South Coast Missing Linkages Project:

A Linkage Design for the Santa Monica-Sierra Madre Connection

Prepared by:

Kristeen Penrod
Clint R. Cabañero
Dr. Paul Beier
Dr. Claudia Luke
Dr. Wayne Spencer
Dr. Esther Rubin
Dr. Raymond Sauvajot
Dr. Seth Riley
Denise Kamradt

South Coast Missing Linkages Project:

A Linkage Design for the
Santa Monica – Sierra Madre Connection

Prepared by:

Kristeen Penrod
Clint R. Cabañero
Dr. Paul Beier
Dr. Claudia Luke
Dr. Wayne Spencer
Dr. Esther Rubin
Dr. Raymond M. Sauvajot
Dr. Seth Riley
Denise Kamradt

June 2006

This report was made possible with financial support from the Santa Monica Mountains Conservancy, California State Parks, National Park Service, Resources Legacy Fund Foundation, The Wildlands Conservancy, The Resources Agency, U.S. Forest Service, California State Parks Foundation, Environment Now, Zoological Society of San Diego, and the Summerlee Foundation.

Results and information in this report are advisory and intended to assist local jurisdictions, agencies, organizations, and property owners in making decisions regarding protection of ecological resources and habitat connectivity in the area.

Produced by South Coast Wildlands: Our mission is to protect, connect and restore the rich natural heritage of the South Coast Ecoregion through the establishment of a system of connected wildlands.

Preferred Citation: Penrod, K., C. Cabañero, P. Beier, C. Luke, W. Spencer, E. Rubin, R. Sauvajot, S. Riley, and D. Kamradt. 2006. South Coast Missing Linkages Project: A Linkage Design for the Santa Monica-Sierra Madre Connection. Produced by South Coast Wildlands, Idyllwild, CA. www.scwildlands.org, in cooperation with National Park Service, Santa Monica Mountains Conservancy, California State Parks, and The Nature Conservancy.

Project Partners: We would like to recognize our partners on the South Coast Missing Linkages Project, including The Wildlands Conservancy, The Resources Agency, U.S. Forest Service, California State Parks, California State Parks Foundation, National Park Service, San Diego State University Field Stations Program, Environment Now, The Nature Conservancy, Conservation Biology Institute, Santa Monica Mountains Conservancy, Wetlands Recovery Project, Mountain Lion Foundation, Rivers and Mountains Conservancy, California Wilderness Coalition, Wildlands Project, Zoological Society of San Diego Center for Reproduction of Endangered Species, Pronatura, Conabio, and Universidad Autonoma de Baja California. We are committed to collaboration to secure a wildlands network for the South Coast Ecoregion and beyond and look forward to adding additional agencies and organizations to our list of partners.

Table of Contents

Linkage Design

Appendices (Enclosed CD)

List of Tables

List of Figures

Workshop Speakers: Ray Sauvajot, National Park Service; Jonathan Levine, University of California Los Angeles; Travis Longcore, The Urban Wildlands Group; Robert Fisher, USGS Biological Resources Division; Kimball Garrett, Los Angeles County Natural History Museum; Seth Riley, National Park Service; Claudia Luke, San Diego State University Field Stations Program.

Taxonomic Working-Group Participants: We would like to thank the following individuals for their participation in the selection of focal species: Paul Beier, Northern Arizona University; Ann Berkley, Angeles National Forest (ANF); Bill Brown, ANF; Clint Cabanero, South Coast Wildlands; Paul Caron, CalTrans; Mike Casterline, University of California Santa Barbara (UCSB); Liz Chattin, formerly with South Coast Wildlands; Brendan Clarke, National Park Service (NPS); Michelle Cullens, Mountain Lion Foundation; Kristi Daniel, CalTrans; Gary Davis, National Park Service; Russ Dingman, Department of Parks and Recreation; Michelle Dohrn, independent consultant; Sabrina Drill, UC Cooperative Extension; Paul Edelman, Santa Monica Mountains Conservancy; Jim Edmondson, CalTrout; Brian Edwards, formerly with South Coast Wildlands; Scott Ellison, County of Ventura; Rick Farris, US Fish and Wildlife Service; Eric Fagraus, UCSB; Robert Fisher, USGS Biological Resources Division; Ei Fujioka, UCSB; Kimball Garrett, Los Angeles Natural History Museum; Sandra Gilboa, University of California Los Angeles (UCLA); Nancy Fuller, California State Parks (CSP); Russel Guiney, CSP; Leigh Hagan, UCSB; Steve Harris, Mountains Restoration Trust (MRT); Denise Kamradt, NPS; Lee Kats, Pepperdine University; Elise Kelley, Santa Clara River Restoration Coordinator; Ken Kietzer, CSP; Jo Kitz, MRT; Lena Lee, NPS; Jonathan Levine, UCLA; Travis Longcore, The Urban Wildlands Group; Claudia Luke, formerly with San Diego State University Field Stations now with Bodega Marine Lab UC Davis; Catrina Mangiardi, UCSB; Barbara Marquez, CalTrans; Peter Nonacs, UCLA; Kristeen Penrod, South Coast Wildlands; Rick Rayburn, California State Parks; E.J. Remson, The Nature Conservancy; Seth Riley, NPS; Matt Riley, UCSB; Rick Rodgers, USFWS; Walter Sakai, Santa Monica Community College; Ray Sauvajot, NPS; Susan Shanks, Santa Monica Mountains Conservancy; Rebecca Shaw, TNC; Judi Tamasi, Wildlife Corridor Conservation Authority, John Tiszler, NPS; Harshita Tiwari, UCSB; Richard Wales, US Forest Service; Wayne Spencer, Conservation Biology Institute; Richard Wales, ANF; Andrea Warniment, formerly with South Coast Wildlands; Hartmut Walter, UCLA; Morgan Whetje, California Department of Fish and Game; Steve Williams, Santa Monica Mountains Resource Conservation District; Carl Wishner, Envicom.

Project Steering Committee: We are extremely grateful to the following individuals, who serve on the steering committee for the South Coast Missing Linkages Project: Paul Beier (Northern Arizona University), Madelyn Glickfeld (formerly with The Resources Agency California Legacy Project), Gail Presley (California Department of Fish and Game), Therese O'Rourke (U.S. Fish & Wildlife Service, formerly with The Nature Conservancy), Kristeen Penrod (South Coast Wildlands), Rick Rayburn (California State Parks), Ray Sauvajot (National Park Service), and Tom White (U.S. Forest Service).

Executive Summary

Habitat loss and fragmentation are the leading threats to biodiversity, both globally and in southern California. Efforts to combat these threats must focus on conserving well-connected networks of large wildland areas where natural ecological and evolutionary processes can continue operating over large spatial and temporal scales—such as top-down regulation by large predators, and natural patterns of gene flow, pollination, dispersal, energy flow, nutrient cycling, inter-specific competition, and mutualism. Adequate landscape connections will thereby allow these ecosystems to respond appropriately to natural and unnatural environmental perturbations, such as fire, flood, climate change, and invasions by alien species.

The tension between fragmentation and conservation is particularly acute in California, because our state is one of the 25 most important hotspots of biological diversity on Earth. And nowhere is the threat to connectivity more severe than in southern California—our nation's largest urban area, and still one of its fastest growing urbanizing areas. But despite a half-century of rapid habitat conversion, southern California retains some large and valuable wildlands, and opportunities remain to conserve and restore a functional wildland network here.

Although embedded in one of the world's largest metropolitan areas, southern California's archipelago of conserved wildlands is fundamentally one interconnected ecological system, and the goal of South Coast Missing Linkages is to keep it so. South Coast Missing Linkages is a collaborative effort among a dozen governmental and non-governmental organizations. Our aim is to develop Linkage Designs for 15 major landscape linkages to ensure a functioning wildland network for the South Coast Ecoregion, along with connections to neighboring ecoregions. The Santa Monica-Sierra Madre Connection is one of the few remaining coastal connections in the South Coast Ecoregion; it is a critical landscape connection to restore and protect.

On July 29, 2002, 60 participants representing over 30 agencies, academic institutions, land managers, land planners, conservation organizations, and community groups met to establish biological foundations for planning landscape linkages in the Santa Monica-Sierra Madre Connection. They identified 20 focal species that are sensitive to habitat loss and fragmentation here, including three plants, four insects, one fish, one amphibian, two reptiles, four birds and five mammals. These focal species cover a broad range of habitat and movement requirements: some are widespread but require huge tracts of land to support viable populations (e.g., mountain lion, badger); others are species with very limited spatial requirements (e.g., harvester ant). Many are habitat specialists (e.g., cactus wren) and others require specific configurations of habitat elements (e.g. steelhead trout that uses rivers for migrating and streams for rearing and spawning). Together, these species cover a wide array of habitats and movement needs in the region, so that planning adequate linkages for them is expected to cover connectivity needs for the ecosystems they represent.

To identify potential routes between existing protected areas we conducted landscape permeability analyses for three focal species for which appropriate data were available. Permeability analyses model the relative cost for a species to move between protected core habitat or population areas. We defined a least-cost corridor—or best potential route—for each species, and then combined these into a Least Cost Union covering all three species. We then analyzed the size and configuration of suitable habitat patches within this Least Cost Union for all focal species to verify that the final Linkage Design would suit the live-in or move-through habitat needs of all. Where the Least Cost Union omitted areas essential to the needs of a particular species, we expanded the Linkage Design to accommodate that species' particular requirements to produce a final Linkage Design (Figure ES-1). We also visited priority areas in the field to identify and evaluate barriers to movement for our focal species. In this plan we suggest restoration strategies to mitigate those barriers, with special emphasis on opportunities to reduce the adverse effects of Interstate 101, and 5, and State Routes 23, 118, 126, and14. Overall, the results and recommendations from our analyses are advisory, but can hopefully assist local jurisdictions, agencies, organizations, and property owners make planning and land use decisions that promote protection of ecological resources and habitat connectivity in the area.

