to Wildlands Conservation for the Central Coast Region of California* is designed to be an informative addition to the decision-maker's toolbox and should be integrated into local planning processes wherever possible. The California Wilderness Coalition anticipates developing this plan at the local level in an effort to protect the wildlands of the central coast region for future generations.

Wildlands Conservation Plan Map for the Central Coast Region

Section 2

INTRODUCTION

Douglas Fir — *Pseudotsuga menziesii*

Introduction

Biodiversity: *The variety of life and its processes, it includes the variety of living organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning, yet ever changing and adapting.*

— Noss, Cooperider, 1994

The challenge of biodiversity protection in a state with accelerating habitat modification and population growth is daunting. The goal of this report is to catalog, map and present some of the remarkable natural ecological systems of the central coast of California. We also chart a vision of stewardship that integrates the needs of natural and human communities.

The scope of this endeavor is bold, and it needs to be. Proactive planning that considers the needs of all members of the natural community is the only means to ensure appropriate land use in the region. Mapping and identifying the habitat needs of wildlife and plant species will help us build a regional vision for the central coast of California that is diverse, and considers the needs of the greater community.

To maintain biodiversity in the region, we need to think big in space and time. One of our primary goals is to map a regional plan for biodiversity conservation in the central coast region of California. To initiate this process, we offer a vision of the necessary steps to maintain the integrity of the ecological systems in the central coast. We hope that this document will become an important tool for planners and land managers throughout the central coast region. Maintaining wild places for future generations can begin with this document.

Utilizing ecological principles as our foundation, we have identified several species of wildlife whose habitat requirements best represent the biological diversity of the region. The hope is that by protecting the needs of a few wide-ranging species, we can encompass and maintain healthy populations of many other species of wildlife, insects, and plants along the way.

We begin this report with an overview of the region's geography, climate, and land ownership. Following chapters present the unique and rich biological diversity of the region. To set the context for regional conservation efforts, we include a section on existing and future threats to that diversity. Finally, we outline and propose our conservation vision for key elements of biodiversity in the region.

We designed this report to be a resource for decision-makers and interested members of the public. To keep it reasonably concise, we make available additional information on the natural history of species in the region, and our analytical assumptions and approach in the appendices.

Section 3

REGIONAL GEOGRAPHY AND LAND OWNERSHIP

Coast Redwood — *Sequoia sempervirens*

Section 3

REGIONAL GEOGRAPHY AND LAND OWNERSHIP

Study Area

The California central coast region extends from Sonoma to Santa Barbara County and east to the border of the San Joaquin Valley. Our planning region was primarily delineated by using watershed boundaries that encompass and buffer the central west ecoregion, as defined in *The Jepson Manual: Higher Plants of California* (Hickman 1993). However, the planning area used in this report does differ slightly from the ecoregion outlined in the Jepson Manual. Although the distribution of most terrestrial species in the central coast region is functionally bounded in the north by the San Francisco Bay and Delta (the Jepson boundary), we have included parts of the northern San Francisco Bay area in our planning region because of the similarity in ecological patterns and communities with the rest of the region *(Map 1)*.

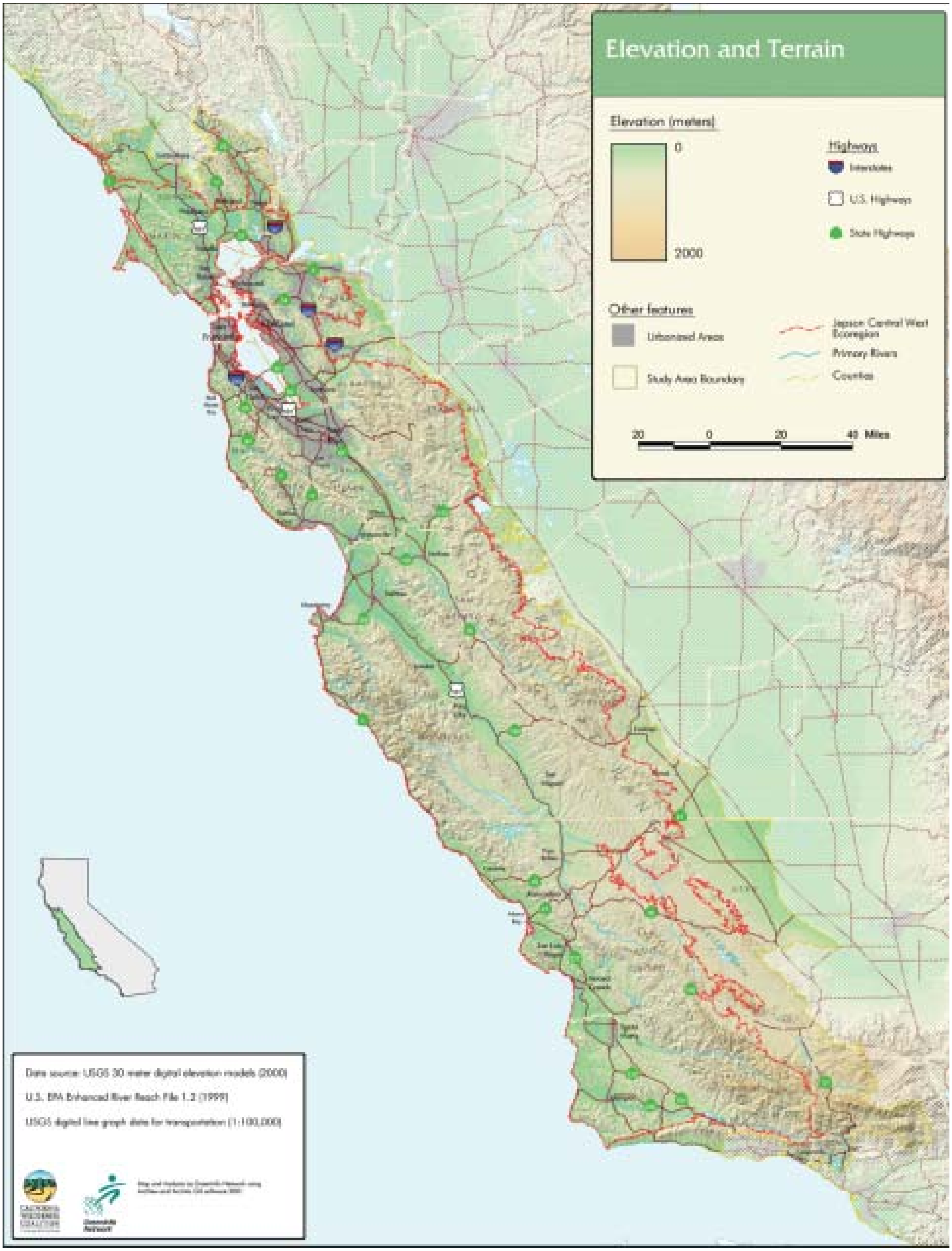
The natural southern boundary of the region is formed by the ridgeline of the Santa Ynez watershed at the western end of the Transverse Ranges just north of Santa Barbara. We have included some watersheds on the south side of that ridgeline to incorporate the interface zone with the marine system. Yet, we excluded the primarily urbanized watersheds around Santa Barbara, a decision that may have overlooked the significance of some of the coastal streams in this area harboring steelhead populations.

The land area of our study region covers more than five million hectares or 50,000 km^2. Though our boundary differs from the Jepson central west ecoregion, we often refer to the California Gap Analysis Project, which used the Jepson boundary for their assessment of the distribution and status of vegetation communities and fauna in the state (Davis et al. 1998). The data and analysis within this report, however, reflect the study area defined by the Central Coast Wildlands Planning Team *(Map 1)*.

Physiography and Climate

The central coast region is geographically defined by the outer and inner Coast Ranges, which are two parallel northeast-to-southwest ranges that frame the region's western and eastern boundaries. The outer Coast Ranges are comprised of the Santa Cruz and Santa Lucia Mountains, along with Mount Tamalpais and Bolinas Ridge in the northwest part of the region. Near the southern end of the region the La Panza, Sierra Madre and San Rafael Mountains are set inland from the coast. The inner Coast Ranges include the Diablo Range, which extends nearly the length of the region, the Gabilan Range near its center, and the Cholame Hills and Temblor Range at the region's southeast boundary. The interaction between this topographic variation and coastal weather patterns strongly influences habitat diversity in the region.

The region experiences a Mediterranean climate of hot, dry summers and cool, wet winters, with localized summer fog near the coast. Average annual rainfall ranges from 13-15 inches in interior valleys, and up to 90 inches or more at the highest peaks along the coast. The Pacific Ocean heavily influences the region's climate and terrestrial environment with a marine layer of fog that forms when the cool, moist air of the ocean meets the warm, dry air of the interior. The resulting "fog drip" is an important source of moisture for coast redwood forests, and nurtures many coastal plant communities through the summer (Dawson 1998). Fog mediates coastal plants' water needs and temperature, while inland temperatures are much more variable. The geographic distribution and daily variability of fog banks significantly influence regional patterns of biodiversity.



Map 1: Elevation and Terrain of the Central Coast Region.

Land Ownership

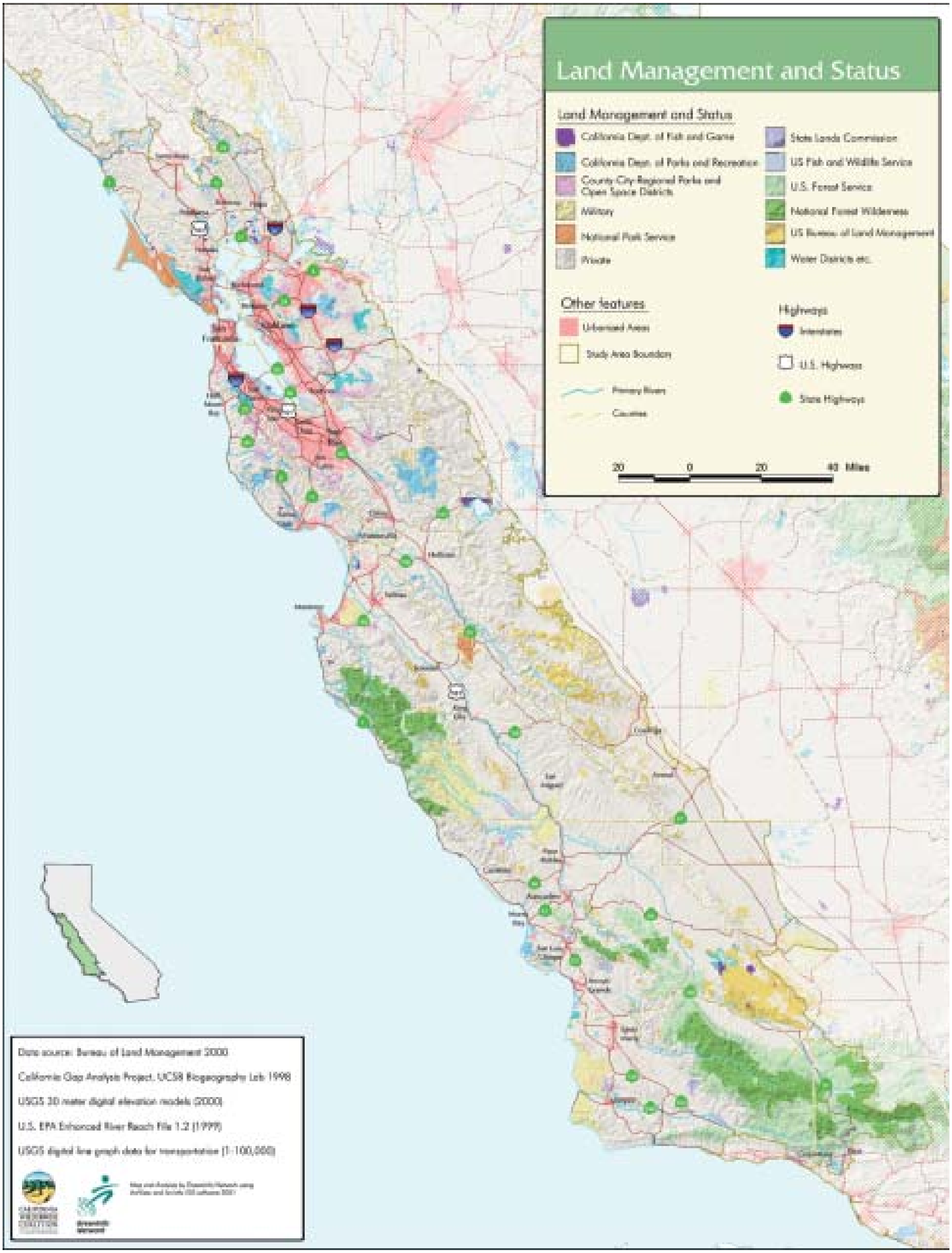
Nearly 75% of the land in the central coast region is in private ownership *(Map 2)*. The major urban center in the region is the San Francisco Bay area, with secondary concentrations around Monterey Bay, San Luis Obispo, Arroyo Grande and Santa Maria. Large private ranches cover much of the region outside of heavily populated areas. Agricultural production, including vineyards, dominates the larger valleys, particularly the Salinas, Pajaro, Napa, and Sonoma Valleys. Most of the Santa Lucia and Transverse ranges are National Forest land, which include several large wilderness areas: the Ventana, Dick Smith, San Rafael and Sespe *(Table 1)*.

Table 1. Land Ownership in the Central Coast Region of California

LAND OWNERSHIP	ACRES	SQUARE KM	PERCENT OF TOTAL
Private	9,200,729	37,226	74.58%
US Forest Service	805,783	3,260	6.53%
US Forest Service Wilderness	667,190	2,699	5.41%
US Bureau of Land Management	516,152	2,088	4.18%
Military	389,103	1,574	3.15%
California Dept. of Parks and Recreation	216,944	877	1.76%
County-City-Regional Parks and Preserves	166,466	673	1.35%
Water Districts etc.	87,839	355	0.71%
National Seashore or National Recreation	80,267	324	0.65%
State Lands—State Lands Commission	35,909	145	0.29%
California Dept. of Fish and Game	34,268	139	0.28%
Open Space Districts	33,724	136	0.27%
Water	30,206	122	0.24%
US Fish and Wildlife Service	26,667	108	0.22%
The Nature Conservancy	17,188	70	0.14%
National Monument — National Park Service	16,723	68	0.14%
Other Conservancy; Land Trust; Private Univ.	9,261	37	0.08%
Audubon Society	1,137	5	0.01%
California Dept. of Forestry and Fire Protection	771	3	0.01%
Total	**12,336,329**	**49,913**	**100.00%**

Source: California GAP Analysis Project (Davis et al. 1998)

At more than 200,000 acres, the Carrizo Plain National Monument, managed by the Bureau of Land Management, harbors some of the last remnants of native grasslands and several endangered species including the San Joaquin kit fox, the blunt-nosed leopard lizard, the giant kangaroo rat, the San Joaquin antelope squirrel, the longhorn fairy shrimp, and the vernal pool fairy shrimp. The Monument also contains Soda Lake, the largest natural alkali wetland in southern California. Despite its designation as a National Monument in 2000, the Carrizo Plain is threatened by potential oil and gas development.



Map 2: Land Management and Status in the Central Coast Region

Section 4

REGIONAL BIODIVERSITY AND WILDLIFE HABITATS

Columbine — *Aquilegia formosa*

Section 4

REGIONAL BIODIVERSITY AND WILDLIFE HABITATS

Climate and vegetation patterns

The proximity to the ocean and topographic diversity of the central coast region provide for a wide array of vegetative diversity. Here, the coast redwoods *(Sequoia sempervirens)* and mixed evergreen forests representative of California's north coast meet the sun-soaked chaparral and oak woodlands of southern California. A mosaic of plant communities results from several factors including elevation, degree of slope, soil, solar aspect, and available moisture as rainfall or fog drip. Raven and Axelrod (1978) identify this area as having a mild climate marked by sporadic climatic variations, which are important influences on the region's biodiversity.

General vegetation types

There are three dominant vegetation types in the central coast region. Interior chaparral types comprise nearly 25% of the natural vegetative cover of the region. Oak woodlands, savannas, and oak forests cover another 25% of the region, although this figure is shrinking due to urbanization and conversion of oak woodlands to vineyards. Nonnative grasslands constitute the third major cover type in the region at approximately 30%, though naturalized exotic grasses are also found in oak woodlands and other plant communities. (All percentage calculations are based on Davis et al. 1998, *Appendix 3*.)

Coastal chaparral covers 7% of the region and is the fourth most extensive vegetation class. It consists of northern coastal bluff scrub, along with Franciscan, Lucian, Venturan, and Diablan coastal scrub (Holland 1986). Mixed evergreen and bay forests cover about 5%, while about 3% of the region is in upland redwood forests. Finally, various wetland habitats comprise less than 1% of the region's natural vegetation.

Many plant species and vegetation types within the region are narrowly distributed. The Gap Analysis Project (Davis et al. 1998) identified 122 landscape classifications according to the California Natural Diversity Database (CNDDB) System (Holland 1986) in the Jepson Central Coast ecoregion, of which 108 are forms of native vegetation and 16 are human-created landscapes, or nonnative vegetation (*Map 3 and Appendix 3*).

For all of the vegetation distribution tables in Appendix 3, we used the Gap Analysis Land Status Classes 1 and 2, which are protected areas under some form of conservation management *(Figure 1).* This is more conservative in terms of biodiversity protection than assuming that all public land is protected. Classes 1 and 2 are managed for natural values and biodiversity conservation, with less of the pressure on ecological systems that stems from the multiple-use mandate on Class 3 land.

Figure 1: Land Management Classes as Defined by the GAP Analysis Program

LAND MANAGEMENT CLASSES AS DEFINED BY THE GAP ANALYSIS PROGRAM

Status 1 — An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events are allowed to proceed without interference or are mimicked through management. Example: wilderness areas, national parks, national monuments, and private nature reserves.

Status 2 — An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities. Example: state parks.

Status 3 — An area having permanent protection from conversion of natural land cover for the majority of the area, but are subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area. Example: multiple-use National Forest and Bureau of Land Management lands, state forests, county and regional parks.

Status 4 — Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat types* and allow for intensive use throughout the tract, or existence of such restrictions is unknown. Examples: private lands, Native American lands, and some military bases.

** Anthropogenic refers to human created habitat such as agricultural land.*

Map 3: Land Cover within the Central Coast Region.

Distribution and Status of Key Terrestrial Habitats

OAK WOODLANDS

It is estimated that more than 200 species of plants, 100 species of birds, 60 species of mammals, 80 species of reptiles, and 5,000 species of insects depend on California's oak woodland habitats (Block et al. 1990, Pavlik et al. 1991). There are six dominant oak forest and woodland communities in the region: blue oak *(Quercus douglasii)*, valley oak *(Qurcus lobata)*, interior live oak *(Quercus wislizenii)*, canyon live oak *(Quercus chrysolepis)*, coast live oak *(Quercus agrifolia)*, and black oak *(Quercus kelloggii)*. There is also a small extent of hybrid Alvord oak (a blue oak and desert scrub oak *(Quercus turbinella)* mix) and tan oak *(Lithocarpus densiflorus)*.

Blue oak in homogenous stands, as well as blue oak mixed with grey pine *(Pinus sabiniana)*, equals 50% of all oak communities in the region. The second most extensive community (10%) is coast live oak (*Table 2*). Additional information on oaks in the region is found in Appendix 6.

Table 2. Oak Habitat and Level of Protection in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM²)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM²)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Foothill Pine-Oak Woodland	2,427	599,774	116	28,659	**4.78**	21.42
Blue Oak Woodland	2,102	519,509	79	19,606	**3.77**	20.29
Coast Live Oak Forest	1,292	319,308	39	9,623	**3.01**	70.88
Coast Live Oak Woodland	975	240,906	32	8,009	**3.32**	96.29
Alvord Oak Woodland	250	61,672	0	17	**0.03**	100.00
Black Oak Woodland	221	54,652	30	7,493	**13.71**	12.87
Juniper-Oak Cismontane Woodland	217	53,550	1	229	**0.43**	46.76
Valley Oak Woodland	139	34,245	8	1,946	**5.68**	19.11
Black Oak Forest	122	30,082	6	1,544	**5.13**	2.14
Bigcone Spruce-Canyon Oak Forest	80	19,831	62	15,308	**77.19**	33.56
Canyon Live Oak Forest	50	12,435	47	11,581	**93.13**	3.67
Tan-Oak Forest	49	12,204	13	3,213	**26.33**	2.35
Interior Live Oak Forest	28	6,998	9	2,123	**30.34**	0.95
Oregon Oak Woodland	19	4,680	0	0	**0.00**	0.79
Total	**7,972**	**1,969,846**	**443**	**109,351**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

GRASSLANDS

California native grasslands are considered one of our nation's most endangered habitats (Noss et al. 1995; Noss and Peters 1995). Introduced annual grasses have taken over the great majority of central coast native grasslands and account for approximately 33% of all vegetation in the region (Davis et al. 1998). Most of these nonnative grasslands are on privately owned agricultural or ranch land *(Table 3)*. Some of the wildlife species analyzed in this report are dependent on grassland habitat. The potential and methods for restoring native grasses are, however, beyond the scope of this report.

Table 3. Grassland Habitat and Level of Protection in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM^2)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM^2)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Coastal Prairie	778	192,340	96	23,795	12.0	93.94
Nonnative Grassland	12,519	3,093,413	702	173,389	5.0	45.46
Total	**13,297**	**3,285,753**	**798**	**197,184**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

In addition to the expansive interior nonnative grasslands, a few remnants of coastal terrace prairie and higher elevation coastal rangelands remain in the region. Some resident grassland fauna rely on both coastal and inland grassland habitats *(Appendix 7)*.

One of this report's focal species, the endangered San Joaquin kit fox *(Vulpes macrotis mutica)*, is a resident of the region's interior grasslands. The kit fox preys upon giant kangaroo rats *(Dipodomes ingens)*, California ground squirrels, black-tailed jackrabbits *(Lepus californicus)*, ground-nesting birds, insects and other rodents (Williams et al. 1998). Two of three core population centers critical for recovery of the San Joaquin kit fox encompass regional grassland habitats. One of these population centers is the Carrizo Plain, which lies entirely within the central coast region. The other, the Ciervo-Panoche Natural Area, spans an area from Panoche Valley in San Benito County to the San Joaquin Valley in Fresno County. The Panoche valley is within our study area, but the San Joaquin valley is not (Williams et al. 1998).

While chroniclers of the Portolá expedition in 1769 reported abundant herds of pronghorn antelope in the Salinas valley (Henson and Usner 1993), these native grazers have been largely displaced by livestock. A reintroduced pronghorn population now exists on the Carrizo Plain and could serve as a potential nucleus for future population expansion, but only with supportive land planning and management.

CHAPARRAL AND COASTAL SCRUBLANDS

Interior chaparral species include manzanitas, ceanothus *(Ceanothus spp.)*, chamise *(Adenostoma fasciculatum)*, toyon *(Heteromeles arbutifolia)*, and associated sclerophylls (thick, waxy-leaved plants). Coastal scrub types within the region include northern coastal bluff scrub, Franciscan, Diablan, Lucian and Venturan coastal scrubs (Holland 1986). The northern coastal bluff scrub and Franciscan scrub types are characterized by the presence of a plant species known as lizardtail *(Eriophyllum staechadifolium)*. The latter three are characterized by the presence of California sagebrush *(Artemisia californica)* and buckwheat species *(Eriogonum latifolium, E. parvifolium* and/or *E. fasciculatum*, depending on locale).

Ninety percent of chaparral communities in the region are unprotected, including Diablan coastal scrub, mixed serpentine chaparral, and coastal sage-scrub chaparral. Protected chaparral communities include montane chaparral such as manzanita *(Arctostaphylos spp.)*, and scrub and interior oak chaparral *(Table 4)*.

Table 4. Chaparral Habitat and Level of Protection in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM²)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM²)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Buck Brush Chaparral	3,740	924,167	757	187,168	**20.25**	79.08
Chamise Chaparral	2,467	609,591	602	148,734	**24.40**	43.83
Valley Saltbush Scrub	992	245,119	91	22,508	**9.18**	53.75
Diablan Sage Scrub	781	193,031	23	5,765	**2.99**	99.72
Scrub Oak Chaparral	636	157,186	287	70,798	**45.04**	35.36
Venturan Coastal Sage Scrub	574	141,740	75	18,576	**13.11**	29.03
Central (Lucian) Coastal Scrub	572	141,242	55	13,512	**9.57**	99.80
Semi-Desert Chaparral	568	140,346	125	30,828	**21.97**	26.28
Northern (Franciscan) Coastal Scrub	407	100,504	80	19,711	**19.61**	95.71
Interior Live Oak Chaparral	377	93,123	262	64,640	**69.41**	20.56
Ceanothus crassifolius Chaparral	350	86,586	147	36,365	**42.00**	14.02
Mesic North Slope Chaparral	346	85,574	130	32,149	**37.57**	62.80
Upper Sonoran Subshrub Scrub	339	83,653	98	24,295	**29.04**	91.16
Upper Sonoran Manzanita Chaparral	247	60,931	121	29,932	**49.12**	30.52
Ceanothus megacarpus Chaparral	235	58,163	3	747	**1.28**	37.73
Central Maritime Chaparral	216	53,390	31	7,666	**14.36**	100.00
Coastal Sage-Chaparral Scrub	122	30,046	0	0	**0.00**	42.39
Northern Mixed Chaparral	95	23,370	8	2,065	**8.84**	5.47
Big Sagebrush Scrub	76	18,854	8	2,016	**10.69**	2.21
Northern Coastal Bluff Scrub	71	17,602	71	17,511	**99.49**	99.65
Leather Oak Chaparral	66	16,300	14	3,466	**21.26**	89.51
Blue Brush Chaparral	57	14,131	5	1,137	**8.04**	87.78
Serpentine Foothill Pine-Chaparral Woodland	52	12,783	7	1,695	**13.26**	9.85
Mule Fat Scrub	50	12,290	2	431	**3.51**	50.24
Mixed Serpentine Chaparral	47	11,667	4	947	**8.12**	16.45
Montane Ceanothus Chaparral	47	11,651	17	4,257	**36.54**	6.11
Interior Coast Range Saltbush Scrub	35	8,626	7	1,646	**19.08**	100.00
Cismontane Juniper Woodland and Scrub	33	8,111	0	1	**0.01**	100.00
Montane Manzanita Chaparral	22	5,437	19	4,595	**84.52**	2.48
Mixed Montane Chaparral	17	4,307	8	2,082	**48.35**	1.28
Valley Sink Scrub	12	3,073	7	1,766	**57.45**	6.47
Central Dune Scrub	12	2,957	3	786	**26.59**	99.57
Tamarisk Scrub	11	2,829	0	3	**0.10**	7.53
Riversidian Sage Scrub	11	2,645	10	2,411	**91.15**	1.71
Great Valley Mesquite Scrub	5	1,184	0	25	**2.15**	20.15
Diegan Coastal Sage Scrub	5	1,155	0	0	**0.00**	0.37
Red Shank Chaparral	2	588	0	0	**0.00**	0.21
Total	**13,694**	**3,383,953**	**3,077**	**760,232**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

MIXED EVERGREEN AND CONIFEROUS FORESTS

Mixed evergreen forests of the central coast region are comprised of hardwood mosaics such as tan oak, madrone *(Arbutus menziesii)*, canyon live oak, black oak, California bay *(Umbellularia californica)*, and bigleaf maple *(Acer macrophyllum)*, along with Douglas fir *(Pseudotsuga menziesii)*.

Other regional forest habitat types are characterized by a diverse array of conifer species, including Coulter, ponderosa and sugar pines *(Pinus coulteri, P. ponderosa, and P. lambertiana)*, and the closed-coned, fire-adapted Monterey, bishop and knobcone pines *(P. radiata, P. muricata and P. attenuata)*. Most of these forests are confined to the relatively moist outer Coast Ranges, though drier forest types occur in the Diablo Range.

An unusual mixed conifer forest exists in the San Benito mountain vicinity, which is a very dry portion of the eastern Diablo Range. This assemblage is adapted to extreme serpentine soils and includes Coulter and gray pines, along with disjunct stands of incense cedar *(Libocedrus decurrens)* and Jeffrey pine *(Pinus jeffreyi)* (Griffin 1974).

There are a few more forest types in the region worth noting. The northern interior cypress forest type is represented by Santa Cruz cypress *(Cupressus abramsiana)* on sandstone in the Santa Cruz mountains and by Sargent cypress *(Cupressus sargentii)* on serpentine in the Santa Lucias. The Santa Lucia fir forms a forest type endemic to the Santa Lucia range. In the extreme south of the region, in the Sierra Madre and San Rafael ranges, the so-called bigcone spruce, or bigcone Douglas fir *(Pseudotsuga macrocarpa)* occurs in forest stands with canyon live oak.

REDWOOD FORESTS

Coast redwood *(Sequoia sempervirens)*, the region's most renowned tree species, reaches its southernmost and easternmost limits in the region and covers 1,262 km^2 *(Table 6)*. Redwood forests south of San Francisco Bay are found in the Santa Cruz and northern Santa Lucia Mountains west of the San Andreas Fault (Sawyer et al. 2000, citing Miles and Goudey 1997), primarily on coastal slopes, with some stands on the eastern slopes where localized fog is concentrated.

Along the Big Sur coast, redwoods are increasingly restricted to coastal canyon bottoms, with the southernmost stand occurring about 3 km south of Salmon Creek in southwest Monterey County. Stands in San Luis Obispo County are believed to have been planted (Sawyer et al. 2000). Four natural stands of redwoods remain in the Oakland Hills (ibid.), comprising the easternmost stands in its range.

Redwood forests of the central coast region are not as lush and diverse as their northern counterparts. These forests have been logged in the past, though a few old growth stands remain in Big Basin and Butano State Parks and Pescadero Creek County Park in the Santa Cruz mountains, along with some ancient trees in the Big Sur area of the Santa Lucias. The threatened marbled murrelet *(Brachyramphus marmoratus)* nests in the crowns of redwood and Douglas-fir old growth as far south as the Santa Cruz mountains (Singer et al. 1991). Resident species of redwood forests include various bats, squirrels, chipmunks, salamanders, and a vast array of invertebrate fauna (Cooperrider et al. 2000).

Table 5. Extent of Conifer/Mixed/Hardwood Forest Habitat in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM^2)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM^2)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Mixed Evergreen Forest	1,630	402,896	429	106,119	26.34	37.73
Upland Redwood Forest	1,248	308,440	246	60,781	19.71	21.64
Mojavean Pinyon and Juniper Woodlands	684	169,109	172	42,402	25.07	15.94
Mixed North Slope Cismontane Woodland	200	49,477	5	1,253	2.53	20.92
Open Foothill Pine Woodland	189	46,613	6	1,439	3.09	13.22
Coulter Pine Forest	91	22,537	31	7,636	33.88	23.90
Coast Range Mixed Coniferous Forest	90	22,311	14	3,512	15.74	0.62
Bishop Pine Forest	65	16,168	31	7,755	47.96	27.22
Monterey Pine Forest	50	12,268	3	775	6.31	99.71
Upland Douglas-Fir Forest	48	11,758	37	9,265	78.80	18.75
Coast Range Ponderosa Pine Forest	42	10,471	9	2,211	21.12	11.80
Westside Ponderosa Pine Forest	34	8,495	34	8,495	100.00	0.36
Ultramafic Mixed Coniferous Forest	30	7,478	27	6,705	89.66	11.73
Jeffrey Pine-Fir Forest	20	4,958	16	3,895	78.56	0.45
Santa Lucia Fir Forest	18	4,388	18	4,388	100.00	100.00
Sierran Mixed Coniferous Forest	15	3,824	13	3,312	86.62	0.09
Alluvial Redwood Forest	14	3,342	0	0	0.00	4.33
Knobcone Pine Forest	9	2,131	6	1,413	66.34	8.36
Non-Serpentine Foothill Pine Woodland	4	946	0	118	12.47	0.67
California Bay Forest	3	849	0	116	13.64	100.00
Jeffrey Pine Forest	3	626	2	434	69.40	0.09
Northern Interior Cypress Forest	2	580	2	373	64.32	1.32
California Walnut Woodland	1	188	0	0	0.00	2.13
Total	**4,491**	**1,109,853**	**1,102**	**272,397**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

Table 6. Extent of Redwood Forest Types in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM^2)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM^2)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Upland Redwood Forest	1,248	308,440	246	60,781	19.71	21.64
Alluvial Redwood Forest	14	3,342	0	0	0.00	4.33
Total	**1,262**	**311,783**	**246**	**60,781**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

Aquatic Habitats

REGIONAL WETLANDS

Regional wetlands have been dramatically reduced in distribution. These areas are critical wildlife breeding, hunting, and foraging areas. Wetlands are areas of seasonally or permanently saturated soils. Water in these communities may be fresh, salty or brackish (a mixture of salt water and fresh water).

There are many wetland types in the central coast region (Ferren et al. 1996). Many are too small to be included in most vegetation map categories (Davis et al. 1998). Vernal pools fall into this category. Vernal pools are seasonal wetlands that occur in landscape depressions underlain by an impermeable layer. Vernal pools provide habitat to many endemic and native plant species (Witham et al. 1998). Unfortunately, only roughly 10% of California's vernal pool communities remain.

About 16% of mapped wetland types in the region are on lands managed for conservation *(Table 7)*. Coastal and valley freshwater marsh types are the most threatened of the wetland classes identified by the Gap Analysis. Table 7 shows the extent of different wetlands in the region and the degree to which they are managed for conservation (Gap Management Status 1 and 2, Davis et al. 1998).

Table 7. Salt and Freshwater Marsh Habitat and Level of Protection in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM^2)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM^2)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Bays and Estuaries	177	43,619	29	7,074	16.22	70.77
Permanently-flooded Lacustrine Habitat	171	42,350	21	5,271	12.45	4.23
Coastal Brackish Marsh	63	15,521	4	972	6.26	23.27
Northern Coastal Salt Marsh	42	10,371	20	5,036	48.55	88.92
Coastal and Valley Freshwater Marsh	2	414	0	0	0.00	0.47
Southern Coastal Salt Marsh	1	155	1	141	91.27	5.00
Total	**455**	**112,431**	**75**	**18,494**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

ESTUARIES

Estuaries are the meeting place of sea and land, and of salt and fresh water. They are biological mixing zones for many different animal species. The estuaries of the region include the San Francisco-San Pablo-Suisun Bay complex, Tomales Bay, Drakes Estero complex, Bolinas Lagoon, Elkhorn Slough in Monterey Bay and Morro Bay.

Of the 46 preliminary Important Bird Areas identified in the region by the National Audubon Society (Cooper 2001), 15 are located on these estuaries *(Appendix 4)*. Ten of these areas are in the San Francisco-San Pablo-Suisun Bay complex. A diverse array of bird species use these waterways. These include: California brown pelicans *(Pelecanus occidentalis)*, Brandt's cormorants *(Phalacrocorax penicillatus)*, double-crested cormorants *(Phalacrocorax auritus)*, black-necked stilts *(Himantopus mexicanus)*, red-necked phalaropes *(Phalaropus lobatus)*, American avocets *(Recurvirostra americana)*, great egrets *(Casmerodius albus)*, great blue herons *(Ardea herodias)*, the endangered California clapper rail *(Rallus longirostris obsoletus)*, snowy plover *(Charadrius alexandrinus)*, and many others.

Chinook salmon *(Oncorhynchus tshawytscha)* may spend time among the wetlands of the San Francisco-San Pablo-Suisun Bay complex and are sometimes sighted moving up local streams. In recent years, chinook salmon have been documented struggling upstream in the channeled Walnut Creek in Concord (Freeman House, pers. comm. 1998). They have also been documented in the Guadalupe River near downtown San Jose, in a stretch where steelhead *(Oncorhynchus spp.)* spawning also still persists.

Numerous smaller, seasonal estuaries are found at the mouths of coastal-draining streams and rivers. These are often temporarily contained by sandbars that form until winter storms breach them. These seasonal estuaries contain a rich diversity of bird species and include six of the 46 preliminary Important Bird Areas identified within the region (Cooper 2001). Moreover, these waters provide steelhead, Pacific lamprey *(Lampetra tridentate)*, and, in a few cases, coho salmon *(Oncorhynchus kisutch)* with the habitats essential for making physiological adaptations to salt water before heading out to feed in the ocean.

There are three Evolutionary Significant Units (an ESU is a distinct genetic group) of steelhead present in the region, of which two are threatened (CDFG, 2001). Yet, steelhead survive, in some cases existing as resident rainbow trout populations in reaches blocked from the ocean by dams, insufficient water flows, or other obstructions (Titus et al. 1999).

RIPARIAN AND RIVERINE HABITATS

Riparian vegetation buffers streams from sedimentation, solar radiation, and other factors that alter riparian habitats. The California GAP Analysis (Davis et al. 1998) recognizes seven types of riparian vegetation in the central coast region, less than 7% of which is currently managed for conservation *(Table 8)*.