The ecological, educational, recreational, and spiritual values of protected wildlands in the South Coast Ecoregion are immense. Our Linkage Design for the Santa Monica-Sierra Madre Connection represents an opportunity to protect a truly functional landscape-level connection. The cost of implementing this vision will be substantial—but the cost is small compared with the benefits. If implemented, our plan would not only permit movement of individuals and genes between the Santa Monica Mountains and the Sierra Madre Ranges, but should also conserve large-scale ecosystem processes that are essential to the continued integrity of existing conservation investments throughout the region. We hope that our biologically based and repeatable procedure will be applied in other parts of California and elsewhere to ensure continued ecosystem integrity in perpetuity.

Nature Needs Room to Roam

Movement is essential to wildlife survival, whether it be the day-to-day movements of individuals seeking food, shelter, or mates, dispersal of offspring (e.g., seeds, pollen, fledglings) to new home areas, or migration of organisms to avoid seasonally unfavorable conditions (Forman 1995). Movements can lead to recolonization of unoccupied habitat after environmental disturbances, the healthy mixing of genes among populations, and the ability of organisms to respond or adapt to environmental stressors. Movements in natural environments lead to complex mosaics of ecological and genetic interactions at various spatial and temporal scales.

In environments fragmented by human development, disruption of movement patterns can alter essential ecosystem functions, such as predator-prey relationships, gene flow, pollination and seed-dispersal, competitive or mutualistic relationships among species, resistance to invasion by alien species, energy flow, and nutrient cycling. Without the ability to move among and within natural habitats, species become more susceptible to fire, flood, disease and other environmental disturbances and show greater rates of local extinction (Soulé and Terborgh 1999). The principles of island biogeography (MacArthur and Wilson 1967), models of demographic stochasticity (Shaffer 1981, Soulé 1987), inbreeding depression (Schonewald-Cox 1983; Mills and Smouse 1994), and metapopulation theory (Levins 1970, Taylor 1990, Hanski and Gilpin 1991) all predict that isolated populations are more susceptible to extinction than connected populations. Establishing connections among natural lands has therefore long been recognized as important for sustaining natural ecological processes and biological diversity (Noss 1987, Harris and Gallagher 1989, Noss 1991, Beier and Loe 1992, Noss 1992, Beier 1993, Forman 1995, Beier and Noss 1998, Hunter 1999, Crooks and Soulé 1999, Soulé and Terborgh 1999, Penrod et al. 2001, Crooks et al. 2001, Tewksbury et al. 2002, Forman et al. 2003).

Patterns of Habitat Conversion

As a consequence of rapid habitat conversion to urban and agricultural uses, the South Coast Ecoregion of California (Figure 1) has become a hotspot for species at risk of extinction. California has the greatest number of threatened and endangered species in the continental U.S, representing nearly every taxonomic group, from plants and invertebrates to birds, mammals, fish, amphibians, and reptiles (Wilcove et al. 1998). In an analysis that identified “irreplaceable” places for preventing species extinctions (Stein et al. 2000), the South Coast Ecoregion stood out as one of the six most important areas in the United States (along with Hawaii, the San Francisco Bay Area, Southern Appalachians, Death Valley, and the Florida Panhandle). The ecoregion is part of the California Floristic Province, one of 25 global hotspots of biodiversity, and the only one in North America (Mittermeier et al. 1998, Mittermeier et al. 1999).

A major reason for regional declines in native species is the pattern of habitat loss. Species that once moved freely through a mosaic of natural vegetation types are now confronted with a man-made labyrinth of barriers, such as roads, homes, businesses, and agricultural fields that fragment formerly expansive natural landscapes. Movement patterns crucial to species survival are being permanently altered at unprecedented rates. Countering this threat requires a systematic approach for identifying, protecting, and restoring functional connections across the landscape to allow essential ecological processes to continue operating as they have for millennia.

A Statewide Vision

In November 2000, a coalition of conservation and research organizations (California State Parks, California Wilderness Coalition, The Nature Conservancy, Zoological Society of San Diego's Center for Reproduction of Endangered Species, and U.S. Geological Survey) launched a statewide interagency workshop at the San Diego Zoo entitled "Missing Linkages: Restoring Connectivity to the California Landscape". The workshop brought together over 200 land managers and conservation ecologists representing federal, state, and local agencies, academic institutions, and non-governmental organizations to delineate habitat linkages critical for preserving the State's biodiversity. Of the 232 linkages identified at the workshop, 69 are associated with the South Coast Ecoregion (Penrod et al. 2001).

Figure 1. South Coast Ecoregion encompasses roughly 8% of California and extends 300 km (190 mi) into Baja California.

South Coast Missing Linkages: A Vision for the Ecoregion

Following the statewide Missing Linkages conference, South Coast Wildlands, a non-profit organization established to pursue habitat connectivity planning in the South Coast Ecoregion, brought together regional ecologists to conduct a formal evaluation of these 69 linkages. The evaluation was designed to assess the biological irreplaceability and vulnerability of each linkage (*sensu* Noss et al. 2002). Irreplaceability assessed the relative biological value of each linkage, including both terrestrial and aquatic criteria: 1) size of habitat blocks served by the linkage; 2) quality of existing habitat in the smaller habitat block; 3) quality and amount of existing habitat in the proposed linkage; 4) linkage to other ecoregions or key to movement through the ecoregion; 5) facilitation of seasonal movement and responses to climatic change; and 6) addition of value for aquatic ecosystems. Vulnerability was evaluated using recent high-resolution aerial

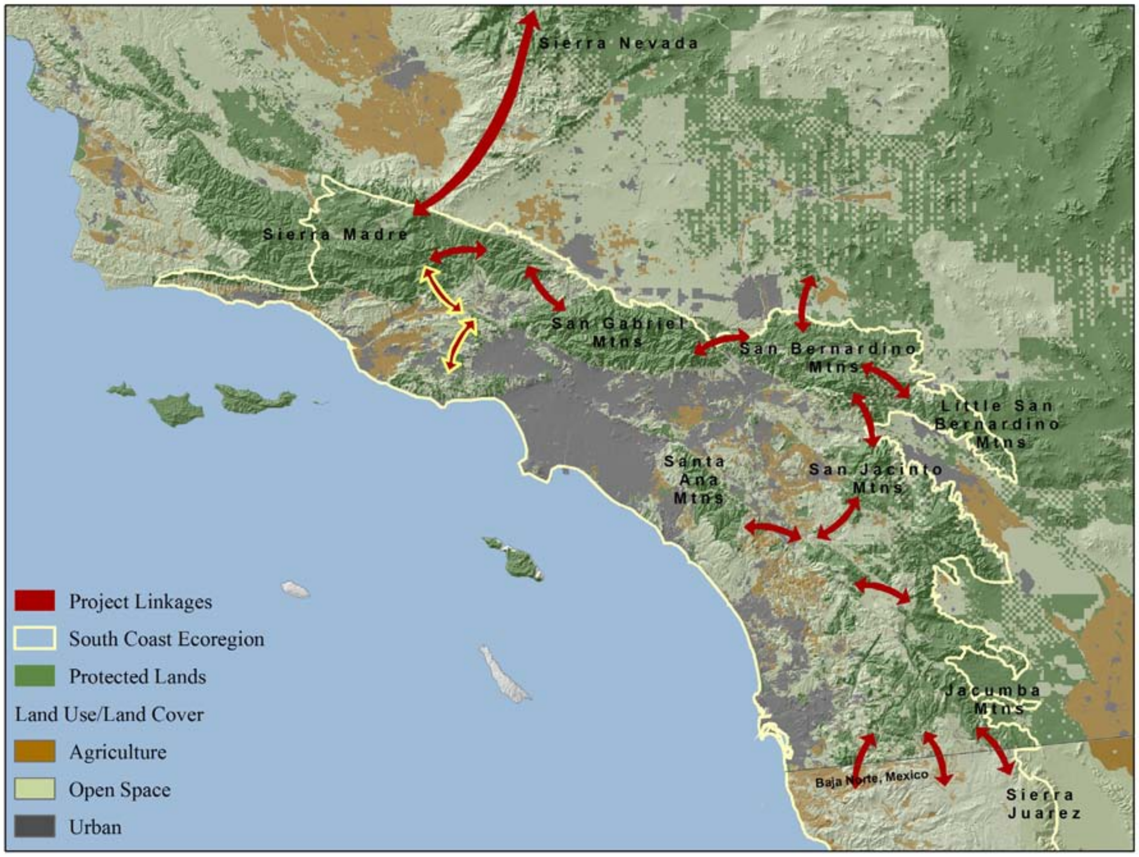


Figure 2. The South Coast Missing Linkages Project addresses habitat fragmentation at a landscape scale, and the needs of a variety of species. The Santa Monica-Sierra Madre Connection is a chain of linkages that connect the Santa Monica, Simi, Santa Susana, and Sierra Madre ranges, addressing two of the 15 landscape linkages identified as irreplaceable and imminently threatened.

photographs, local planning documents, and other data concerning threats of habitat loss or fragmentation in the linkage area. This process identified 15 linkages of crucial biological value that are likely to be irretrievably compromised by development projects over the next decade unless immediate conservation action occurs (Figure 2). The biological integrity of several thousand square miles of the very best southern California wildlands would be irreversibly jeopardized if these linkages were lost.