Table 8. Riparian Habitat and Level of Protection in the Central Coast Region

CNDDB COMMUNITY NAME (HOLLAND 1986)	TOTAL MAPPED DIST. IN REGION (KM²)	TOTAL MAPPED DIST. IN REGION (ACRES)	AREA UNDER CONS. MGMT. (KM²)	AREA UNDER CONS. MGMT. (ACRES)	PERCENT UNDER CONS. MGMT.	PERCENT OF STATEWIDE DIST.
Central Coast Cottonwood-Sycamore Riparian Forest	84	20,747	7	1,616	7.79	99.9547
Central Coast Live Oak Riparian Forest	32	7,802	6	1,502	19.26	99.9727
Central Coast Arroyo Willow Riparian Forest	23	5,715	0	1	0.02	99.9888
Great Valley Cottonwood Riparian Forest	20	5,039	0	61	1.20	6.6026
Southern Coast Live Oak Riparian Forest	14	3,380	6	1,392	41.19	90.9767
Sycamore Alluvial Woodland	9	2,267	0	0	0.00	100.0000
Southern Cottonwood-Willow Riparian Forest	6	1,480	0	20	1.33	10.0707
North Coast Riparian Scrub	3	813	0	0	0.00	27.8593
White Alder Riparian Forest	3	649	3	649	100.00	12.3446
Southern Sycamore-Alder Riparian Woodland	2	479	0	0	0.00	23.9681
Southern Arroyo Willow Riparian Forest	1	327	1	327	100.00	7.0124
Total	**197**	**48,698**	**23**	**5,567**		

Data Source: California GAP Analysis Project (Davis et al. 1998)

Riparian habitats in the region are dominated by a variety of willows *(Salix sp.)*, cottonwoods *(Populus fremontii and P. balsamifera)*, white and red alders (Alnus rhombifolia and A. rubra), and California sycamore *(Platanus racemosa).* These habitats provide many ecological services to aquatic and terrestrial wildlife (Mayer and Laudenslayer 1988). For example, riparian habitats are important to birds because these habitats provide opportunities for foraging and breeding (RHJV 2000), as well as resting stops during migration (Otahal, pers. comm. 1998).

The central coast region contains an extensive network of waterways, including large rivers, smaller streams and intermittent waterways. Flowing north 170 miles from San Luis Obispo through Monterey County, the upper reaches and tributaries of the Salinas River once hosted steelhead. The prevalence of dams, diversions, and water pumping now blocks access to historic spawning and rearing habitats.

Other large rivers in the region include the Santa Maria, Pajaro, Cuyama (a tributary of the Santa Maria), and Santa Ynez Rivers. These large rivers have also attracted human activities that have degraded the integrity of riparian habitats. The least impacted rivers and streams in the region are in short, steep coastal watersheds found on public lands in the Santa Cruz and Santa Lucia mountain ranges. Examples of these include, Pescadero and Waddell Creeks in the Santa Cruz mountains and the Little Sur River and Big Creek in the northern Santa Lucias. These streams continue to support reduced steelhead populations.

Mammals, such as gray fox *(Urocyon cinereoargenteus)*, coyote *(Canis latrans)*, ringtail *(Bassariscus astutus)*, raccoon *(Procyon lotor)*, and striped skunk *(Mephitis mephitis)* use riparian habitats. Historic tule elk *(Cervus elaphus nannodes)* populations once used them during breeding season, as well as for foraging. The southwestern pond turtle *(Clemmys marmorata pallida)*, a federal species of concern, is dependent on riverine and riparian habitats. Amphibians associated with riparian habitats include Pacific tree frog *(Pseudacris regilla)*, California red-legged frog *(Rana aurora draytonii)* (a federally listed threatened species for which critical habitat was recently designated), foothill yellow-legged frog *(Rana boylii)* (a federal species of concern), and the federally listed endangered arroyo southwestern toad *(Bufo microscaphus californicus)*. Another federally listed endangered amphibian species, the Santa Cruz long-toed salamander *(Ambystoma macrodactylum croceum)* may reside in riparian or oak woodland retreats, from which it migrates annually to small ponds or sloughs to breed.

Section 5

THREATS TO BIODIVERSITY WITHIN THE CENTRAL COAST REGION

Swordfern — *Polystichum munitum*

Section 5

THREATS TO BIODIVERSITY WITHIN THE CENTRAL COAST REGION

Overview

"We live among the remnants," observed author Wallace Stegner. Human activities have had a profound impact on the central coast region. Once-prolific wildlife and expansive wildlands have diminished to remnant habitats and populations. Since European settlement in the central coast began in earnest (around 1850), much of the lower-elevation landscape has been converted from native habitat to agricultural and developed landscapes.

In setting a vision for long-term ecological integrity, it is important to have a sense of what has already been lost to human activities. This section covers the threats to biodiversity in the region that stem from these impacts.

Habitat fragmentation is the process by which habitats are increasingly subdivided into smaller units, resulting in their increased insularity as well as losses of total habitat area.

— Noss and Cooperrider, 1994

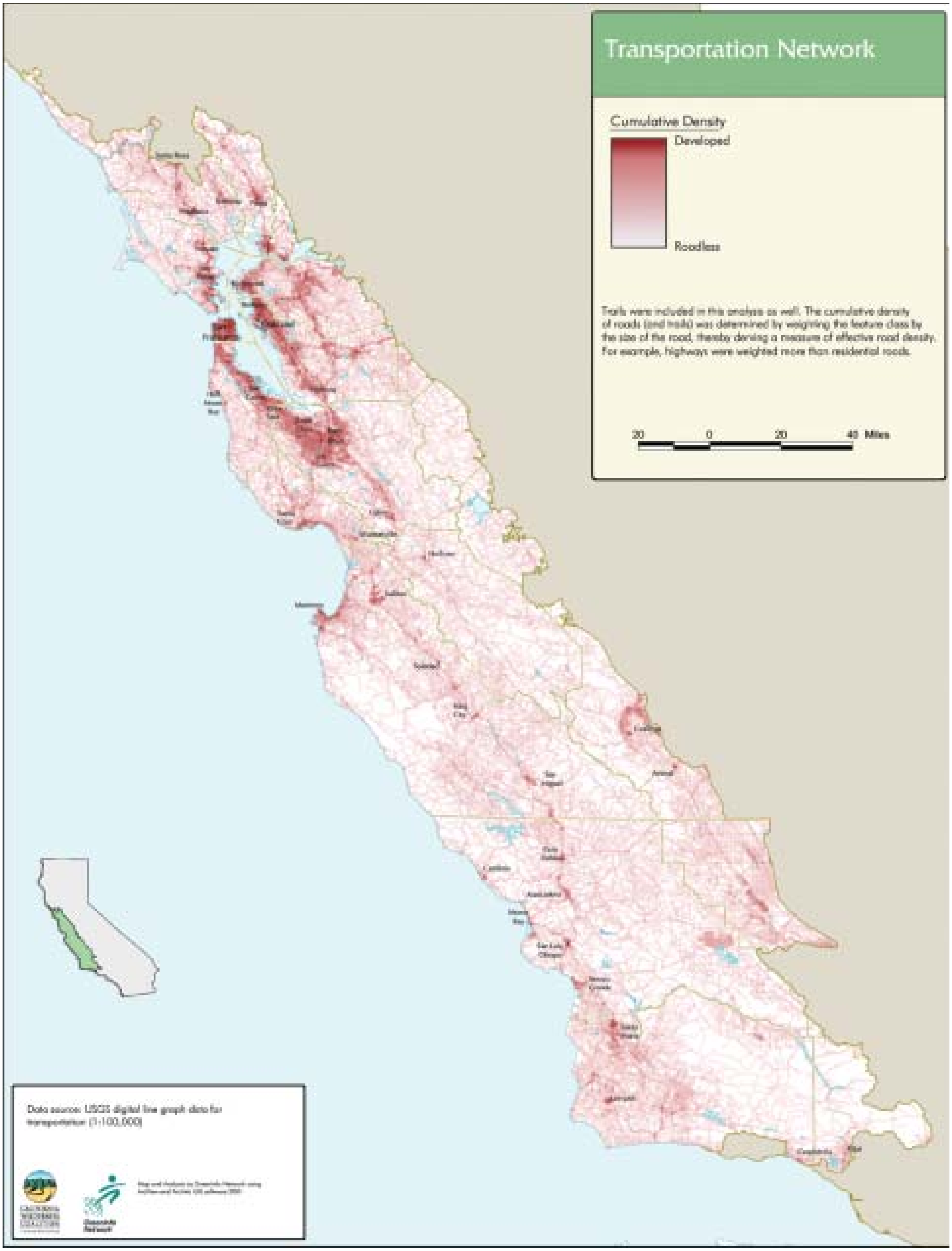
Habitat fragmentation

Fragmentation of habitat is the greatest threat to biological diversity in the region, in California, and worldwide (Burgess and Sharpe 1981, Noss 1983, and Harris 1984). Habitat fragmentation occurs at both local and regional scales (Soule and Terbourg 1999). On the central coast, habitat fragmentation results from urban and suburban sprawl, clearcutting, and extensive agricultural development.

Today, nine million people live in the central coast region, a number that is expected to grow to 11 million by 2020 (FRAP 1997). This rapid human population growth in the region continues to fragment wildlife habitat and populations into ever-shrinking habitat patches and subpopulations.

Urban and suburban development has occurred in more than 21% of the region's natural areas (Davis et al. 1998). Development in the region has been centered largely in the low-elevation areas surrounding San Francisco, Salinas, San Jose, Santa Clara, Oakland, Livermore, and Santa Maria. Other communities such as Santa Rosa, Santa Cruz, San Luis Obispo, Paso Robles and Atascadero are also experiencing rapid growth. Seventy-five percent of the region is open to new development (Davis et al. 1998). California's population projections place much of the region's wildlife, wildlands, and water resources in jeopardy. Urban sprawl and roads are two of the greatest impacts on wildlife sub-populations, seasonal migrations, and the long-term genetic exchange necessary for population viability.

Roads have been documented as one of the most potent agents of ecological destruction around the world, with numerous impacts on habitat structure and wildlife populations (Forman and Alexander 1998). Different types of roads have different impacts. For example, single-track dirt roads increase access for poachers and harassment from off-road vehicles. Multi-lane highways and paved roads effectively subdivide habitat for many animals into smaller and smaller fragments until their habitat is no longer viable. Roads act as vectors for disturbance and land conversion. Residential, industrial, and agricultural development follows roads into formerly natural areas. In Map 4, a north-south pattern of road impact in the region's valley bottoms is evident, reflecting challenges to wildlife moving east to west.



Map 4. Cumulative Road Density Present in the Central Coast Region

Data Source: USGS Digital line graph 1993, 1:100,000

Industrial agriculture

The driving force behind loss of biodiversity is an increasing human population and consumption of resources (Noss and Cooperrider 1994). Habitat degradation and conversion due to urbanization, industrial agriculture, vineyard development, and livestock grazing are major threats to wildlife habitat and habitat linkages in the central coast region.

Agriculture is widespread throughout many of the valleys in the region because crops can flourish in prime valley-bottom soils. The climate is also good for growing grapes, which are often planted on steeper slopes with poorer soils. Silt, pesticides, and fertilizers are carried away by rain runoff from these industrial agricultural fields with negative impacts on water quality and aquatic habitats.

Conversion of once-natural landscapes into vineyards threatens oak and chaparral habitats in many locations in the region including Sonoma, Monterey, San Luis Obispo, and Santa Barbara Counties. A recent study in Sonoma County found vineyard development is encroaching on upland habitats (Merenlender 2000). Merenlender cites three factors driving this trend: preferred flat land is already developed, flat lands generally are more expensive, and grape quality can benefit from microclimate conditions found on hillsides.

Logging

Logging activity in the central coast region affects mixed conifer, oak, and redwood forests. Most of the region's forest types are open to development or logging on private or US Forest Service lands, including 75% percent of old-growth upland redwoods and 80% of oak woodland forests. There are approximately 1.6 million acres of privately owned conifer forest in Mendocino, Sonoma, Marin, San Mateo, Santa Cruz, and Monterey counties (FRAP 1997).

Livestock grazing

Livestock grazing is also widespread in the region, especially on expansive ranches in the inner Coast Ranges. Grazing practices have contributed to the conversion of native perennial grasslands to non-native Mediterranean annual grasses. In addition, livestock grazing has negative impacts on aquatic species such as the federally listed endangered California red-legged frog *(Rana aurora draytonii)*. Several studies have shown that livestock grazing can negatively affect riparian habitat, marshes, and ponds (USFWS 2000). Unmanaged cattle can trample and eat emergent and riparian vegetation, often eliminating or severely reducing plant cover (Duff 1979). Loss of streamside vegetation also reduces habitat for many insects and small mammals, which are important dietary components for aquatic and riparian associated species (Cordone and Kelly 1961).

Dams and diversions

Over 200 dams and diversions affect every major river and nearly every large creek in the region. At least 73 dams block migrating steelhead *(Oncorhynchus mykiss)* and coho salmon *(Oncorynchus tshawytsch)* from spawning in upriver habitats (Jigour 2000). These dams contribute to the decline in populations of anadromous (or migrating) fish in the region. Currently, three Evolutionarily Significant Units (ESU's) of steelhead are federally listed threatened. One ESU steelhead population is federally listed endangered. Three ESU's of coho salmon are also federally listed threatened and one ESU of coho is federally listed endangered (CDFG, 2001).

Loss of oak habitat

Oak woodlands account for 16% of the region's vegetation, but only 5.5% of oak woodlands and forests occur on lands specifically managed for conservation purposes in the central coast region. A vast majority of oak species, and the diversity of life they harbor, are on lands with little or no formal conservation management priorities. Oaks are cut statewide for firewood and timber, yet they receive no regulatory protection from the California Forest Practice Rules, a set of policies governing management of timber on private lands (California Forest Practice Rules, 2001).

California has lost two-thirds of its oak woodlands (Thomas 1997). In the region, oak woodlands are threatened by development and conversion to vineyards (Davis et al. 1998). In Sonoma County, approximately 34,683 hectares (11,600 acres) of oak woodlands were converted to vineyards between 1990 and 1997 (Merenlender 2000).

Sudden Oak Death syndrome

In recent years, a new pathogen has posed a great threat to many native California oaks. This pathogen could detrimentally affect the distribution and survival of these species along the central coast and throughout California. Over the past five years large numbers of tanoaks *(Lithocarpus densiflorus)*, coast live oaks *(Quercus agrifolia)*, and black oaks *(Quercus kelloggii)* have been dying in California's coastal counties.

The epidemic, referred to as Sudden Oak Death syndrome, results from a new species of fungus that has since been officially named *Phytophthora ramorum*. The name refers to the pathogen's tendency to cause infection on branches. Sudden Oak Death was first seen on tanoak in Mill Valley in Marin County in 1995. Since then, it has been confirmed in ten central coast counties: Marin, Santa Cruz, Sonoma, Napa, San Mateo, Monterey, Santa Clara, Mendocino, Solano and Alameda, and has been found in Curry County, Oregon (Svihra et al. 2001).

Invasive, non-native species

Considered a global threat to biodiversity, invasive plants and animals compete with native species in the region. In the central coast region, about 33% of the flora is non-native and many animals are also introduced. This report does not attempt to develop management recommendations specifically targeting control of non-native species. Such recommendations should be part of a comprehensive program to control and mitigate the effects of non-native species, which is beyond the scope of this report.

Section 6

WILDLANDS CONSERVATION PLANNING

Coast Live Oak — *Quercus agrifolia*

Section 6

WILDLANDS CONSERVATION PLANNING

Overview

Wildlands are generally characterized as large, ideally roadless, areas. In the central coast, they are distributed throughout the mountainous and non-valley portions of the ecoregion. The distribution of wildlands in the central coast region is quite diverse. Many of these wildlands are found on large private ranches, while the remaining areas are located within the boundaries of state parks, wilderness areas, and public lands managed by the U.S. Forest Service and Bureau of Land Management.

The magnitude of habitat loss, rate of species decline, and adverse impacts to a variety of ecosystems that occur in the central coast region, mandates that we initiate the immediate protection and restoration of these natural areas to preserve the biodiversity within the region. Noss and Cooperrider (1994) state four goals of regional conservation that must be satisfied in order to achieve the maintenance of biodiversity and ecological integrity in perpetuity. These goals are:

1. Represent, in a system of protected areas, all native ecosystem types and seral stages across their natural range of variation.
2. Maintain viable populations of all native species in natural patterns of abundance and distribution.
3. Maintain ecological and evolutionary processes, such as disturbance regimes, hydrological processes, nutrient cycles, and biotic interactions.
4. Manage landscapes and communities to be responsive to short-term and long-term environmental change and to maintain the evolutionary potential of biota.

To achieve these goals, a network of large, interconnected wildlands is necessary.

Every species of wildlife has basic needs. Animals need food, water, and viable habitat to thrive within a larger ecosystem. Some wildlife species, such as the mountain lion, require large, undisturbed wild spaces in order to support a viable population of individuals. If these wild spaces are too small and isolated from other viable habitat, the species will ultimately fall prey to local extirpation. The grizzly bear, the gray wolf, and many other species have followed this path in California over the past century, primarily because of the impact of humans on the landscape.

The presence of top carnivores, such as the mountain lion, often signifies ecological integrity. The effect of their absence ripples throughout an ecosystem with deleterious effects cascading down the food chain *(see Top-down effects of predators, page 25)*. Conservation approaches at the ecosystem and landscape level are probably the only way to conserve these essential elements of biodiversity (Franklin 1993). Merely setting aside small parcels of rare or threatened habitats is insufficient over the long-term (300 years or longer) if the goal is persistence of functional ecosystems (Noss 1992, 1994, Jeo et al. 1999, Terborgh and Soulé 1999).

As human populations increase, critical habitats will continue to become fragmented and vital habitat linkages may ultimately be lost. A new set of conservation planning tools must be adopted to address these ecological threats. It is the goal of this conservation plan to create a wildlands vision that will lead to the protection of these wild places in perpetuity.

Rewilding

A major component of any wildlands vision is the concept of "rewilding." As defined by Soulé and Noss (1999), rewilding is "the scientific argument for restoring big wilderness based on the regulatory roles of large predators." Rewilding is based on the reasoning that the protection of large wild spaces comprised of core habitat for top carnivores (or other keystone species) is critical for maintaining biodiversity.

There are three components to the rewilding concept (Noss and Soulé 1998):

1. Large protected core areas
2. Connectivity (Linkages)
3. Keystone species

- **Cores** are large wildlands that can support viable populations of wildlife. They contain large, representative areas of native plant communities.
- **Habitat Linkages** connect core areas across the landscape, allowing for safe movement of wildlife.
- **Keystone Species** are species whose influence on ecosystem function and diversity are disproportionate to their numerical abundance.

As stated above, keystone species are species whose influence on ecosystem function and diversity are disproportionate to their numerical abundance (Paine 1980, Gilbert 1986, Terborgh 1988, Mills et al. 1993, Powers et al. 1996). Keystone species have the unique role of regulators of the system in which they live. According to Noss and Soule' (1999), "the interactions of some species are more profound and far-reaching than others, such that their elimination from an ecosystem often triggers cascades of direct and indirect changes…, leading eventually to loss of habitat and extirpation of other species in the food web."

The core-linkage-keystone species approach has been applied to many landscape-level conservation projects in places such as Florida, the Rocky Mountains, Washington, Maine, New York, and parts of California. (The Wildlands Project web site 2001, see *Case Study: The Florida Greenway Program*, on following page).

A core-linkage-keystone species approach, when implemented, consists of a number of large, protected areas connected together by a series of habitat linkages that allow wildlife movement between the core areas. This approach is based on the belief that our present arrangement of land management and protected places does not ensure the maintenance of ecological processes and survival of all species.

Certain fine-scale elements, such as serpentine rock outcrops or small populations of tiger salamander, may or may not be represented under this framework. However, these elements should be included in conservation planning efforts to identify locations of individual populations and occurrences of multiple species (biodiversity hotspots).

Both approaches to wildlands planning, the core-linkage-keystone species and biodiversity hotspots, are complementary and together provide a comprehensive strategy for protecting native plants, animals, and natural processes (Noss and Soulé 1999). In our analysis, we selected a variety of fine-scale elements and examined how they are represented in our landscape-level design.

CASE STUDY: THE FLORIDA GREENWAY PROGRAM

The Florida Greenway Program is a working example of how regional Wildlands Conservation Planning can be successful. Since the first statewide vision for an interconnected system of wildlands was proposed for Florida in 1985, the state's public awareness has grown in support of a greenway strategy. A greenway is a continuous strip of open space that provides habitat for wildlife and/or passive recreation opportunities. Greenways generally follow natural land forms connecting two or more large wildland areas. As large, highly mobile wildlife struggle to survive in Florida's ever-diminishing natural areas, greenways can facilitate wildlife travel between nature parks. In these and many other ways, the greenway strategy has taken root.

Florida has long been a destination for new families, industry, military, and the retired. This steadily growing human population has greatly affected Florida's dynamic natural world. As human communities sprout and extend into swamps, savannas, and pine forests, limited resources have become stressed. The Everglades National Park, a wetland of international importance, has been drained significantly to supply Florida's cities and suburban communities with water. Roads and highways fragment fragile habitat and subject certain wildlife, such as the Florida panther, to fatal vehicle collisions. Approximately 65% of Florida panther deaths are caused by vehicle collisions.

Realizing that the situation was degrading and threatening Florida's natural heritage, Dr. Reed Noss proposed a long-term vision for protecting and restoring whole ecosystems, large wildlife populations, and linkages. In 1985, Dr. Noss published a generalized map defining a system of "core" habitat areas and habitat "linkages" in addition to the current array of protected areas. Throughout the years, Dr. Noss's visionary map for Florida's wildlands has been cited as a model for long-term regional restoration and protection, emphasizing the need to maintain all native species, including large mammals, in a system of protected areas. Since then, Florida has investigated how Dr. Noss's model could evolve into a practical strategy for protecting the state's sensitive natural lands while providing direct benefits to society (Cox et al. 1994).

In 1993, Florida's governor, Lawton Chiles enacted the Florida Greenway Commission to realize a statewide system of greenways, consisting of large habitat blocks linked together to protect native ecosystems and wildlife, as well as provide public recreation opportunities. Many of Florida's proposed greenways are designed for human recreation: nature watching, hiking, horseback riding, and biking. This proactive program counters soaring urban and rural sprawl by protecting wildlands and migration routes for large native wildlife such as the black bear and the Florida panther. Florida's conservation vision, the Florida Greenway Program, will eventually add an additional 2.7 million acres of wildlands to the existing 7.4 million acres of conservation lands.

The Guide to Wildlands Planning in the Central Coast Region of California is designed in much the same way; it connects large intact habitats (core areas) with linear connectors (linkages). The core/linkage model is regarded as an effective approach to protecting a region's natural diversity of plants and animals while allowing migrating wildlife and natural occurances such as wildfire to move across the landscape.

The size of the Florida greenway core areas is important because these areas need to provide essential wildlife species with breeding and feeding habitat. Two ecologically important native wildlife species in that state are the black bear and Florida panther. The Florida panther is federally endangered and is protected under the Endangered Species Act of 1973. Currently there are believed to be fewer than 400 Florida panthers in the state. It is hoped the Florida Greenway Program, as implemented, will not prove too little too late, and will allow the black bear and Florida panther populations to regain their numbers over time.

Today, Florida has protected many parts of the greenway system, using funding from Florida programs, such as the Preservation 2000 program, the Conservation and Recreation Lands (CARL) program, and many other incentives and funds. In addition to protecting wildlands, the Florida Department of Transportation is constructing wildlife crossing structures and land bridges across roads to improve migration of black bear, Florida panther, and the key deer.

To learn more about the Florida Greenway Program: http://www.geoplan.ufl.edu/projects/greenways/greenwayindex.html

Focal Species

Focal species are used in planning and managing nature reserves because their requirements for survival represent factors important to maintaining overall ecological integrity (SIWNCP 2000). Ultimately, questions of ecological patterns and processes cannot be answered without reference to the species that live in the landscape (Lambeck 1997). Focal species analysis identifies habitat and addresses the questions: "What is the quality of the habitat?" and "How much area is needed?" The habitat requirements of focal species can be used to develop explicit guidelines regarding the composition, quantity, and configuration of habitat patches and management regimes that must be applied to the resulting design (Lambeck 1997).

Focal species are organisms used in planning and managing nature reserves because their requirements for survival represent factors important to maintaining ecological integrity

— (SIWNCP 2000).

Umbrella species have been defined as a type of focal species whose value in a conservation plan stems from their large area requirements (Miller 1999, Noss and Cooperrider 1994, Simberloff 1998). It is often assumed that developing a conservation strategy to protect umbrella species will protect other species as well (Noss and Cooperrider 1994). Umbrella species in conjunction with special biological elements and ecological processes are the focus for conservation planning in regional conservation planning efforts worldwide. Examples include the Sky Islands Wildlands Project, the Yellowstone to Yukon Initiative, the Southern Rockies Ecosystem Project, and Central Coast Region of British Columbia (Talberth and Bird 1998, Jeo et al. 1999).

Types of Focal Species

Keystone species play a unique role not filled by other species. Often, their effect is disproportionate to their abundance. Examples: mountain lion, gray wolf, beaver.

Area limited species are wildlife that need a lot of habitat daily, seasonally, or throughout their lifetime. Examples: grizzly bear, wolverine.

Dispersal limited species are wildlife most reluctant to travel, or those incurring high mortality during seasonal movements. Examples: sage grouse.

Process limited species are wildlife that require certain ecological processes for their survival. Examples: deer require wild brush fires, willow flycatcher require riparian flooding.

Resource limited species are wildlife that require special habitats or prey to survive Examples: Acorn Woodpecker, California spotted owl.

Narrowly endemic species are wildlife that occurs at very few sites, within a small geographic range (e.g., 50,000 km^2).

Special cases species include flagship species. Examples: "charismatic megafauna," tule elk, gray wolf.

Seven categories of focal species are recognized as useful in our planning phase: keystone, area limited, dispersal limited, process limited, resource limited, narrowly endemic, and special cases (Noss et al. 1997; Lambeck 1997). These categories enable planners to place wildlife species in an ecological context that will help meet the goals of the conservation plan. Multiple categories can apply to a single species. Above are the technical categories used for selecting the focal species utilized in our analysis.

The focal species identified in this report provide the baseline for planning the minimum size of core areas and distribution of linkages. Certain species, including keystone species such as the mountain lion, focal elements such as oak woodlands, and rare habitat types are then used to assess the effectiveness of the conservation plan. For more discussion on focal species analysis or the natural history of the focal species selected for the central coast conservation plan, see Section 7.

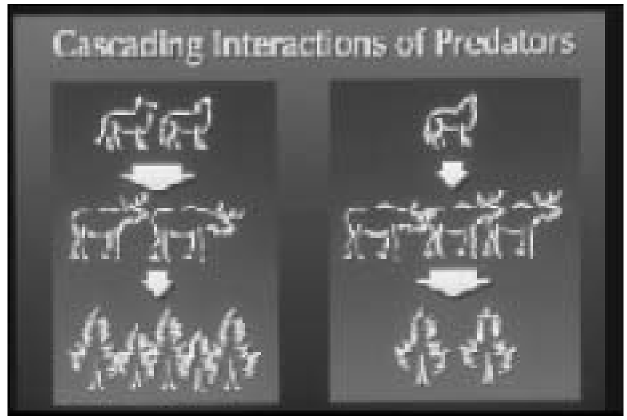


Figure 2: Cascading Interactions of Predators

Long-term observations of interactions among moose, balsam fir, and gray wolves on Isle Royale, Michigan show that when wolves are rare and moose abundant, the growth rate of balsam fir trees is depressed because the moose are consuming the balsam fir at a faster rate (McLaren and Peterson, 1994).

Top-down effects of predators

Scientific research suggests large carnivores play a "keystone" role in the ecosystem (Crooks and Soulé 1999). In particular, there is a growing body of evidence for the stabilizing influence of predator species interactions in food webs (Terborgh and Soulé 1999). This is often refered to as a "top-down" effect. Top predators such as the grizzly bear, gray wolf, wolverine, mountain lion, or bobcat control the abundance of their prey species lower down on the food chain. The removal of top predator species from the ecosystem has a disproportionate effect on the system and often results in greater numbers of prey species than an ecosystem can support. The overabundance of deer, raccoons, or feral cats in suburban areas is testimony to this. Maintaining populations of native predators in ecosystems is a sound goal for the proper management of entire ecosystems *(Figure 2)*.

The California Wilderness Coalition (CWC) advocates a conservation planning approach that addresses habitat needs of predator species as an indicator of ecological integrity. Two predator focal species we use in our analysis are the mountain lion *(Felis concolor)* and San Joaquin kit fox *(Vulpes macrotis mutica)*. While differing in size, habitat requirements, and prey, the mountain lion and kit fox are positioned similarly in their respective food webs. Both species may exert top-down forces in the ecosystems they inhabit. Mountain lion have been shown to be a primary source of mortality among some populations of deer (Bleich and Taylor 1998). The degree to which kit fox regulate their prey is unknown, but it is likely that they do contribute to regulation of prey species in the region.

Role of connectivity

Habitat linkages connect larger blocks of habitat and provide safe passage for wildlife. Linkages are quickly vanishing in the central coast region. The Missing Linkages Conference (Penrod et al. 2001) identified 24 linkages in the central coast region based on the expert knowledge of wildlife biologists and land managers. Not surprisingly, primary threats to habitat linkages include urbanization and roads, with agriculture, water diversions, and logging. Almost half of the linkages identified serve mammalian predator species such as the mountain lion. Natural features such as stream linkages support wildlife movement in some cases. We compare the results of our conservation design to the Missing Linkages Conference in the results section of this report.

Wildlife

The central coast region once supported a diverse and abundant array of large mammals, such as the grizzly bear, mountain lion, tule elk, pronghorn antelope, mule deer *(Odocoileus hemionus)*, and coyote. It is thought that gray wolf *(Canis lupus)* was not present in the region (Schmidt 1991), but there is some disagreement (Henson and Usner 1993). Steelhead and salmon were also present in much higher numbers than present populations, and the grizzly bear has been extinct from the region for nearly 100 years *(Appendix 9)*.

Accelerating rates of habitat loss and fragmentation of native vegetation likely threaten remaining large-bodied wildlife in the region. Songbird populations are also declining due to the competition and parasitism of non-native birds, as well as habitat loss and livestock grazing (CPIF 2000).

Maintenance of natural processes

Wildfires and floods are naturally reoccurring phenomena in the central coast region. With the construction of homes in oak and chaparral habitats, and the diversion of water to reservoirs and crops, these natural cycles have been highly altered.

Fire prevention occurs across the region primarily in proximity to residential areas. As sprawl continues, and expands into fire-adapted ecosystems and vegetation, wildfires will be increasingly regulated. The effects of fire suppression include the increase of fuels and changes in the composition of species of plants in plant communities. In forested systems, fire suppression leads to the potential for catastrophic fires. Minnich (1995) found that fires were larger in areas that had fire suppression. Fire can also influence the regeneration of native oak species. If fires are suppressed over long periods of time, the non-native understory may overwhelm seedlings that have not yet been established. In addition, the fast vertical growth following a wildfire may help young trees more rapidly achieve heights that are beyond the reach of herbivores, making them more successful (Pavlik, et al. 1991).

Dams and diversions effectively remove flooding as a natural process in most rivers and creek systems in the region. Flooding is beneficial to these systems because it serves to deposit river silts in valley floors and recharge wetlands. Floods also have been known to burst natural closures of small coastal streams, whose outlets become jammed with silt and debris during the low flow part of the year. When the winter high waters arrive, they open the river mouths, allowing some anadromous fish, such as steelhead and coho salmon, to continue up the river to spawn.

Fires and floods have not traditionally been weighted with the same importance as biodiversity protection. However, it is now evident that maintaining the natural processes with which species have evolved is essential to species survival and the maintenance of biodiversity.

This report does not directly analyze the impacts of loss of these processes from the region, but it does attempt to measure the degree to which humans have changed hydrological systems by an inventory of the presence of dams on streams and rivers and an estimation of the condition of steelhead populations in those waterways. Recommendations on integration of ecosystem processes with conservation and restoration efforts are presented in the discussion.

Section 7

DEVELOPING A WILDLANDS CONSERVATION PLAN FOR THE CENTRAL COAST REGION

Ponderosa Pine — *Pinus ponderosa*

Section 7

DEVELOPING A WILDLANDS CONSERVATION PLAN FOR THE CENTRAL COAST REGION

Overview

Our Wildland Conservation Plan (WCP) methodology is based on a model of preferred habitat for three terrestrial focal species and one acquatic species *(see below)*. The steps in the process of identifying conservation priorities include:

1. Develop a conservation "network" based on area requirements for three mammal species that, together, rely on majority of habitat types in the region
2. Assess how conservation and restoration of steelhead habitat would overlap with the above network
3. Evaluate how the Mammal Network overlaps with, or represents, elements of biodiversity, including important bird or amphibian habitat and rare plant communities

Data framework

The abundance of data available to conservation planners can be overwhelming. Commonly available data include point locations representing known populations or sightings of a particular species, maps of vegetation or habitat types, and data related to human population and land use. Understanding the limitations of available data is essential to using the information properly. These limitations may be spatial (biased or incomplete sampling), temporal (dated or limited range) or taxonomic (misclassification). While Geographic Information Systems (GIS) can expand our ability to understand the spatial relationships between the components of an ecosystem, it is limited in helping us understand the dynamic nature of ecosystems over time. Therefore, models are developed that use ecological data to help predict the effect of changes in ecosystem structure and composition. These changes may be negative (habitat fragmentation) or positive (reintroduction of native species).

To maintain flexibility throughout this planning process, we designed our analytical framework to be modular and expandable. Data and analysis are divided into current and future structure and function of the regional landscape. The basic classification identifies:

CURRENT STRUCTURE AND FUNCTION:

Class 1 — Biological data such as habitat maps and known populations

Class 2 — Data on the human footprint such as road network and urbanization, and land management

FUTURE STRUCTURE AND FUNCTION:

Class 3 — Beneficial scenarios that project results of landscape management and restoration efforts

Class 4 — Negative scenarios that project future fragmentation and degradation of ecosystems

This framework maintains the flexibility required to incorporate additional data to refine conservation priorities in the region and compare different management regimes. In this report, we only consider the current relationship between human and natural systems, and not future scenarios. These first two categories are sufficient to conduct an initial conservation analysis. Further analyses may be conducted to refine and test the WCP as new data become available. Since the data organization is not critical to understanding the current analysis, we have put this methodology in Appendix 13, but the framework is recommended to other conservation planners as a means of clearly organizing data.

Selection of focal species for analysis

We used the habitat of four focal species, as well as linkages for mountain lion as the basis of our Wildland Conservation Plan. Habitats for the three mammal focal species, mountain lion, San Joaquin kit fox, and pronghorn, were defined by the California Wildlife Habitat Relationships models (CDFG, 1990). In addition, the distribution and status of steelhead in streams and rivers of the central coast region were considered in developing conservation recommendations for the area. Mountain lion is the most wide-ranging carnivore present in the region and is considered both a keystone and umbrella species. The San Joaquin kit fox and pronghorn were included primarily because they depend on grassland habitat, a habitat not used by mountain lions.

Other species considered, but ultimately rejected, as focal species for this report, were bobcat *(Lynx rufus)*, coyote *(Canis latrans)*, grizzly bear *(Ursus arctos horribilis)*, and black bear *(Ursus americanus) (Appendix 9)*. The range of bobcat largely overlapped that of mountain lion, and we felt it did not add significantly to the analysis. The coyote is a habitat generalist whose adaptability to human encroachment makes it a poor indicator of wildland integrity. Black bear were not included because they are a recent phenomenon in the central coast, stemming from an introduction in the northern Transverse Ranges about 60 years ago (Updike, pers. comm.; *Appendix 9*). Grizzly bear are extirpated (locally extinct) from all of California, and reintroduction into the central coast is very unlikely in the near future. While desirable from an ecological perspective, reintroduction of extirpated species is beyond the scope of this report.

Natural history of selected focal species

MOUNTAIN LION (PUMA CONCOLOR)

The mountain lion is the second largest carnivore in California. Adult males average seven feet in length (nose to tail tip) and weigh between 100 and 160 lbs. Adult females average six feet in length and weigh between 60 and 100 lbs. Mountain lions are found throughout the state, but are most abundant where there are high numbers of deer and enough cover for good hunting. Mountain lions do not generally defend a territory against other mountain lions, but they do tend to avoid each other and often exhibit aggressive behavior during encounters. An adult male's home range is often over 100 square miles (259 km^2), while the female's home range is smaller. Densities of mountain lion vary, with high densities of approximately 10 adults per 100 square miles in areas with high deer concentrations, to one adult per 1000 square miles in desert areas (Torres and Bleich 2000).

Mountain lion has been chosen as a focal species for its keystone role in ecosystems and its ability to serve as an umbrella species for multiple species and ecological processes (Torres and Lupo 2000, Noss and Cooperider 1994). Although they can exist in developed areas, mountain lions are sensitive to human activities (Torres et al. 1996) and tend to avoid areas of high human population density (Beier 1995). We selected mountain lion as a focal species because it is highly probable that they are important in controlling populations of herbivores. While we know of no direct evidence that mountain lion regulate deer, it is known that mountain lion population densities increase with deer population densities (Torres and Bleich 2000). Mountain lions have also been shown to be the primary cause of mortality in mule deer (Bleich and Taylor 1998), so it is likely they regulate populations of herbivores. Deer and other herbivores are plentiful in much of the United States because their predators have been removed. The impact of this herbivory by deer and other animals is a likely cause of the failure of many species of California oaks to regenerate (Pavlik et al. 1991).

Mountain lions may also control mesopredator populations, such as red fox, raccoon, and domestic cats. In southern California, Crooks and Soulé (1999) have demonstrated that songbird numbers in fragmented habitat are related to the limiting role of a top predator, coyote, on the bird's predators (red fox and domestic cats). Higher numbers of birds are found where the coyotes control the number of mesopredators. Mountain lions could also serve this function for the central coast region, although again we have no direct evidence of mountain lion regulation of mesopredators.