Identification of these 15 priority linkages launched the South Coast Missing Linkages Project. This project is a highly collaborative effort among federal and state agencies and non-governmental organizations to identify and conserve landscape-level habitat linkages to protect essential biological and ecological processes in the South Coast Ecoregion. Partners include but are not limited to: South Coast Wildlands, The Wildlands Conservancy, The Resources Agency California Legacy Project, California State Parks, California State Parks Foundation, United States Forest Service, National Park Service, Santa Monica Mountains Conservancy, The Nature Conservancy, Rivers and Mountains Conservancy, Conservation Biology Institute, San Diego State University Field Stations Program, Southern California Wetlands Recovery Project, Environment Now, Mountain Lion Foundation, and the Zoological Society of San Diego's Center for

Reproduction of Endangered Species (now called Conservation and Research for Endangered Species). Cross-border alliances have also been formed with Pronatura, Universidad Autonoma de Baja California, and Conabio to further the South Coast Missing Linkages initiative in northern Baja. It is our hope that the South Coast Missing Linkages Project will serve as a catalyst for directing funds and attention toward the protection of ecological connectivity for the South Coast Ecoregion and beyond.

To this end, South Coast Wildlands is coordinating and hosting regional workshops, providing resources to partnering organizations, conducting systematic GIS analyses for all 15 linkages, and helping to raise public awareness regarding habitat connectivity needs in the ecoregion. South Coast Wildlands has taken the lead in researching and planning for 8 of the 15 linkages; while the National Park Service at Santa Monica Mountains National Recreation Area, Santa Monica Mountains Conservancy, The Nature Conservancy, San Diego State University Field Station Programs, California State Parks, U. S. Forest Service, and Conservation Biology Institute have taken the lead on the other 7 linkages. The Santa Monica-Sierra Madre Connection addresses two of these 15 linkages, whose protection is crucial to maintaining ecological and evolutionary processes among large blocks of protected habitat within the South Coast Ecoregion.

The 15 Priority Linkages

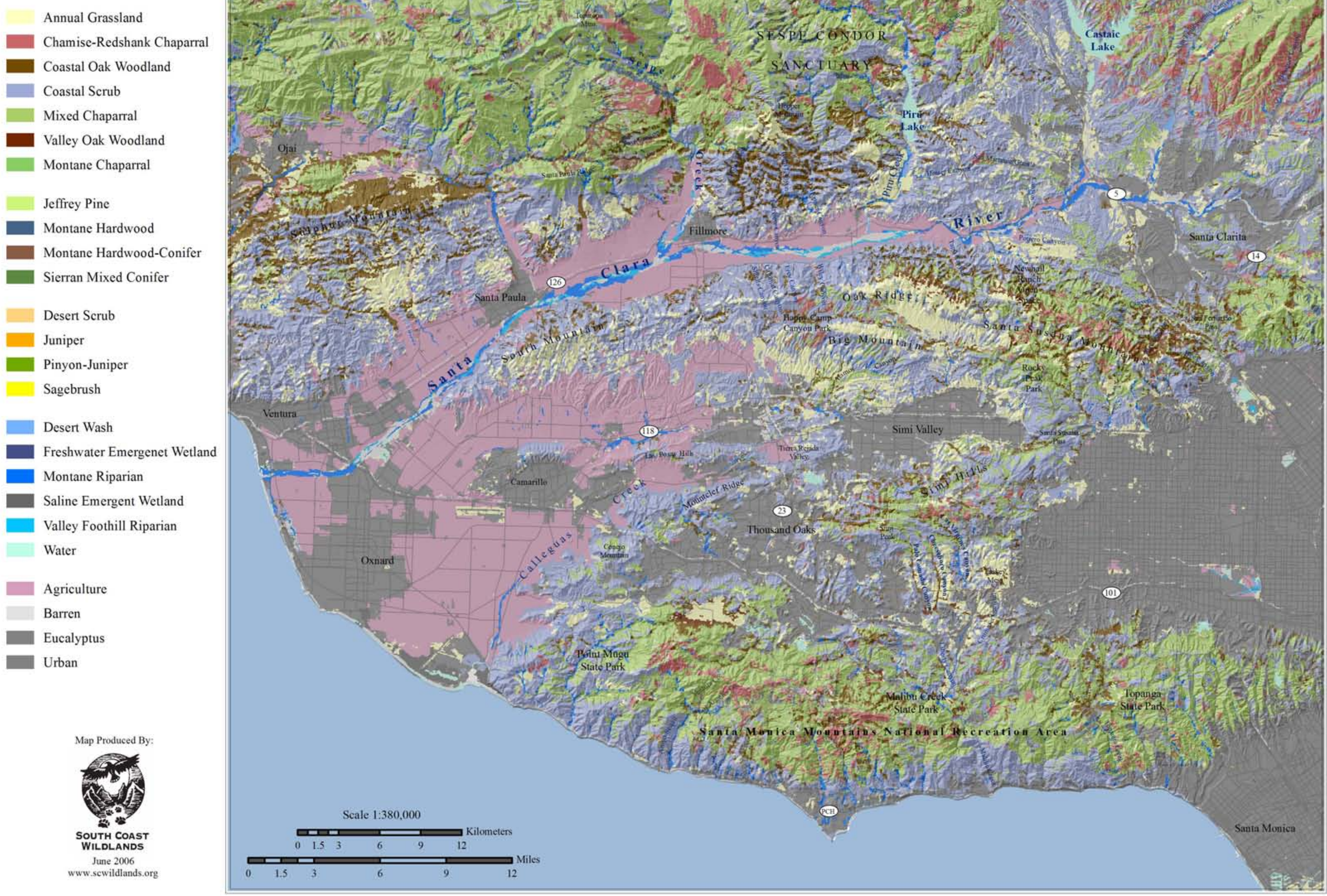
Santa Monica Mountains-Santa Susana Mountains
Santa Susana Mountains-Sierra Madre Mountains
Sierra Madre Mountains-Castaic Ranges
Sierra Madre Mountains-Sierra Nevada Mountains
San Gabriel Mountains-Castaic Ranges
San Bernardino Mountains-San Gabriel Mountains
San Bernardino Mountains-San Jacinto Mountains
San Bernardino Mountains-Little San Bernardino Mountains
San Bernardino Mountains-Granite Mountains
Santa Ana Mountains-Palomar Ranges
Palomar Ranges-San Jacinto/Santa Rosa Mountains
Peninsular Ranges-Anza Borrego
Laguna Mountains-Otay Mountain-Northern Baja
Campo Valley-Laguna Mountains
Jacumba Mountains-Sierra Juarez Mountains

Ecological Significance of the Santa Monica-Sierra Madre Connection

The Santa Monica-Sierra Madre Connection is one of the few coastal to inland connections remaining in the South Coast Ecoregion, stretching from the rugged Santa Monica Mountains at the coast to the gently sloping Simi Hills, and on to the jagged peaks of the Santa Susana Mountains and the Sierra Madre Ranges of Los Padres National Forest. A rich mosaic of natural communities occur in this area, from coast live oak woodland, valley oak savanna, and walnut woodland, to chaparral, coastal sage scrub, grasslands, and diverse riparian forests and woodlands (Figure 3). Coastal sage scrub and chaparral are the dominant plant communities, with scattered groves of coast live oak woodland and walnut woodland on north facing slopes and in ravines, and riparian communities dominated by cottonwood, sycamore, and various willow species along drainages. A number of sensitive natural communities occur in the planning area, including valley foothill riparian, cottonwood willow riparian forest, coast live oak riparian forest, valley oak woodland, and walnut woodland (CDFG 2005). These are some of the most rare vegetation communities in the United States.

This variety of habitats supports a diversity of organisms, including many species listed as endangered, threatened, or sensitive by government agencies (USFWS 1980, 1998,

Figure 3. Vegetation Types in the Planning Area



1999, 2000, 2001, 2002, 2006, CDFG 1996, 2005a, 2005b). A number of rare species depend on the area's riparian communities, which provide breeding locations for many special status amphibians and reptiles, such as California red-legged frog (*Rana aurora draytonii*), arroyo toad (*Bufo californicus*), western pond turtle (*Emys marmorata*), and the two-striped garter snake (*Thamnophis hammondii*). The critically endangered southern steelhead trout (*Oncorhynchus mykiss mykiss*) also occurs in the planning area and both the Malibu Creek Watershed and the Santa Clara River Watershed have been identified as core watersheds for recovery efforts (CDFG 1996). The Pacific lamprey (*Lampetra tridentate*), arroyo chub (*Gila orcutti*), and the endangered tidewater goby (*Eucyclogobius newberryi*) are other native freshwater fish species known to still inhabit the planning area. The creeks and lagoons in the area are also important to resident, over wintering, and migratory birds on the Pacific Flyway, in addition to providing year round habitat and critical resources for resident species. Several riparian songbirds, such as yellow warbler (*Dendroica petechia*), and the endangered least Bell's vireo (*Vireo bellii pusillus*), southwestern willow flycatcher (*Empidonax traillii extimus*), and yellow-billed cuckoo (*Coccyzus americanus*) have the potential to occur in riparian habitats in the linkage. Sensitive reptiles that prefer drier habitats and sparser vegetative cover, such as the coast horned lizard (*Phrynosoma coronatum blainvillei*) also occur, as do a number of sensitive birds of prey, including Swainson's hawk (*Buteo swainsoni*), northern harrier (*Circus cyaneus*), and bald eagle (*Haliaeetus leucocephalus*). The planning area also provides habitat for a number of imperiled plant species, including the San Fernando Valley spineflower (*Chorizanthe parryi* var. *fernandina*), which was presumed extinct in 1929 until it was rediscovered on Ahmanson Ranch in the Simi Hills and Newhall Ranch in the Santa Susana Mountains.