Mountain lion young (1.5 to 2 years of age) disperse after leaving their mother to establish their own home ranges (California Dept. Fish and Game 2001; Torres and Bleich 2000). Dispersal is an important regional process that helps maintain stability in mountain lion population dynamics (Smallwood 1994, Ricklefs 1987, Taylor 1991, La Polla and Barrett 1993). Dispersal plays an important role in population dynamics because recruitment into a local population occurs mainly by immigration of juveniles from adjacent populations (Seidensticker et al. 1973). Beier (1995) found that dispersing mountain lions will use linkages that are located along natural travel routes, have ample woody cover, incorporate safe road crossings at high-speed roads, lack artificial outdoor lighting, and have low human population density.

Habitat fragmentation is a major concern for mountain lion populations in such a rapidly growing region (Beier 1993, Maehr 1997, Torres and Lupo 2000). In the central coast region, road building, conversion of natural habitat to agriculture, and urban expansion are directly eliminating and fragmenting once-continuous mountain lion range. Small, isolated populations face a potentially greater risk of extinction due to multiple factors, including disease, inbreeding, and natural disasters. Protection and restoration of habitat linkages between mountain lion populations is essential to the long-term survival of these magnificent animals. Urbanization around the Diablo Range and elsewhere in the region is eroding mountain lion habitat and pinching their movement linkages (Hopkins 1989).

SAN JOAQUIN KIT FOX (VULPES MACROTIS MUTICA)

Kit foxes *(Vulpes macrotis)* are the smallest canids in North America, with the San Joaquin kit fox *(Vulpes macrotis mutica)* being the largest of the kit fox subspecies. Adult kit foxes weigh 2.1 to 2.3 kg (4.6 to 5 lbs.), with males typically weighing slightly more than females. Home range sizes are highly variable (1.0 to 12.0 mi^2), and likely reflect fluctuating resource abundance (Williams et al. 1997). The primary prey of kit foxes in the central portion of their range, including the interior coast region, includes white-footed mice *(Peromyscus leucopus)*, insects, California ground squirrels *(Spermophilus beecheyi)*, black-tailed hares *(Lepus californicus)*, and chukar *(Alectoris chukar)* (Jensen 1972, Archon 1992).

Kit fox pups in the Elk Hills disperse an average of three miles, though maximum distance can be as high as 100 miles (Williams et al. 1997). Both pups and adults are known to disperse, and at least one adult male dispersed from Camp Roberts to the Carrizo Plain (Williams et al. 1997). Dispersal occurs through a wide diversity of habitats, including agricultural fields, oil fields, rangelands, and even over mountain ranges (Williams et al. 1997).

The reproductive success of kit foxes has been tied to prey density, which is often correlated with precipitation. During drought conditions, pairs may produce kits, but are unable to provide adequate food. Kits often experience high mortality due to starvation (White and Ralls 1993). Even during normal reproductive years, kits that are successfully whelped have a mortality rate of 70% in their first year. After the first year, mortality rate drops, to 50% annually for adults. Mortality results primarily from predation by larger carnivores such as coyotes (Williams et al. 1997).

Historically, kit fox were found primarily in valley bottom communities. The loss of these habitats has resulted in the kit fox being largely restricted to open foothill habitats. While foothill communities may represent refuge habitats for kit fox in the absence of valley bottoms, it is likely that the requirement for flat and gentle slopes for reproductive dens may limit the viability of populations found in areas with substantial topographic relief.

San Joaquin kit fox have inhabited most of the San Joaquin Valley (Grinnell et al. 1937), with population extensions into the Inner Coast Ranges (Williams et al. 1997). Habitat loss, along with hunting, trapping and poisoning, caused dramatic declines in the kit fox (Bell 1995), and it is estimated that by 1930, the distribution of the species was reduced by half (Grinnell et al. 1937). In 1967, the kit fox was listed as endangered under the Endangered Species Preservation Act (a precursor to the Endangered Species Act; Bell 1995). It is currently listed as endangered at both the federal and state levels.

Habitat loss in the San Joaquin Valley is almost complete. In 1979 it was estimated that only 6.7% of the valley floor south of Stanislaus County was in an undeveloped condition (Williams et al. 1997). At present, the kit fox is primarily restricted to suitable foothill areas in the San Joaquin Valley. The same is true of the Inner Coast Range, where small and potentially isolated populations of kit foxes occupy open grassland habitats in the Salinas, Pajaro, and Cuyama River watersheds (Williams et al. 1997). Within the Inner Coast Ranges, little is known of the current distribution and status of kit fox. Most work in the region has occurred primarily on the Fort Hunter Liggett and Camp Roberts military bases, in conjunction with federal monitoring programs, and consists of unpublished internal documents.

Presently, the highest numbers of the San Joaquin kit fox are found in the Elk Hills and Carrizo Plain region of the San Joaquin Valley (Williams et al. 1997), just to the east of the southern boundary of the central coast region. The populations in our study area are likely extensions of these core populations into the suitable habitats remaining along the valley and foothills of the study region. As extensions into a geographic region distinct and separate from the San Joaquin Valley, the kit fox populations in the Inner Coast Ranges are critical components to the long-term survival of kit foxes. The U.S. Fish & Wildlife Service explicitly recognizes the need to maintain populations across the extent of the geographic range of the kit fox in the Recovery Plan for Upland Species of the San Joaquin Valley (Williams et al. 1997, pg 132; *Appendix 10*).

PRONGHORN (ANTILOCARPA AMERICANA)

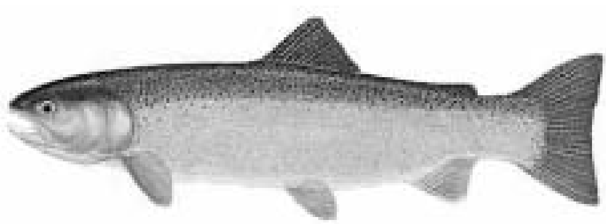
The pronghorn, sometimes referred to as the prairie ghost, is a common resident of northeastern California. In pre-settlement California, pronghorn occupied most of the grasslands and valleys of the state. They occurred in the central coast region from Sonoma and Napa Counties south along the Inner Coast Ranges to the Transverse Ranges in Santa Barbara County. They also ranged out to the coast between Pismo Beach and the Vandenberg area. Heavy hunting pressures and settlement of grassland habitat greatly reduced pronghorn in California. By the mid-1970's, they were found only in the northeastern Modoc Plateau region (Dasmann 1975).

Pronghorn were reintroduced into the central coast region in San Luis Obispo County in the late 1970s and early 1980s by the California Department of Fish and Game. Since then, a small population has been established in the grasslands of that county. Pronghorn compete with various domesticated grazers, including cattle and sheep (Henson and Usner 1993, Gordon 1974). Overgrazing by domestic livestock reduces the carrying capacity of the land for pronghorn. In addition, fences are detrimental to pronghorn mobility (Hopkins 1978).

Pronghorn prefer open, rolling terrain and have variable home range requirements. Daily movements are less than a kilometer in spring and summer, but up to 9.7 kilometers (3.7 miles) in winter. Herds may migrate as much as 150 kilometers (57.7 miles) between summer and winter ranges (Yoakham 1978).

This report does not attempt to introduce a recovery plan for the species across its historic range. Rather, pronghorn and kit fox habitat were added to a habitat/linkage network designed for mountain lion. Linkages were not developed specifically for kit fox and pronghorn because, at the scale of our mapping and analysis, the habitat was well connected. We recommend the use of the more detailed plans already developed for these species (CDFG 2001).

STEELHEAD (ONCORHYNCHUS MYKISS IRIDEUS)



The presence of native salmonids, specifically steelhead, in a stream serves as an indicator of the condition and ecological integrity of the stream and its associated watersheds. The protection and restoration of salmonid populations will facilitate the maintenance of many other species dependent on riverine and riparian habitats. While salmonid habitat requirements do not explicitly overlap with habitat requirements of other species dependent on riparian habitats (e.g., red-legged frog and breeding birds), meeting salmonid hydrological requirements involves restoration and protection of water and streambed quality. Riparian buffers that are adequate to trap silt and shade streams will also serve as habitat for many species.

The five salmonid species documented as historically present in the central coast region are steelhead *(Oncorhynchus mykiss irideus)* (this coastal subspecies is believed to be the sole subspecies in California), coho salmon *(O. kisutch)*, chinook salmon *(O. tshawytscha)*, pink salmon *(O. gorbuscha)*, and chum salmon *(O. keta)*. The latter two are considered extinct in the region (NMFS 1997a). The known historic extent of chinook salmon in the region is restricted to 13 streams draining into the San Francisco-San Pablo Bay complex, along with their use of estuary habitats within and ringing the bays. These are noted in our database, based on information provided by the San Francisco Estuary Project (1998) and Freeman House (pers. comm. 1998). While coho and chinook salmon are restricted to the northern part of the central coast ecoregion, steelhead historically occupied streams throughout the region, extending southward to Baja California (Titus et al. 1999).

Brown et al. (1994) state that coho salmon were historically known from only four streams in the region, with the Big Sur River as the possible southernmost extent of their range. However, in the process of collecting data for the expansion of our database, Matt Stoecker reported existing or historic coho runs on 22 streams (17 drainages) in the region, including the four identified by Brown et al. Stoecker's sources include his own personal observations, along with personal communications in 2000 with Jerry Smith, Gil Murphy, and Dennis Fong, as well as the following published sources: Coastal Watershed Council (undated), San Francisco Estuary Project (1998), Eng (1981), and SPAWN.

Steelhead possess perhaps the most complex life history traits of any salmonid. They may exhibit anadromy (juveniles migrate from fresh water to the ocean, and then return to spawn in fresh water), or freshwater residency (reside their entire life in fresh water). Resident freshwater forms are usually referred to as "rainbow" or "redband" trout, while anadromous lifeforms are termed "steelhead." Few detailed studies have been conducted regarding the relationship between resident and anadromous *O. mykiss* and, as a result, the relationship between these two life forms is poorly understood. Recently, the scientific name for the biological species that includes both steelhead and rainbow trout was changed from *Salmo gairdneri* to *O. mykiss.* This change reflects the premise that all trouts from western North America share a common lineage with Pacific salmon (ibid.).

Striking evidence of this relationship is that genetically, steelhead from a given stream are more similar to the resident rainbow trout than they are to steelhead from another stream. Environmental triggers, not genetics, determine whether a fish will become anadromous or not. This polymorphic life history enables steelhead to occur in streams where chinook and coho cannot. The relative resilience of steelhead to their dynamic stream environments is echoed in their metapopulation structure, in which occupied streams serve as a source for recolonization of streams temporarily made inhospitable due to watershed issues (e.g., fire, drought or other disturbances). Temporary "extinction" is a natural part of this dynamic, but in healthy ecosystems, recolonization from shifting source populations sustains the metapopulation. Furthermore, the "resilience of steelhead is absolutely dependent on their ability to reach their headwaters." Yet, "where resident rainbow trout still exist, we can get steelhead back by removing barriers," (McEwan pers. comm.).

Steelhead serve as an ideal surrogate to represent conditions in the region's coastal watersheds because of their reliance upon all portions of a river system. They rely on estuaries for acclimation to saltwater, main river channels for migration, and their natal tributary streams for spawning and rearing, where they must spend from one to three years (CalTrout 1998). McEwan and Jackson (1996) state that restoration of steelhead habitat will have a beneficial effect on many other species of anadromous fish as well, because steelhead have the widest presence in freshwater streams of all anadromous fish in the region. Moreover, their highly adaptive life history enables them to occupy even intermittent drainages in the region's regime (McEwan pers. comm.).

Despite the species adaptability, human alterations of occupied watersheds have resulted in precipitous declines in population numbers over the past three to four decades. In 1997, the National Marine Fisheries Service listed the northernmost two Evolutionary Significant Units (ESU's) in the region (the Central California Coast and South Central California Coast ESU's), as threatened, while the Southern California ESU was listed as endangered (NMFS 1997b). However, the ability of steelhead to persist in obstructed watersheds as resident rainbow trout provides hope that the species can be recovered with removal of barriers, provision of adequate flows, and watershed restoration.

The ecological integrity of riverine systems also has a profound influence on the ecology of interface zones between terrestrial and marine habitats along the coast. Thus, the implications of salmon restoration apply to a broad spectrum of biodiversity issues.

Steelhead data development

The richest database we used was developed by Verna Jigour and others, in association with the Ventana Wildlands Project during 1999 and 2000. For the central and southern Coast Ranges of California, this database catalogs the current status of salmonids in streams and rivers, along with stream and watershed factors affecting the persistence and abundance of steelhead in each stream. Tremendous amounts of time and effort have gone into research, development, mapping and validating these data. For a detailed description of the database and its potential see Appendix 12.

The database identifies all coastal streams in the central coast region by name and the status of steelhead runs in each waterway. Additional indicators of watershed integrity such as dams and other barriers are included, as well as information on land uses such as logging. We mapped steelhead status in streams and rivers in the region except those draining to the Central Valley *(Map 5)*.

The following status categories are represented in the steelhead database:

- Present with no known decline from historic levels (P)
- Present, but population reduced (P-)
- Present historically, current status unknown (U)
- Obstructed; barrier prevents migration between ocean and spawning habitats (O)
- Steelhead not present in recent history
- Historical and current status of steelhead unknown

This database provides an overview of the status of steelhead for essentially the entire region. Status was primarily determined by Titus et al. (in press), based on data accumulated by the California Department of Fish and Game (CDFG), with the exception of streams north of and draining into San Francisco Bay, and excluding the central valley drainages of the inner coast ranges *(Appendix 12)*. The status designations should be understood as generally broad categories. For example, streams with status P, indicating steelhead populations generally at historic levels, may still be hampered by problems that should be addressed to ensure sustainability. The P- status indicates that steelhead are present in the given stream, but at reduced production levels. It must be understood that a wide range of population levels may be included in this category.

The term "Obstructed" has been used where a more precise term has not been determined to date. While the Obstructed status may apply to streams with physical barriers, such as dams, impassable culverts or other structures, it also applies to streams whose mainstem flows have been reduced through water diversions and/or dams on associated tributaries. One example is the Sisquoc River, tributary to Santa Maria River. Titus assigned the equivalent of the Obstructed status to this stream, while the associated text description notes that "steelhead may still have access to the Sisquoc system when flow conditions allow," since there are apparently no physical barriers that would otherwise preclude migration (Titus, in press).

Development of the Mammal Network

Focal mammal species distributions were mapped using the Wildlife Habitat Relationship (WHR) classification version 5.3/6 (CDFG 1990). The California Gap Analysis Program (GAP) related these classifications to vegetation data that it had developed for the entire state. Different types of vegetation have different levels of suitability according to the WHR definition of suitable habitat for each focal species (CDFG 2001). These data represent the maximum predicted ranges of the focal species. They show potential distribution rather than actual distribution, and are not evidence that the species is using all of the areas identified.

The WHR classification only allows assessment of suitable vegetation habitat. It does not identify other habitat requirements such as access to water, denning sites, or adequate prey base. Still, the GAP-WHR habitat data are the best regional and statewide public data available. For each vegetation polygon mapped by the Gap Analysis Program, a habitat quality value was assigned based on suitability and areal extent. We only used values of 4 (>50% medium or high suitability) and 5 (>50% high suitability) in our assessment of focal species habitat. For other value definitions, see Appendix 8.

Map 5: Steelhead Status in the Central Coast Region.

Mountain lion linkage modeling

To assess the connectivity between large areas of mountain lion habitat and plan for linkages, we modeled the optimal dispersal route between areas of high quality habitat using a technique called "least cost path" modeling. Least cost path analysis considers low costs (high quality habitat) and high costs (no habitat or a presence of roads) as the factors that could determine movement paths for the selected animals (Walker and Craighead 1997). These factors are weighted to reflect their relative impact on a mountain lion moving through the landscape.

In this model, the landscape is a grid divided up into cells. The sum of the weights for each factor represents the "cost" of moving through each cell. By creating a cumulative cost grid, or "surface," that incorporates habitat quality, road density, and forest cover, we identified linkages between large blocks of habitat. High cost areas that may negatively affect movement include human settlement, roads, and agriculture, while low cost areas would be comprised of high quality habitat with forest cover and low road density.

In least cost path modeling, linkages are identified between designated "sources," or areas that act as the origin/destination for the model lion. Because we are trying to identify linkages that will sustain populations over long periods of time, we only chose the largest, most well distributed sources in the region. At a finer scale of analysis, linkages and corridors for daily movements may be identified and prioritized for protection.

Initially, the minimum size of the sources used was 100,000 acres (40,460 hectares). These areas fall below the estimated minimum size core (220,000 hectares) for a self-sustaining mountain lion population (Beier 1993), but capture some of the smaller, relatively undeveloped tracts of land left in the region. Secondary sources were added later and were chosen subjectively because they represented smaller areas of high quality habitat that fell well outside of the existing network of large blocks of habitat. More detailed information on methods and the weighting scheme used in this modeling is presented in Appendix 8.

Mountain lion network

The mountain lion network is comprised of WHR habitat and linkages identified in the least cost path modeling. The areas used as sources in the linkage modeling were a subset of the areas that were included in the network. In other words, the "network" is more than just the sources and the linkages. It includes additional areas of less contiguous, and possibly lower quality, habitat. In many areas linkages may include existing habitat identified in the WHR data. Overall, 42% of the total region is included in the non-linkage portion of the network, and including linkages brought the total area up to 51% of the region. This is a conservative (extensive) estimate, biased in favor of identifying all of the moderate to high quality habitat. It was felt that this decision will give resource managers more options for implementation opportunities. For further discussion of habitat analysis methods, see Limitations and Discussion in Appendix 8.

Comparative representation of biological elements of concern with the Mammal Network

The central coast region is unusual in the western U.S. for its habitat richness and narrow endemism. Endemism means that a species is restricted in range to a particular place (e.g., a species endemic to California is found only in California). Because of their limited distribution, endemic species deserve special consideration when planning for biodiversity conservation.

In the central coast there are several examples of habitats that are restricted in size, but support a wealth of diversity. When one considers the richness of amphibians, endemic plants on serpentine soils, and pockets of wetlands found in the region, it is reasonable to ask whether a conservation plan developed for mammals will meet the needs of species in narrower habitats. By definition, a network designed for an umbrella species such as the mountain lion will capture a certain percentage of populations of other species, no matter how (or where) the system is designed. To determine the effectiveness of the umbrella species approach, we compared the mammal focal species network to known distributions for a variety of species and habitats.

To understand how habitat is dispersed for different taxa in the region, we totaled the habitat suitability scores for each polygon in the Gap Analysis vegetation data for the region (Davis et al. 1998; *Map 6)*. This analysis is at a coarse scale and can only be used to derive general patterns of distribution, but illustrates the heterogeneity in habitat by taxa.

The Mammal Network was tested with four categories of biodiversity elements: 1) areas that contain concentrations of rare and unique species, 2) key habitats for specific groups (or taxa) of species, 3) selected keystone species distributions, and 4) endemic and localized species. Figure 3 at right shows the analytical framework for the comparative representation of all the elements tested.

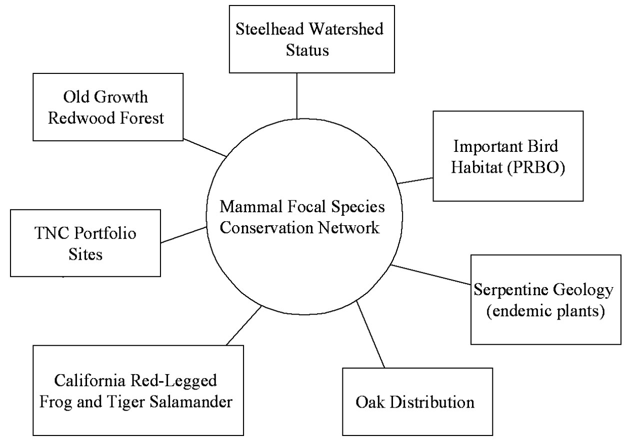
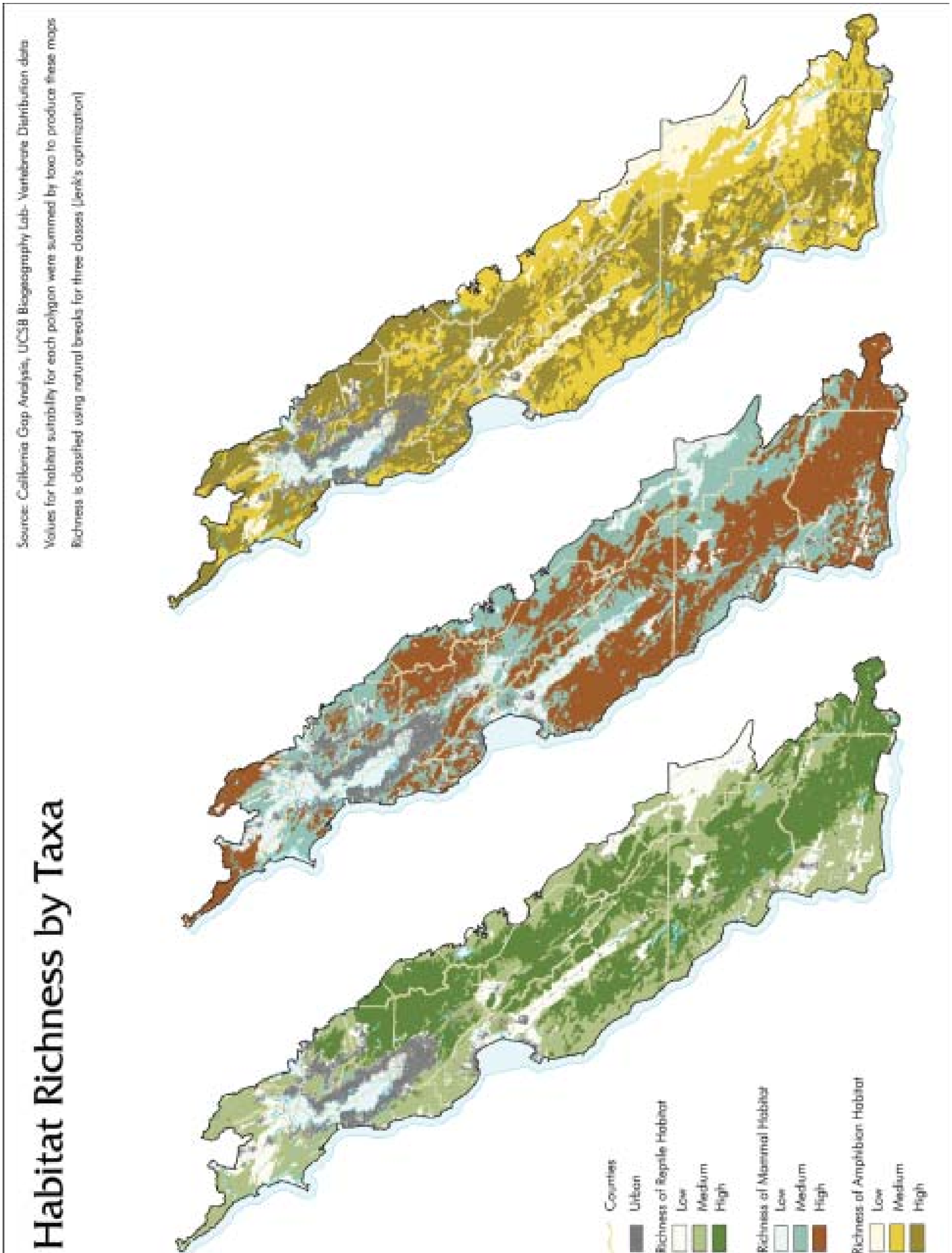


Figure 3: Comparative Representation of Elements of Biodiversity

1. **Areas with unique species** included old growth redwood forests, portfolio sites determined by The Nature Conservancy to contain regional natural diversity, and serpentine (ultramafic) geology. Serpentine geology data are being used as a surrogate for endemic plants in the region. There are over 180 endemic plants in the region. While not all of these plants occur on serpentine, Kruckeberg (1984) identifies 82 serpentine endemics in the region and an additional 50 serpentine indicator species. While this approach will certainly miss some rare plants, and even some serpentine-derived soils, the data enable a comparison that would be much more costly otherwise. Given more time, we would develop higher resolution spatial data for endemic plants.
2. The distribution of **key habitats** for groups of species was compared to the Mammal Network as a proxy for avian species distribution. Point Reyes Bird Observatory (PRBO) lists five types of important bird habitat, four of which occur across a wide portion of the region: riparian, coastal sage scrub-chaparral, grassland, and oak woodland (PRBO website 2001; *Appendix 4*). Riparian vegetation has not been satisfactorily mapped for the region, so we were not able to assess how well it is represented in our Mammal Network.

3. The distribution of one group of **keystone species**, oaks, has been mapped by the California Department of Forestry (CDF 1994, Pillsbury 1991). We tested how well represented different oak species were in the Mammal Network. This brings some circularity into our analysis because mountain lions are also associated with oak woodland for habitat. To account for this, we used different oak distribution data from those used in the WHR modeling of mountain lion habitat.

4. **Localized, endemic species** chosen were the California tiger salamander *(Ambystoma californiense)*, which is federally listed as endangered, and the California red-legged frog *(Rana aurora draytonii)*, which is federally listed as threatened (CDF, 2001). These species are endemic to California, but not the central coast region. At the spatial scales used for this study, we treat populations of these species as point data, and look to see how many of the known occurrences fall within the Mammal Network. These species are not the only listed amphibians in the region, but due to limitations in data and resources, we only included these two species. Other amphibians that we recommend including at a later date include the Santa Cruz long-toed salamander *(Ambystoma macrodactylum croceum)* and the arroyo southwestern toad *(Bufo micorscaphus californicus)*.



Map 6: Habitat Richness by Taxa

Section 8

REGIONAL NETWORK DEVELOPMENT

Coulter Pine— *Pinus coulteri*

Section 8

REGIONAL NETWORK DEVELOPMENT

Linkages between core mammal areas

The five largest contiguous blocks of habitat, or primary sources from which we modeled mountain lion dispersal, form the basis of a network of core areas. We identified five primary core areas (larger than 100,000 acres) in the region. In addition, we identified five secondary (smaller than 100,000 acres) habitat blocks and eight linkages. The five primary core areas are:

- Santa Cruz mountains (276,247 acres)
- Santa Lucia range (570,529 acres)
- Transverse ranges (481,180 acres)
- Northern Diablo range (338,308 acres)
- Southern Diablo range (starting east of Salinas and going south to the Cholame Hills) (551,344 acres).

These areas represent the highest quality habitat for the lion, but their boundaries are somewhat arbitrary as there are no clear breaks in habitat between these areas and adjacent habitat included in the network. The total area in the mountain lion network is 17,626 km^2 (5,270,356 acres) and represents 42% of the region.

There are three smaller areas north of the San Francisco Bay area used as secondary sources in the linkage modeling. The northern two of these are extensions of mountain lion habitat further north. The third is in the Point Reyes area. Two secondary areas are in the southern portion of the region at the Irish Hills, just west of San Luis Obispo, and Vandenberg Air Force Base south of Santa Maria. These secondary areas should be managed to maintain high quality habitat.

The long-term protection of core areas is necessary for mountain lion persistence. Two of the core areas are mostly on public lands (Santa Lucia, Transverse ranges) and should be managed to maintain the qualities characteristic of prime habitat. Three core areas are mostly on private lands, and should become the focus of conservation easement efforts since it is unlikely that acquisition of a large proportion of the core is feasible. Management for core areas across mixed ownership will need to be coordinated among the various entities concerned. As a follow-up to this document, the California Wilderness Coalition plans an implementation phase that will involve various stakeholders in the process of prioritizing these areas.

The degree to which core areas are actually functioning to maintain viable mountain lion populations is unknown. Beier (1993) identifies an area of about 2200 km^2 as the minimum size for viable populations. None of our cores are that large independently, though three are close to that size. It is possible that smaller areas may support viable populations, since lions thrive where deer densities are high (Torres and Bleich 2000).

The core areas identified are very similar to the California Fish and Game habitat suitability assessment for the area (Torres and Lupo 2000). This is not surprising since both are derived from the same data. Their statewide map indicates that the two northernmost secondary cores in our assessment fall on the edge of a much larger contiguous range of habitat for mountain lion to the north. The westernmost secondary core we identify north of the San Francisco Bay (around Point Reyes) appears to be most easily connected to contiguous habitat to the north, rather than to the other cores in the region.

Linkage modeling

The mountain lion linkage modeling identified broad swaths of land that may be important for habitat connectivity *(Map 7)*. The lack of precision in the linkages reflects the coarse input data used and the uncertainty associated with the weighting scheme. Finer-scale definition of corridors needs to include tracking information and better data on human settlements (roads, houses) and adequate cover. The area north of San Francisco Bay has not been included in the individual linkage maps. We felt it should be included in an analysis of the north coast region since much of the suitable habitat we identified is connected to habitat further north.

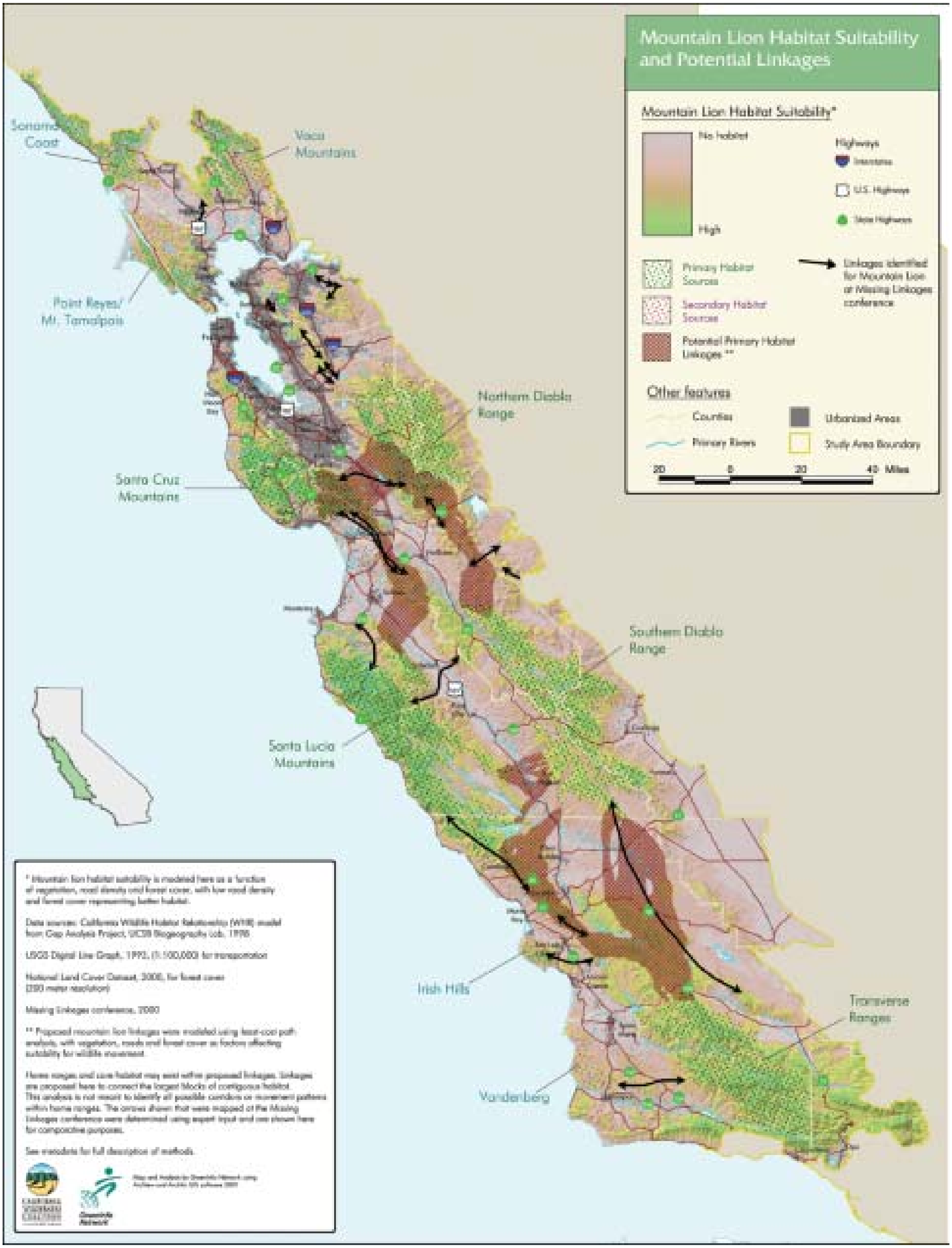
The linkages identified should be priorities for conservation activity. Refinement of the modeling methods may illustrate the importance of larger private parcels in the region. Conservation easements may be the most effective means of long-term protection due to the large proportion of private land in the linkages. Whether there actually is connectivity (and how much) between mountain lion populations is not known, although ongoing genetic work by Holly Ernest (2000) may inform us within a few years. Only in a few cases, itemized in the detailed maps of each linkage identified, are specific lands identified.

Pronghorn and San Joaquin kit fox habitat

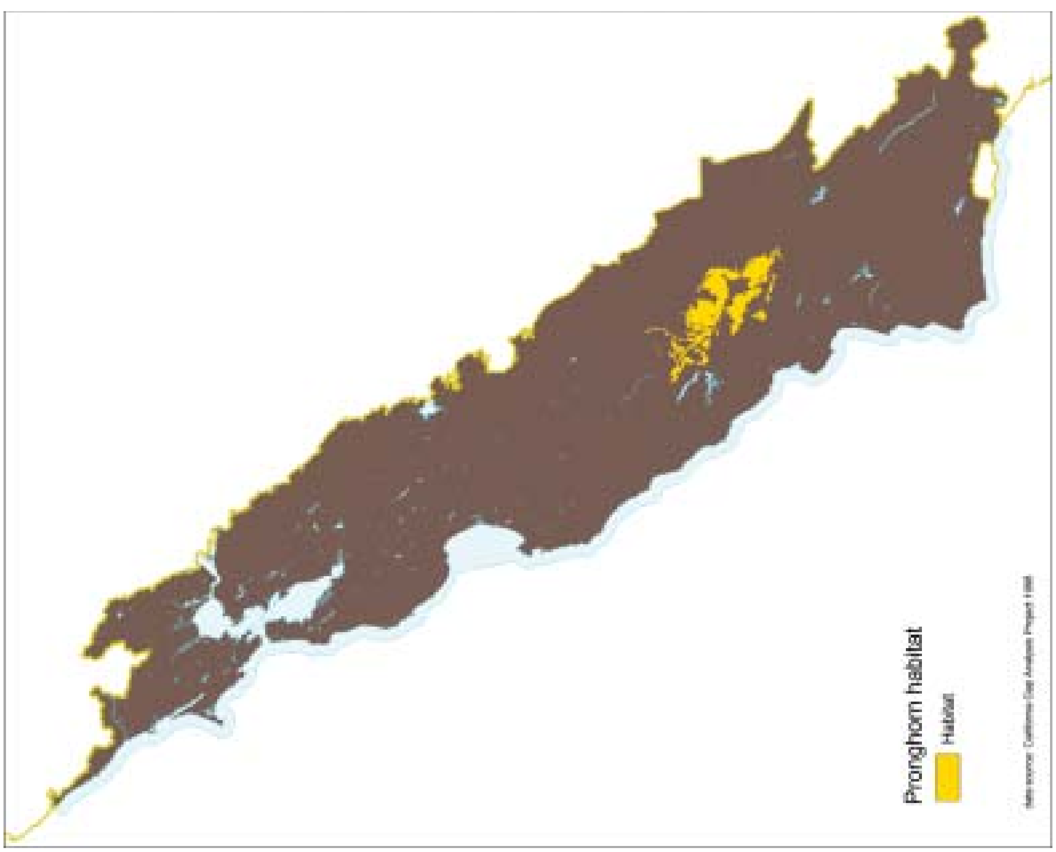
Pronghorn and kit fox predominantly use grasslands. Their ranges in the region reflect this, and are somewhat overlapping. Neither species is found across the entire region, but their potential habitat complements that of the mountain lion. The juxtaposition of habitat requirements makes these species suitable additions to the mountain lion network, as their habitat needs represent areas of conservation concern not otherwise recognized.

At our scale of analysis with the data available, Pronghorn habitat is contiguous enough that no linkage modeling was necessary to connect the habitat blocks. Habitat with a WHR value of 5 (> 50% high quality habitat) was used to delineate these areas.

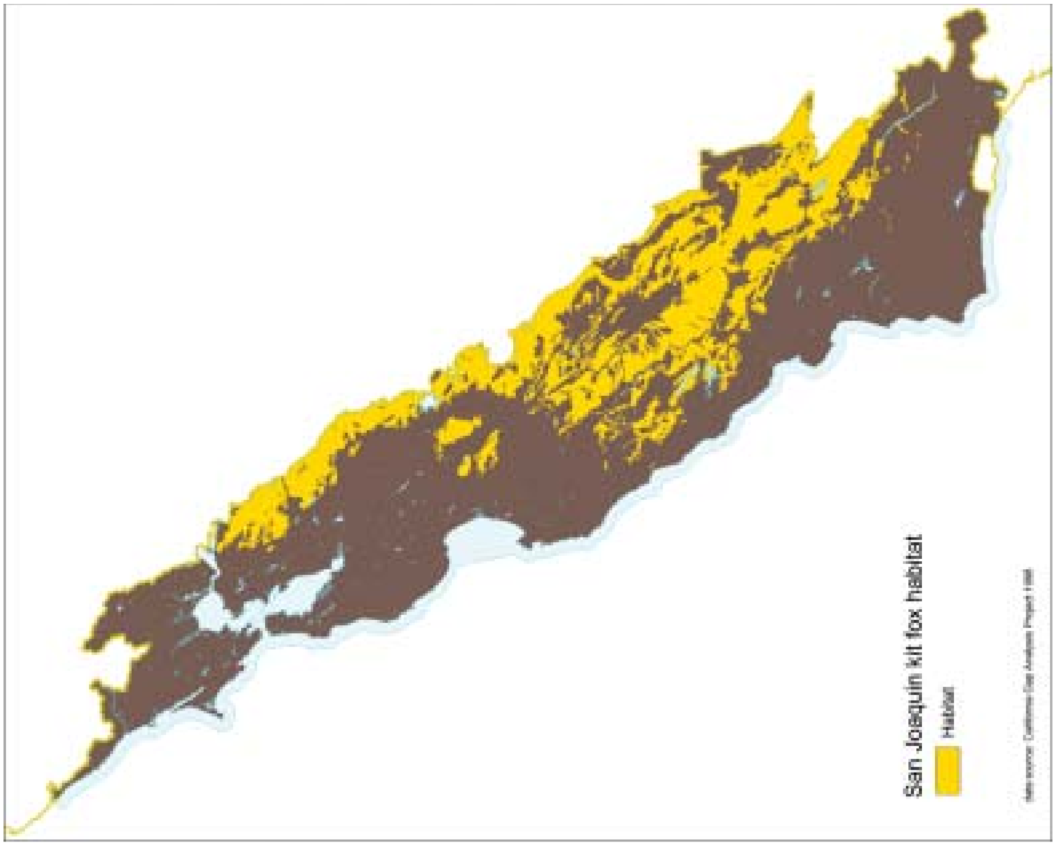
San Joaquin kit fox habitat is more fragmented than Pronghorn habitat *(Maps 8 and 9)*. There are large strips of contiguous habitat to which linkages could not be meaningfully designed. Habitat discontinuity is present between the Carrizo Plain-San Juan Valley region and habitat just north of Paso Robles, yet the same area is an important potential linkage for mountain lion. We assumed that the lion linkage would also facilitate kit fox dispersal. The areas of kit fox habitat that were included in the Mammal Network were all areas with a WHR score of 4 or 5 (> 50% moderate to high habitat suitability) with a road density of less than 10 km/km^2 as an arbitrary cutoff point for the level of human impact. While it is a misnomer to call modified suitable habitat a “core” we decided to be conservative at this point in the assessment and not refine these data.



Map 7: Mountain Lion Habitat Suitability and Potential Linkages



Map 8: Predicted Pronghorn Habitat



Map 9: Predicted San Joaquin Kit Fox Habitat

Steelhead presence within the Mammal Network

The tables below summarize the results by watershed status and Map 5 shows the status of steelhead populations in different streams within the region.

Fewer than 45% of the region is mapped into the steelhead population status classes, or 27,874 km^2 *(Table 9)*. Only 3.7% of all watershed areas mapped have steelhead populations at their original levels. Approximately 80% of the area mapped has either depressed steelhead populations or barriers in the streams that prevent migration to and from the sea. For 12.8% of the mapped area, the status of steelhead populations is unknown.

Area of Watersheds in each Steelhead Population Status

STATUS CLASS OF STEELHEAD IN WATERSHED	AREA (KM²) IN REGION BY STEELHEAD STATUS CLASS	AREA (ACRES) IN REGION BY STEELHEAD STATUS CLASS
Present, Population Undiminished	1,040.90	311,237
Present with Reduced Population	18,038.70	5,393,531
Not present within known history	32	9,578
Waterway Obstructed	5,170.90	1,546,085
Present Historically, Current Status Unknown	3,209.60	959,677
Status Unknown	382.20	114,289

Table 9: Area of Watersheds in each Steelhead Population Status

Area and Percent of Watersheds by Steelhead Population Status

STATUS CLASS OF STEELHEAD IN WATERSHED	MAMMAL NETWORK	EXTENT STEELHEAD WATERSHEDS IN CORE OR LINKAGE BY AREA (KM²)	EXTENT STEELHEAD WATERSHEDS IN CORE OR LINKAGE BY AREA (ACRES)	PERCENT OF WATERSHED STATUS AREA CORE OR LINKAGE
Present, Population Undiminished	Key Habitat	977	241,357	77.60%
Present with Reduced Population	Key Habitat	11,953	2,954,229	54.80%
Not present within known history	Key Habitat	12	2,995	31.30%
Waterway Obstructed	Key Habitat	4,617	1,141,049	73.80%
Present Historically Current Status Unknown	Key Habitat	2,064	510,212	53.20%
Status Unknown	Key Habitat	70	17,278	15.10%
Present, Population Undiminished	Linkage Areas	27	6,780	2.20%
Present with Reduced Population	Linkage Areas	2,079	513,949	9.50%
Not present within known history	Linkage Areas	0	0	0
Waterway Obstructed	Linkage Areas	417	103,100	6.70%
Present Historically Current Status Unknown	Linkage Areas	517	127,830	13.30%
Status Unknown	Linkage Areas	213	52,721	46.10%

Table 10: Area and Percent of Watersheds by Steelhead Population Status

Overall, the level of representation of watersheds with healthy steelhead populations (status P) was high, with 77.6 % represented within core mammal habitat *(Table 10)*. Another 2.2 % of watersheds with status P were found in the linkages. However, these watersheds represent only 4.4% of all the watershed area in the habitat-linkage network. In other words, while there are relatively few streams with intact steelhead populations, 80% of these watershed areas occur in mountain lion habitat or linkages.

Coastal stream restoration can be addressed at two spatial scales. The Salinas, Pajaro, Santa Ynez and Santa Maria rivers represent large, complex challenges to restoration. Smaller streams represent more numerous, simpler restoration possibilities. Most of the intact habitat is in the smaller streams. At these two scales of restoration, different organizations will likely lead the efforts. For example, steelhead restoration efforts on the Salinas or Pajaro rivers probably will require long-term public-private collaborative programs, whereas local watershed groups could adopt small coastal streams for habitat restoration.

Salmonid populations are present but reduced across most of the region *(Map 5)*. This map illustrates the diverse spatial scale of restoration possibilities and highlights the need for adaptive management. Ongoing research needs include inventorying and monitoring of areas with unknown current status, such as the San Benito River and the south fork of the Pajaro. Potential recovery strategies include removing obstructions from small coastal streams in Big Sur and long-term recovery plans for major river systems such as the Salinas and Pajaro.

Incorporating salmonids into an overall conservation plan also allows planners a method of addressing ecosystem degradation in management plans. Ecosystem degradation problems are generally approached through an ecosystem process-oriented management plan rather than a biodiversity or population viability approach.

Traditional conservation planning, which relies on species abundance or biodiversity may not adequately address ecosystem functioning, particularly in areas with heavy human habitation and use. For example, increased temperature and sediment loading in creeks result from stream obstructions and loss of plant cover. Such degradation does not necessarily require acquisition of property (a time honored conservation strategy), but it does require proactive land management and restoration activities.

We found that examining both the spatial needs of the wide-ranging mountain lion and the habitat restoration needs of steelhead allowed us to identify riparian restoration projects that potentially serve to both increase suitable steelhead stream habitat and provide cover for dispersing lions though rural agricultural settings. Specifically, establishing continuous riparian vegetation that spans across the Salinas Valley may prove to be useful cover for mountain lion.

Comparative representation analysis

A representation analysis assesses the degree to which any particular biological element is included within the network of existing or potential conservation areas. In this case, we are using a network of mammal focal species habitat and linkages as potential conservation areas. We are not addressing the question of "how much protection is enough?" Rather, we want to assess the level of protection afforded biodiversity elements by protecting mammal focal species. To do this, we quantify the degree of overlap between the distribution of focal species habitat and the distribution of other elements of biodiversity. As mentioned earlier, these analyses test the validity of the umbrella species approach to conservation planning and determine the adequacy of using wide-ranging species as a basis for reserve design. Below, we summarize the results of the comparative representation analysis for: oaks, key bird habitat, The Nature Conservancy portfolio sites, old-growth redwood, red-legged frog and tiger salamander.

DISTRIBUTION OF MAJOR SPECIES OF OAKS

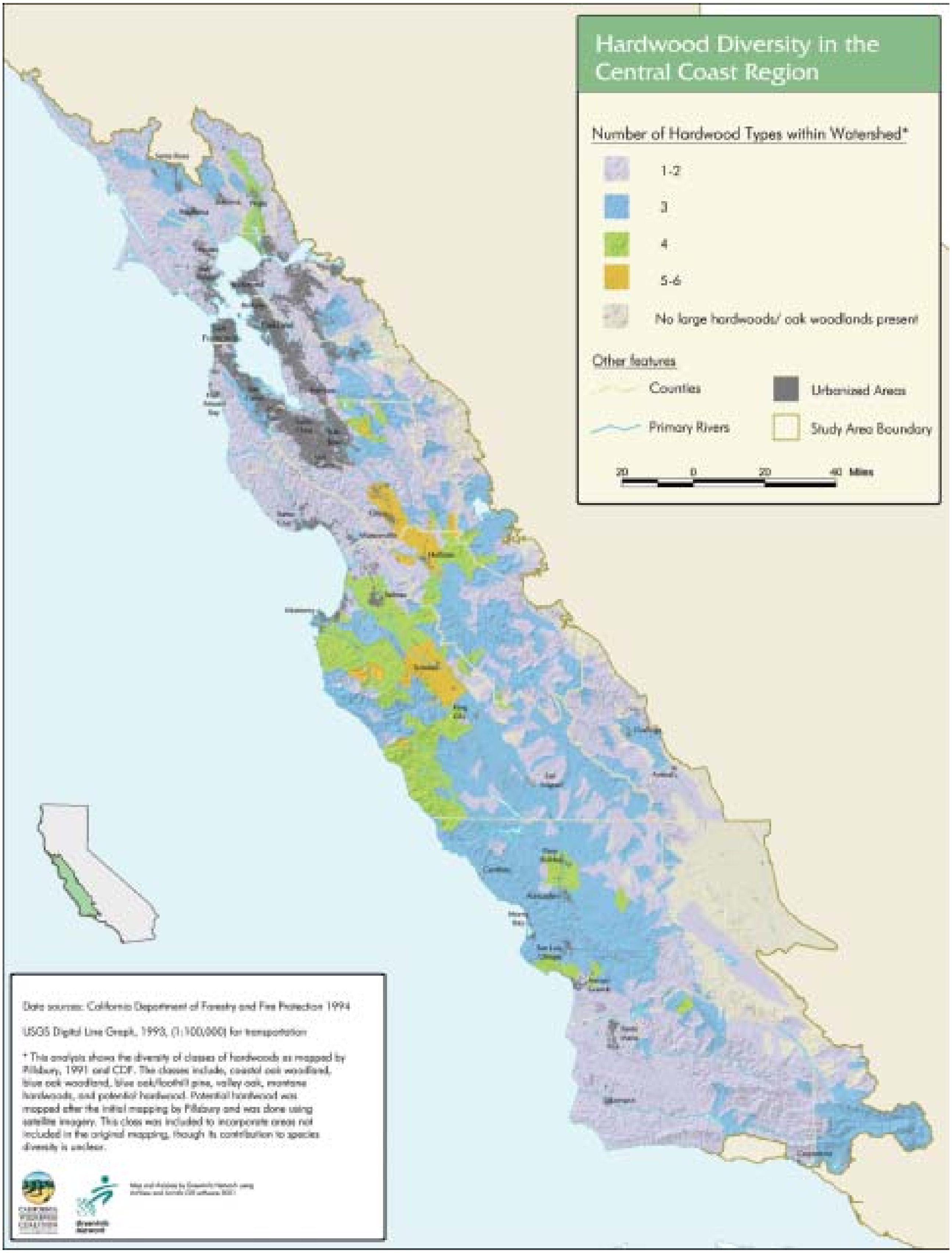
Various oak communities are found throughout the region *(Map 11)*. Blue oak communities are found toward the eastern edge of the region where they form the famous 'bathtub ring' around the Central Valley. Valley oaks, however, are widely distributed. It is likely that Valley oaks are found in more locations than the data indicate, since it is a species that can grow in sparse stands that may not be picked up by satellite imagery analysis. While coast live oak is found toward the coast, interior live oak grows in the eastern part of the region. It is likely that there is considerable error in species identification between these two, due to their similar appearance, and potential to grow near each other in this region. There are also small amounts of canyon live oak and Oregon oak in the region.

A watershed assessment of oak density and diversity was conducted to provide context for this report. It can be used to prioritize conservation targets within the focal species network that have high oak density and diversity. Watershed boundaries were determined from the CALWATER data (v 2.2 DFG 2000) and were used as sampling areas to map the relative density and diversity of hardwoods. From the original hardwoods data, we selected all species that had a canopy closure greater than 40% and a large tree size (greater than 12" diameter at breast height). We only wanted to include denser stands of large trees, though it is unlikely that exclusion of oak savannahs would change the relative density by watershed *(Maps 10, 11, 12, and 13)*.

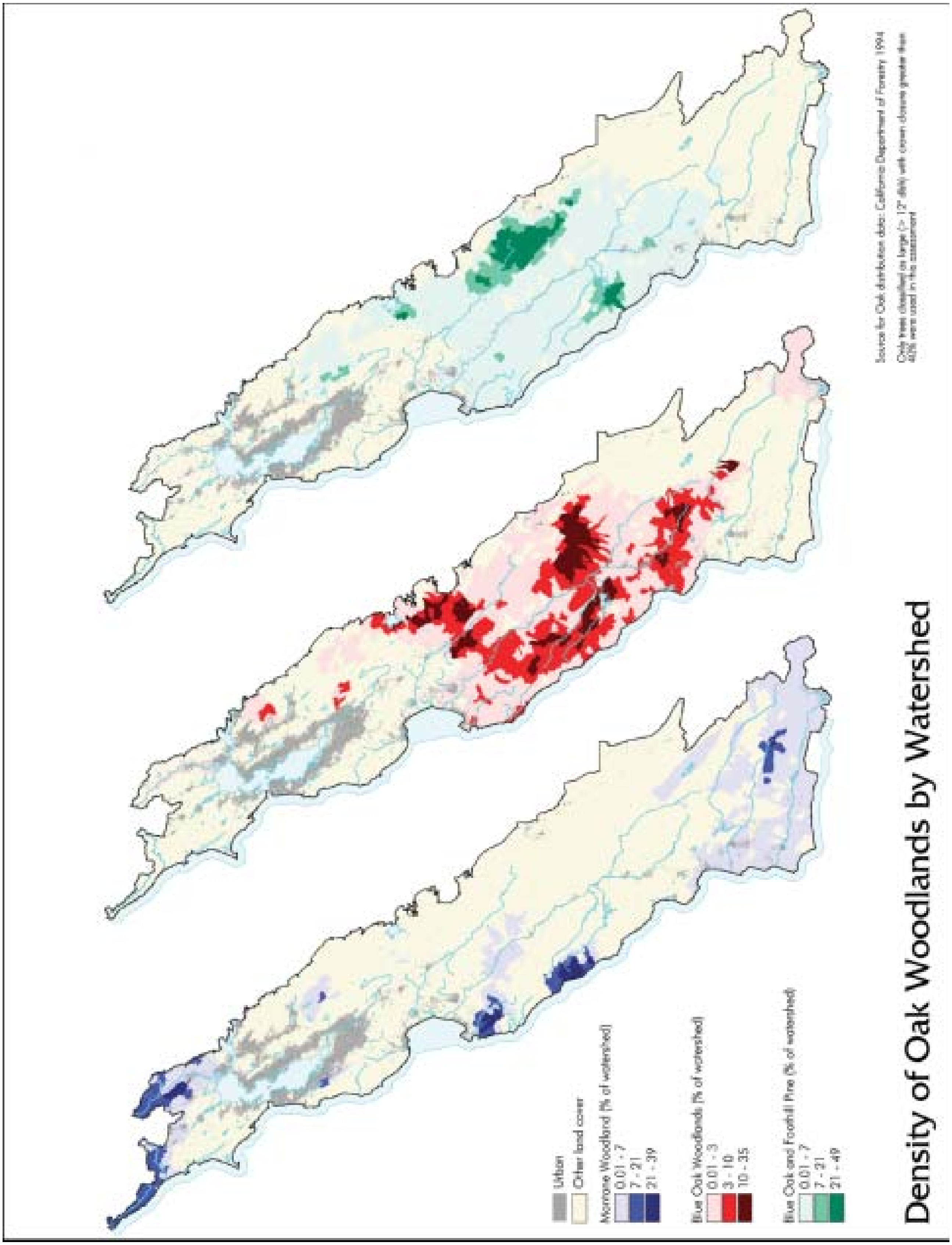
Oaks are keystone species for the central coast region, and many species depend upon them (Block et al. 1990, Pavlik et al. 1991, Underwood-Russell et al. 2001). They are widely distributed through the region and may be used as a flagship tree species to build public support for habitat protection due to their widespread appeal. Oak conservation can be incorporated into local actions by protecting individual trees or restoring small stands, in addition to protecting larger stands through land acquisition and ecological management. The latter strategy is the focus of this report.

Oak woodlands have been identified as critical habitat for eight birds by Point Reyes Bird Observatory: acorn woodpecker, blue-gray gnatcatcher, lark sparrow, Nuttall's woodpecker, oak titmouse, western bluebird, western scrub-jay and yellow-billed magpie (PRBO 2001). While we did not attempt to design a conservation plan for these birds, extensive representation of oaks in our conservation network is an indirect way of protecting them.

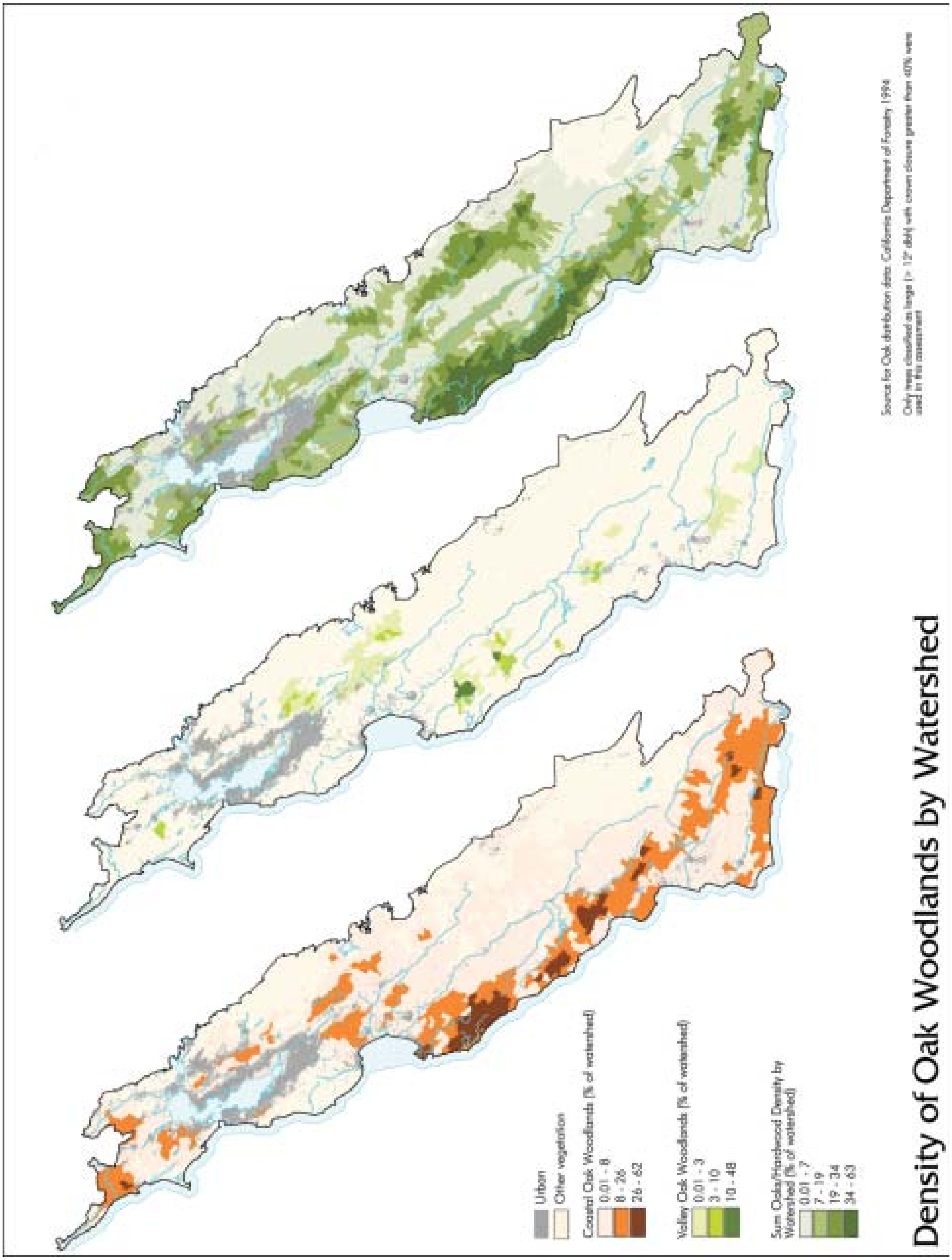
Map 10: Hardwoods of the Central Coast



Map 11: Hardwood Diversity in the Central Coast Region



Map 12: Density of Oak Woodlands by Watershed (part I)



Map 13: Density of Oak Woodlands by Watershed (part II)

REPRESENTATION OF OAKS IN MAMMAL NETWORK

The level of representation for each oak type in the Mammal Network is displayed in the table below. Oaks are well represented within the Mammal Network, with over 75% of oaks occurring within non-linkage habitat. This is not surprising because oak communities are ranked as good mountain lion habitat.

MAMMAL NETWORK	OAK/ HARDWOOD TYPE	AREA IN OAKS AND MAMMAL NETWORK (KM^2)	AREA IN OAKS AND MAMMAL NETWORK (ACRES)	% REPRESENTED
Key Habitat	Blue Oak \ Foothill Pine	681	168,226	92.09
Key Habitat	Blue Oak Woodland	663	163,837	86.56
Key Habitat	Coastal Oak Woodland	1802	445,432	75.83
Key Habitat	Montane Hardwood	412	101,795	88.68
Key Habitat	Valley Oak Woodland	63	15,676	81.67
Linkage	Blue Oak \ Foothill Pine	12	3,034	1.66
Linkage	Blue Oak Woodland	27	6,553	3.46
Linkage	Coastal Oak Woodland	108	26,677	4.54
Linkage	Montane Hardwood	5	1,166	1.02
Linkage	Valley Oak Woodland	6	1,453	7.57

Table 11: Representation of Hardwoods in the Mammal Network

This table indicates what amount of the total of each oak community type in the region is found in the Mammal Network.

COMMENTS ABOUT OAK CONSERVATION

Because oaks have so many associated species, it makes sense to protect them in as many places as possible. Since people like oaks, many local oak conservation projects can be used as a way to introduce towns and communities to local conservation within a regional plan. It may be possible to forge agreements to not cut oaks and incentives to plant oaks to gather support for regional conservation efforts. Given more time, we would recommend a more thorough integration and analysis of the spatial relationships between oaks and other conservation elements.

IMPORTANT BIRD HABITATS: COASTAL SAGE-CHAPARRAL SCRUB AND GRASSLANDS

Oak woodlands, discussed above, are one of five PRBO classes of critical habitats for birds in the region *(Appendix 4)*. We examined two other PRBO identified habitat types: coastal sage-chaparral scrub and grasslands. We used the Gap Analysis vegetation data for the state (Holland classification) for scrub and grassland distribution. Almost 84% of coast sage-scrub type was represented in the mammal habitat and an additional 8% was picked up in the linkage areas. About 68% of the non-native grassland type was represented in key habitat for mammals and an additional 9% was in linkages. It is reasonable to assume that this level of representation would adequately protect these key bird habitats.

Birds are able to use much finer scale patches of grassland habitat than kit fox or pronghorn. Additional research is necessary to integrate habitat-based conservation plans for bird species (e.g., work in progress under direction of Doug Updike, CDFG) with other species dependent on grasslands. Additional challenges remain for grassland habitat protection. Due to the introduction of livestock, grasslands have been almost completely converted to non-native species. Restoration of native grasses is a significant conservation challenge and falls beyond the scope of this report.

PORTFOLIO SITES FOR BIODIVERSITY

Ecologically significant areas containing rare species or community concentrations have been identified by The Nature Conservancy (TNC) using vegetation maps, field surveys and consultation with experts. According to TNC, these areas represent a portfolio of sites that, in sum, represent the biodiversity of the region. We found that 65% of the area designated as TNC portfolio sites were represented within the focal species habitat and an additional 8% were represented in the linkages *(Table 12)*. Since these areas have been surveyed at a higher resolution than the public data we used, our recommendation is that all of the portfolio sites should be included within a future iteration of this Wildland Conservation Plan.

MAMMAL NETWORK	AREA IN PORTFOLIO SITE AND MAMMAL NETWORK (KM^2)	AREA IN PORTFOLIO SITE AND MAMMAL NETWORK (ACRES)	% REPRESENTED
Key Habitat	6,878	1,699,692	64.52
Linkage	883	218,209	8.28

Table 12: Representation of TNC Portfolio Sites

REPRESENTATION OF AREAS THAT CONTAIN UNIQUE SPECIES

We compared the Mammal Network with two unique plant communities: those that occur on serpentine soils and old growth redwood forests. At the regional scale, these plant communities have similar extents to the habitat types described above; they appear as small polygons in a map of regional vegetation.

SERPENTINE ROCK PLANT COMMUNITIES: COMPARISON TO THE MAMMAL NETWORK

Serpentine rock was used as a surrogate for the presence of endemic plants. Serpentine is less common in the southern half of the state than in the northern due to different geologic conditions. Major outcrops in the region occur in two diagonal belts: northwest from southeast Santa Barbara county to southern Monterey county near the coast, and northwest along ridges near the central valley from northern San Luis Obispo county to Alameda and Contra Costa Counties.

We found that 72% of serpentine rock was within our mammal habitat and an additional 10% was in the linkages *(Table 13)*. It is difficult to say if this represents adequate protection for plants that may exist nowhere else in the world, but it is a good start. Additional field surveys for serpentine plant communities would be necessary to identify all of the areas that need protection.

MAMMAL NETWORK	AREA IN SERPENTINE GEOLOGY AND MAMMAL NETWORK (KM^2)	AREA IN SERPENTINE GEOLOGY AND MAMMAL NETWORK (ACRES)	% REPRESENTED
Key Habitat	437	108,121	72.02
Linkage	60	14,727	9.81

Table 13. Status of Serpentine Geology Relative to the Mammal Network

This table shows the percentage and amount of serpentine rock from the central coast region that falls within the Mammal Conservation Network.

Challenges for conservation of serpentine plant communities include changing BLM land management policies at the largest serpentine outcrop in the region, New Idria in San Benito County. The extensive use of this area by off-road vehicles threatens the rare plant communities and degrades habitat quality for associated animals. The New Idria complex falls completely within the Mammal Network, raising the level of representation for serpentine considerably. Yet, the geologic data are at a coarse scale, and many serpentine soils were probably not represented in this analysis. The inclusion of serpentine in the Mammal Network was as much due to chance as to design. We would expect the proportion of serpentine represented in the Mammal Network to be lower if the same technique were used in northern California.

OLD GROWTH REDWOOD FOREST

Old growth redwood forests are an endangered habitat type and a potential flagship for the region. We used two different classifications of old growth redwood, one conducted by Pacific Biodiversity Institute in 1998 and the other conducted by Steve Singer for the Santa Cruz Mountains. Overall, the representation of old growth redwood in the Mammal Network was high, with 88.4% old growth in focal species habitat and 2.4% in the linkages *(Table 14)*. Similar to the oak distribution, redwood is suitable habitat for mountain lion, so this result merely affirms the classification accuracy of the WHR modeling at this scale. The results indicate a focal species network would protect a high percentage of old growth redwood.

MAMMAL NETWORK	AREA IN OLD GROWTH REDWOOD AND MAMMAL NETWORK (KM^2)	AREA IN OLD GROWTH REDWOOD AND MAMMAL NETWORK (ACRES)	% REPRESENTED
Habitat	145	35,750	88.4
Linkage	4	1,018	2.4

Table 14: Status of Old-Growth Redwood Relative to the Mammal Network

This table shows the percentage and the amount of old-growth redwood in the central coast region that falls within the Mammal Conservation Network.

CALIFORNIA RED-LEGGED FROG AND TIGER SALAMANDER

Populations of species with low dispersal capabilities can be represented as points at the regional scale. We used occurrence records of two species that fall into this category, California red-legged frog and California tiger salamander. Locations came from the California Natural Diversity Database (CNDDB 2000) for our comparison with the Mammal Network. It should be noted that these data are incomplete and subject to sampling error.

We selected all of the records in the CNDDB and determined how many occurrences overlapped with either mammal habitat or linkages. Of 302 records for the California red-legged frog, 160 (53%) were represented in either a core or a linkage. For the 304 records in the database for the California tiger salamander, 161 (53%) were represented in the Mammal Network.

The frog and salamander were probably poorly represented for two reasons. First, none of our three terrestrial focal species can persist in a developed landscape, whereas frog and salamander apparently can. Second, the CNDDB lists known locations, and surveys tend to be disproportionately skewed to locations near urban areas. Because both of these species are listed under the Endangered Species Act, sampling was probably more thorough near areas under threat of development.

The scale at which these species use habitat is much finer than the scale of our focal species analysis. Our Mammal Network is consistently restricted near urbanized areas and in valleys where agriculture is the predominant land use. We recommend that all known populations of California red-legged frog and California tiger salamander be included in a future Wildland Conservation Plan. We further recommend that other species of amphibians be analyzed in a similar manner. Issues of connectivity for these species were not addressed in this study, as they require finer scale analyses and data.

Summary of representation analysis for elements of diversity

The network identified for focal mammals is extensive, taking up 68% of the total region. Within that network we found (within the region)

- Between 75 and 92% of the five oak communities
- 73% of Nature Conservancy portfolio sites
- 82% of the serpentine rock outcrops
- 91% of old growth redwood stands
- 92% of the coast sage chaparral
- 77% of the non-native grasslands
- 53% of the known populations of California red-legged frog and
- 53% of the known populations of California tiger salamander.

We expected oak communities and old growth redwood to be well represented in the network since both are classified as suitable habitat for mountain lion. For this reason, the results for these communities cannot be taken as evidence supporting the umbrella species concept.

The main locations for redwood are on the west side of the Santa Cruz mountains, in Napa County, and in the valleys of Big Sur. In each of these places, there is enough surrounding area to put the redwoods in primary or secondary core areas. Remaining large populations of oaks also tend to be in less developed areas.

Discussion

The Mammal Network of preferred habitat and linkages captured roughly proportional amounts of the finer scale elements of biodiversity. In this case, the umbrella species concept held largely true for many of the elements that we analyzed. Yet, for the California red-legged frog and tiger salamander occurrences, the level of representation (~50%) was inadequate given the rarity of these species and the associated threat of extinction.

It should not be surprising that habitat for wide-ranging mammals overlapped significantly with more localized elements of biodiversity. Conservation recommendations for these elements need to be made at an appropriate scale. For example, developing a reserve network for mountain lion may not preserve an endemic plant community on serpentine soil just because the plants fall within the boundaries of the reserve. The factors that maintain the integrity of that plant community operate at a scale much finer than the factors important for mountain lion persistence. Management recommendations specific to each element are beyond the scope of this report, but biodiversity conservation must be addressed at scales appropriate to the targets.

By determining comparative representation between mammal species and other indicators of biodiversity, we determined the degree of spatial overlap between the Mammal Network and the mapped distributions of these various elements. We only briefly discussed the ecological or functional relationship between the focal species and any of the elements. Our results quantify the level of representation using available data for a snapshot in time, but there is no reason to assume that these results would scale linearly. For example, the patchy distribution of many of the elements (e.g., serpentine soils, old growth redwood) suggests that there are thresholds in the amount of overlap between mammal habitat and these elements. In other words, the proportional representation that we observed is more likely a function of the extensiveness of the Mammal Network than similarity in the spatial pattern.

In addition, it is unlikely that the response to future disturbance would be similar for the elements. The spatial pattern or distribution of each element will influence the impact of ecosystem disturbance or degradation. This is true for both short- and long-term disturbance regimes. For example, a fire may burn through 40% of the old growth redwood in the region and only impact 5% of the mountain lion habitat. In the long term, the response of an element to climate change will vary depending several factors, including its dispersal abilities and latitudinal distribution.

The level of representation of habitat types and proxies for endemic species were quite high, though we do not claim to know how much protection is enough. The locations of California red-legged frog and tiger salamander were not well represented, showing potential limitations of an umbrella focal species approach. As additional species and habitat are identified for conservation targets in the region, we recommend their distributions be mapped and a similar representation analysis be done to assess their level of presence within the mammal conservation network.

Overall, a conservation approach based on representing the habitat needs of mammals covers about 68% of the region with the following proportions: 42% mountain lion, 24% kit fox and 2% pronghorn. It may be daunting to consider that such a large proportion of the landscape needs to be managed for conservation to protect species that need the most space. We were conservative in favor of the focal species and future refinement of habitat maps and data would likely yield a less extensive network. However, we are not far off from regional assessments in other areas. This is slightly higher than the approximately 50% identified by the State of Florida for conservation acquisition (Hoctor et al., 2000).

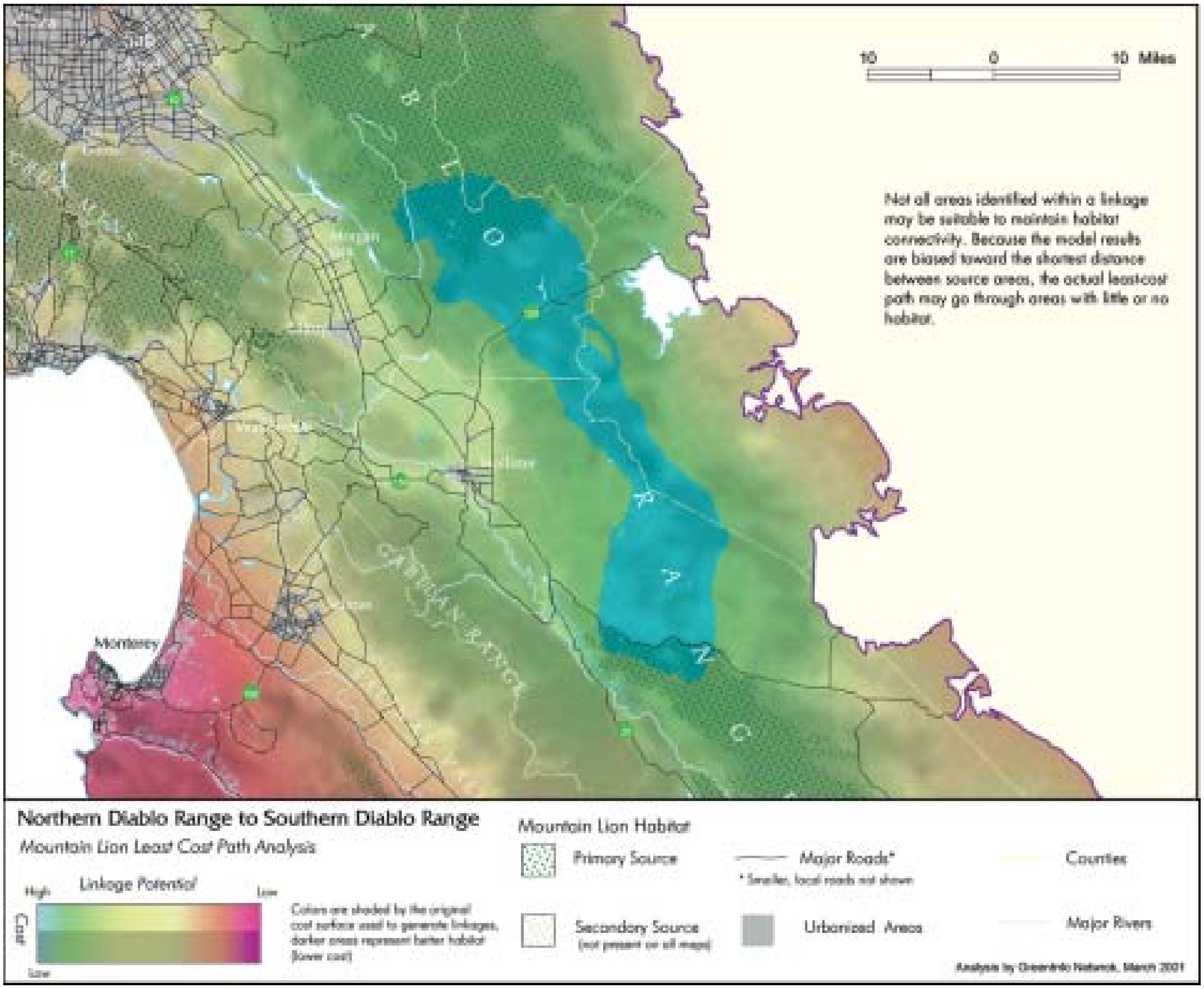
Description and ranking of identified linkages

In the following pages, we provide a map and description of each of six potential linkages identified between the five primary cores, and two potential linkages for the secondary cores. The area north of the San Francisco Bay area has not been included in the subsection maps. We felt it should be included in the north coast region since much of the suitable habitat we identified is connected to larger habitat areas further north. Each description has a corresponding map *(see subsection maps)* that shows two layers of information.