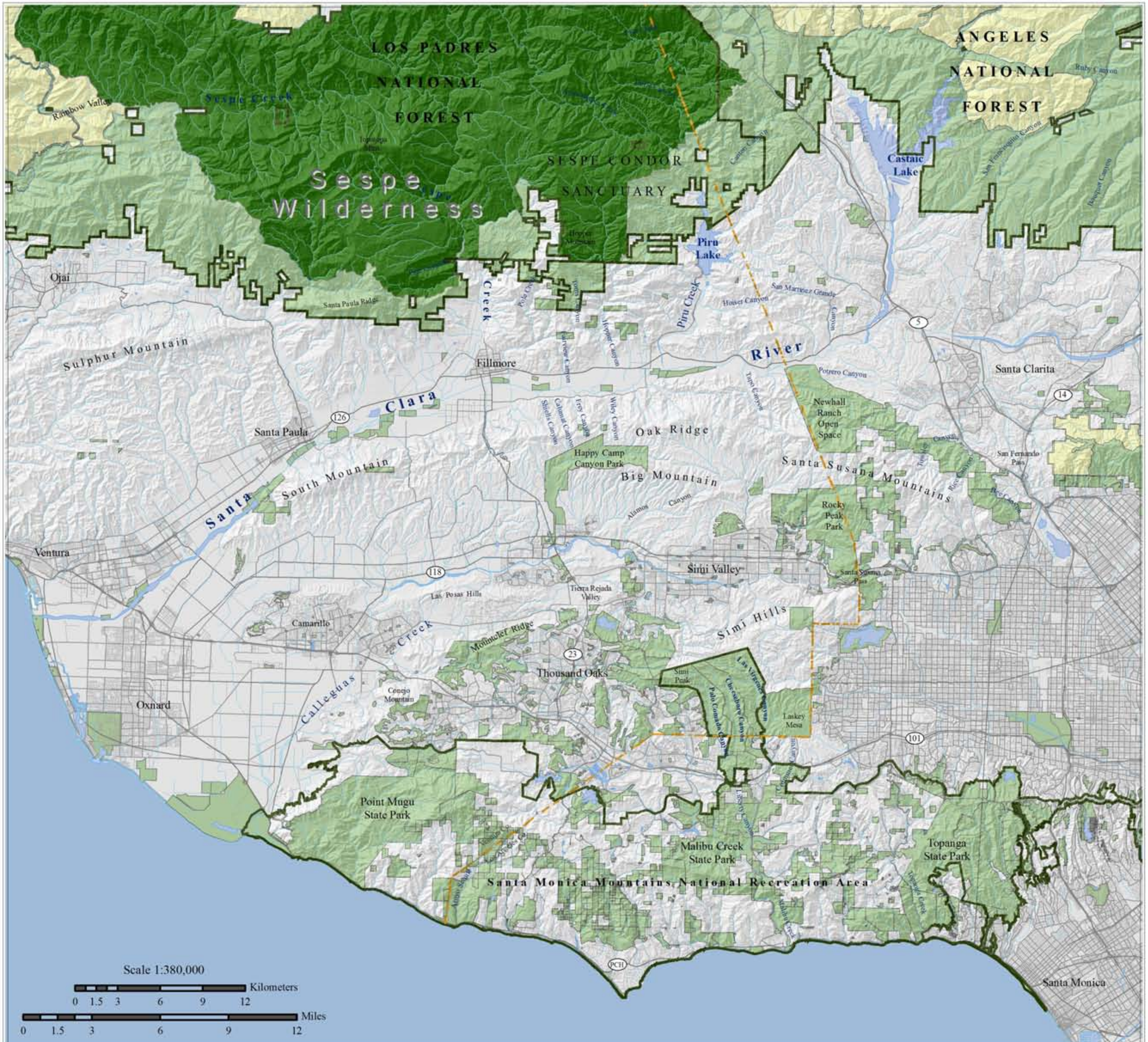
In addition to providing habitat for rare and endangered species, the linkage provides live-in and move-through habitat for numerous native species such as American badger (*Taxidea taxus*), mule deer (*Odocoileus hemionus*), and mountain lion (*Felis concolor*) that require extensive wildlands to thrive. Several peer-reviewed scientific studies have called attention to maintaining connectivity between remaining patches of natural habitat in this region (Soulé 1989, Edelman 1991, Kohn et al. 1999, Ng 2000, Sauvajot et al. 2000, Allen 2001, Riley et al. 2003, Casterline et al. 2003, Ng et al. 2004, LSA 2004, Riley et al. 2005, Riley et al. 2006 a,b).

Existing Conservation Investments

Significant conservation investments already exist in the region (Figure 4), but the resource values they support could be irreparably harmed by loss of connections between them. This linkage connects two expansive core areas that are largely conserved within the Los Padres National Forest and the Santa Monica Mountains National Recreation Area. The Sespe Wilderness Area occurs just inside the boundary of Los Padres National Forest and the California Wild Heritage Campaign (www.californiawild.org) has proposed additional Wilderness Areas in both Los Padres and Angeles National Forests.

Much of the land in the linkage has already been protected though successful conservation planning efforts undertaken by Santa Monica Mountains Conservancy, National Park Service, The Nature Conservancy, California State Parks, U.S. Forest Service, Mountain Recreation Conservation Authority, Mountain Restoration Trust, Friends of the Santa Clara River, and other county, city and local agencies, although

**Figure 4.
Existing Conservation Investments
in the
Planning Area**



- Designated Wilderness
- Proposed Wilderness
- Protected Lands
- Santa Monica Mountains National Recreation Area
- County Boundary
- Lakes & Reservoirs
- Hydrography
- Roads

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

gaps in protection remain. The Santa Monica Mountains Conservancy has been working with other federal, state, county, and local agencies for over 25 years to protect the Rim of the Valley Corridor. The Los Angeles County General Plan update would establish 3 Significant Ecological Areas (SEA): the proposed Santa Monica Mountains SEA (99,430 acres) that crosses the 101 freeway at Liberty and Crummer canyons; the Santa Susana/Simi Hills SEA (26,795 ac) that covers the eastern part of these ranges within the county; and the Santa Clara River SEA which covers the portion of the river in the county (PCR Services Corporation 2000 a, b, c). The value of already protected land in the region for biodiversity conservation, environmental education, outdoor recreation, and scenic beauty is immense.

Southern California's remaining wildlands form an archipelago of natural open space thrust into one of the world's largest metropolitan area within a global hotspot of biological diversity. These wild areas are naturally interconnected; indeed, they historically functioned as one ecological system. However, recent intensive and unsustainable activities threaten to sever natural connections, forever altering the functional integrity of this remarkable natural system. The ecological, educational, recreational, and spiritual impacts of such a severance would be substantial. Certainly, restoring functional habitat connectivity to this regionally important landscape linkage is a wise investment.

Conservation Planning Approach

The goal of linkage conservation planning is to identify specific lands that must be conserved to maintain or restore functional connections for all species or ecological processes of interest, generally between two or more protected core habitat areas. We adopted a spatially hierarchical approach, gradually working from landscape-level processes down to the needs of individual species on the ground. The planning area encompasses habitats between the Santa Monica Mountains National Recreation Area (south of the 101 Freeway) and Los Padres National Forest. We conducted various landscape analyses to identify those areas necessary to accommodate continued movement of selected focal species through this landscape. Our approach can be summarized as follows:

1) *Focal Species Selection:* Select focal species from diverse taxonomic groups to represent a diversity of habitat requirements and movement needs.

2) *Landscape Permeability Analysis:* Conduct landscape permeability analyses to identify a zone of habitat that addresses the needs of multiple species potentially traveling through or residing in the linkage.

3) *Patch Size & Configuration Analysis:* Use patch size and configuration analyses to identify the priority areas needed to maintain linkage function.

4) *Field Investigations:* Conduct fieldwork to ground-truth results of prioritization analyses, identify barriers, and document conservation management needs.

5) *Linkage Design:* Compile results of analyses and fieldwork into a comprehensive report detailing what is required to conserve and improve linkage function.

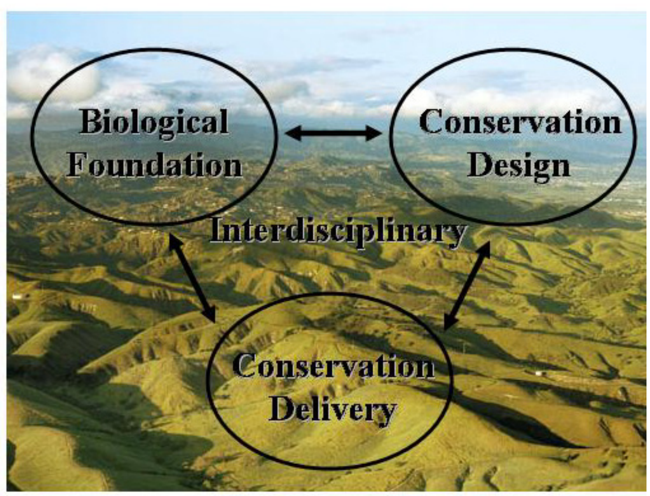


Figure 5. Successful conservation planning requires an interdisciplinary and reiterative approach among biologists, planners and activists (Baxter 2001).

Our approach has been highly collaborative and interdisciplinary (Beier et al. 2005). We followed Baxter (2001) in recognizing that successful conservation planning is based on the participation of experts in biology, conservation design, and implementation in a reiterative process (Figure 5). To engage regional biologists and planners early in the process, we held a habitat connectivity workshop on July 29, 2002. The workshop gathered indispensable information on conservation needs and opportunities in the linkage. The workshop engaged 60 participants representing over 30 different agencies, academic institutions, conservation organizations, and community groups (Appendix A).