The result of the linkage modeling is shown in rainbow colors with the optimal linkage (in blue) identified by the model. The costs combined from roads, forest cover and WHR habitat suitability are used to shade the colors; darker shading represents lower costs (better dispersal habitat). The shading may be confused with topography or elevation because of the correlation between forest cover and topography. Proposed cores are used as the source-destination in the modeling and are shown as stippled areas.

These stippled areas are proposed core areas, requiring a high level of habitat protection. Two of the core areas are mostly on public lands and should be managed as prime focal species habitat. Three of the proposed core areas are mostly on private lands, and should become the focus of conservation easement efforts with willing landowners since it is unlikely that a purchase of a whole core area is feasible. Management for core areas across mixed ownership will need to be coordinated among various landowners and stakeholders.

The identification of linkages that are important for mountain lion habitat connectivity presented here needs to be refined and integrated with tracking research and on-the-ground verification of use by the animals. Linkages identified in our model merely show the area of least cost dispersal. In addition, these linkages represent the broadest scale of habitat connectivity for mountain lion because they are between the largest, farthest-apart cores of habitat. Finer-scale corridors will need to be identified using other methods to identify movement paths within contiguous habitat. We recommend that local resource managers work with the stakeholders to identify which parcels of land within the linkage might be useable. An example of a finer-scale linkages is the riparian forest along Arroyo Seco Creek in Monterey County. This creek reaches all the way to the Salinas, and riparian forest along its banks could serve as a dispersal corridor half-way across the Salinas Valley.

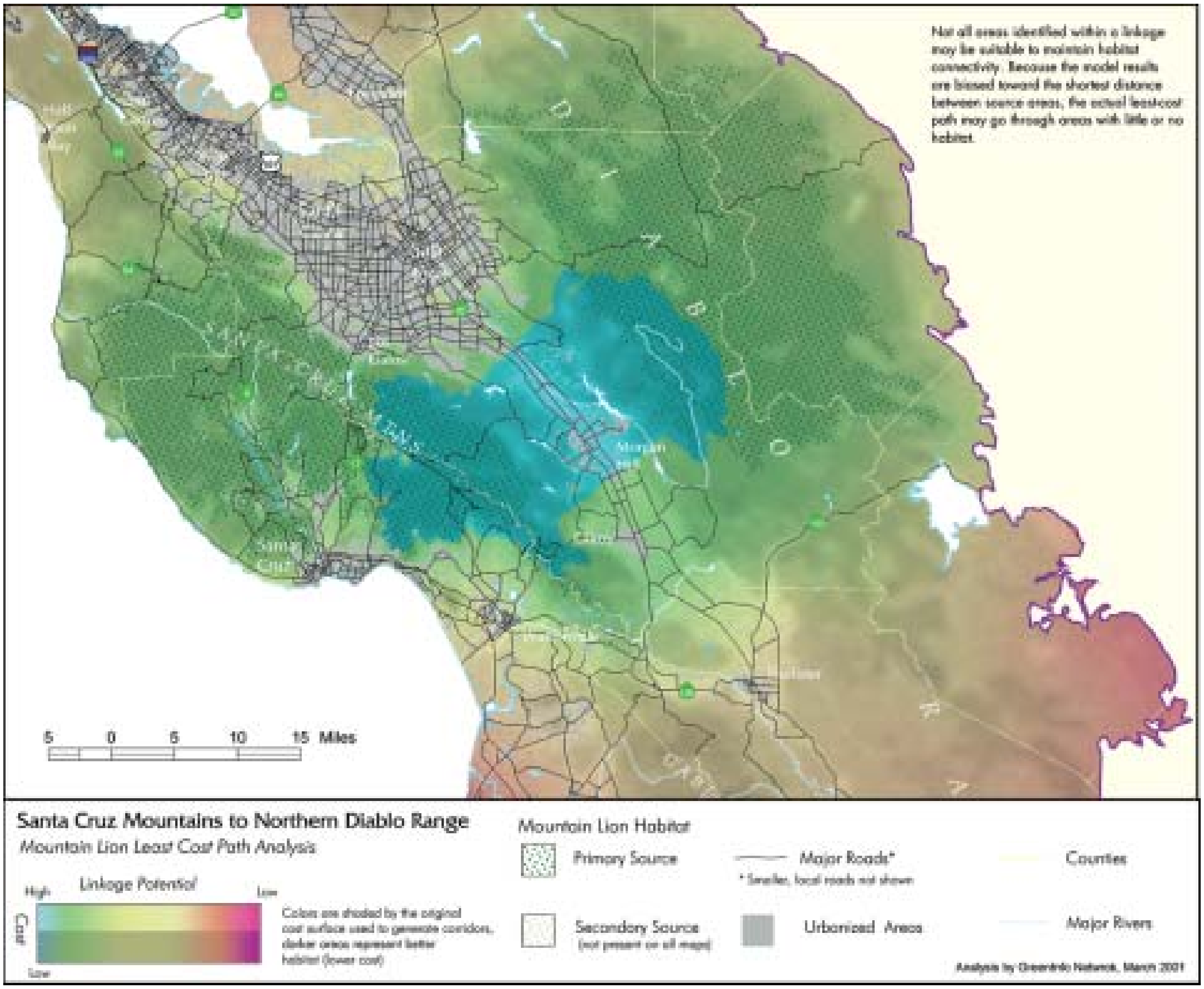


Subsection Map 14: Northern Diablo Range to Southern Diablo Range

LINKAGE 1:

Northern Diablo Range to Southern Diablo Range

This linkage passes through the rural countryside east of Hollister and west of San Luis Reservoir. It crosses State Highway 152 and 25-J1 and continues along the Quien Sabe Valley-Potrero Peak south towards the Call Mountains. The region is predominantly in ranch lands although development pressures to the west are beginning to push into the linkage. Apart from rural roads and fences, the area is likely fairly permeable to large vertebrates. Both the linkage and both cores in this area are predominantly on private lands. For the most part, these lands are not yet heavily developed, although many areas have been over-grazed. The challenge for mountain lion preservation in this area will be to construct a conservation scheme that is acceptable to local ranchers.

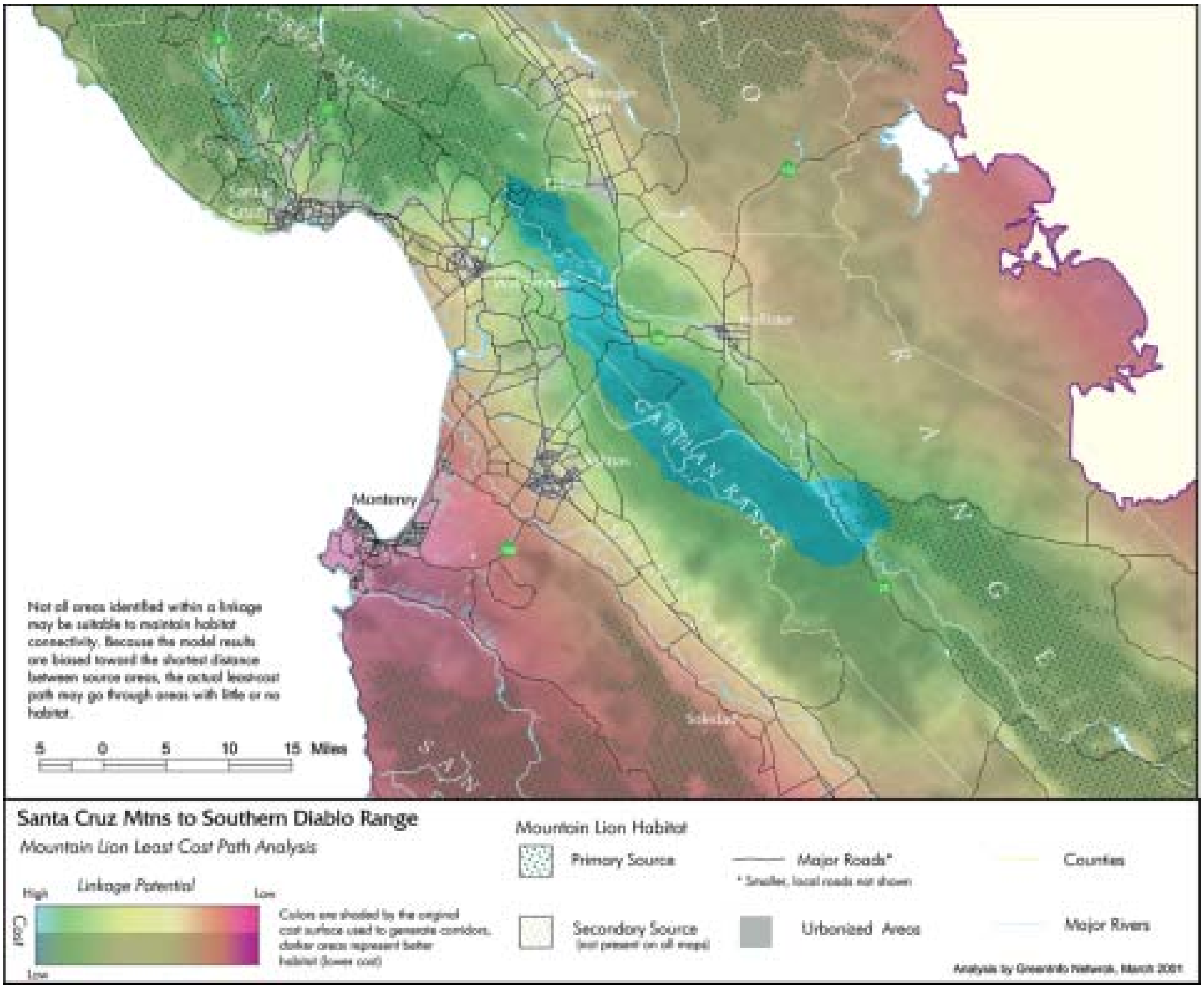


Subsection Map 15: Santa Cruz Mountains to the Northern Diablo Range

LINKAGE 2:

Santa Cruz Mountains to the Northern Diablo Range

This linkage runs east-west across Coyote Valley, site of tremendous urban pressure from San Jose to the north. Currently approved for construction in the valley is a major development for Cisco, though the scope of this project has been scaled back by changes in the economy. Highway 101 runs through the area, which is also laced with large numbers of secondary roads, housing and orchards. If the linkage is actually functioning, it is certainly not easy for animals to try and get through. Detailed localized planning is needed to identify if linkage can be protected. It should be noted that the area just south of Gilroy is also under development pressure, although perhaps not as intense as in other areas. It is imperative that these model results be interpreted with a good sense of practicality. While factors such as habitat suitability and road density were used to map optimal linkages, linear distance is also a factor in showing the least cost path. In this map and others later in the document, the optimal path will go right through a city, an obviously absurd scenario. This is a limitation of the model and particularly, the weighting scheme applied to the different factors. Further research on the movement paths of mountain lion in a developed habitat matrix will help to refine and improve this model.



Subsection Map 16: Santa Cruz Mountains to the Southern Diablo Range

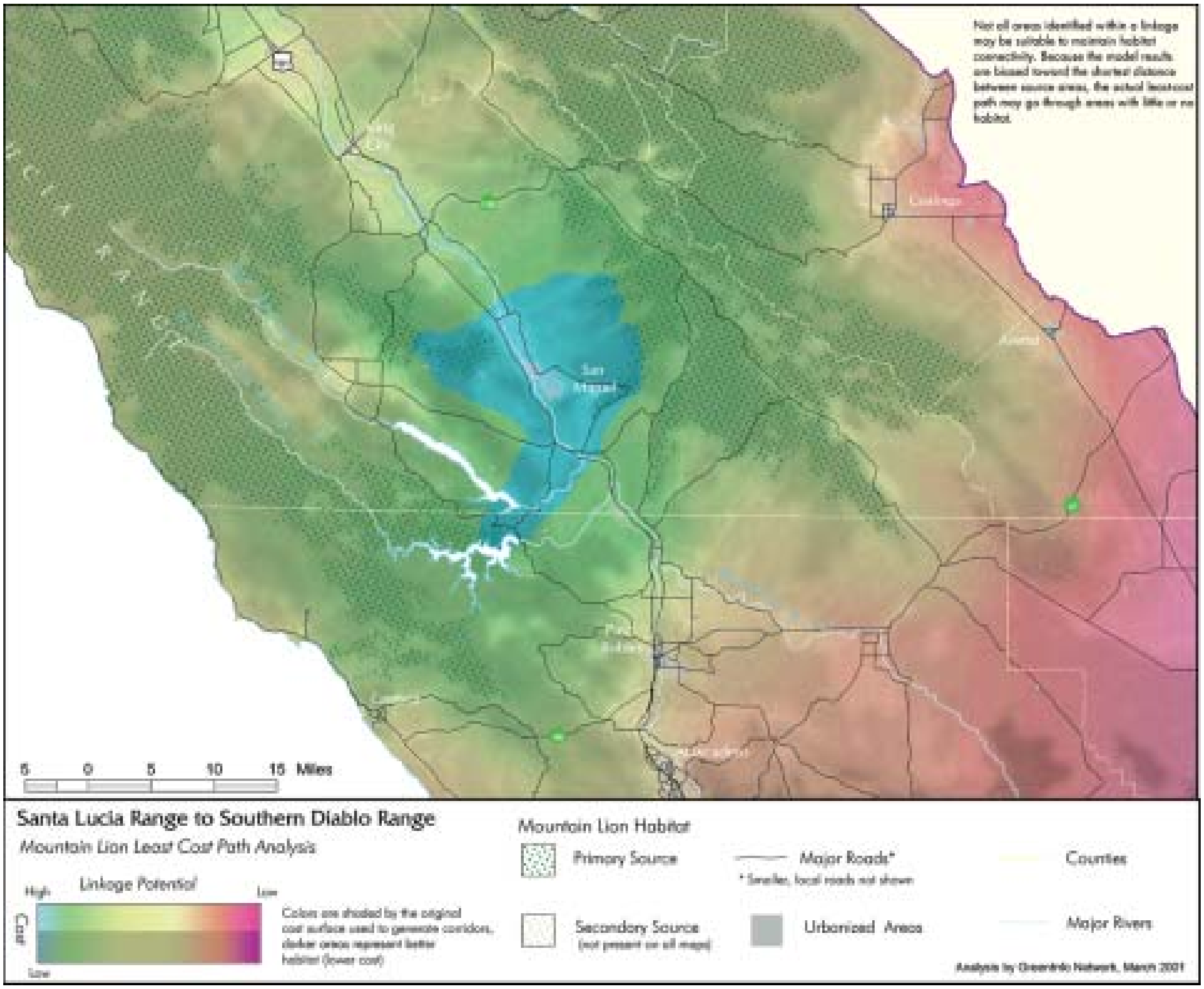
LINKAGE 3:

Santa Cruz Mountains to the Southern Diablo Range

This linkage connects the southern end of the Santa Cruz Mountains with the Gabilan Range immediately south of the Pajaro River. It is likely the best, and possibly the only, remaining linkage connecting Santa Cruz Mountains mountain lion with those in other parts of the state. This linkage is under heavy pressure, and may cease to function in the near future due to potential development along the Pajaro River. The crux of this linkage, where it crosses the river, is one of the two linkages most at risk in the central coast region. It is probably the most important, considering the Santa Cruz Mountains probably do not provide the minimum area needed for a viable mountain lion population and are therefore in need of a way for additional individuals to get into the region. This linkage and the Coyote Valley linkage are the last links in the entire mountain range for mountain lion.

Highway 129 runs west along the Pajaro River serving as the major link between Hollister and the coast. This road is heavily used, and urban development is expanding along it from both the coast-Watsonville and Hollister-San Juan Batista. There is a narrow strip of undeveloped ranch lands and an even narrower strip of shrubs and trees still connecting the core regions that mountain lion could potentially use. This strip is located in the steepest part of the canyon that the river flows through. Appearances from the road suggest that it would not take many additional development projects to leave no vegetative cover intact along this area, making this a choke point (Hunter 1999). This linkage should definitely be one of the highest priorities for conservation work in the near future.

The Pajaro River is important in its own right for the potential salmonid habitat it offers, should river restoration efforts be a success.

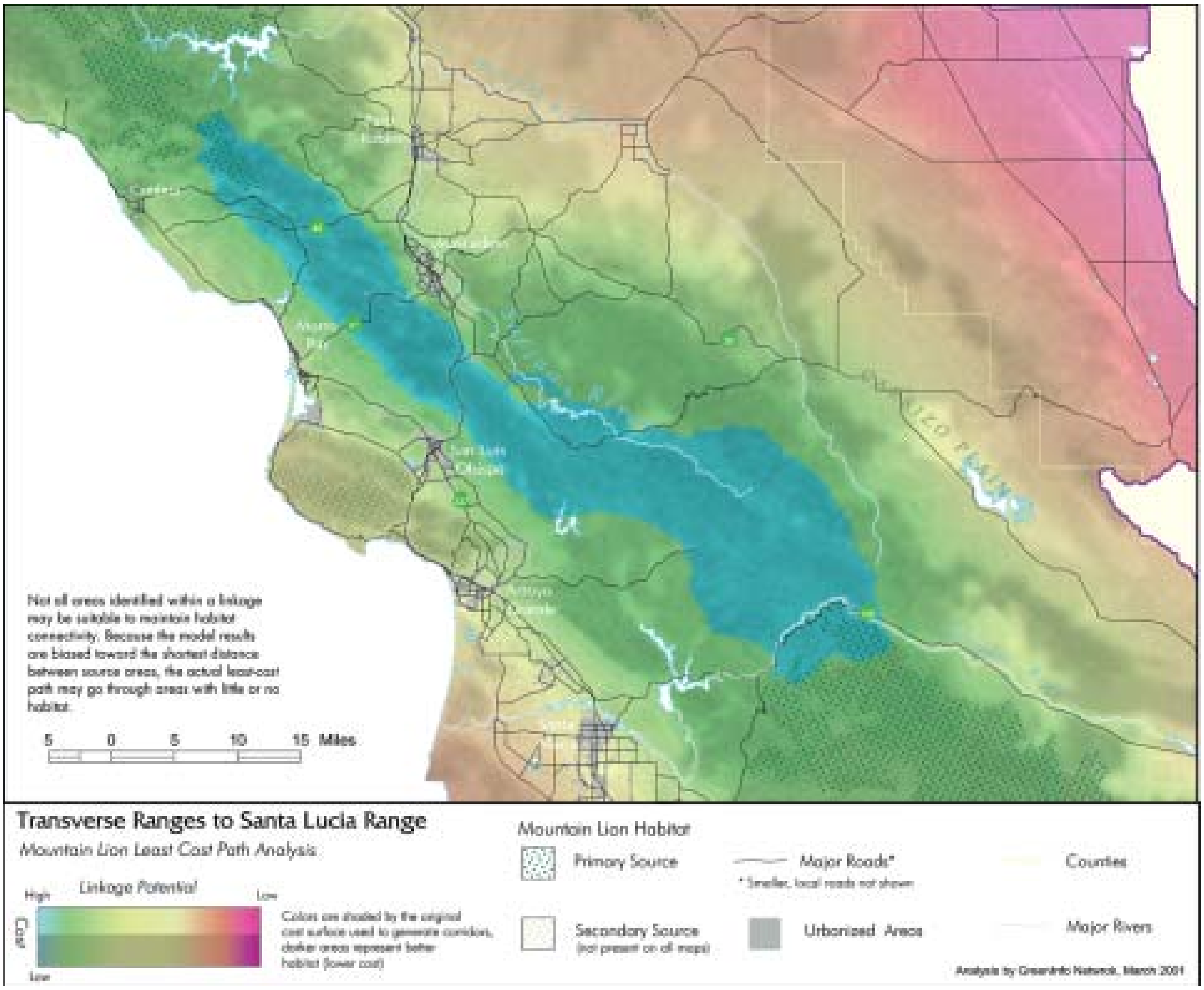


Subsection Map 17: Santa Lucia Range to the Southern Diablo Ranges

LINKAGE 4:

Santa Lucia Range to the Southern Diablo Range

This linkage connects the mountains of Big Sur to those that line the eastern side of the Salinas Valley. The linkage identifies a broad swath that will probably not become a wildlife passageway, as it traverses one of the major agricultural centers of California. However, the need for some connectivity between the coastal mountains and interior coast ranges is illustrated. The area is predominantly rural, although urbanization is advancing along the Highway 101 linkage, which runs straight through the valley. The results of the least cost path analysis place the linkage approximately in the flood plain of the river. It should be noted that the distance between hilly sections of the landscape is less in the north (into more urbanized locations) and further in the south near Panchorico Road and Lynch Valley. See the discussion on salmonids for ideas about building connectivity across this valley by conducting riparian vegetation restoration.



Subsection Map 18: Transverse Ranges to the Santa Lucia Range

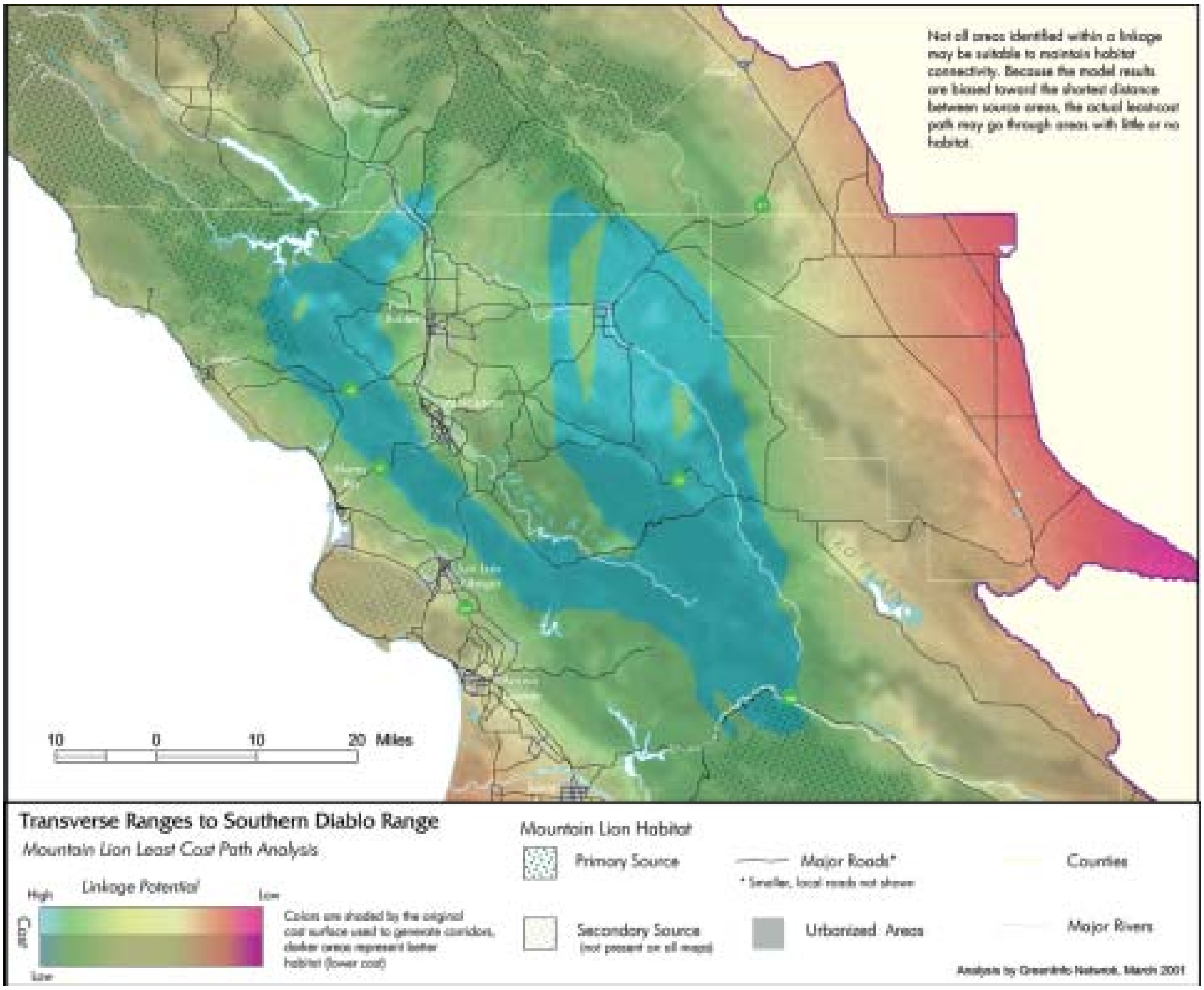
LINKAGE 5:

Transverse Ranges to the Santa Lucia Range

This linkage runs from the Nacimiento Reservoir in the Santa Lucia Mountains south along the narrowing spine of the Santa Lucias to the Los Padres National Forest's southern section and the Garcia Mountains. It passes west of Paso Robles and Atascadero and east of San Simeon and San Luis Obispo. The linkage connects the largest remaining wilderness areas in the region and is under increasing pressure. There are two choke points along the linkage: due west of Paso Robles, and the Highway 101 and San Luis Obispo grade intersection.

Paso Robles is the epicenter of southern California's vineyard expansion. Once speckled with small wineries, the area is now seeing tremendous growth along Highway 101, east along Highway 46 towards Shandon, and west into the Santa Lucias. The distance from Paso Robles to Cambria on the coast is about 20 miles. The prime oak woodlands in this area are increasingly fragmented toward Paso Robles. Because of increasing oak woodland conversion into vineyards around Paso Robles, and the potential to lose this functioning, major linkage, this area is a top conservation priority.

The second choke point is where Highway 101 crosses the San Luis Grade. Identifying some pathways for mountain lion to disperse through this rapidly urbanizing matrix should also be a high priority.

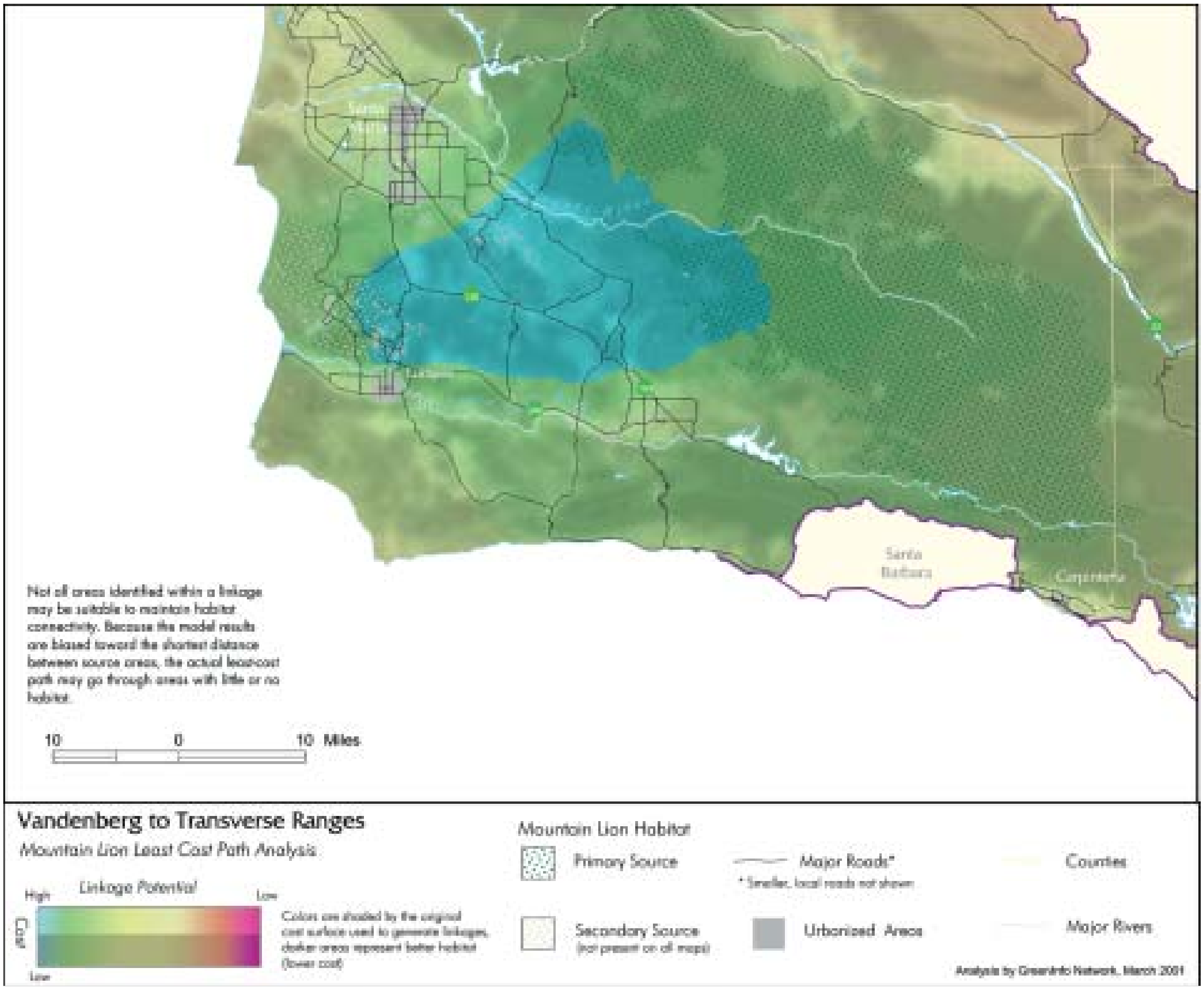


Subsection Map 19: Southern Diablo Range to the Transverse Ranges

LINKAGE 6:

Southern Diablo Range to the Transverse Ranges

This linkage connects the Cholame Hills in the north to the La Planza Range to the south. It cuts across Highways 46 and 58 and passes through a large open area of heavily over-grazed grasslands. There is very little vegetation cover. The area identified in the analysis is broad, and research is needed to identify the best location for actual conservation efforts. This linkage has the potential to link both mountain lion and San Joaquin kit fox populations. There is very little to prevent development along the highways in this area, since the land is so open. Roads may also be problematic for animal crossings here since there is no cover for several miles on either side of Highway 46, making its crossing by wildlife difficult.

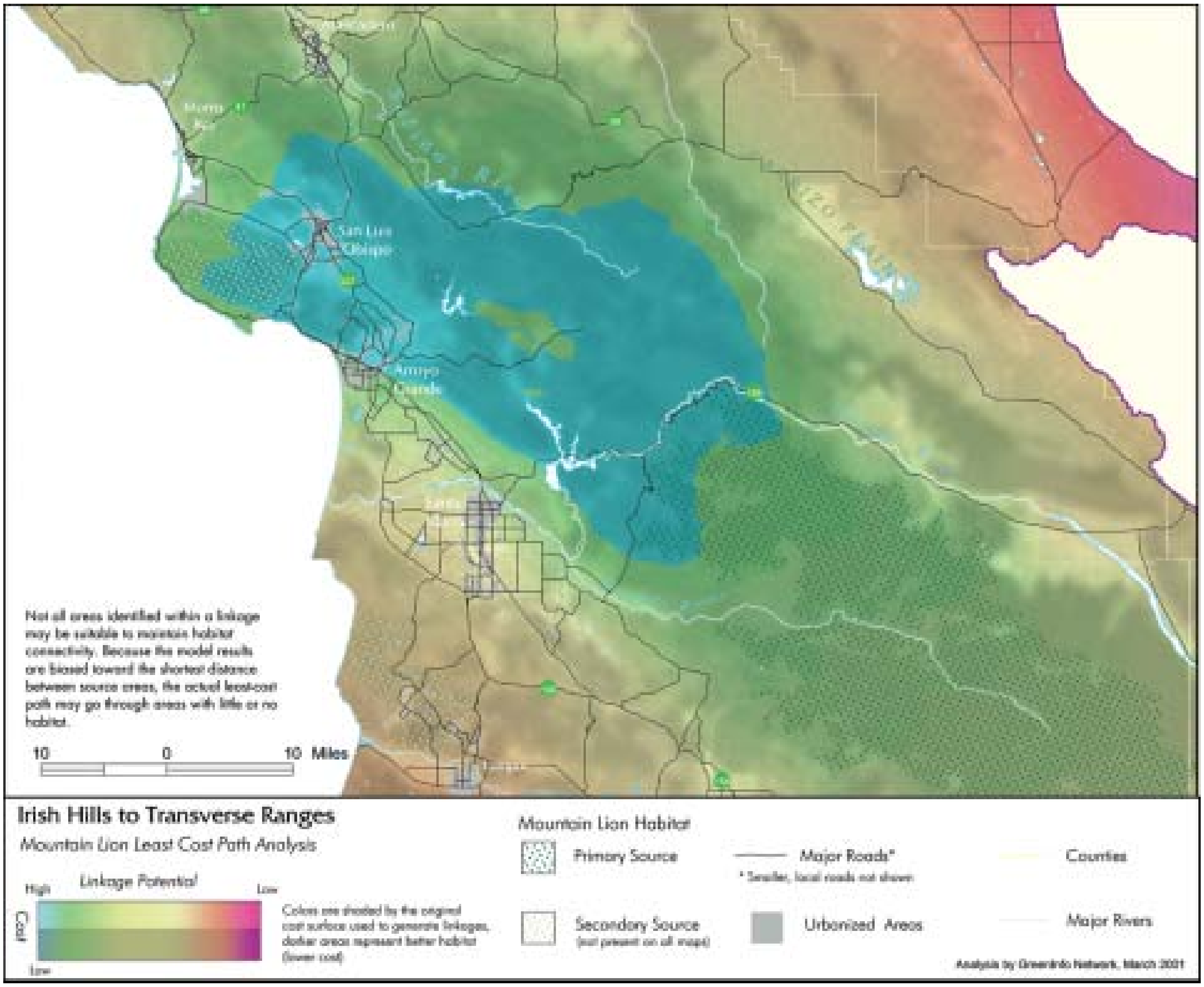


Subsection Map 20: Transverse Ranges to Vandenberg Air Force Base

LINKAGE 7:

Transverse Ranges to Vandenberg Air Force Base

An area on Vandenberg Air Force Base is identified as one of the secondary core areas. There are two potential linkages for this core, south along the coast crest of the Santa Ynez Mountains or east through the Purisima Hills. The analysis identified the Purisima Hills as a more viable option, due to its shorter distance. A broad swath is identified for this linkage, encompassing the Los Alamos Valley, Purisima Hills and the Santa Rita Hills as potential conduits between the Air Force base and the San Rafael Mountains in the southern Los Padres National Forest. Animals attempting this linkage must negotiate the town of Lompoc, Highways 101, 135 and 246, as well as numerous smaller roads.



Subsection Map 21: Transverse Ranges to the Irish Hills

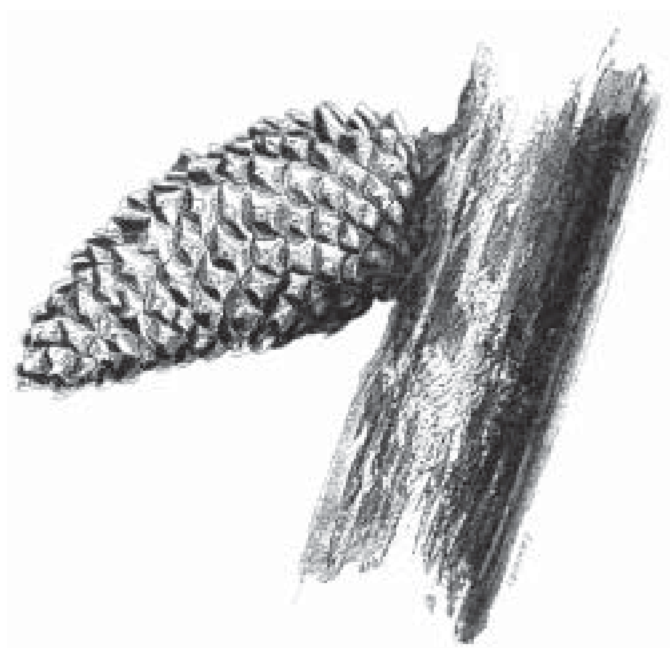
LINKAGE 8:

Transverse Ranges to the Irish Hills

The Irish Hills are a secondary core area of high environmental quality found west of San Luis Obispo. The linkage connects to the southeast along Newsom Ridge to the southern Los Padres National Forest. The linkage cuts across Highway 101 and passes just north of the coastal urban zone of Pismo Beach-Arroyo Grande. Development along Lopez Drive east of Arroyo Grande is likely to make it difficult to establish a viable connection. Whether the Irish Hills are large enough to support a viable population of mountain lion was not established during the course of this investigation.

Section 9

PRELIMINARY WILDLAND CONSERVATION PLAN



Knob Cone Pine — *Pinus attenuata*

Section 9

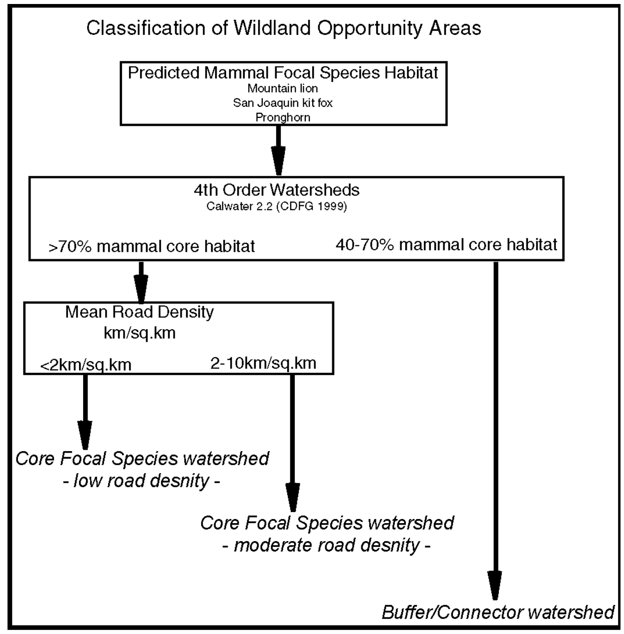
PRELIMINARY WILDLAND CONSERVATION PLAN

Overview

Up to this point, we have mapped a network of suitable habitat and linkages for three focal species and identified the status of steelhead in streams and rivers in the region. In addition, we have quantified the level of representation that this network provides to finer-scale elements of biodiversity. Further, we have ranked the level of threats to each linkage identified. We found two linkages, the Santa Cruz-Southern Diablo Range and the Santa Lucia-Transverse Range, to be particularly threatened. In an effort to identify conservation priorities in the region, we have combined the Mammal Network with road density data to determine what areas have been least impacted by development. This is an attempt to refine our Mammal Network and identify the highest quality habitat for our focal species, particularly the mountain lion. This refinement is a first step toward designing a Wildland Conservation Plan (WCP) for the central coast region, and sets the stage for future research and implementation.

Methods

Using the CALWATER (2.2) hydrologic subareas (HSA) as watershed boundaries, we determined what percentage of each watershed was included in the Mammal Network. In addition, we sampled the mean road density (USGS DLG 1993) within the watershed, as a proxy for human impact. We used these two criteria to classify all watersheds in the region according to the following model:



By combining the focal species habitat data with road density, we intended to develop a hierarchy of landscape units (watersheds) that could be used in a conservation area design. We broke out watersheds with a high percentage of mammal habitat into two classes: those with low road density and those with moderate road density. Watersheds with less focal species habitat were designated buffer or connector watersheds. This is a further refinement of the Mammal Network toward a WCP for the central coast. This refinement begins to incorporate design principles such as size, shape and connectivity of conservation areas. Simply put, these design principles state that larger areas are better than smaller (size), connected better than isolated (connectivity), and high interior-to-edge ratio (more compact shape) is better than a low ratio. These principles are most often applied to strictly protected areas, such as ecological reserves or parks, as a way to maximize the benefits of protection to species and communities. This type of design incorporates existing land ownership and status with biodiversity or wildland values. We have identified the existing pattern of these values, but not gone so far as to map a land conservation strategy. This process will be the next step and will require a broad range of stakeholders to successfully conduct.

At this point we chose not to combine the steelhead watershed status data with these focal species core areas to maintain flexibility in restoration strategies for steelhead. While we advocate for the integration of focal mammal conservation and steelhead recovery, the spatial considerations of combining such disparate data into one database need to be resolved. We discuss implementation of steelhead recovery below.

Steelhead recovery strategies and challenges

Steelhead recovery can be done in conjunction with terrestrial restoration work, but it is also important in and of itself. A regional overview is helpful in envisioning and planning for recovery of steelhead metapopulation structure, while factors limiting the viability of each population must be addressed at the stream and watershed level. Within each Evolutionary Significant Unit (ESU) it is prudent to recover a representative geographic distribution of historic steelhead populations.

In addition to north-south distribution, attention must be focused on the interior watersheds that are generally larger, with a more complex array of problems, as well as the smaller coastal streams that are typically more intact. Especially given the uncertainties of climate change, steelhead lineages adapted to the more challenging conditions of interior watersheds may hold genetic resources important to sustaining each ESU through environmental change. Recovery planning must also stress redundancy, due to the vulnerability of individual watersheds to harmful sedimentation events resulting from fires, landslides, earthquakes, or human activities. Restoration of steelhead populations to historic levels will require cooperation and collaboration among land managers, research scientists and the public.

We recommend splitting recovery efforts spearheaded by local conservation groups, and work on large drainages (Salina, Pajaro, Santa Maria, Santa Ynez) which will require agency coordination. We recommend the integration of salmonid recovery plans with terrestrial biodiversity conservation. It may be possible to integrate conservation easements, acquisitions, and resource management practices that benefit both terrestrial species and salmonids. For example, a riparian vegetation restoration project could supply habitat to a suite of bird species, with benefits for salmonids as well. Riparian vegetation also provides cover for dispersing or foraging animals within a matrix of developed and agricultural land.

Limitations

The initial WCP presented here is not intended to represent adequate protection for any species not specifically mentioned in the report. Even for those included in the report, the model is more a way of assessing the magnitude of work required than a definitive answer to the region's conservation needs. However, the data sets used in developing the analysis are almost all publicly available, making local planning with the information presented here a possibility for groups interested in developing the model further. Adherence to the data structure used will facilitate incorporation of new information as it becomes available.

Map 22: Wildlands Conservation Plan for the Central Coast Region

Landscape-level ecological assessments using umbrella species as focal elements of biodiversity usually fall into the "coarse-filter" class of reserve design taxonomy. We feel that it is important to assess how "coarse" our filter really is using wide-ranging mammals as primary focal species. The central coast of California is an ideal place to test this assumption for three reasons: the high number of localized, endemic species present, the wide range of human settlement patterns and the large proportion of private land. By comparing data sets at widely different scales, we are undoubtedly building in some non-biological artifacts of scale into our analytical framework, but we are also testing the scale dependence of a coarse-filter approach.

Wildland Conservation Planning is an iterative process. This report is one step in a process of continually refining biological information of the central coast region. Implementation may be most effectively conducted locally by a wide range of stakeholders, for each of the cores and linkages identified here. We hope that this report will bring together scientists, land managers and conservationists in ways that will foster future research and implementation of a regional Wildland Conservation Plan through ecological restoration and habitat protection.

Ongoing efforts such as the central coast Regional Conservation Partnership and the Missing Linkages Conference represent steps in this direction. It is interesting to note that of the linkages in our region identified at the Missing Linkages Conference proceedings (Penrod 2000), our approach identified all but one, a connection from Big Sur north to Fort Ord Military Reservation. Fort Ord likely falls beneath the minimum area we used to consider cores. The Missing Linkages Conference also identified numerous connections around San Francisco Bay area cities.

Future research is necessary to determine how the regional perspective presented here may interface with ongoing conservation and open space preservation efforts. We hope that this report will at least provide context for local efforts. It will help organizations and individuals weave their projects into a broader tapestry. We recommend that local efforts focus on different pieces of the puzzle in an effort to secure regional connectivity for wide-ranging species.

The San Francisco Bay area is probably a good place to start developing a way to integrate local and regional efforts. This integration will challenge conservation groups as they try to place the significance of land acquisition in a regional context. In addition, neighboring areas such as the Bay-Delta ecosystem will have significant influence on the functioning of the central coast. Even though we looked at such a large area of the landscape, it is important to remember that an ecoregion is very much an open system with external influences.

Section 10

IMPLEMENTATION RECOMMENDATIONS

Bracken Fern — *Pteridium aquilinum*

Section 10

IMPLEMENTATION RECOMMENDATIONS

Implementation of the conservation strategy presented here is likely to be conducted locally by a variety of people and organizations with various agendas. As mentioned earlier, the most important contribution this report can make to these individual actions is to present a regional biological perspective for successful integration of local conservation plans into a broader framework.

We identified four general conservation strategies that can be derived from this report:

1. collaborative efforts working directly with stakeholders in the region (county planners, state and federal agencies, watershed groups, land trusts, land owners, biologists, etc.) to identify priorities and opportunities for habitat connectivity and habitat protection in the region;
2. the use of conservation easements and other negotiated conservation agreements with willing landowners on large parcels of land that make up the core and linkage sections of the region;
3. the use of available resources to work with willing landowners and acquire specific parcels that protect special biological features (i.e. listed species) at specific locations that fall outside the initial WCP;
4. the implementation of restoration activities that are targeted to benefit several species simultaneously.

Due to the scale of land needed for a mountain lion habitat network, conservation easements on large tracts of private land within the network need to be implemented. Large ranches contiguous with public lands are good places to start this type of work, as they can serve as a buffer between administratively protected land and other private lands. In addition, we recommend development of case-specific plans for each linkage identified, and the use of riparian vegetation restoration projects that are coordinated at the county level to improve mammal connectivity between mountain ranges as well as to aid in steelhead restoration.

We recommend taking a multi-species view of restoration and initiating projects that will benefit suites of species. Specifically, we recommend riparian restoration projects in areas that could also enhance connectivity for mammals, such as restoration of gallery forests on streams that drain into the Salinas River from the mountains on either side.

We have recommendations specific to the steelhead data at both the regional and watershed scales. At the regional scale we recommend projects that:

- Recover a representative geographic distribution of historic steelhead populations within each Evolutionary Significant Unit;
- Plan for recovery of multiple steelhead streams and watersheds to ensure sustainability in each subregion and to synergistically support recovery of the species as a whole;

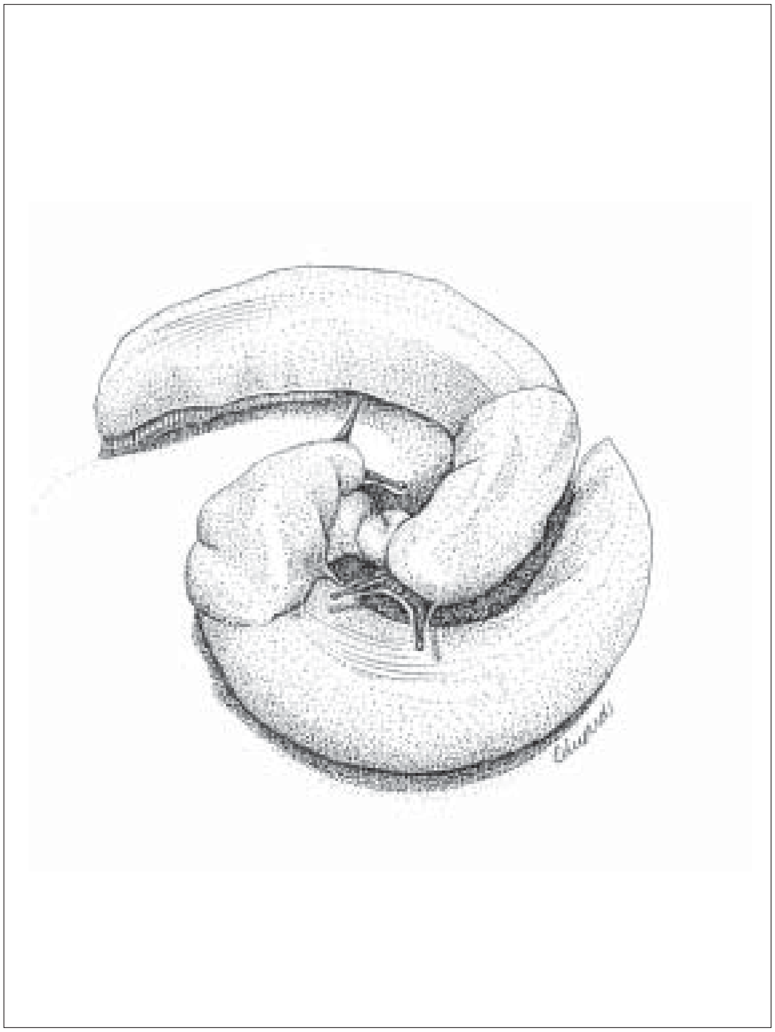
- Prioritize application of financial resources, including updated surveys, according to a ranking scheme including the above considerations along with:
  - steelhead population status and genetic viability
  - watershed size, condition and potential threats to watershed integrity
  - feasibility of restorative measures, and
  - political feasibility and dedication by local-watershed groups.

At the watershed scale we recommend the following projects:

- Update or initiate watershed and stream assessments to enhance understanding of restorative measures needed for each drainage (e.g., CDFG California Salmonid Stream Restoration Manual). Some of this work is being done by the Conception Coast Project in Santa Barbara.
- Evaluate condition of riparian vegetation throughout affected watersheds, including fishless headwaters, and implement restorative actions as appropriate (refer to the following recommendation).
- Ensure sustainability of functional riparian habitats by providing for habitat-structuring hydrological conditions, including episodic flooding. Floodplain easements, setback levees, overflow channels and other methods should be considered to enable flooding that does not jeopardize human land uses.

Section 11

CONCLUSION



Banana Slug — *Arilimax columbianus*

Section 11

CONCLUSION

The need for regional conservation initiatives has become more apparent over the last 10 years. As the fields of conservation biology and landscape ecology mature, the importance of ecological processes in maintaining regional and local biodiversity has been illustrated over and over. The natural diversity endemic to California's central coast has evolved over millions of years with intense human influence on ecosystems over the last 100 years. As we develop creative solutions to conflicts between the needs of wild nature and human communities, we need to remember that the complexity inherent in complete ecosystems can unravel in an alarmingly short time period. Restoration of these systems will not necessarily bring immediate results, but maintaining the existing habitat connections and species that are struggling to survive is critical. It takes much longer to put something back together than to break it down, and we can enable effective restoration in the future by vigilant protection now.

While a regional approach is necessary to maintain those species and processes that need the most space to persist, the protection of biodiversity will most effectively be conducted by citizens and agencies that are rooted in the place that they are trying to protect. Therefore, a need for collaborative dialogue between state-level and local organizations and agencies is necessary to effectively protect what exists and restore what belongs to the natural communities of the central coast. Experience tells us that it will be challenging to maintain these relationships and to stay focused on common goals rather than divisive issues, but it is imperative that we remember that we share a vision of flourishing human and natural communities.

The vision presented in this report lays the foundation for protection and restoration of ecological integrity in the central coast region. We illustrate the importance of protecting three of the region's most wide-ranging species, the San Joaquin kit fox, mountain lion and steelhead, while demonstrating the challenges of basing landscape protection on their habitat needs. We hope that the information presented here can be used by county planners, private land owners and conservation activists to further develop priorities for conservation and develop a shared vision of a wild coastal California.

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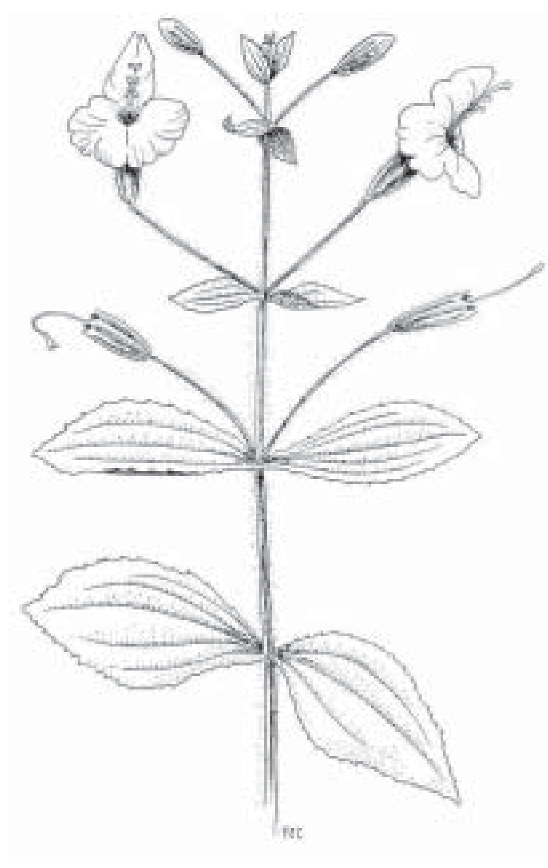

Red Monkey Flower — *Mimulus cardinalis*

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Case Study:

MONTEREY COUNTY

Starflower — *Trientalis latifolia*

Case Study:

MONTEREY COUNTY

This case study is included in the report to illustrate how to interpret the report's findings for a specific area within the central coast region. The area selected for the case study includes all of Monterey County, and parts of neighboring San Benito, Fresno and Kings Counties. The steps we followed to develop the interpretation were:

1. Review findings for terrestrial focal species and identify salient landscape-level projects.
2. Combine steelhead maps and re-interpret results of terrestrial species analysis.
3. Examine findings for other biological features — how well are they represented by the proposed Wildland Conservation Plan?
4. Discuss other possible restoration and conservation activities.

Monterey County and neighboring San Benito County exemplify the transition from the forested ecosystems of the north to the chaparral and scrublands of the south. They also represent a moisture gradient from the cooler and moister coastal areas to the hot and dry inland areas. The region has relatively large expanses of undeveloped lands, including wildlife refugia that are now critical to sustaining the ecological integrity of the region as a whole. The areal extent of these remaining undeveloped, relatively unfragmented lands begins to approach the hundreds of thousands of acres that may be needed to sustain functional ecosystems (Noss 1992).

While 216,000 acres are encompassed by the existing Ventana and Silver Peak Wilderness areas, 166,000 acres of relatively intact complementary habitats lie in adjacent Fort Hunter Liggett. These two areas encompass much of the northern Santa Lucia Range. Smaller extents of federal land lie in the Gabilan and Diablo Ranges east of the Salinas Valley, and vast expanses of private lands remain relatively open, useable by wildlife, with great potential for conservation management.

One of the major challenges at the county level is how to connect contiguous blocks of protected habitat. Potential opportunities for maintaining or reconnecting large blocks of habitat in functional networks are less constrained by human land uses in Monterey County (and along its interface with San Benito County) than in the more urbanized counties. Thus, this area is well suited to the scale of our regional analyses.

The boundary between northeastern Monterey County and southeastern San Benito County runs along the ridgeline of the Gabilan Range. The Gabilans are composed of a series of valleys and high hills that trend north-south. They are mostly private lands. This region was found to be important habitat for mountain lion, even though it currently is not managed for mountain lion preservation. The core area continues south to the Choalme Hills in Monterey County and the Black Mountain area in Fresno and Kings Counties.

In this case study region, two large areas are currently undeveloped enough to support viable populations of mountain lion: the Santa Lucia Range, including Big Sur, and the Gabilan/Diablo Range complex. These areas should be considered for various types of protection and conservation programs. Note that the Fort Hunter Liggett Military Reservation would need to pass into conservation management for the Santa Lucia core to continue to function in its capacity as we have defined it. Since the core areas cover such a large region, outright purchase of all lands is not feasible nor desirable. A campaign to promote conservation easements, perhaps coupled with other landowner incentives such as "eco-labeling" for predator-friendly beef ranching and/or compensation programs for ranchers who lose livestock to mountain lion, might permit development of those cores from a conservation perspective.

Three linkage connections identified for the study area are recommended as priority conservation targets. These are:

1. The Santa Cruz Mountains-Southern Diablo Range Connection *(Map 16)*
2. The Big Sur (Santa Lucia)-Northern Diablo Range Connection *(Map 17)*
3. The Santa Lucia-Transverse Range Connection *(Map 18)*

We rank the priority for conservation of each linkage here by how imminent development pressures appear to be. Maps for each of these linkages are presented in the subsection reports earlier. Map 18 shows the first two linkages along with point occurrence of a variety of species, serpentine, oak densities by watershed and steelhead status in the streams. Map 24 is meant to illustrate what a complete conservation design might look like.

The **Santa Cruz Mountains-Southern Diablo Range Linkage** is most at risk. Currently, residential developments are advancing into the linkage from both the Monterey Bay side (Watsonville-Aromas) and the inland side of the mountains (Sargent-San Juan Bautista). The linkage passes across the Pajaro River and Highway 129, a major two-lane, rural highway between the residential areas. Currently, a narrow strip of brush descends to the river from the north. The brush is surrounded by grasslands. This cover is potentially the last cover for mountain lion that might attempt this crossing. Potential paths are less constrained on the south side of the river, although a large quarry must be skirted. Dispersing mountain lions would need to find this best point to cross the river, and deal with crossing Highway 129, the main choke point of the route. Residential development in the hills on the north side of the river could also become an impediment to movement, if it continues to expand. This linkage runs between two counties, so it would be necessary to coordinate between the appropriate agencies in both counties to develop an effective approach to maintaining connectivity. This linkage is particularly important since it links our smallest identified core (the Santa Cruz Mountains) to other areas. The Santa Cruz Mountain area is well below Beier's (1993) minimum viable population area estimate for mountain lion. There are very few alternative linkage possibilities for the Santa Cruz Mountains (only Coyote Valley, which faces even heavier development pressure), due to the urban matrix which nearly surrounds them.

The **Santa Lucia-Transverse Range Linkage** has the next highest level of urgency. This linkage extends south from Big Sur through oak woodland and mixed oak-coniferous habitat along the spine of the coastal mountains and terminates in the Transverse Ranges. It faces several threats from fragmentation. The north end of the linkage is flanked by the town of Paso Robles to the interior and the Hearst properties on the coast. Paso Robles has been one of the centers of California vineyard expansion in the past decade. Vineyards, expanding westwards from town, are cutting into the relatively intact linkage habitat. Potential coastal development from the Hearst estate, around Cambria and along Highway 46, threaten to encroach on this linkage from the west.

Farther south the linkage passes between the town of Morro Bay on the coast and Atascadero on the east side of the Santa Lucias. The linkage is here transected by Highway 101 and State Route 41. Some blocks of land in this stretch are public and more easily protected: Los Padres National Forest lands including Questa Ridge Botanical Area are north of 101 and the Santa Lucia Wilderness (USFS) is just south of 101. However, there is a gap in protected lands across the 101 linkage, and the highway itself, a four-lane with concrete dividers, poses a formidable barrier. This would be a good location for a wildlife overpass.

The **Salinas Valley Linkage** is ranked as third priority for protection. The goal of an east-west linkage across the north-south Salinas Valley is to link the Santa Lucia Mountains of Big Sur with the Gabilan Range. Our map shows a wide swath for a linkage (about 10 miles wide) stretching across the valley. This is due to the manner in which the GIS constructs a least-cost path, in this case selecting the minimum distance through adverse habitat between the two mountain ranges.

The Salinas River valley is over 120 miles long, and runs north-south through Monterey County. The river itself offers cover for north-south mobility, though its riparian canopies and scrub cover are diminished from their historic extents as a result of decreased flows and human land uses. But while extensive wildlife habitat covers the lengths of the mountain ranges on either side, the valley itself is wide, relatively flat, and covered with agricultural uses that are unlikely to invite wildlife movement across them. Moreover, if an animal does find its way through the lettuce or broccoli fields (or increasingly vineyards), it will eventually encounter the four-lane, divided Highway 101, with potentially fatal results.

It is possible that habitat connectivity across the Salinas Valley has been cut off for decades and that it is not needed to sustain viable mountain lion populations in either the Santa Lucias or the Gabilan-Diablo Range complex. At least one researcher has documented high densities in the Santa Lucias, though the results may not have been widely distributed (Smiley pers. com.). This is possibly due to high concentrations of deer, which influence mountain lion population density (Torres and Bleich 2000). The Gabilan-Diablo Range complex includes sufficiently large habitat areas to presumably support healthy populations there.

While the linkage may not be functioning at present, lion movement across the valley would have been natural prior to agricultural and other land development. Thus, there is likely genetic connection among the populations of the two mountain ranges. Given the uncertainties of climate change and its potential long-term effects on distributions of vegetation and habitat types in the region, it is prudent to consider the potential need for future genetic connectivity among the two ranges to ensure adaptability, and thus resilience, under environmental shifts. An additional consideration is the need for movement opportunities in the event of catastrophic wildfires in either range. While it was noteworthy for its size, the 1977 Marble-Cone fire charred 178,000 acres in the Santa Lucia Range (Griffin 1978), illustrating that extensive alterations to habitat structure can occur quite suddenly. Thus, habitat connectivity may be important for mountain lions as well as other species needing to relocate in response to natural catastrophes.

We recommend examining how restoration of riparian vegetation along tributaries from both mountain ranges down to the Salinas River could establish linkages of cover that extend across the valley. These could occur on a variety of streams without requiring the broad spatial swath indicated on our linkage map. Riparian linkages were not selected through our method, but are nevertheless worth considering. One possibility from the Santa Lucia side is the Arroyo Seco.

Stream habitat connectivity here is critical to the river's steelhead population, whose most accessible spawning habitats lie in the Arroyo Seco headwaters. Land uses in this vicinity must necessarily be constrained due to the Arroyo Seco floodplain. In fact, the finer scale land use map developed by Monterey County Water Resources Agency (MCWRA 1998, 2001) indicates native vegetation along most of the Arroyo Seco where it passes through the valley before meeting the Salinas. Another feature of this confluence is that it lies just downstream of a Highway 101 bridge over the Salinas River – the northernmost of only three points in Monterey County where wildlife can currently pass under highway bridges over the river.

Whether or not mountain lion currently use this path for movement across the valley, it is likely that smaller predators such as gray fox, and possibly bobcat, use it. About six miles downstream of the Arroyo Seco confluence with the Salinas, a couple of minor tributaries draining the Sierra de Salinas reach past the alluvial fans where most others are lost to valley floor agriculture, and actually connect with the Salinas riparian zone. This connectivity may provide another movement route for wildlife from the Santa Lucias to move up the Salinas to cross under the Highway 101 bridge near the Arroyo Seco confluence. Upstream of the bridge, the Salinas River meanders very close to the Gabilan Range, providing opportunities for dispersal through riparian habitat linkages there.

Among the strategies worth considering to facilitate wildlife movement through these valley agricultural lands are incentives that would promote restoration of riparian and associated habitats along historic tributary drainage routes that may have long been converted to agricultural uses. Many of the streams visibly draining the flanking ranges vanish by the time they leave the alluvial fans for the valley floor. Whether these streams historically merged with the Salinas below ground, or were simply lost to land conversion and/or local pumping remains to be determined. But restoration of such riparian linkages could facilitate wildlife movement to and from the Salinas River, thence across the valley between the ranges.

A related strategy that will likely benefit some wildlife species is the encouragement of hedgerow plantings. Jo Ann Baumgartner of the Wild Farm Alliance in Watsonville reports that the Community Alliance for Family Farmers is currently working with farmers in the Salinas and Pajaro Valleys to encourage hedgerow plantings (Baumgartner 2001 pers. com.). It is possible that alternative agricultural approaches, such as a permaculture layering of vegetation, could provide cover suitable for wildlife passage. Such approaches merit further investigation, encouragement, and monitoring to assess their efficacy in facilitating wildlife movement. It is likely that such methods would offer corollary watershed benefits – decreasing stormwater and irrigation runoff rates, while helping to improve water quality.

An array of incentive programs being actively pursued by local progressive agricultural interests offer promise for integrating wildlife habitat and movement needs with Salinas Valley agriculture (e.g., Mackey 2001, Imhoff 2001). An example of an incentive-based program is an eco-labeling project, the Pajaro Valley Pilot Project [http://www.pvpilot.org]. This is a first step in what will be the Monterey Bay Farmers' Clean Water Initiative. Currently there are ten farmers enrolled (Baumgartner 2001 pers. com.). Such programs can have clear benefits for restoration of riparian cover supporting a range of biodiversity, from nesting songbirds to migrating steelhead and associated riverine species.

Pronghorn habitat is mostly identified south of the study area, although we have historical evidence of pronghorn in the upper Salinas Valley. We have developed no spatially explicit recommendations for the pronghorn in the study area, but note that suitable habitat for the species occurs on primarily private lands to the west of the existing Carrizo Plain herd. If it could be shown to be in the interests of local landowners, a fence-free grazing commons supported by pronghorn hunting could enable the expansion of the existing pronghorn range. Known San Joaquin kit fox habitat occurs in the upper Salinas Valley, in open areas near Hollister and south of Hollister. Much of the kit fox habitat was contiguous in our modeling, implying that development of a core-linkage design was not required. Known populations should be protected and we recommend further studies, at finer spatial scales, along with ecological studies concerning prey populations and their specific habitat needs. Since kit fox prefer extremely flat grasslands, special emphasis should be given on habitat meeting that requirement.

Once the terrestrial Mammal Network was identified, we turned to the steelhead analysis. Our map shows two major types of streams: steep short coastal and large watershed rivers such as the Salinas and Pajaro Rivers. We recommend using the "factors affecting persistence and abundance" included in the steelhead database to help prioritize restoration strategies on each stream and in corresponding watersheds, as applicable.

Within Monterey County lie some of the most dramatic contrasts between current and historic steelhead runs. The Big Sur coast has high gradient, relatively short, coastal streams, while the Salinas Valley is a long route for steelhead traveling to spawning gravels. Titus (1999) indicates that the Little Sur River drainage (on the coast) is probably the most productive steelhead river south of San Francisco Bay at this time. Its lower drainage is on private lands inaccessible to the public, and its headwaters are on roadless public lands, primarily in the Los Padres National Forest. While actually among the larger drainages on the Big Sur Coast, the Little Sur is only 12 miles in length, with a watershed area of 45 square miles (CA State Lands Commission 1993).

The corresponding figures for the Big Sur River, the largest on the Big Sur coast, are 21 miles in length and 70 square miles of watershed (ibid.). While most streams along the Big Sur coast continue to support steelhead populations, many of those populations have been reduced from historic levels. Typical factors affecting persistence and abundance of steelhead in Big Sur coast streams are siltation, and sometimes pollution from human and livestock sources. Over-fishing may also be a problem, but is beyond the scope of our report to assess. These factors can be ameliorated to some extent through concerted watershed restoration actions. Yet, since these coastal drainages may be episodically impacted by the aftermaths of catastrophic wildfires, all are subject to episodic interruptions of conditions supporting steelhead reproduction. This natural background pattern of cessation and renewal of suitable reproductive environments points to the importance of overall metapopulation structure, and of a series of proximate, functional, potentially-interacting steelhead runs maintaining the lineages of each stream, and the region as a whole (or, more accurately, the South Central California Coast ESU, over time. CDFG 2001).

The Salinas River poses an additional set of challenges to steelhead populations: insufficient flows to allow passage up the river to tributary spawning sites (Titus 1999). The Salinas is 180 miles long and its combined watersheds and tributaries encompass 5,980 square miles (ibid.). Salinas River steelhead must traverse 46 miles of the mainstem before reaching the first turnoff at the Arroyo Seco tributary (MCWRA 2001: 5.6-14). From there, they must travel a few to several more miles to reach upstream spawning areas.

Steelhead whose spawning gravels lie on upper Salinas tributaries (in San Luis Obispo County) must travel 140 miles or more along the Salinas mainstem to reach spawning and rearing habitats (ibid.). Passage on the mainstem can become impaired by low flows due to dams, diversions and drawdown of subterranean flows due to pumping. Low flow conditions on the upper river are also to some extent natural. A recent agency plan, MCWRA (2001: 5.6-7) cites Snyder (1913) describing the river as "an erratic and torrential stream, with a feeble current during the dry season that shifts over broad stretches of wind-blown sand, entirely disappearing at times and again rising to the surface." Human water use has made these natural low water levels extreme. Adapted to such challenging conditions, Salinas River steelhead populations may be that much more important to sustain, as their particular genes could prove important to the entire metapopulation in adapting to the impacts of climate change.

Also citing Snyder (1913), Titus (1999) states that the Nacimiento and San Antonio Rivers were among the most important spawning and rearing tributaries for Salinas River steelhead. Water resource development, including dams completed on the Nacimiento in 1956 and on the San Antonio in 1965 (in San Luis Obispo County, but for Monterey County uses), effectively cutoff access to upstream spawning and rearing habitats on these tributaries. Resident rainbow trout still persist, perhaps impacted by aggressive salmonid stocking programs initiated during the 1960s.

In concert with downstream pumping and diversions, the dams (along with Salinas Dam completed in 1942), impacted the duration and magnitude of flows in the Salinas River mainstem. The very nature of the river's relationship to the Monterey Bay has been altered by these changes, with seawater intrusion reaching farther into the aquifers of the lower Salinas River since as early as 1946 (MCWRA 2001: 1-7). Facing potential state adjudication regarding this issue, the MCWRA has been seeking a remedy to this devaluation of downstream water rights for several years. Responses so far have been limited to infrastructure fixes, with no consideration of watershed restoration as a potential long-term strategy to increase available water. One potential, but untested, remedy could be the increase of soil moisture through large-scale restoration of native vegetation, particularly bunchgrasses (Lowery 1991, St. John 1992). Should the watersheds' ability to retain water be positively influenced by large-scale restoration of native grasses and other vegetation types, the region holds extensive areas of nonnative grasslands that could cumulatively result in the enhanced water resources to benefit the needs of steelhead, as well as humans. However, these ideas have not yet had sufficient testing for us to be able to recommend them as concrete restoration actions. We recommend a small-scale pilot study, including a spatial modeling component, to measure both economic and ecological benefits of perennial vegetation type restoration.

While 53% of the watersheds supporting intact ("P" status) steelhead populations (110 sq. mi.) in the county lie on lands with the highest level of conservation management, these constitute a mere 3% of the total watershed areas in Monterey County. In contrast, 78% of "P" (populations present but reduced) watersheds (2,130 sq. mi.) are privately held, constituting 67% of the total watershed area. Thus, incentives for private landowners must be considered to promote watershed and stream restoration.

A variety of restorative land management practices may be useful including: focused range management, application of seed-rich native grass hay, prescription burning and combinations thereof. Some ranchers within the region have explored the Holistic Resource Management approach popularized by Allan Savory (http://www.holisticmanagement.org, 2000) as a means of restoring native grasslands while maintaining economic viability. Others criticize that approach as unproven in California rangelands and argue that the best approach is conservative stocking in the context of scientifically proven range management practices and principles with restoration of native vegetation as a management goal (McClanahan 2000). Considering economics, another possible approach that merits consideration is restoration of native grazers, such as tule elk. Hunting fees for tule elk could support restoration of the native grasslands that these ungulates coevolved with.

One of the questions about the recovery of native grassland species is whether their population viability can be sustained on the nonnative annual grasslands of modern times. The prehistoric grasslands included various perennial bunchgrasses, as well as likely annual associates.

Native perennial grassland species that persist in smaller numbers across some regional rangelands include purple and nodding needlegrasses *(Nassella pulchra and N. cernua)*, blue wildrye *(Elymus glaucus)*, pine bluegrass *(Poa secunda)*, California and coast range melic *(Melica californica and M. imperfecta)*, California brome *(Bromus carinatus)*, junegrass *(Koeleria macrantha)* and California oatgrass *(Danthonia californica)* (Crampton 1974).

Weedy nonnative grasses include wild oats *(Avena spp.)*, bromes *(Bromus spp.)*, barley *(Hordeum spp.)* and fescues *(Festuca sp.)*. They produce abundant spring seed crops, believed to have favored an explosion of small rodents in these lands. This explosion of rodents may have improved conditions for kit fox, as well as coyote.

Conversely, production of biomass (i.e., food) for grazers and possibly other species was likely more sustained throughout the year under native vegetation.

The region's oak woodlands are also identified in the mammal analysis as targets for conservation and restoration efforts. Nearly all oak woodlands serve as mountain lion habitat. If their value in terms of watershed function may be accurately quantified, incentives might be developed to slow the conversion of oak woodlands to vineyards within the county and beyond. That conversion has been implicated as a causal factor in the reduced regenerative ability of valley oaks (Danielsen and Halvorsen 1991). Restoration of oak woodlands and their understories should be a top priority, and targeted, along with non-native grasslands, for incentive programs that can hasten restorative efforts on private lands. Possibly, water users would contribute to the costs of such incentives since these efforts may have positive effects on water supply. Again, we recommend pilot studies and watershed modeling to evaluate the potential feasibility and efficacy of such an approach.

Practices on other agricultural lands in Monterey County could be modified to promote watershed function benefiting steelhead and human water users. Of those county watersheds with the "P-" status, the second most expansive cover type is agricultural lands, comprising 17% of those watersheds (453 sq. mi.). As mentioned previously, permacultural or related organic farming approaches could enhance the watershed function of agricultural lands, benefiting the farmers themselves, as well as all users of the system's water. Incentives to promote such approaches, along with restoration of riparian habitats where they have been cleared to expand agricultural uses could do much to alleviate the water problems facing the county and the Salinas River's struggling steelhead population. One caveat is that restoration of riparian habitats along natural (unchannelized) river linkages should rarely be considered simple replanting programs. The natural fluctuations of rivers are the best sculptors of riparian vegetation structure and habitat quality over time, and must be allowed the ultimate hand in shaping the restoration.

Serpentine rock outcrops are well represented in our mammal network, although the largest outcrop of serpentine in the area, around New Idria, is heavily used by off-road vehicle enthusiasts. Most redwood forests in the study area are already protected. Oaks are well represented by the mammal network, although stands of oaks near and in urban areas should be a focus of preservation and restoration. Red-legged frog and Tiger salamander populations are less than proportionally represented in the conservation network, these species, and others with similar mobility patterns (as well as endemic plants that fall outside of the mammal network) should be targets for acquisition, since they occur on limited areas.

Utilizing the implementation recommendations outlined in Section 10, stragegies can be developed within the Monterey region to protect this important landscape.

Appendix 1

GIS DATA SOURCES

Base data

Elevation and Topography: USGS 7.5 minute digital elevation model 2000

Transportation: USGS digital line graph 1:100,000 1993

Rivers: U.S. EPA Enhanced River Reach file 1.2 1998

Land Cover and Forest Cover: U.S. EPA MRLC National Land Cover Data set 2000

Counties: U.S. Census Bureau TIGER files 1:100,000 1995

Vegetation and WHR Habitat Suitability: California Gap Analysis Project, UCSB Biogeography Lab 1998

Watersheds: CALWATER v2.2 California Department of Fish and Game 1999

Land Ownership and Management Status: California Gap Analysis Project, UCSB Biogeography Lab 1998

Habitat-species data

Hardwoods: California Department of Forestry and Fire Protection, 1994 (based on Pillsbury 1991)

Salmonids data base: Ventana Wildlands Project and Coast Ranges Ecosystem Alliance 2000

California Natural Diversity Database: California Department of Fish and Game, Natural Heritage Division 2000

Serpentine Geology: Statewide Geology layer: California Department of Mines and Geology 2000

Redwood Old Growth: Pacific Biodiversity Institute and Save-the-Redwoods League (1998) and Steve Singer (1999) for Santa Cruz Mountains

Habitat Richness and Focal Species Distribution: California Gap Analysis Project, UCSB Biogeography Lab 1998

Appendix 2

GEOBOTANY OF THE CENTRAL COAST REGION

Among the northern *(Arcto-Tertiary)* relicts in the region are coast redwood *(Sequoia sempervirens)*, Monterrey pine *(Pinus radiata)* and Santa Lucia Fir *(Abies bracteata)*. Sugar Pine *(Pinus lambertiana)* is a disjunct remnant, also found in the Sierra Nevada.