Focal Species Selection

The workshop participants identified a taxonomically diverse group of focal species that are sensitive to habitat loss and fragmentation (Table 1). These species represent the diversity of ecological interactions that can be sustained by successful linkage design. The focal species approach (Beier and Loe 1992) recognizes that species move through and utilize habitat in a wide variety of ways. Workshop participants divided into taxonomic working groups; each group identified life history characteristics of species that were either particularly sensitive to habitat fragmentation or otherwise meaningful to linkage design. Participants then summarized the relevant information on species occurrence, movement characteristics, and habitat preferences and delineated suitable habitat and potential movement routes through the linkage region. (For more on the workshop see Appendix B.)

Table 1. Regional ecologists selected 20 focal species for the Santa Monica-Sierra Madre Connection

Plants
Arctostaphylos glauca (Bigberry manzanita)
Quercus lobata (Valley oak)
Juglans californica (California walnut)
Invertebrates
Pogonomyrmex rugosus (Harvester ant)
Euphydryas chalcedona (Chalcedon checkerspot butterfly)
Odonata - Zygoptera spp. (Damselflies)
Anuroctonus phaiodactylus (Scorpion)
Fish
Oncorhynchus mykiss mykiss (Southern steelhead trout)
Reptiles & Amphibians
Cnemidophoris tigris stejnegeri (Western whiptail)
Lampropeltis getula (California kingsnake)
Bufo boreas (Western toad)
Birds
Melanerpes formicivorus (Acorn woodpecker)
Toxostoma redivivum (California thrasher)
Campylorhynchus brunneicapillus (Cactus wren)
Lanius ludovicianus (Loggerhead shrike)
Mammals
Neotoma lepida (Desert woodrat)
Sylvilagus bachmanni (Brush rabbit)
Odocoileus hemionus (Mule deer)
Taxidea taxus (American badger)
Puma concolor (Mountain lion)

The 20 focal species identified at the workshop capture a diversity of movement needs and ecological requirements, from species that require large tracts of land (e.g., mountain lion, badger, mule deer) to those with very limited spatial requirements (e.g., desert woodrat). They include habitat specialists (e.g., acorn woodpeckers in oak woodlands) and those requiring a specific configuration of habitat types and elements (e.g., southern steelhead trout that utilize the entire river or stream system, from the headwaters to the ocean, and require clean, cool, well-oxygenated water). Dispersal distance capability of focal species ranges from 160 m to 274 km; modes of dispersal include walking, flying, swimming, climbing, hopping, and slithering.

Landscape Permeability Analysis

Landscape permeability analysis is a GIS technique that models the relative cost for a species to move between core areas based on how each species is affected by habitat characteristics, such as slope, elevation, vegetation composition, and road density. This analysis identifies a least-cost corridor, or the best potential route for each species between protected core areas (Walker and Craighead 1997, Craighead et al. 2001, Singleton et al. 2002). The purpose of the analysis was to identify land areas, which would best accommodate all focal species living in or moving through the linkage (Beier et al. 2005). Species used in landscape permeability analysis must be carefully chosen, and were included in this analysis only if:

- We know enough about the movement of the species to reasonably estimate the cost-weighted distance using the data layers available to our analysis.
- The data layers in the analysis reflect the species' ability to move.
- The species occurs in both cores (or historically did so and could be restored) and can potentially move between cores, at least over multiple generations.
- The time scale of gene flow between core areas is shorter than, or not much longer than, the time scale at which currently mapped vegetation is likely to change due to disturbance events and environmental variation (e.g. climatic changes).

Three of the 20 focal species were found to meet these criteria and were used in permeability analyses to identify the least-cost corridor between protected core areas: mountain lion, badger, and mule deer. Ranks and weightings adopted for each species are shown in Table 2.

The relative cost of travel was assigned for each of these three species based upon its ease of movement through a suite of landscape characteristics (vegetation type, road density, and topographic features). The following spatial data layers were assembled at 30-m resolution: vegetation, roads, elevation, and topographic features (Figure 6). We derived four topographic classes from elevation and slope models: canyon bottoms, ridgelines, flats, or slopes. Road density was measured as kilometers of paved road per square kilometer. Within each data layer, we ranked all categories between 1 (preferred) and 10 (avoided) based on focal species preferences as determined from available literature and expert opinion regarding how movement is facilitated or hindered by natural and urban landscape characteristics. Each input category was ranked and weighted, such that: (Vegetation * w%) + (Road Density * x%) + (Topography * y%) + (Elevation * z%) = Cost to Movement, where w + x + y + z = 100%.

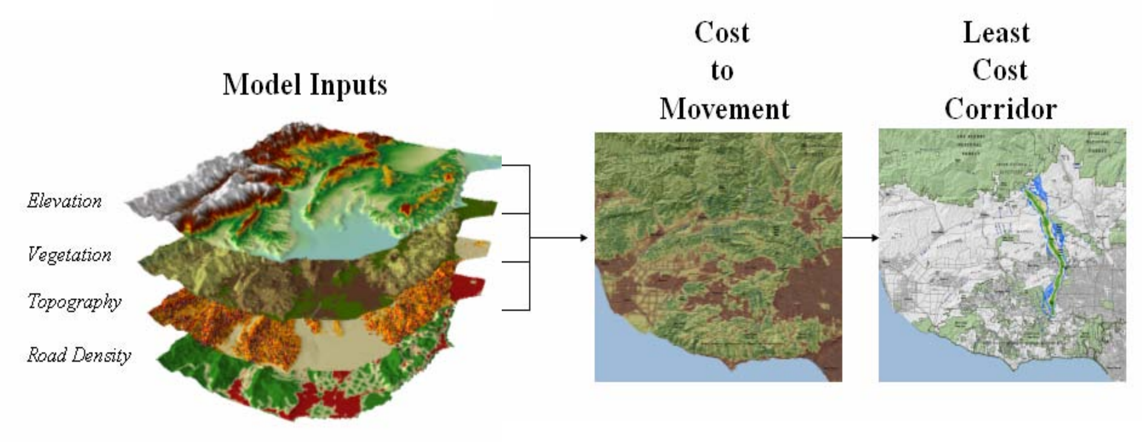


Figure 6. Permeability Model Inputs: elevation, vegetation, topography, and road density. Landscape permeability analysis models the relative cost for a species to move between core areas based on how each species is affected by various habitat characteristics.

Table 2. Model Parameters for Landscape Permeability Analyses

	Odocoileus hemionus (Mule deer)	*Taxidea taxus* (Badger)	*Puma concolor* (Mountain lion)
MODEL VARIABLES			
VEGETATION			
Alpine-Dwarf Shrub	9	4	4
Agriculture	9	7	10
Annual Grassland	9	1	7
Alkali Desert Scrub	10	2	7
Barren	10	9	10
Bitterbrush	3	3	2
Blue Oak-Foothill Pine	1	5	3
Blue Oak Woodland	1	5	2
Coastal Oak Woodland	1	5	2
Closed-Cone Pine-Cypress	3	6	5
Chamise-Redshank Chaparral	6	4	5
Coastal Scrub	3	4	2
Desert Riparian	4	3	1
Desert Scrub	9	2	7
Desert Succulent Shrub	8	2	7
Desert Wash	5	3	2
Eastside Pine	1	5	5
Estuarine	10	10	5
Freshwater Emergent Wetland	9	9	2
Jeffrey Pine	2	5	5
Joshua Tree	8	2	4
Juniper	5	3	3
Lacustrine	10	9	10
Lodgepole Pine	5	6	5
Mixed Chaparral	6	4	5
Montane Chaparral	5	4	5
Montane Hardwood-Conifer	1	6	3
Montane Hardwood	1	6	3
Montane Riparian	2	6	1
Perennial Grassland	7	1	6
Pinyon-Juniper	4	3	3
Palm Oasis	7	6	3
Ponderosa Pine	2	5	5
Riverine	9	9	1
Red Fir	4	6	5
Subalpine Conifer	6	6	5
Saline Emergent Wetland	10	10	6
Sagebrush	5	3	7
Sierran Mixed Conifer	2	6	5
Urban	10	10	10

Table 2. Continued	*Odocoileus hemionus* (Mule deer)	*Taxidea taxus* (Badger)	*Puma concolor* (Mountain lion)
MODEL VARIABLES			
Valley Oak Woodland	1	4	2
Valley Foothill Riparian	1	4	2
Water	10	10	9
White Fir	2	6	5
Wet Meadow	5	4	6
Unknown Shrub Type	5	5	5
Unknown Conifer Type	4	5	5
Eucalyptus	8	6	6
ROAD DENSITY			
0-0.5 km/sq. km	1	1	1
0.5-1 km/sq. km	1	1	3
1-2 km/sq. km	2	2	4
2-4 km/sq. km	5	2	6
4-6 km/sq.km	7	4	9
6-8 km/sq. km	10	7	10
8-10 km/sq.km	10	10	10
10 or more km/sq. km	10	10	10
TOPOGRAPHY			
Canyon bottoms	5	2	1
Ridgetops	2	7	7
Flats	8	1	3
Slopes	1	9	5
ELEVATION (feet)			
-260-0	6	1	N/A
0-500	4	1	
500-750	3	1	
750-1000	3	1	
1000-3000	3	2	
3000-5000	3	3	
5000-7000	3	3	
7000-8000	5	5	
8000-9000	5	5	
9000-11500	5	5	
>11500	8	8	
WEIGHTS			
Land Cover	0.65	0.55	0.40
Road Density	0.15	0.15	0.30
Topography	0.20	0.20	0.30
Elevation	0.00	0.10	0.00

Weighting allowed the model to capture variation in the influence of each input (vegetation, road density, topography, elevation) on focal species movements. A unique cost surface was thus developed for each species. A corridor function was then performed in GIS to generate a data layer showing the relative degree of permeability between core areas.