The southern climate (Madro-Tertiary) plant species in the region include oaks and chaparral species. Prominent regional species include coast and canyon live oaks *(Quercus agrifolia and Q. chrysolepis)*, blue oaks *(Q. douglasii)*, madrones *(Arbutus menziesii)* and pinyon pines *(Pinus monophylla)* [Raven and Axelrod 1978; Sharsmith 1982 (1945)]. Within the Madro-Tertiary, the Xerothermic (literally "dry, hot") period that followed the glacial ages contributed further to chaparral in the region and also saw the spread of desert species. Some of these occur as far north as the interior of the south Coast Ranges (Raven and Axelrod 1978). Xerothermic representatives in the region include the high desert California juniper *(Juniperus californicus)*, which extends northward to the northern inner Coast Ranges, and scalebroom *(Lepidospartum squamatum)*, the alluvial scrub indicator species that reaches its northern limit in the Mount Hamilton Range [Sharsmith 1982 (1945)]. Perhaps the most obvious regional representative of the Xerothermic period is the chaparral yucca *(Yucca whipplei)*, also known as Our Lord's candle, which reaches from southern and Baja California northward to Big Sur along the coast, and to San Benito County in the region's interior. These, along with numerous other Xerothermic and Madrean species, add interest and diversity to the regional flora.

But other, less obvious forces have also played decisive roles. In their classic treatise, *Origin and Relationships of the California Flora* (1978), Peter Raven and Daniel Axelrod noted that environmental complexity is but one of three factors responsible for the large number of plant species and high degree of endemism in the California Floristic Province as a whole. Past topographic and climatic changes over geologic time have been the source of that physical complexity, accompanied by biological responses. Thus, another factor responsible for the diversity of California plant life was the relatively benign climate that arose with uplift of the Sierra Nevada, Peninsular and Coast Ranges, enabling Tertiary Period relicts to survive here while extreme continental climates developed over the interior after the Pliocene Epoch. A third factor was outbursts of speciation in response to recurrent climatic fluctuations (cool-moist, warm-dry) while the complexity of environmental variables was developing simultaneously. These fluctuations of cool-moist with warm-dry climates resulted respectively in Arcto- and Madro-Tertiary Geoflora, as revealed by the fossil record. Relict endemics of the former are now a hallmark of the Klamath-Siskiyou region, and those of the latter are prominent in southern California (ibid.).

The central coast Region retains relicts of both Arcto- and Madro-Tertiary floras, the entire region constituting an expansive ecotone between these. But moreover, the region is an area of active evolution, leading to a high proportion of recently evolved endemic plant species, including natural hybrids, along with the progenitors and offspring of many polyploid species (Raven and Axelrod 1978). The region is home to over 180 endemic vascular plant species (Walker 2000), including 102 serpentine endemics (Kruckeberg 1984) and numerous species adapted to other restrictive soil conditions. Edaphic endemics often occur in natural associations that necessarily have limited distributions, such as serpentine soils. Some of these associated species, especially those of serpentine grasslands, likely enjoyed wider distributions before the land cover type conversions that began with the Spanish cattle ranching period. (Refer to Historic and Current Land Use Patterns). Other unusual edaphic conditions may host combinations of endemics, relicts and-or disjunct species. Prime examples are the sand hills associations of Santa Cruz County, in the Santa Cruz Mountains, where edaphic endemics co-exist with coastal relicts and the disjunct ponderosa pine *(Pinus ponderosa)* (Thomas 1961; Marangio and Morgan 1987).

Several Arcto-Tertiary relicts are noteworthy within the region. While it has become an important timber species in other parts of the world, and a popular landscape specimen in California and elsewhere, the native Monterey pine *(Pinus radiata)* forests are now essentially restricted to this region, having once extended north of San Francisco Bay, and southward well into southern California (Raven and Axelrod 1978). Today, three native Monterey pine forests occur on the mainland – along the Santa Cruz-San Mateo Co. coastline, Año Nuevo vicinity; the Monterey Peninsula; and the Cambria vicinity of the San Luis Obispo Co. coastline, comprising about 16,000 acres (Matthews and Nedeff 1995). Stands of Monterey pine also occur on Guadalupe and Cedros Islands, west of Baja California. Santa Lucia fir *(Abies bracteata)* is another relictual endemic that is restricted to the Santa Lucia Mountains, with fossil records of the

Miocene Epoch placing it in what is now western Nevada. Sugar pine *(Pinus lambertiana)* is another relic of those cooler, moister periods that is not endemic, but rather disjunct from the species' main population in the Sierra Nevada, with two disjunct regional populations 220 km apart, in the Santa Lucias and San Rafael Mountains (Henson and Usner 1993).

Coast redwood *(Sequoia sempervirens)* is the region's most renowned Arcto-Tertiary relict and, like literally hundreds of other species, it reaches its southern (as well as eastern) limits in the region. Redwood forests south of San Francisco bay lie in the Santa Cruz and northern Santa Lucia Mountains, west of the San Andreas Fault (Sawyer et al. 2000, citing Miles and Goudey 1997). Along the Big Sur coast, redwoods are increasingly restricted to coastal canyon bottoms, with the southernmost natural patch occurring about 3 km south of Salmon Creek in southwest Monterey Co. Stands in San Luis Obispo county are believed to have been planted (Sawyer et al. 2000). Four natural stands of redwoods, including one extensive one, remain in the Oakland Hills (ibid.), comprising the easternmost stands in its range.

Stands of second and third growth redwood forest, with small patches of old growth are found north of San Francisco bay is greater abundance than south, the center of the distribution for redwoods lies just north of the central coast Region in northern coastal California. It is said that giant redwoods that once dotted the ridgeline of those hills were used as landmarks by ships entering San Francisco Bay, giving us a sense of some of the relatively recent anthropogenic losses. On the San Francisco Peninsula, Redwood City and Palo Alto were both named for the species, which occupied stands in those bayside lowlands, and in some locations still do, though they have been engulfed by urbanization.

Further illustrating the Arcto-Madro-Tertiary ecotone within the region, Thomas (1961) lists over 200 vascular plant species that reach their southern distributional limits in Santa Cruz County. Raven and Axelrod (1978) cite Howell's (1970) corresponding notation of 84 taxa for Marin County, along with Howit and Howell's (1964) approximately 146 taxa for Monterey County, and state that 154 taxa reach their southern limit in San Luis Obispo County. Rogers (1991) counts 225 species as reaching their southernmost distribution within the Coast Ranges in the Santa Lucias, though some of these may extend to more southerly latitudes in the Sierras or the higher elevation peaks in southern California. A few other species, notably Douglas fir *(Pseudotsuga menziesii)*, reach their southern limits in Santa Barbara County. Conversely, 177 taxa reach their northern limit in San Luis Obispo County, and 156 in Monterey County, primarily on the drier eastern slopes of the Santa Lucias and eastward to the Diablo Range (Raven and Axelrod 1978). Thomas (1961) states that within the Coast Ranges 61 taxa reach their northern distributional limits in the Santa Cruz Mountains, while the corresponding figure for Marin County is 34, for Mount Diablo – 32, and for the Hamilton Range – 23.

The Madro-Tertiary Geoflora documents the spread through the region of live oak woodlands, along with other sclerophyllous vegetation that lead to the chaparral associations covering more than one quarter of the region today (Stoms et al.1998). Prominent regional representatives of that period include coast and canyon live oaks *(Quercus agrifolia and Q. chrysolepis)*, blue oaks *(Q. douglasii)*, madrones *(Arbutus menziesii)* and pinyon pines *(Pinus monophylla)* [Raven and Axelrod 1978; Sharsmith 1982 (1945)]. Within the Madro-Tertiary, the Xerothermic period that succeeded the glacial ages contributed further to the chaparral component and saw the spread of desert species into the region, some of which occur as far north as the interior of the south Coast Ranges (Raven and Axelrod 1978). Xerothermic representatives in the region include the high desert California juniper *(Juniperus californicus)*, which extends northward to the northern inner Coast Ranges, and scalebroom *(Lepidospartum squamatum)*, the alluvial scrub indicator species that reaches its northern limit in the Mount Hamilton Range [Sharsmith 1982 (1945)].

Appendix 3

EXTENT OF VEGETATION TYPES (CNDDB) IN STUDY AREA

CNDDB TYPE	ACRES	SQUARE KM
Agricultural Land	1,255,488	5,080.77
Alluvial Redwood Forest	3,342	13.53
Alvord Oak Woodland	61,672	249.58
Bare Exposed Rock	5,074	20.53
Bays and Estuaries	43,619	176.52
Beaches and Coastal Dunes	9,867	39.93
Big Sagebrush Scrub	18,854	76.30
Bigcone Spruce-Canyon Oak Forest	19,831	80.25
Bishop Pine Forest	16,168	65.43
Black Oak Forest	30,082	121.74
Black Oak Woodland	54,652	221.17
Blue Brush Chaparral	14,131	57.19
Blue Oak Woodland	519,509	2,102.38
Buck Brush Chaparral	924,167	3,739.96
California Bay Forest	849	3.43
California Walnut Woodland	188	0.76
Canyon Live Oak Forest	12,435	50.32
Ceanothus crassifolius Chaparral	86,586	350.40
Ceanothus megacarpus Chaparral	58,163	235.38
Central (Lucian) Coastal Scrub	141,242	571.58
central coast Arroyo Willow Riparian Forest	5,715	23.13
central coast Cottonwood-Sycamore Riparian Forest	20,747	83.96
central coast Live Oak Riparian Forest	7,802	31.57
Central Dune Scrub	2,957	11.97
Central Maritime Chaparral	53,390	216.06
Chamise Chaparral	609,591	2,466.93
Cismontane Juniper Woodland and Scrub	8,111	32.82
Coast Live Oak Forest	319,308	1,292.19
Coast Live Oak Woodland	240,906	974.91
Coast Range Mixed Coniferous Forest	22,311	90.29
Coast Range Ponderosa Pine Forest	10,471	42.37
Coastal Brackish Marsh	15,521	62.81
Coastal Prairie	192,340	778.37
Coastal Sage-Chaparral Scrub	30,046	121.59
Coastal and Valley Freshwater Marsh	414	1.68
Coulter Pine Forest	22,537	91.20
Deciduous Orchard	50	0.20
Diablan Sage Scrub	193,031	781.17
Diegan Coastal Sage Scrub	1,155	4.67
Dry Salt Flat	2,453	9.93
Dryland Grain Crops	302	1.22
Eucalyptus	1,998	8.09
Evergreen Orchard	971	3.93
Foothill Pine-Oak Woodland	599,774	2,427.19
Great Valley Cottonwood Riparian Forest	5,039	20.39

Great Valley Mesquite Scrub	1,184	4.79
Interior Coast Range Saltbush Scrub	8,626	34.91
Interior Live Oak Chaparral	93,123	376.85
Interior Live Oak Forest	6,998	28.32
Jeffrey Pine Forest	626	2.53
Jeffrey Pine-Fir Forest	4,958	20.07
Juniper-Oak Cismontane Woodland	53,550	216.71
Knobcone Pine Forest	2,131	8.62
Leather Oak Chaparral	16,300	65.96
Mesic North Slope Chaparral	85,574	346.31
Mid-elevation Conifer Plantation	383	1.55
Mixed Evergreen Forest	402,896	1,630.46
Mixed Montane Chaparral	4,307	17.43
Mixed North Slope Cismontane Woodland	49,477	200.23
Mixed Serpentine Chaparral	11,667	47.21
Mojavean Pinyon and Juniper Woodlands	169,109	684.36
Montane Ceanothus Chaparral	11,651	47.15
Montane Manzanita Chaparral	5,437	22.00
Monterey Pine Forest	12,268	49.65
Monvero Residual Dunes	750	3.03
Mule Fat Scrub	12,290	49.74
Non-Native Grassland	3,093,413	12,518.58
Non-Serpentine Foothill Pine Woodland	946	3.83
North Coast Riparian Scrub	813	3.29
Northern (Franciscan) Coastal Scrub	100,504	406.73
Northern Coastal Bluff Scrub	17,602	71.23
Northern Coastal Salt Marsh	10,371	41.97
Northern Interior Cypress Forest	580	2.35
Northern Mixed Chaparral	23,370	94.57
Open Foothill Pine Woodland	46,613	188.63
Orchard or Vineyard	126,829	513.26
Oregon Oak Woodland	4,680	18.94
Pasture	8,110	32.82
Permanently-flooded Lacustrine Habitat	42,350	171.38
Red Shank Chaparral	588	2.38
Riversidian Sage Scrub	2,645	10.70
Row and Field Crops	6,555	26.53
Sandy Area Other than Beaches	18,514	74.92
Santa Lucia Fir Forest	4,388	17.76
Scrub Oak Chaparral	157,186	636.11
Semi-Desert Chaparral	140,346	567.96
Serpentine Foothill Pine-Chaparral Woodland	12,783	51.73
Sierran Mixed Coniferous Forest	3,824	15.47
Southern Arroyo Willow Riparian Forest	327	1.32
Southern Coast Live Oak Riparian Forest	3,380	13.68
Southern Coastal Salt Marsh	155	0.63
Southern Cottonwood-Willow Riparian Forest	1,480	5.99
Southern Sycamore-Alder Riparian Woodland	479	1.94
Streams and Canals	4,589	18.57
Strip Mines, Quarries and Gravel Pits	17,702	71.64
Sycamore Alluvial Woodland	2,267	9.18
Tamarisk Scrub	2,829	11.45

Tan-Oak Forest	12,204	49.39
Transitional Bare Areas	19,194	77.68
Ultramafic Mixed Coniferous Forest	7,478	30.26
Upland Douglas-Fir Forest	11,758	47.58
Upland Redwood Forest	308,440	1,248.21
Upper Sonoran Manzanita Chaparral	60,931	246.58
Upper Sonoran Subshrub Scrub	83,653	338.53
Urban or Built-up Land	960,823	3,888.31
Valley Oak Woodland	34,245	138.58
Valley Saltbush Scrub	245,119	991.96
Valley Sink Scrub	3,073	12.44
Venturan Coastal Sage Scrub	141,740	573.60
Vineyard	3,294	13.33
Westside Ponderosa Pine Forest	8,495	34.38
White Alder Riparian Forest	649	2.63
Total	**12,353,480**	**49,992.68**

Appendix 4

PRELIMINARY IMPORTANT BIRD AREAS

Preliminary Important Bird Areas (IBAs) for the central coast region of California:

(Daniel S. Cooper, National Audubon Society, unpubl. data.)

Alameda NWR**

American-Lynch Cyn.-Green Valley Linkage RJ (Napa-Solano Co.)

Ano Nuevo-Big Basin

Benicia SRA

Big Pine Mtn. Area RJ (Santa Barbara Co.)

Big Sur River mouth-Pt. Sur (incl. Andrew Molera SP**)

Bodega Bay**

Bolinas Lagoon

Bolsa de San Felipe (mainly Santa Clara and San Benito Co.)

Brooks Isl. Regional Preserve**

Carmel River mouth-Pt. Lobos

Concord Marshes (Contra Costa Co.)

Corte Madera Marsh

East Diablo Range

Elkhorn Slough

Golden Gate Park

King City Grasslands (Monterey Co.)

Lake Merced Area RJ

Lopez Lk. Area (SLO Co.)

Los Buellis Hills (Santa Clara Co.)

Marin Highlands (incl. Mt. Tamalpais, Golden Gate NRA)

Morro Bay**

Pajaro River

Petaluma Grasslands

Pt. Pinole Area

Pt. Pinos (Pacific Grove)

Pt. Reyes - Outer

Quien Sabe Valley (San Benito Co.)

Richardson Bay**

Russian River Mouth

Salinas River - Lower

Salinas River - Middle (vic. Monterey-SLO Co. line)

San Andreas Valley (San Benito Co.)

San Antonio Valley (Monterey Co.)

San Benito Mtn.

San Pablo Bay Wetlands (incl. Napa River Marshes*)

Santa Cruz Creek Mouths

Santa Lucia Peaks

Santa Margarita Valley

Santa Maria River Mouth

Santa Ynez River - Lower (west of Hwy. 101)

Santa Ynez River - Upper**

South SF Bay Wetlands*

Suisun Marsh**

Tomales Bay

Vandenberg AFB**

** Nominated as an IBA prior to 1999*

*** Accepted as an IBA by American Bird Conservancy, prior to 1999*

RJ Rejected as an IBA by American Bird Conservancy, but considered one here

Appendix 5

POINT REYES BIRD OBSERVATORY: BIRDS BY HABITAT

The following are lists of avian focal species defined by Point Reyes Bird Observatory (PRBO) that are associated with particular habitat types in California. PRBO additionally lists birds associated with coniferous vegetation, but that was not examined in this report.

Riparian

- Bank Swallow
- Bell's Vireo
- Black-headed Grosbeak
- Blue Grosbeak
- Common Yellowthroat
- Song Sparrow
- Swainson's Hawk
- Swainson's Thrush
- Warbling Vireo
- Willow Flycatcher
- Wilson's Warbler
- Yellow-Billed Cuckoo
- Yellow Breasted Chat
- Yellow Warbler

Coastal Scrub-Chaparral

- Mountain Quail
- Greater Roadrunner
- Lesser Nighthawk
- Costa's Hummingbird
- Coastal Cactus Wren
- Blue-Gray Gnatcatcher
- California Gnatcatcher
- Wrentit
- LeConte's Thrasher
- Gray Vireo
- Rufous-Crowned Sparrow
- Black-chinned Sparrow
- Bells Sage Sparrow
- Nuttalls White-Crowned Sparrow

Grassland

- Ferruginous Hawk
- Grasshopper Sparrow
- Mountain Plover
- Northern Harrier
- Western Meadowlark
- White-tailed kite
- Savannah Sparrow
- Burrowing Owl

Oak Woodland (and savannah)

- Acorn Woodpecker
- Blue-Gray Gnatcatcher
- Lark Sparrow
- Nuttall's Woodpecker
- Oak Titmouse
- Western Bluebird
- Western Scrub-jay
- Yellow-billed Magpie

Appendix 6

WILDLIFE RELATIONSHIPS TO OAKS AROUND FORT HUNTER LIGGETT

Along with the Arroyo Toad, numerous other species are partially or wholly dependent on oak woodlands, savannas and forests that extend the length of the region. The structure and composition of the region's oak woodlands changes along gradients of elevation, slope, aspect and proximity to the coast. A multitude of wildlife species are supported in these habitats. The Acorn Woodpecker *(Melanerpes formicivorous)* is among those most often seen and heard, along with Nuttall's Woodpecker *(Picoides nuttallii)*, White-breasted Nuthatch *(Sitta caolinensis)*, Western Bluebird *(Sialia mexicana)*and Yellow-billed Magpie *(Pica nuttalli)*, all of whom are specifically adapted to the region's oak woodland-savannas and their acorns. (Pavlik et al.1991, Roberson and Banks 1998, Stephenson and Calcarone 1999, also see Appendix 5) Conversely, the spatial arrangement of the oaks themselves may be partly or wholly due to the placement of unused caches of acorns stored away by these species, along with Scrub and Steller Jays *(Aphelocoma coerulscens and Cyanocitta stellari)*, Band-tailed Pigeons *(Columba fasciata)*, California Ground Squirrels *(Spermophilus beecheyi)* and Gray Squirrels *(Sciurus carolinensis)* (Pavlik et al.1991, citing Grinnell 1936).

The region's oak woodland and forest habitats shelter hundreds of essentially uncounted insect species (see Pavlik et al.1991, p. 80), amphibious species such as Arboreal Salamander *(Aneides lugubris lugubris)*, Tiger Salamander *(Ambystoma tigrinum)*, California Slender Salamander (Batrachoseps attenuatus), California Newt *(Taricha torosa)*, Pacific Treefrog *(Pseudacris regilla)* and Western Toad *(Bufo boreas)*, along with reptiles including Western Skink *(Eumeces skiltonianus)*, Western Fence Lizard *(Sceloporus occidentalis)*, Side-blotched Lizard *(Uta stansburiana)*, California Legless Lizard *(Anniella pulchra)*, Ring-necked Snake *(Diadophis punctatus)*, Striped Racer *(Coluber constrictor)* and California Mountain Kingsnake *(Lampropeltis zonata)*. Dusky-footed Woodrat *(Neotoma fuscipes)*, Mule Deer *(Odocoileus hemionus)*, reintroduced Tule Elk *(Cervus elaphus nannodes)*, Gray Fox *(Urocyon cinereoargenteus)* and Bobcat *(Felis rufus)* frequent regional oak woodlands, while San Joaquin Kit Fox *(Vulpes macrotis mutica)* range into oak savanna habitats.

The most expansive, relatively intact blue and valley oak *(Quercus douglasii and Q. lobata)* woodland-savannas in the region are sustained within the boundaries of Fort Hunter Liggett. According to an annual Breeding Bird Survey conducted by the US Fish and Wildlife Service, the Fort contains the highest concentration of oak savanna dependent species in the nation (Roberson and Banks 1998). Along with its foothill pine-oak woodlands, riparian habitats and rocky outcrops, the Fort encompasses lands that, though unseen by most humans, are quintessentially Californian in beauty, as well as natural diversity. Among the other noteworthy bird species that reside in or visit these lands are Golden Eagle, Prairie Falcon, Peregrine Falcon, Cooper's Hawk, Sharp-shinned Hawk, Red-shouldered Hawk, Red-tailed Hawk, American Kestrel, Western Screech Owl, Barn Owl, Great Horned Owl, Northern Pygmy Owl, Long-eared Owl, Purple Martin and Yellow-breasted Chat (ibid.). Least Bell's Vireo has inhabited these lands in the past and habitat still exists for them, so if recovery efforts for the species are successful, it may someday call these lands home again. The recently reintroduced Bald Eagle has established nesting sites just south of the Fort, and, given that it may be successfully reintroduced, the California Condor may hopefully resume its historic nesting pattern there (ibid., citing Pemberton and Carriger 1915).

The blue and valley oak woodland-savannas at Fort Hunter Liggett retain some of the character likely associated with those that once clothed the Santa Clara Valley (Griffin 1973, citing Capt. George Vancouver 1798), remnants of which remain in southern Santa Clara County. Griffin points out that early settlers recognized valley oaks as signs of the richest soil, and thus cultivation took an early toll on valley oak woodlands. But even those vital expanses of extant wildlife habitats are altered from their prehistoric character, due to the impacts of past land uses, principally historic grazing regimes (Griffin 1973; Pavlik et al.1991). As is the case statewide, concern remains that the region's valley oaks, treasured as the most stately of oak specimens, are limited to just that – stately old specimens, with few young of their species coming up to replace the old ones when they eventually senesce and die. This concern applies to blue oaks, as well, both species having been impacted by historic grazing regimes.

Griffin notes (1973) that the region's valley oaks range to such surprising heights as the ridgeline of the Mt. Hamilton Range, and in the Santa Lucia Range begin at the 60 m. (200 ft.) elevation in Carmel Valley and continue up to the 1,520 m. (5,000 ft.) summit of Chews Ridge, where they exist in mixed stands with other vegetation types. He also noted that a few grow within a half mile of the surf in the Santa Lucias, but at the 300 m. (1,000 ft.) elevation. However, one locally notorious valley oak specimen stands within one mile of the Pacific at about the 1,000 m. (3,280 ft.) elevation on Prewitt Ridge along the southern Big Sur coast, its bark tattooed with horizontal rows of callused scars believed to have arisen from past insect damage, and its form sculptured by its coastal ridgeline environment. Oak species more typically expected in such ridgeline locales within the region include black oak *(Quercus kelloggii)* and canyon and interior live oaks *(Q. chrysolepis and Q. wislizenii)*, the latter often growing as a shrub at higher elevations. (Griffin and Critchfield 1972). Coast live oak is a widespread oak within the region, typically occupying low to mid elevation foothill slopes and, along with interior live oak and madrone, forming dense oak forests on north facing foothill slopes (Henson and Usner 1993).

Appendix 7

FAUNAL ASSOCIATIONS OF THE MAJOR HABITAT TYPES IN THE CENTRAL COAST REGION

A. Grassland Faunal Species

Grassland fauna include Western Meadowlark *(Sturnella neglecta)*, Grasshopper Sparrow *(Ammodramus savannarum)*, Savannah Sparrow *(Passerculus sandwichensis)*, Lark Sparrow *(Chondestes grammacus)*, Squirrels *(Sciuridae)*, Burrowing Owl *(Athene cunicularia)* (a federal Species of Concern), Black-tailed Jackrabbit *(Lepus californicus)*, Botta's Pocket Gopher *(Thomomys bottae)*, California Ground Squirrel *(Spermophilus beecheyi)*, California Vole *(Microtus californicus)* and Western Harvest Mouse *(Reithrodontomys megalotis)*. (Henson and Usner 1993; Mayer and Laudenslayer 1988).

Many other species come to these grasslands to feed, including Prairie Falcon *(Falco mexicanus)*, Black-shouldered Kite *(Elanus caeruleus)*, Red-Tail *(Buteo jamaicensis)* and Red-shouldered Hawks *(Buteo lineatus)*, American Kestrel *(Falco sparverius)*, Golden Eagle *(Aquila chrysaetos)*, Barn Owl *(Tyto alba)*, Great Horned Owl *(Bubo virginianus)*, Gopher Snakes *(Pituophis melanoleucus)*, Long-tailed Weasel *(Mustela frenata)*, Badger (Taxidea taxus) and Coyote *(Canis latrans)* (ibid.).

B. Chaparral and coastal scrublands; faunal associations

Bird species common to both coastal scrub and chaparral habitats include Scrub Jay *(Aphelocoma coerulescens)*, California Thrasher *(Toxostoma redivivum)*, Wrentit (Chamaea fasciata), Song Sparrow *(Melospiza melodia)*, White-crowned Sparrow *(Zonotrichia leucophrys)*, Bushtit *(Psaltriparus minimus)*, Rufous-sided *(Pipilo erythrophthalmus)* and California *(Pipilo crissalis)* Towhees, Anna's hummingbird *(Calypte anna)*, and California Quail *(Callipepla californica)*. Seasonal visitors include Wilson's Warbler *(Wilsonia pusilla)*, Orange-crowned Warbler *(Vermivora celata)*, Lazuli Bunting *(Passerina amoena)* and others.

Reptiles include those mentioned above for chaparral, along with Southern *(Gerrhonotus multicarinatus)* and Northern Alligator *(Gerrhonotus coeruleus)* Lizards, Western Skink *(Eumeces skiltonianus)*, Western Terrestrial Garter Snake *(Thamnophis elegans)*, Gopher Snake *(Pituophis melanoleucus)*, California Mountain Kingsnake *(Lampropeltis zonata)*, and Western Rattlesnake *(Crotalis viridis)*.

Prey for the snakes, as well as mammalian predators include California *(Peromyscus californicus)*, Brush *(Peromyscus boylii)*, Pinyon *(Peromyscus truei)*, and Deer *(Peromyscus maniculatus)* Mice. Merriam Chipmunks *(Tamias merriami)* and Brush Rabbits *(Sylvilagus bachmani)* also scurry through the scrubby underbrush, providing sustenance for Gray Fox *(Urocyon cinereoargenteus)* and Bobcat *(Felis rufus)*, while Coyote *(Canis latrans)* skirt the ecotones between the scrub and grasslands. The Black-tailed Deer *(Odocoileus hemionus)* of the coastal scrubs are the preferred prey of Cougar, or Mountain Lion *(Felis concolor)* (Henson and Usner 1993).

C. Mixed evergreen and coniferous forest habitat faunal associations

The diverse mixed evergreen and coniferous forests provide diverse niches for numerous insects and the avian gleaners that feast on them, such as chickadees *(Parus sp.)*, warblers *(Parulidae)* and Bushtits *(Psaltriparus minimus)*. White-breasted Nuthatch *(Sitta carolinensis)* and Brown Creepers *(Certhia americana)* pick their insect meals from crevices in tree bark. Band-tailed pigeons *(Columba fasciata)*, American Robins *(Turdus migratorius)* and Cedar Waxwings *(Bombycilla cedrorum)* feast on the fruits of various forest understory shrubs. Dead pine snags are occupied or frequented by Acorn Woodpeckers *(Melanerpes formicivorus)*, Hairy Woodpeckers *(Picoides villosus)*, Northern Flickers *(Colaptes auratus)*, Purple Martins *(Progne subis)*, Western Bluebirds (Sialia mexicana), Violet-green Swallows *(Tachycineta thalassina)*, and Olive-sided *(Contopus borealis)* and Ash-throated *(Myiarchus cinerascens)* Flycatchers. Avian forest predators include Cooper's *(Accipiter cooperii)* and Sharp-shinned *(Accipiter striatus)* Hawks, along with Great Horned *(Bubo virginianus)*, Spotted *(Strix occidentalis)*, Northern Sawwhet *(Aegolius acadicus)*, Northern Pygmy *(Glaucidium gnoma)*, Eastern Screech *(Otus kennicottii)* and Flammulated *(Otus flammeolus)* Owls.

The reptile component includes Western Fence Lizard *(Sceloporus occidentalis)*, Southern Alligator Lizard *(Gerrhonotus multicarinatus)*, Western Skink *(Eumeces skiltonianus)*, Sharp-tailed Snake *(Contia tenuis)*, Striped Racer *(Coluber constrictor)*, Western Terrestrial Garter Snake *(Thamnophis elegans)*, Gopher Snake *(Pituophis melanoleucus)*, California Mountain Kingsnake *(Lampropeltis zonata)*, and Western Rattlesnake *(Crotalis viridis)*. Several salamander species occupy these forest floors, including Coast Range Newt *(Taricha torosa torosa)*, California Tiger Salamander *(Ambystoma tigrinum)*, California Giant Salamander *(Dicamptodon ensatus)* and others.

Small mammals include Deer Mice *(Peromyscus maniculatus)*, Caliornia Pocket Mice *(Chaetodipus californicus)*, Merriam Chipmunks *(Tamias merriami)*, Dusky-footed Woodrat *(Neotoma fuscipes)* and Gray Squirrel *(Sciurus carolinensis)*. Coyotes *(Canis latrans)*, Gray Fox *(Urocyon cinereoargenteus)*, Bobcat (Felis rufus) and Cougar *(Felis concolor)* comprise the mammalian predators that keep these forest ecosystems in check (Henson and Usner 1993; Brown and Lawrence 1965).

D. Redwood forests

The region's redwood forests are commonly mixed with the various evergreen and coast live oak forests. The understory of pure redwood stands is typically limited to low-growing herbs, including such hallmarks as sword and chain ferns *(Polystichum munitum and Woodwardia fimbriata)*, fairy bells *(Disporum hookeri)* and vanilla grass *(Hierochoe occidentalis)*. Second growth understories include huckleberry *(Vaccinium ovatum)*, salal *(Gaultheria shallon)* and wax-myrtle *(Myrica californica)*. Faunal inhabitants of the redwood forests are relatively few, compared with other habitats. The Marbled Murrelet *(Brachyramphus marmoratus)* nesting is unusual in that it is a sea bird who uses the old growth tops for nesting. Other avian inhabitants include Steller's Jay *(Cyanocitta stelleri)*, Winter Wren *(Troglodytes troglodytes)*, Brown Creeper *(Certhia americana)*, Pacific Slope Flycatcher *(Empidonax difficilis)*, Dark-eyed Junco *(Junco hyemalis)*, Acorn Woodpecker *(Melanerpes formicivorus)* and Great Horned Owl *(Bubo virginianus)*. (Henson and Usner 1993) Coast Range Newt *(Taricha torosa rivularis)*, Slender Salamander *(Batrachoseps sp.)*, and the popular Banana Slug *(Ariolimax columbianus)* occupy the deep duff of the forest floor.

E. Marine systems

There is a deep underwater canyon at Monterey Bay which brings cold, ocean floor water and nutrients to the coast through upwelling, a process that increases offshore diversity, with corresponding influences on the land.

While steelhead and salmon constitute the most obvious connection to the nearby marine environment, our interests and analyses are necessarily focused on terrestrial species. But we acknowledge the many relationships among our actions on the land and impacts to the region's intertidal and marine species. The Monterey Bay National Marine Sanctuary and numerous regional nonprofit organizations are facilitating our awareness of these interconnections.

Appendix 8

MOUNTAIN LION LINKAGE MODELING

A. Influence of predicted habitat

The WHR-GAP predicted distribution map (rasterized at 100 meters) was reclassified according to a habitat suitability weighting scheme grid in which the higher the number, the worse the habitat is considered to be for mountain lion (shown below, Hunter 2000). This was then resampled to 200 meters and smoothed using the Arc-Grid function FOCALMEAN. The radius used with the FOCALMEAN function was 5 cells or 1km. By smoothing the data, we hoped to create a more conservative representation of edge contrast between habitat quality, because a mountain lion would likely not be sensitive to most of the contrasts in habitat represented in the WHR data.

WHR VALUE	COST VALUE	SUITABILITY
5	0	> 50% High
4	2	> 50% Medium or High
3	6	>50% Low, Medium or High
1,2	9	Little or <50% Low
0	10	None

Mountain lion habitat suitability cost values. A higher WHR value indicates better habitat conditions and therefore has a lower cost value.

B. Influence of road impact

The LINEDENSITY function in Arc-Grid was used to create the road cost surface. For each cell, a value assigned based on the linear length of features. Values are sensitive to search radius distance; the larger the radius, the smoother the grid values. Roads were weighted according to the road class (see table below). We did give trails and four-wheel drive roads a weight of 1 rather than 0, given the influence that human access may have on lion movement patterns and habitat quality. Using these weights, the LINEDENSITY function counts the length of lines within a given search radius (500 meters) and applies that value to the cell. The weighting works by acting as the number of times that a given road class is counted . The higher the weighting, the more difficult it would be for a mountain lion to traverse that cell. The output map we use represents the density of roads by cell.

CLASS	WEIGHT	DESCRIPTION
10	6	Primary Route-undivided
11	7	Primary Route-divided by centerline
12	8	Primary Route-divided, lanes separated
20	4	Secondary Route-undivided
22	5	Secondary Route-divided, lanes separated
30	3	Thoroughfares, County Roads-mostly paved
40	2	Residential Roads, unimproved, unpaved
50	1	Trails
51	1	4WD vehicle
60	7	Interchanges
70	1	Misc. USGS classification
80	1	Rest Area
90	2	Caltrans digitized (not many of these)

USGS digital line graph (1:100,000) road-trail classes and weights.

C. Influence of forest cover

Coniferous, mixed and deciduous vegetation is assumed to be better for mountain lion dispersal. These vegetation types were extracted from the National Land Cover Dataset (NLCD, EPA MRLC 2000) database to create a new grid resampled to a resolution of 200 meters. This grid was reclassifed to binary with forested classes classified as 1 and all other areas classified as 6 (forest = 1, non-forest = 6). This means that a low value represents positive mountain lion habitat. To smooth the forest cover grid, the grid was converted it to a floating point grid (to make it non-integer) and then an averaging filter was run on it with a circle search radius of 400 meters. This smoothed the forest cover conservatively to account for edge effects and misclassification. The values were scaled from 1-6 as the range of forest-non-forest distinction because this would refine the existing low-high quality habitat costs.

While the data used for the mountain lion linkage modeling incorporated forest cover as a positive factor in long distance dispersal, we decided to just use WHR data and road impact data to delineate areas to be included in the mammal network. We assume that forest cover is more significant in dispersal than it is in a home range, because areas a lion may be moving through while dispersing will likely be lower habitat quality than areas where they may live. In addition, chaparral is an important habitat type for the lion (CDFG 2001) and these areas would have received a lower score if we had included forest cover.

The mountain lion network was created by identifying cores as all areas greater than 10,000 hectares, with a cumulative score lower than four on the surface that incorporated WHR habitat and roads. This was roughly the top 20% of the habitat scores for this surface. These areas are referred to as cores (note that primary cores are over 100,000 acres-33,445 hectares). Including linkages identified using the least cost path modeling brought the total area up to 51% of the region. This is a conservative estimate, biased in favor of identifying the moderate to high habitat quality habitat, and as much terrain for the cats as possible. It was felt that as conservation implementation is put in to place, the broader view will give resource managers more to options to work with.

D. Limitations and discussion

There is some circularity in the creation of these cost grids for mountain lion movement. The WHR classification was based on GAP vegetation community mapping, which uses the same source- Landsat TM imagery (though different year) as the NLCD classification. The intent in combining these grids as cumulative costs was to refine the WHR data with independent data sources for potentially significant factors. Yet, the level of resolution of any of these cost grids is insufficient to model actual movement paths for mountain lion with any degree of certainty. For example, riparian canopy forest represents an important habitat for lion dispersal, though the level of spatial resolution needed for classification of this habitat is far beyond the limits of these data sets.

Because of the coarse resolution of the input data used to create the cost surfaces, it is likely that areas identified as potential linkage would suffice as high quality core habitat for many individuals. The broad spatial extent of linkage delineation roughly tracks the long temporal extent of management recommendations that may be developed from this assessment. More detailed biological information can be used to refine the model framework by incorporating different factors as additional or surrogate costs. Other data sources, including radio-collar data, can be used to "scale-down" this model framework to identify key tracts of land or parcels in need of protection. These results should be used to identify areas on the landscape in need of further investigation and to focus tracking and research.