Running the permeability analysis required identifying the endpoints to be connected. Usually, these targeted endpoints are selected as medium to highly suitable habitat within protected core habitat areas (e.g., National Forests, State Parks) that needed to be connected through currently unprotected lands. However, since some of the land in the linkage was already protected (e.g., Ahmanson Ranch, Rocky Peak Park), and because of the complexity of ownerships in the Santa Monica Mountains, we selected endpoints for this analysis as areas supporting medium to highly suitable habitat for each species in Los Padres and Angeles National Forests within the analysis extent, and the Santa Monica Mountains National Recreation Area south of the 101 Freeway, near the far northern and southern extents of the study area. This gave the model broad latitude in interpreting functional corridors across the entire study area.

For each focal species, the most permeable area of the study window was designated as the least-cost corridor. An arbitrary definition of “most permeable” was assigned such that only the areas representing the top 1% of the least cost corridor function were included in the final output. In some instances (e.g. mountain lion), we relaxed the top 1% criteria to examine the sensitivity of mapped output to this constraint and to assess if and how least cost results would change. However, in our final analysis and in the mapped results presented in this report, the “most permeable” routes are shown for the top 1% output for each of the three focal species (and for the Least Cost Union, see below).

The least-cost corridor output for all three species was then combined to generate a Least Cost Union. The biological significance of this Union can best be described as the zone within which all three modeled species would encounter the least energy expenditure (i.e., preferred travel route) and the most favorable habitat as they move between targeted protected areas. The output does not identify barriers (which were later identified through fieldwork), mortality risks, dispersal limitations or other biologically significant processes that could prevent a species from successfully reaching a core area. Rather, it identifies the best zone available for focal species movement based on the data layers used in the analyses.

Patch Size & Configuration Analysis

Although the Least-Cost Union identifies the best zone available for movement based on the data layers used in the analyses, it does not address whether suitable habitat in the Union occurs in large enough patches to support viable populations and whether these patches are close enough together to allow for inter-patch dispersal. We therefore conducted patch size and configuration analyses for all focal species (Table 1) and adjusted the boundaries of the Least Cost Union where necessary to enhance the likelihood of movement. Patch size and configuration analyses are particularly important for species that require multiple generations to traverse the linkage. Many species exhibit metapopulation dynamics, whereby the long-term persistence of a local population requires connection to other populations (Hanski and Gilpin 1991). For relatively sedentary species like desert woodrat and terrestrial insects, gene flow will occur over decades through a metapopulation. Thus, the linkage must be able to accommodate metapopulation dynamics to support ecological and evolutionary processes in the long term.

A habitat suitability model formed the basis of the patch size and configuration analyses. Habitat suitability models were developed for each focal species using the literature and expert opinion. Spatial data layers used in the analysis varied by species and included: vegetation, elevation, topographic features, slope, aspect, hydrography, and soils. Using scoring and weighting schemes similar to those described in the previous section, we generated a spectrum of suitability scores that were divided into five classes using natural breaks: low, low to medium, medium, medium to high, or high. Suitable habitat was identified as all land that scored medium, medium to high, or high.

To identify areas of suitable habitat that were large enough to provide a significant resource for individuals in the linkage, we conducted a patch size analysis. The size of all suitable habitat patches in the planning area were identified and marked as potential cores, patches, or less than a patch. *Potential core areas* were defined as the amount of contiguous suitable habitat necessary to sustain at least 50 individuals. A *patch* was defined as the area of contiguous suitable habitat needed to support at least one male and one female, but less than the potential core area. Potential cores are probably capable of supporting the species for several generations (although with erosion of genetic material if isolated). Patches can support at least one breeding pair of animals (perhaps more if home ranges overlap greatly) and are probably useful to the species if the patch can be linked via dispersal to other patches and core areas (Figure 7).

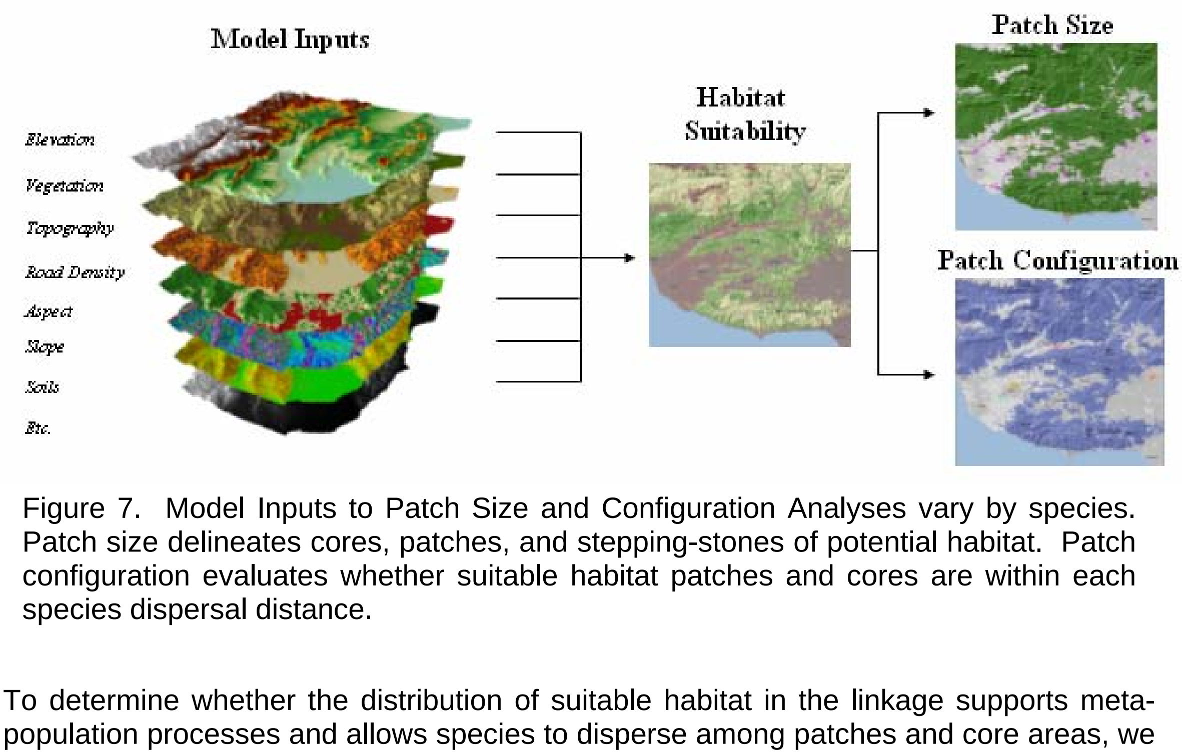


Figure 7. Model Inputs to Patch Size and Configuration Analyses vary by species. Patch size delineates cores, patches, and stepping-stones of potential habitat. Patch configuration evaluates whether suitable habitat patches and cores are within each species dispersal distance.

To determine whether the distribution of suitable habitat in the linkage supports meta-population processes and allows species to disperse among patches and core areas, we conducted a configuration analysis to identify which patches and core areas were functionally isolated by distances too great for the focal species to traverse. Because the majority of methods used to document dispersal distance underestimate the true value (LaHaye et al. 2001), we assumed each species could disperse twice as far as the longest documented dispersal distance. This assumption is conservative in the sense that it retains habitat patches as potentially important to dispersal for a species even if it may appear to be isolated based on known dispersal distances. Groupings of core areas and patches that were greater than the adopted dispersal distance from other suitable habitat were identified using a unique color.

For each species we compared the configuration and extent of potential cores and patches, relative to the species dispersal ability, to evaluate whether the Least Cost Union was likely to serve the species. If necessary, we added additional habitat to help ensure that the linkage provides sufficient live-in or “move-through” habitat for the species’ needs.

Minimum Linkage Width

While the size and distance among habitats (addressed by patch size and configuration analyses) must be adequate to support species movement, the shape of those habitats also plays a key role. In particular, constriction points—areas where habitats have been narrowed by surrounding development—can prevent organisms from moving through the Least Cost Union. To ensure that functional processes are protected, we imposed a minimum width of 2 km (1.2 mi) for all portions of the final Linkage Design.

For a variety of species, including those we did not formally model, a wide linkage helps ensure availability of appropriate habitat, host plants (e.g., for butterflies), pollinators, and areas with low predation risk. In addition, fires and floods are part of the natural disturbance regime and a wide linkage allows for a semblance of these natural disturbances to operate with minimal constraints from adjacent urban areas. A wide linkage should also enhance the ability of the biota to respond to climate change, and buffer against edge effects.

Field Investigations

We conducted field surveys to ground-truth existing habitat conditions, document existing barriers and potential passageways, and describe restoration opportunities. All location data were recorded using a mobile GIS/GPS with ESRI’s ArcPad. Because paved roads often present the most formidable potential barriers, biologists drove or walked each accessible section of paved road that transected the linkage. All types of potential crossing structures (e.g., bridge, underpass, overpass, culvert, pipe) were photo documented and measured. Data taken for each crossing included: shape; height, width, and length of the passageway; stream type, if applicable (perennial or intermittent); floor type (metal, dirt, concrete, natural); passageway construction (concrete, metal, other); visibility to other side; light level; fencing; and vegetative community within and/or adjacent to the passageway. Existing highways and crossing structures are not considered permanent landscape features. In particular, crossing structures can be added or improved during projects to widen and realign highways and interchanges. Therefore, we also identified areas where crossing structures could be improved or installed, and opportunities to restore vegetation to improve road crossings and minimize roadkills.