Appendix 9

EXTIRPATED AND REDUCED SPECIES AND COMMUNITIES OF THE CENTRAL COAST REGION

Threatened species and communities

Roughly 430 special status species and natural communities occur in the central coast region (CDFG 2001). These account for approximately 25% of the state's threatened and endangered natural communities, and 23% of the state's natural elements.

TULE ELK (CERVUS ELAPHUS NANNODES)

Tule elk, the only elk endemic to California, was historically found in the expanse of low elevation marsh habitats that were once plentiful in the region. Elkhorn Slough's namesake is likely derived from a common inhabitant, tule elk. Records of Spanish explorer Viscaíno observe tule elk in great abundance in Pajaro and Salinas valleys (Gordon 1974). Overhunting of elk all but eliminated the species from California by the turn of the 20th century. A history of tule elk resurrection has met with pressures to open elk hunting again. Today, 5,000 tule elk, partly mixed with Rocky Mountain Elk lineage, are tightly managed by the California Department of Fish and Game. Options for expanding tule elk herds in the central coast Region will be lost as available habitat is developed or isolated from subdivision or agriculture. This species was not selected for analysis due to intense management and re-introductions in the central coast region.

CALIFORNIA CONDOR (GYMNOGYPS CALIFORNIANUS)

Once common along the coastal mountains south of San Francisco Bay through the Transverse Range to the southern Sierra foothills, the California Condor has been reduced to a federally listed, endangered species. Historically, the condor co-inhabited the coastal ranges with the turkey vulture, a seasonal resident. It is speculated that the Pajaro River comes from the condor, which was called Pajaro (Gordon 1974). A year round resident, the condor has declined in abundance due to a host of human activities, starting at the height of European settlement, ranging from habitat loss, lead poisoning, and DDT poisoning (Gordon 1974). A captive breeding program of the US Fish and Wildlife Service is restoring the Condor to the Transverse and Santa Lucia Ranges. This species was not selected for inclusion in the analysis of this report due to its intensive management.

Species locally extinct

GRIZZLY BEAR (URSUS ACTOS HORRIBILUS)

The grizzly bear, California's emblem, once resided in great densities along the region's coastal riverine, estuarine, and oak habitats (Storer and Tevis 1983; Henson and Usner 1993). Naturally omnivorous, the grizzly ranged throughout much of California, except the deserts, and used a variety of food resources. The introduction of whaling and cattle in coastal California during the late 18th century presented a new and reliable food resource for the bear (Gordon 1974; Henson and Usner 1993). Prosecution from Spaniard and later European settlers effectively eliminated the grizzly from its critical position in the ecoregion. While the grizzly slowly retracted from the region, occasional sightings were made, including one in Santa Cruz in 1885. The last grizzly seen in California was in 1924 by a rancher in Sequoia National Park, Kern County (Storer 1955).

Black bear is apparently a relatively recent colonizer of the region's mixed evergreen and conifer forests, where historic grizzly once dominated. According to Stephenson and Calcarone (2000), "after the grizzly was extirpated around the turn of the century, black bears started to appear in Ventura and Santa Barbara Counties (Grinnel et al.1937). The Dept. of Fish and Game supplemented this natural range expansion by moving twenty-eight black bears from the Sierra Nevada into the San Gabriel and San Bernardino mountains during the early 1930s." Populations in those ranges are likely descended from those introductions, and the suggestion in their report is that the northerly populations got there on their own, presumably across the Tehachapis. Since grizzly are known to prey on Black bear, it is believed that their extirpation opened opportunities for natural Black bear range expansion. While Black bear populations have expanded most significantly in the southern portion of the region, a number of sitings have been anecdotally reported in the northern Santa Lucias over the past two decades. A number of Black bear vehicular fatalities have occurred at Cuesta Pass in the southern Santa Lucias, north of San Luis Obispo, suggesting a possible dispersal blockage there. In recent years a number of Black bear "incidences" have involved bears stumbling out of the northern Santa Lucias into such urbanized locations as Fort Ord, Santa Cruz, and Felton (1999), Carmel (May 2001), Salinas (June 2001). There are even sightings of a dead Black bear within five miles south of the City of San Francisco in the Santa Cruz Mountains (Stienstra 2001).

GRAY WOLF (CANIS LUPUS)

If gray wolf was present in this region at one time, it was along the eastern edge of the inner coast ranges (Schmidt 1991). There are reports of sightings elsewhere in the region (Gordon 1974, Henson and Usner 1993), but little verification of this exists aside from anecdotal historical records. Likely, the gray wolf was exterminated in same wave of predator removal that accompanied settlement of widespread ranching in the region.

OTHER SPECIES LOST FROM THE REGION

Short-tailed Albatross

Southern Bald Eagle *(Haliaeetus leucocephalus)*

Clapper Rail *(Rallus limicola)*

Least Tern *(Sterna antillarum)*

Western Burrowing Owl *(Athene cunicularia)*

Appendix 10

SAN JOAQUIN KIT FOX ASSESSMENT

by Kim Heinemeyer

The USFWS has selected 3 core populations to "anchor the spine of the metapopulation" (Williams et al.1997, page 132), and will eventually select 9 to 12 satellite populations (location yet to be determined) to receive priority recovery efforts. The agency identifies the populations in the interior coast range as important, with a focus on the populations found on military bases (Camp Roberts and Fort Hunter Liggett; Williams et al.1997). In fact, the USFWS identifies a series of recovery actions focused on the interior coast range populations, including both recovery and enhancement of the populations, as well as research into the movements and connectivity potential to other populations.

The goal is to work toward the establishment of a viable complex of kit fox populations (i.e., a viable metapopulation) on private and public lands throughout its geographic range. Because kit foxes require large areas of habitat and have dramatic, short-term population fluctuations, one cannot rely on a single population to achieve recovery.

Conserving a number of populations, some much more significant than others because of their large sizes or strategic locations, therefore, will be a necessary foundation for recovery. The areas these populations inhabit need to encompass as much of the environmental variability of the historical range as possible. This will ensure that maximal genetic diversity is conserved in the kit fox metapopulation to respond to varying environmental conditions, and that one environmental event does not negatively impact to the same extent all existing populations. Also, connections need to be established, maintained, and promoted between populations to counteract negative consequences of inbreeding, random catastrophic events (e.g., droughts) and demographic factors.

The document continues, with a discussion of the habitat degradation in the form of fragmentation that threatens the existence of kit fox in many of the more isolated habitats:

Connecting larger blocks of isolated natural land to core and other populations, thus, is an important element of recovery of kit foxes. Connecting large blocks will help reduce the harmful effects of habitat loss and fragmentation.

Appendix 11

JUSTIFICATION FOR LARGE PROTECTED AREAS

A fundamental problem of conservation planning is the configuration of protected areas, their size and proximity to one another. It is generally regarded that larger, closer, and connected habitats will maintain biological and genetic diversity in the long-term better than a smattering of small habitat islands or biological 'hot spots'. While small reserves may be financially and politically feasible at present, large, connected wildlands provide a long-term solution for maintaining natural processes and protecting all native species.

Belovsky (1987) estimated that natural areas smaller than 10,000 acres to be incapable of ensuring the survival of large predators. Further, Belovsky's model predicted key parks in California to become mere zoos within 100 years if they are not expanded or connected together by habitat linkages. Other studies have also supported the need for large protected natural areas (Schonewald-Cox 1983, Newmark 1985).

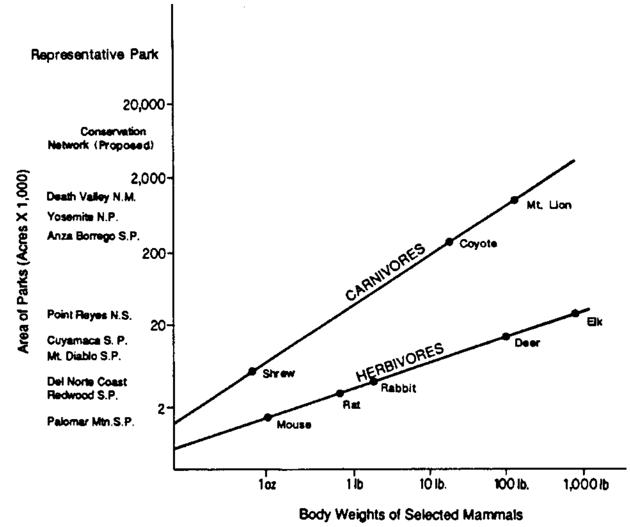

Figure 5: Graph of Belovsky's model of California park sizes to support mammals by body weight

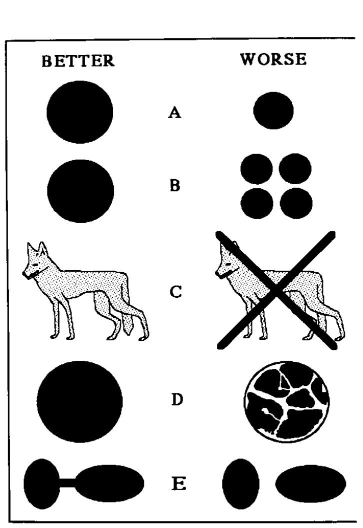

Figure 4: Wildlands approach of several large core areas, linkages, and native predators (courtesy of The Wildlands Project)

Linkages

Numerous wildlife species, especially predators like the fox and mountain lion, roam about either seasonally, during migration, or once in a lifetime to establish new territory. Therefore, a degree of habitat connectedness is critical to maintain the safe travel of these species. Ensuring habitat connectedness and linkages is a goal of wildlands planning (Wilcox Murphy 1985; Newmark 1987).

Habitat linkages, also called wildlife linkages, connect two larger blocks of habitat together, providing mobile wildlife with safe access to greater habitat resources. Recent field studies have documented use of linear strips of habitat to access habitat resources by mountain lions and small rodents (J. Hilty pers. comm; Mech and Hallet 2001). A growing body of research is strengthening the justification for protecting habitat linkages. Yet, just how wide and how long should linkages be is not well understood for many species.

While there is no consensus on the effectiveness of wildlife linkages has been disputed (Simberloff et al. 1992), their function in the landscape is historical and should be maintained until their effectiveness is proven otherwise (Beier and Noss 1998). For now, many wildlife biologists believe a few rules of thumb can be safely applied to linkage design: plan big; wider is better than narrow; and direct is better than winding and long (Ibid). In some instances, drainages and forested stream linkages make for ideal linkages between large protected areas. In fact, riparian habitats in the central coast Region are critical habitat linkages (Penrod et al. 2001).

The general size and location for potential wilderness linkages was determined in our report by using landcover data and GIS analysis. However, with a few specific exceptions, the linkages identify a general area suitable from the focal species prespective for a linkage. Which actual land parcels should be involved, and what the final shape and size of a linkage will be, should be decided at the site level by considering many case specific details not feasible at the regional perspective.

Appendix 12

STEELHEAD DATABASE DESIGN

A. An account of its construction, metadata, possible uses and availability

B. The database and action recommendations regarding specific comments in various data fields

By Verna Jigour, Ventana Wildlands Project. For access to the database, contact Verna at:
3318 Granada Avenue, Santa Clara, CA. 95051. email: Vjigour@aol.com

A. An account of its construction, metadata, possible uses and availability

The steelhead database catalogs the current status of salmonids in streams and rivers throughout the central coast Region, and parts of the south coast region. steelhead in each watershed are assessed as: present and undimished; historically present current condition unknown; present but reduced. The database also identifies which county the stream is in, name of the drainage, is it a primary tributary, and other attributes described below. This report uses the database to create a view (Map 21) of status of streams in the central coast Region, which can serve as a guide for management activities.

This appendix describes the assembly of the database, its component parts and some potential vegetation restoration targets that have been identified.

We reviewed existing digital coverages of current and historic salmonid distributions, (with help from Eric Lowrance, Bonneville Power Administration GIS Lab) and concluded none were sufficient for our regional planning purposes. Most previous mapping efforts charted broad geographic areas, rather than identifying specific streams. We incorporated the digital Ecologically Significant Unit (ESU) designations we received with Lowrance's assistance, but other digital coverages were ultimately not used in the analyses. Instead, we were fortunate to obtain more specific and useful data through Robert Titus and Richard Fitzgerald, California Department of Fish and Game (CDFG).

Given the specificity of that data set, we were inspired to create a GIS database for the Central West and South West Ecoregions using Titus' data as the original source, modified as noted below:

Rob Titus of CDFG generously provided the project with the draft manuscript and a word processing file of Table 4 in July, 1999. Richard Fitzgerald of CDFG provided image files of the county map locations of streams included in Table 4. Titus' methods for gathering stream-specific data, described in the manuscript, included: 1.) a literature search and review, including journal articles, CDFG administrative reports and fish bulletins; 2.) review of California Resource Agency files, especially CDFG stream surveys (in some cases going back several decades); and 3.) interviews with professional biologists, academicians, representatives of sportfishing organizations and other special interest groups.

Verna Jigour, Ventana Wildlands Project, imported the Table 4 word processing file into an Excel spreadsheet. She revised Titus' original format, substituting letter abbreviations for certain symbols, and adding limited data for streams draining into San Francisco Bay. Upon conferring with Rob Titus, she assigned the term "Obstructed" to that status as defined by Titus, for lack of a more accurate term. The data were then exported as a database file to ArcInfo, to serve as part of the attribute table for the spatial database. Using the CDFG image files illustrating pertinent streams as templates, and the Calwater hydrology layer as spatial data source, Jigour and Josh Logan created the ArcInfo coverage at the UC Santa Cruz GIS Lab with guidance from John Deck (then Lab Manager) and volunteer assistance from Quincy Loo in 1999. Matt Stoecker compiled additional data in 2000, with a focus on streams north of, and draining into San Francisco Bay. Jigour and Logan subsequently added the new streams to the ArcInfo database and made additional modifications to the associated Arc attribute table – especially to denote obstructed portions of otherwise intact drainages. Unfortunately the watershed boundaries were limited to the clipped CW boundary, and thus the coverages do not extend to some buffer edges of the wildlands network design boundaries that were set subsequent to development of the steelhead database.)

The data we used to create our database reflects only part of the data available in Rob Titus' draft manuscript, which includes text descriptions for most streams included in the database. When that document becomes available to the public these descriptions will facilitate clearer understandings of issues pertinent to the streams covered. Our database provides the overview summary for each stream, based on the data categories in Titus' Table 4, and can be queried for factors in any of these categories, as follows:

1. County where mouth of stream is located
2. Drainage
3. Primary tributary
4. Number of secondary tributaries included
5. Most recent survey: fish sampling survey, or general stream survey with fish observations
6. Steelhead status (refer to status categories, following)
7. Types of biological data available: juvenile sizes, juvenile densities and adult sizes – based on actual measurements and not visual estimates
8. Resident rainbows: the presence of wild resident rainbow trout in the drainage, e.g., upstream from a waterfall or dam;
9. Stocking history: hatchery-reared steelhead, wild steelhead, e.g. from rescue operations, or hatchery-reared resident rainbow trout;
10. Factors affecting abundance-persistence:
    - Access impaired in main stem;
    - Barrier: Impassable culverts and other barriers, except logjams and dams (natural barriers excluded)
    - Channelization
    - Dam which lacks functional fishway
    - Water diversion
    - Logjam barrier
    - Pollution: Urban debris, chemical or organic input
    - Siltation
    - Logging debris

To date we have employed all categories in our analyses, with the exceptions of most recent survey, biological data and stocking history. All of these can be helpful to future ecological restoration planning efforts.

We added the following additional categories:

11. Comments: including historic and — or known presence of Coho or Chinook salmon in the stream
12. Data sources other than Titus et al. — for each addition to the database

The expanded table is available as an Excel spreadsheet to facilitate data sharing with users who may not have ready access to the spatial database. The individual streams and tributaries correspond to rows, while the data categories correspond to columns.

Database metadata:

County designations are for the mouth of the stream 293 streams included

1. Most recent survey: Fish sampling survey, or general stream survey with fish observations. — indicates no survey on file.
2. Steelhead status:

P	Steelhead present currently, any significant change in production from historical levels not discernible based on available information
P-	Steelhead present currently, but production reduced or likely so
?	Steelhead present historically but current presence-absence not known.
Obstructed	Given current habitat conditions, the steelhead life history of coastal rainbow trout is no longer supported in the stream. In all cases, viable trout habitat still exists in the system, typically in headwaters areas. These areas support the resident life history of coastal rainbow trout. However, the lack of connectivity between the ocean and these viable spawning and rearing areas, as a result of habitat alterations, no longer allows anadromy to occur and noticeably persist.
N-A	Steelhead not present within recent geological history, e.g. due to impassable barrier at stream mouth.
U	The historical and contemporary presence of an anadromous steelhead population is unknown to date (this status class added by Matt Stoecker)

3. Biological data available on the following, based on actual measurements and not visual estimates. Data on juvenile sizes and densities may also include adult resident rainbow trout.

JS Juvenile sizes

JD Juvenile densities

AS Adult sizes

4. Resident rainbows: + indicates presence of wild resident rainbow trout in the drainage, e.g., upstream from a waterfall.
5. Stocking history

SHh Hatchery-reared steelhead

SHw Wild steelhead, e.g. from rescue operations.

RTh Hatchery-reared resident rainbow trout.

6. Factors affecting abundance-persistence:

Access	Access impaired in main stem
Barr	Impassable culverts and other barriers, except logjams and dams (natural barriers excluded)
Chan	Channelization
Dam	Dam which lacks functional fishway
Div	Water diversion
Jam	Logjam barrier
Poll	Urban debris, chemical or organic input-pollution
Silt	Siltation
Slash	Logging debris.

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Gill Murphy, Marin County Wildlife and Fisheries Advisory Committee Aug. 15, 2000

Jerry Smith, Fisheries Biologist San Jose State University.

Matt Stoecker, salmonid consultant to Ventana Wildlands Project, Conception Coast Project stream ecologist – ongoing communications.

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The project GIS incorporates the following data from this document:

1. Table 4: Status Summary of California steelhead in coastal drainages south of San Francisco Bay. (Format revised, including SF Bay additions, 8-13-99 by V. Jigour)
2. County-based maps.

ACKNOWLEDGMENTS — STEELHEAD DATABASE FOR:

Ventana Wildlands Project and South Coast Wildlands Project

Verna Jigour, Josh Logan, Matt Stoecker, John Deck, Quincy Loo, Anne Mullan,

Robert Titus, California Department of Fish and Game

Richard Fitzgerald, California Department of Fish and Game

Dennis McEwan, California Department of Fish and Game

Paul Veisze, California Department of Fish and Game

Eric Lowrance, Bonneville Power Administration GIS Lab

B. The database and action recommendations regarding specific comments in various data fields

The table provides an overview of the major problems that must be addressed on each stream to facilitate the recovery of steelhead populations. Factors affecting the abundance and persistence of steelhead populations on each stream denote conditions that must be addressed at the watershed level. A number of groups have arisen to promote restoration of local steelhead populations.

History of fish stocking operations is also noted, providing an indication of the degree to which each steelhead population may have been compromised by introduction of genetically dissimilar lines. The last survey date indicates how current the data is. In some cases, surveys that are more current and have been conducted locally that are not reflected in this table. The condition of associated riparian vegetation is not included in the table but is critically important for steelhead recovery. Riparian vegetation shelters and provides the foodweb for riverine ecosystems supporting steelhead. Even “fishless headwaters streams are crucial conduits of food for fishes and other aquatic fauna that live downstream.” (PNW 2001). The condition of entire watersheds affects the timing, intensity, and quality of riverine flows, which, in turn affects the structure of riparian vegetation.

Inventory and Management Recommendations regarding factors noted in the table:

Access impaired in mainstem:

- Evaluate potential opportunities to alter the amount and-or timing of upstream diversions and dam releases.
- Evaluate potential opportunities to improve water storage capacity of watersheds.
- Evaluate feasibility of implementing occasional "flushing flows" from reservoirs to transport sediments built up in mainstem through altered hydrological regimes.

Dams lacking functional fishways:

- Develop programs for removal of obsolete dams, e.g., Searsville Dam on San Francisquito Creek and San Clemente Dam on Carmel River.
- Develop infrastructure to permit fish movement past dams and reservoirs.
- Evaluate and develop opportunities for offstream-decentralized water storage, including watershed restoration to retard runoff and infrastructural measures, such as cisterns.
- Plan for eventual removal of key dams as alternative water storage strategies are developed.

Diversions of water:

- Evaluate direct and cumulative impacts of specific diversions on fish migration.
- Develop protective infrastructure to prevent entrainment of fish into diversion structures.
- Establish watershed councils to negotiate the amount and timing of diversions to allow for fish migration, along with related water conservation measures.

Barriers, including impassable culverts and other human-built structures:

- Conduct comprehensive barrier assessments and prioritize barrier removal-modification actions within each watershed.

Logjam barriers:

- Assess remediation needed on a case-by-case basis.

Silt, slash (logging debris) and pollution – watershed problems:

- Implement comprehensive watershed restoration and protection programs, including urbanized lands.

Channelization:

- Develop short and long-term strategies for naturalization of stream channels throughout the region.
- Begin the naturalization process by gradually acquiring and restoring portions of historic floodplains, enabling channel naturalization-slowing of flood flows.
- Promote urban stormwater detention measures, including reduction of impervious surfaces, along with upper watershed restoration, to reduce the flashiness of stormwater runoff.

Appendix 13

CONSERVATION PLAN DATA STRUCTURE

The database structure resembles a cross dividing four different data types: upper left includes all human perturbations: roads, housing, and landscape classifications such as the National Land Cover Database (EPA 1999). Any additional human infrastructure maps that become available are placed in this area. The upper right quadrant houses all biological and physical data. Focal species are represented here, as well as a variety of other types of biological information that will be used in designing the WCP. In this case, the upper right quadrant also contains point data about California Red legged frogs, California tiger salamander (CNDDB), serpentine rock distribution (California Department of Mines and Geology, 2000) the California Dept of Forestry (CDF) hardwoods data , ecologically significant areas for rare and threatened ecological communities, and the distribution of old growth redwood (Pacific Biodiversity Institute 1998 and Steve Singer 1999). The first iteration of Wildland Conservation Plan is developed from the information in these two quadrants, starting with an additive series of comparisons of the biological data to be used, and adding in the human effects as late as possible in the design.

The two upper quadrants generally represent the current state of human activities and ecological resources or species-habitat distributions . They hold all the data that will be used in the WCP as it is presented here.

The lower quadrants hold other types of information that are useful in prioritizing acquisitions and for long term management. The lower left quad encompasses models of human activities that have a negative effect on species distributions. These include urban expansion such as the CDF FRAP model (CDF website 2001) and vineyard expansion models (Brooks et al. 1999), projected logging and the long-term effects of climate change on species distributions. The lower right quadrant houses more conceptual types of biological data and models that deal with re-wilding or restoration. These approaches are biological predictions, or prescriptions for restoration of natural processes such as species reintroductions, use of fire to restore native plants, physical alteration of habitat through native plant plantings, programs to control the levels of siltation, and eradication of non-natives.

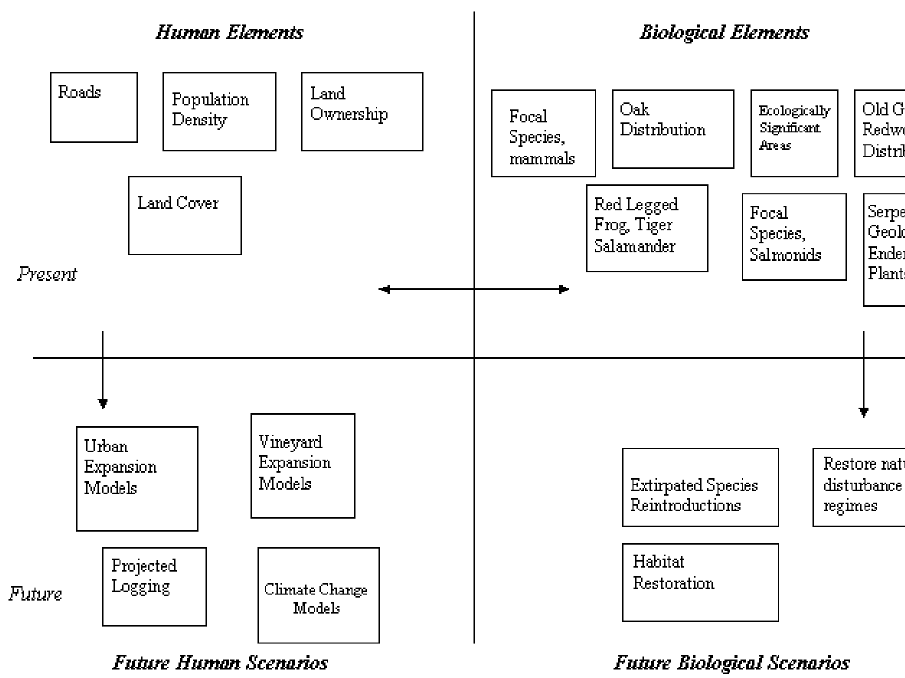

Figure 6: Wildlands Conservation Plan Database Structure

Wildland Conservation Plan database structure

Recommendation on landscape management, such as restoration of riparian gallery forests, represents a positive human action and would be grouped in Class 4. A prediction of increasing habitat fragmentation due to vineyard expansion is a Class 3 model. Each of those could be modeled and a map of what future conditions might be like produced. This is a promising field of conservation planning, but is beyond the scope of this report. We recommend that these types of predicted scenarios be provided for the central coast region.

In addition, it is a straightforward test to conduct a representation analysis of other special elements against the mammal conservation network. As new data are developed or interest arises in a particular species, further representation analyses can and should be conducted.

DATA FLOW WITHIN THE DATABASE STRUCTURE

The upper right quadrant: biological elements

The upper right quadrant holds all the biological data. Vegetation maps that can be used to create grid based habitat models for selected focal species are held and worked here. Steps of work identified for this quadrant are:

1. Identify focal species and focal elements.
2. Identify data sources.
3. Produce habitat maps based on combinations of available data: sightings and vegetation.
4. Use least cost path analysis to identify least difficult dispersal paths to connect the focal species (in this case only mountain lion, see below), excepting salmonids. This network should start using only habitat based values, but may then incorporate human elements (roads) into the design.
5. Combine the individual focal species designs for all the identified focal units to develop the overall WCP.
6. Overlay this combined (and the individual maps) with a network derived from roads to test for feasibility.
7. Representation analysis of how well focal species capture other biological elements of concern on the landscape. Add other biological elements to overall WCP as needed.

The upper left quadrant: human elements

This quadrant contains all human data available: e.g. transportation, population density , demographic indicators, land ownership, parcel boundaries, land management classifications. Steps of work identified for this quadrant are:

1. Identify human data needed.
2. Identify data sources.
3. Use the best available roads coverage to identify areas of low road density that may provide adequate and the least problematic locations of linkages linking suitable habitat. This approach can also be used to identify roads that are recommended for closure.
4. Use this network in conjunction with biological models to identify and prioritize acquisitions, conservation easements, etc.

The lower left quadrant: future human scenarios

This quadrant contains all models and projections of how human activity may negatively alter the landscape in the future. Types of change which can be included here include climate change models, urbanization build out projections, land use change models, and other predictions about human use of or impact on landscapes. Steps of work identified for this quadrant are:

1. Identify demographic/policy based models needed
2. Identify model sources, or initiate model development
3. Identify and acquire needed inputs for models for bioregion in question
4. Run models for bioregion
5. Use model output to re-prioritize WCP developed in upper two quadrants

The lower right quadrant: future biological scenarios

This quadrant contains all models and projections of how human activity may positively alter the landscape in the future. After acquisition of lands and development of conservation easements, much of the work in re-wilding a bioregion will involve altering land management practices to better accommodate the native biota. Activities which may improve the overall ecological health of a bioregion include: reintroduction of extirpated native carnivores; reintroduction of fire, in controlled burn settings; and planting of native vegetation to improve habitat quality. Steps of work identified for this quadrant are:

1. Identify what extirpated species should be brought back
2. Model the possible locations, spatial requirements, and networks required for reintroduction
3. Identify at the parcel level what types of restoration activities are needed
4. Develop plans for implementation of restoration activities.
5. Develop public education and outreach programs and location specific conservation and restoration groups for implementation of regional goals at the local level.

All four quadrants can contribute to the Wildland Conservation Plan. As new data become available, it can be classed into one of the four quadrants, then its effect on the overall view of the region can be assessed by additively layering the new information over the existing plans. Futures scenarios (quadrants 3and4) are particularly useful in aiding prioritization of areas where land purchases, conservation easements, and other on the ground conservation work is needed. The basic strategy is to keep different data types and modules independent as long as possible in the course of the analysis to allow for comparisons that avoid circularity.

Scale considerations

While combining data sets that represent a variety of special elements such as populations in a pond or on a patch of serpentine to areas derived from regional vegetation maps that are identified as mountain lion habitat, it is important to consider the effect of scale on patterns of diversity, distribution and, level of representation. Species see the same landscape differently and respond to changes in terrain or vegetation structure differently. Even among the three mammals that we chose to use as focal species, detection of habitat heterogeneity is widely variable; what the kit fox sees as an important feature or resource, a mountain lion might not even notice.

Ideally, GIS-based representations of suitable habitat would incorporate heterogeneity, or detail, appropriate to the species of interest and be validated by survey data. Rarely are such spatial data available, particularly for species not listed as threatened or endangered. Given this situation, we used the Gap Analysis predicted distribution data which is based on the California Department of Fish and Games's Wildlife Habitat Relationships (WHR) to map the wildlife focal species habitats. Distributions for mountain lion, pronghorn antelope, and San Joaquin kit fox mapped this way were used as the basis for our mammal conservation network. The minimum mapping unit (mmu) of the Gap Analysis defines the smallest feature to be mapped. For upland (non-wetland) communities, the mmu is 100 hectares. This defines the lower limit of our habitat resolution for the species that we chose. At this point in the WCP, we felt that it was not necessary or cost effective to refine the spatial data based on additional expert review and more complex habitat suitability models.

Appendix 14

SCRUB AND GRASSLAND TYPES IN MAMMAL NETWORK

MAMMAL NETWORK	CNDDB VEGETATION	ACRES	HECTARES	% REPRESENTED
Key Habitat	Big Sagebrush Scrub	17851	7222	94.36
Key Habitat	Blue Brush Chaparral	12118	4902	85.44
Key Habitat	Buck Brush Chaparral	899592	363975	97.42
Key Habitat	Ceanothus crassifolius Chaparral	85121	34440	98.56
Key Habitat	Ceanothus megacarpus Chaparral	50092	20267	86.15
Key Habitat	Central (Lucian) Coastal Scrub	51654	20899	36.60
Key Habitat	Central Maritime Chaparral	25511	10321	48.07
Key Habitat	Chamise Chaparral	570030	230634	93.48
Key Habitat	Cismontane Juniper Woodland and	7957	3219	98.53
Key Habitat	Coastal Sage-Chaparral Scrub	25145	10173	83.93
Key Habitat	Diablan Sage Scrub	140857	56991	72.90
Key Habitat	Great Valley Mesquite Scrub	1018	412	85.83
Key Habitat	Interior Coast Range Saltbush Sc	8530	3451	98.29
Key Habitat	Interior Live Oak Chaparral	91595	37059	98.54
Key Habitat	Leather Oak Chaparral	15953	6454	98.12
Key Habitat	Mesic North Slope Chaparral	84419	34156	98.27
Key Habitat	Mixed Montane Chaparral	4319	1748	100.00
Key Habitat	Mixed Serpentine Chaparral	9162	3707	78.23
Key Habitat	Montane Ceanothus Chaparral	11495	4651	100.00
Key Habitat	Montane Manzanita Chaparral	5466	2211	100.00
Key Habitat	Mule Fat Scrub	1641	664	13.42
Key Habitat	Non-Native Grassland	2083448	842963	67.46
Key Habitat	North Coast Riparian Scrub	623	252	77.78
Key Habitat	Northern (Franciscan) Coastal Sc	61716	24970	61.78
Key Habitat	Northern Coastal Bluff Scrub	69	28	0.40
Key Habitat	Northern Mixed Chaparral	23119	9354	99.28
Key Habitat	Red Shank Chaparral	593	240	100.00
Key Habitat	Riversidian Sage Scrub	2669	1080	100.00
Key Habitat	Scrub Oak Chaparral	154823	62641	98.64
Key Habitat	Semi-Desert Chaparral	106569	43118	76.01
Key Habitat	Serpentine Foothill Pine-Chaparr	12523	5067	97.84
Key Habitat	Tamarisk Scrub	2807	1136	96.93
Key Habitat	Upper Sonoran Manzanita Chaparra	60302	24398	98.93
Key Habitat	Upper Sonoran Subshrub Scrub	66500	26906	79.61
Key Habitat	Valley Saltbush Scrub	194675	78766	79.55
Key Habitat	Valley Sink Scrub	2609	1056	82.76
Key Habitat	Venturan Coastal Sage Scrub	88996	36008	62.94

MAMMAL NETWORK	CNDDB VEGETATION	ACRES	HECTARES	% REPRESENTED
Linkage	Buck Brush Chaparral	3272	1324	0.35
Linkage	Ceanothus crassifolius Chaparral	10	4	0.01
Linkage	Ceanothus megacarpus Chaparral	109	44	0.19
Linkage	Central (Lucian) Coastal Scrub	10536	4263	7.47
Linkage	Central Maritime Chaparral	4369	1768	8.23
Linkage	Chamise Chaparral	11307	4575	1.85
Linkage	Coastal Sage-Chaparral Scrub	2481	1004	8.28
Linkage	Diablan Sage Scrub	5011	2028	2.59
Linkage	Leather Oak Chaparral	158	64	0.97
Linkage	Mesic North Slope Chaparral	69	28	0.08
Linkage	Mixed Serpentine Chaparral	2501	1012	21.35
Linkage	Mule Fat Scrub	2372	960	19.40
Linkage	Non-Native Grassland	285450	115493	9.24
Linkage	North Coast Riparian Scrub	178	72	22.22
Linkage	Northern (Franciscan) Coastal Sc	7640	3091	7.65
Linkage	Northern Coastal Bluff Scrub	4695	1900	27.16
Linkage	Semi-Desert Chaparral	820	332	0.59
Linkage	Upper Sonoran Manzanita Chaparra	405	164	0.66
Linkage	Upper Sonoran Subshrub Scrub	613	248	0.73
Linkage	Venturan Coastal Sage Scrub	23811	9634	16.84

Appendix 15

MAMMAL NETWORK BY OWNERSHIP

MAMMAL NETWORK	OWNERSHIP-MANAGEMENT	ACRES	TOTAL OWNERSHIP ACRES	PERCENT OF MAMMAL NETWORK IN OWNERSHIP	PERCENTOF OWNERSHIP MAMMAL NETWORK
Key Habitat	Air Force	25540	103130	0.33	24.8
Key Habitat	Army	158114	201060	2.07	78.6
Key Habitat	Audubon Society	1097	1137	0.01	96.5
Key Habitat	California Dept. of Fish and Game	14885	34268	0.19	43.4
Key Habitat	California Dept. of Forestry and Fire Prot	771	771	0.01	100.0
Key Habitat	California Dept. of Parks and Recreation	161159	216944	2.11	74.3
Key Habitat	County-City-Regional Parks and Preserves	71382	166466	0.93	42.9
Key Habitat	Military—unknown branch	376	2204	0.00	17.0
Key Habitat	National Guard	39427	45447	0.52	86.8
Key Habitat	National Monument	16714	16724	0.22	99.9
Key Habitat	National Seashore or National Recreation	40169	80268	0.53	50.0
Key Habitat	Navy	21290	37243	0.28	57.2
Key Habitat	Open Space Districts	25580	33724	0.33	75.9
Key Habitat	Other Conservancy; Land Trust; Private U	3934	9261	0.05	42.5
Key Habitat	Private	5069513	9200729	66.28	55.1
Key Habitat	State Lands—State Lands Commission	19540	35909	0.26	54.4
Key Habitat	The Nature Conservancy	11060	17188	0.14	64.4
Key Habitat	U.S. Forest Service	776250	805783	10.15	96.3
Key Habitat	U.S. Forest Service Wilderness	659915	667190	8.63	98.9
Key Habitat	US Bureau of Land Management	487874	516152	6.38	94.5
Key Habitat	US Fish and Wildlife Service	3618	26667	0.05	13.6
Key Habitat	Water	801	30206	0.01	2.7
Key Habitat	Water Districts etc.	39091	87839	0.51	44.5
Linkage	Air Force	4962	103130	0.53	4.8
Linkage	Army	890	201060	0.10	0.4
Linkage	Audubon Society	40	1137	0.00	3.5
Linkage	California Dept. of Fish and Game	2679	34268	0.3	7.8
Linkage	California Dept. of Parks and Recreation	3163	216944	0.3	1.5
Linkage	County-City-Regional Parks and Preserves	7789	166466	0.8	4.7
Linkage	Military—unknown branch	89	2204	0.01	4.0
Linkage	National Guard	3193	45447	0.3	7.0
Linkage	National Seashore or National Recreation	13185	80268	1.4	16.4
Linkage	Private	883462	9200729	95.0	9.6
Linkage	State Lands—State Lands Commission	8619	35909	0.9	24.0
Linkage	The Nature Conservancy	10	17188	0.0	0.06
Linkage	U.S. Forest Service	10	805783	0.0	0.0
Linkage	US Bureau of Land Management	1147	516152	0.1	0.2
Linkage	Water	10	30206	0.0	0.03
Linkage	Water Districts etc.	455	87839	0.05	0.5

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