Identify Conservation Opportunities

The Linkage Design serves as the target area for linkage conservation opportunities. We provided biological and land use summaries, and identified implementation opportunities for agencies, organizations, and individuals interested in helping conserve the Santa Monica-Sierra Madre Connection. Biological and land use summaries include descriptions and maps of vegetation, land cover, land use, roads, road crossings, and restoration opportunities. We also identified existing planning efforts addressing the conservation and use of natural resources in the planning area. Finally, we developed a flyover animation using aerial imagery, satellite imagery, and digital elevations models, which provides a visualization of the linkage from a landscape perspective (Appendix C).

Landscape Permeability Analyses

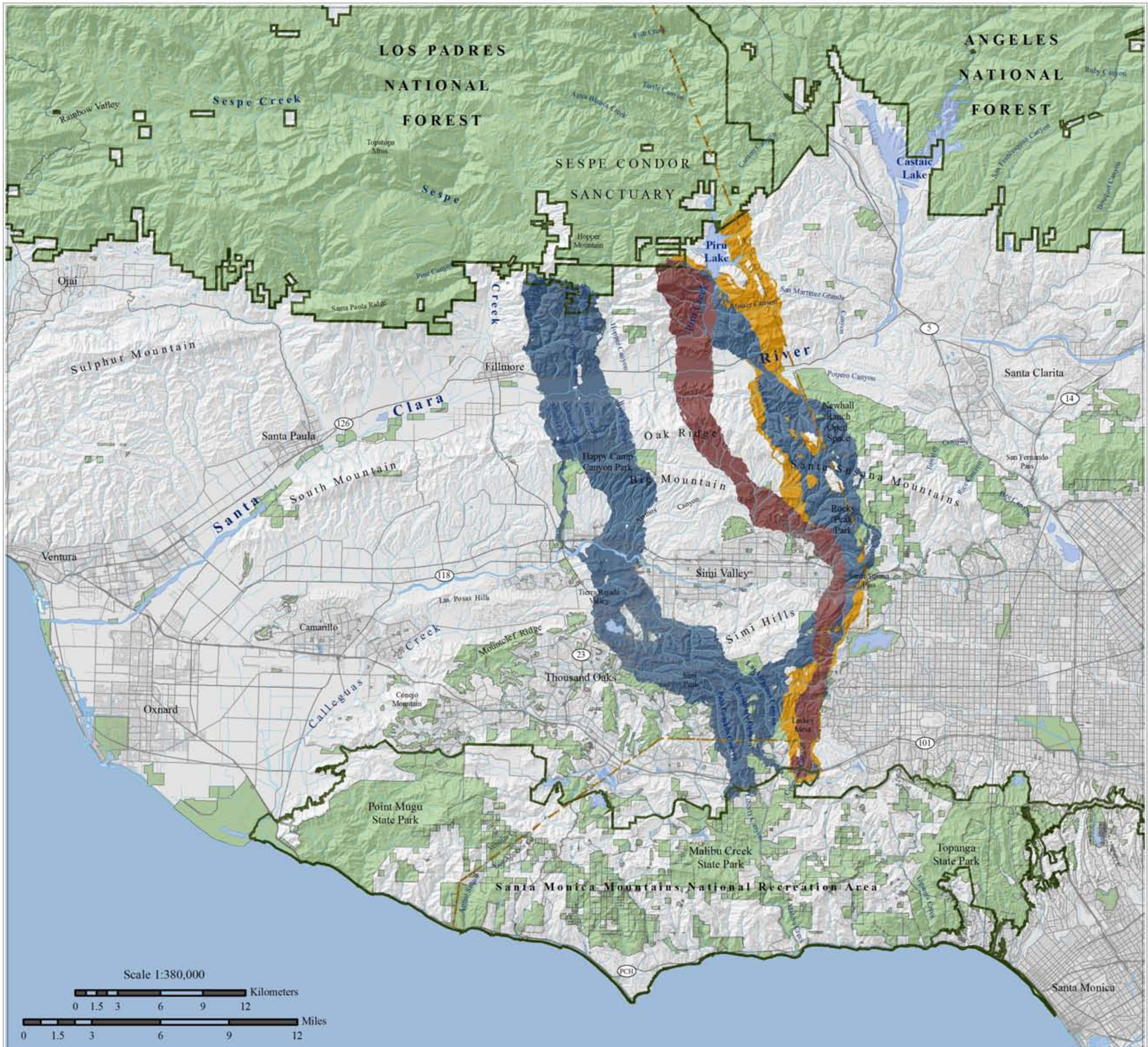
We conducted landscape permeability analyses for three focal species (mountain lion, badger, and mule deer). The least cost corridors for these species were quite similar despite their diverse ecological and movement requirements (see following species accounts in this section and Table 2 in the previous section). The most permeable paths for these focal species converged and overlapped considerably in the eastern part of the linkage, with two species, mule deer and badger, diverging to generate additional routes that also contain highly suitable habitat for mountain lions (Figure 8).

The Least Cost Union (i.e., the union of the top 1% of the least cost corridors for all three species) stretches about 40 km (25 mi) between the Santa Monica Mountains National Recreation Area and the Sierra Madre Range of Los Padres National Forest (Figure 9). It encompasses diverse vegetation and physiographic zones to account for the needs of the focal species, including coastal sage, chaparral, grassland, oak woodland, riparian woodlands and forests, and conifer habitats.

The branches of the least cost union identify the areas best suited to facilitate species movement between core areas based on model assumptions and available GIS data. All branches of the Union extend from the Santa Monica Mountains in the same general vicinity, crossing the 101 Freeway at Liberty and Crummer canyons, and then merging north of the freeway to take in most habitats in the Simi Hills. From the Simi Hills, all three focal species took the eastern branch, crossing the 118 at the Santa Susana Pass into Rocky Peak Park. From here, mountain lion and mule deer follow the riparian habitats of Tapo and Salt canyons down to the Santa Clara River and then cross Highway 126 to take in habitat in Piru Creek, Hoiser Canyon, and upper San Martinez Grande Canyon. The permeability analysis for badger follows preferred habitat for this species to the west, taking in the grasslands over Oak Ridge and up the western bank of Piru Creek, delineating another branch to the Union in the Santa Susana Mountains. Mule deer also delineated the western branch of the linkage, which was identified as the most permeable route for this species. The western branch takes in habitat in Palo Comado, Cheeseboro, and Las Virgenes canyons in the Simi Hills, and crosses over Simi Peak and through the Tierra Rejada Valley to traverse Highway 118 at Alamos Canyon and enter the Santa Susana Mountains. From here, mule deer utilizes habitat in Happy Camp Canyon Park, and then follows Sheils, Calumat, Frey, and Wiley canyons down to the Santa Clara River, and then up Pole Creek, Fairview and Toms canyons in the Sierra Madre Ranges. The western branch of the Union ranges in width from about 3 to 6 km (1.9 to 3.7 mi), the central branch from roughly 1.5 to 3 km (0.9 to 1.9 mi), and the eastern branch from approximately 1.5 to 8 km (0.9 to 5.0 mi).

The next several pages summarize the permeability analyses for each of the three modeled species. For convenience, the narratives describe the most permeable paths from south to north, although our analyses gave equal weight to movements in both directions. The following section (Patch Size and Configuration Analyses) describes how well the Least Cost Union would likely serve the needs of all focal species, including those for which we could not conduct permeability analysis. The latter analysis expanded the Least Cost Union to provide for critical live-in and/or move-through habitat for particular focal species.

Figure 8.
Least Cost Union
Displaying Species Overlap



- Mountain lion
- Mule deer
- Badger
- Target Areas
- Protected Lands
- County Boundary
- Lakes & Reservoirs
- Hydrography
- Roads

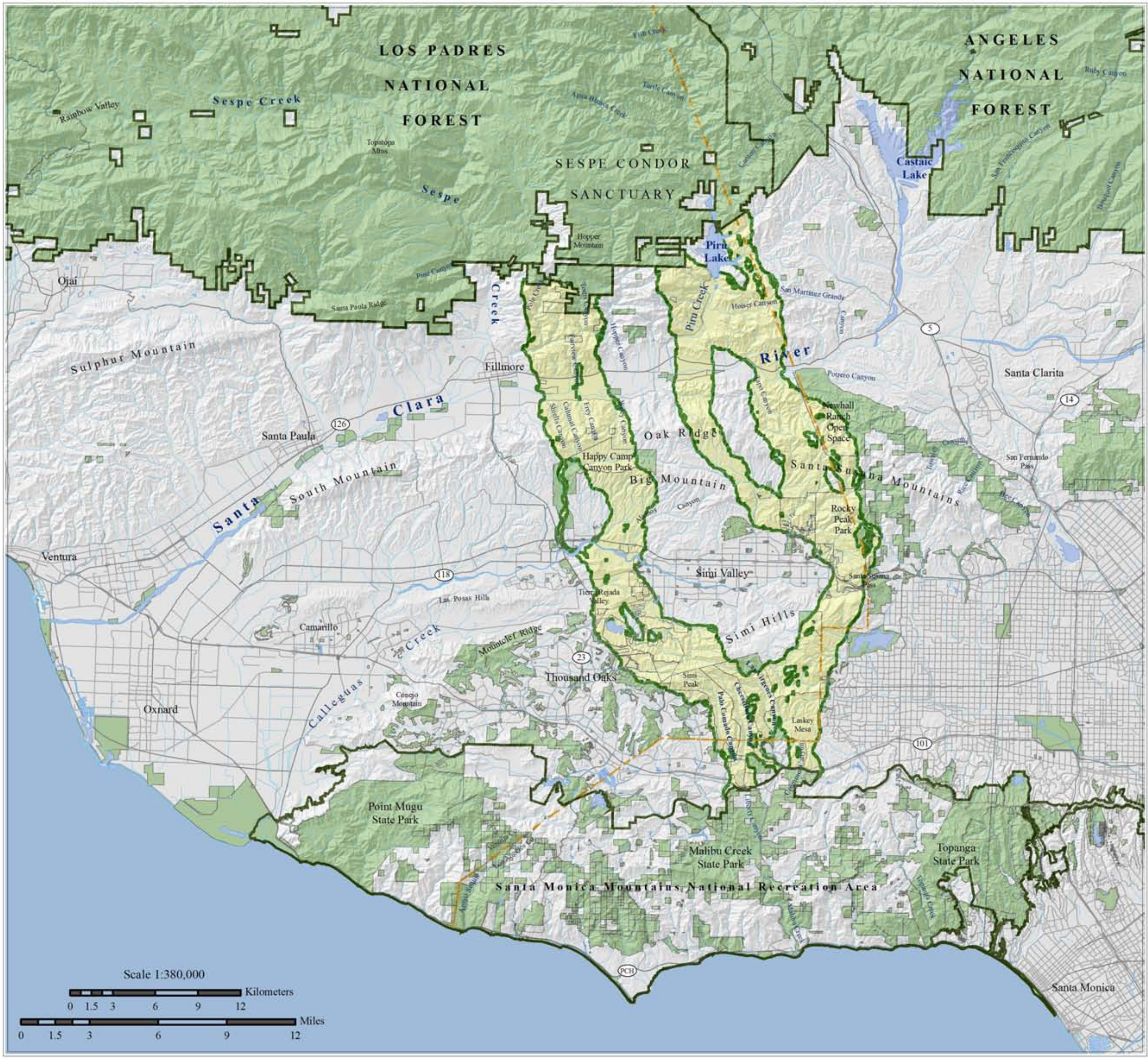
Map Produced By:

SOUTH COAST WILDLANDS

June 2006

www.scwildlands.org

Figure 9.
Least Cost Union



Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Mountain lion (*Puma concolor*)

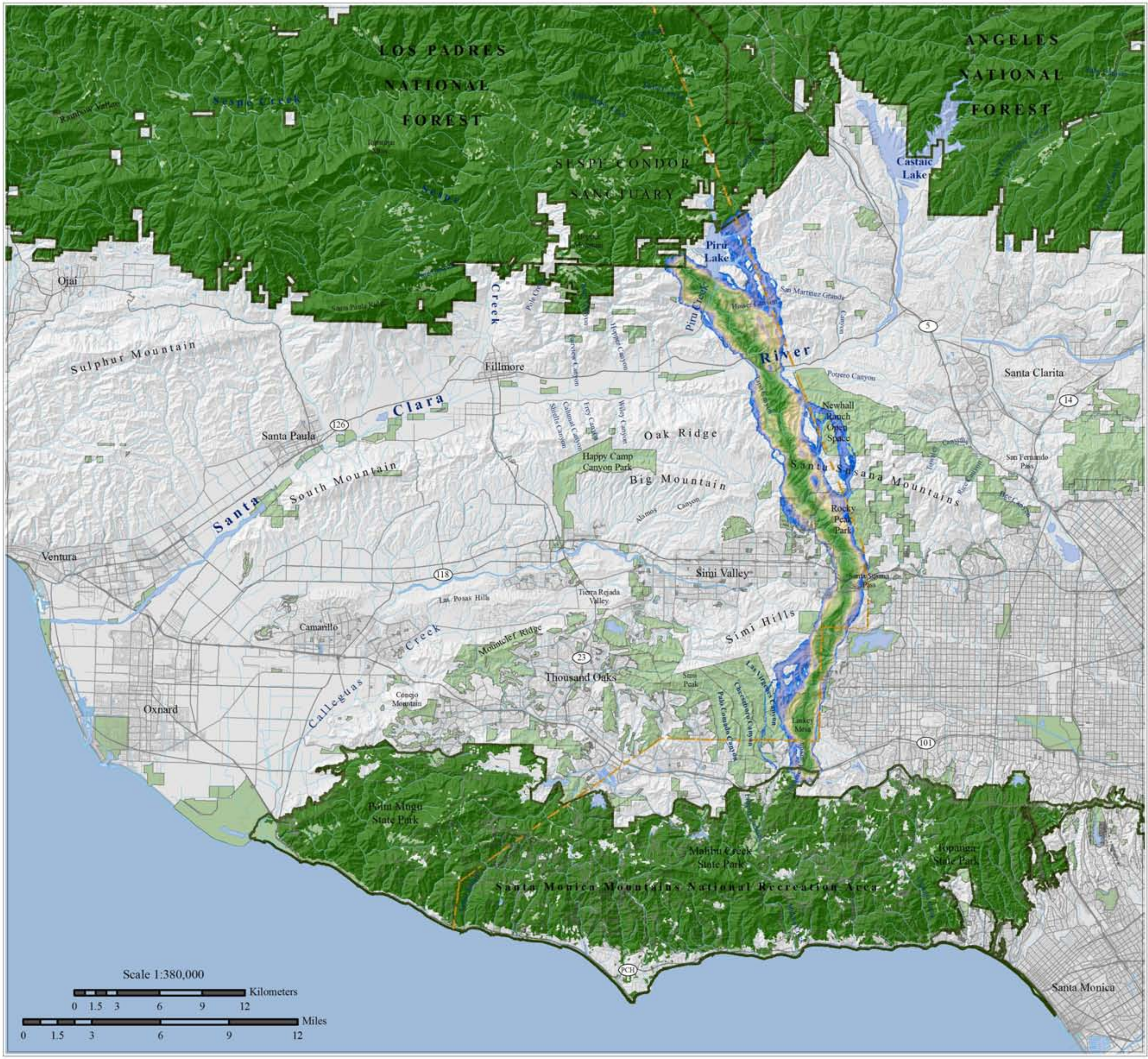
Justification for Selection: This area-sensitive species is an appropriate focal species because its naturally low densities render mountain lions highly sensitive to habitat fragmentation (Noss 1991, Noss and Cooperrider 1994). Consequently mountain lions serve as excellent indicators of broad scale landscape connectivity (Riley et al. 2006). The ecological consequences of losing large carnivores from complex ecosystems is largely unknown and difficult to predict, but may have cascading effects through the entire ecosystem (Soulé and Terborgh 1999). Regardless, loss of this species from southern California, and from the Sierra Madre-Santa Monica Mountains region in particular, would run counter to extensive public investments in parks and open spaces designed to protect biodiversity for future generations to enjoy, understand, and appreciate (Riley et al. 2005). Mountain lions have already lost a number of dispersal corridors in southern California, making them susceptible to extirpation from existing protected areas (Beier 1993). Habitat fragmentation caused by urbanization and the extensive road network has had detrimental effects on mountain lions by restricting movement, escalating mortality, and increasing contact with humans.

Conceptual Basis for Model Development: Mountain lions use brushy stages of a variety of habitat types with good cover (Spowart and Samson 1986, Zeiner et al. 1990). Within the study area, mountain lions are known to occupy a wide variety of habitat types, including within the urban interface and in parklands used extensively by recreating humans (Riley et al. 2006). Preferred travel routes are along stream courses and gentle terrain, but all habitats with cover are used (Beier and Barrett 1993, Dickson et al. 2004). In southern California, grasslands, agricultural areas, and human-altered landscapes are avoided (Dickson et al. 2004), although mountain lions can and will use these less-than-ideal habitats (Riley et al. 2006). Dirt roads do not impede movement, but highways, residential roads, and 2-lane paved roads can (Beier and Barrett 1993, Beier 1995, Dickson et al. 2004). Juvenile dispersal distances average 32 km (20 mi) for females, with a range of 9-140 km (6-87 mi), and 85 km (53 mi) for males, with a range of 23-274 km (14-170 mi; Anderson et al. 1992, Sweanor et al. 2000). The somewhat shorter dispersal distances reported in southern California (Beier 1995) reflect the fragmented nature of Beier's study area. Please see Table 2 for model variable scorings for this species. Cost to movement for mountain lion was defined by weighting the inputs as follows:

(Vegetation * 40%) + (Road Density * 30%) + (Topography * 30%)

Results & Discussion: The least cost corridor for mountain lion movement between the Santa Monica and Sierra Madre ranges (Figure 10) varies in width from about 1.5 to 6 km (0.9 to 3.7 mi). The most permeable path extends from the Santa Monica

Figure 10.
Least Cost Corridor
for
Mountain lion
(Puma concolor)



Least Cost Corridor
- Highly Permeable
- Less Permeable
- Suitable Habitat*
- Target Areas
- Protected Lands
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*This analysis was run from medium to high suitable habitat within targeted protected areas.

Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Mountains, crosses the 101 Freeway at Las Virgenes and Crummer Canyons to enter the Simi Hills, heads toward Chatsworth Peak, and crosses the 118 Freeway at Santa Susana Pass into Rocky Peak Park, where both an overpass and bridged underpass are located. From there, the route follows Tapo and Salt Canyons in the Santa Susana Mountains down to the Santa Clara River, and traverses the river and Highway 126 to enter Hoiser Canyon. It then branches to encompass habitat on either side of Piru Lake Reservoir, with the most permeable path following the riparian habitats of Piru Creek to Lime Canyon toward Hopper Mountain in the Sespe Condor Sanctuary, and another route taking in habitat in upper San Martinez Grande Canyon to the east of the reservoir. The analysis captured medium to highly suitable habitat for puma moving between the Santa Monica and Sierra Madre Mountains along their preferred travel routes.

To evaluate the sensitivity of constraining the least cost corridor to the top 1% of the model output, criteria were relaxed and resulting paths were assessed for mountain lion. In general, when criteria were more inclusive (e.g. top 1.5%, 2%, 2.5%, and 3% of model output), the least cost corridors largely overlapped results obtained for mule deer and, to a lesser extent, badger (Figs. 11 and 12). For example, the top 1.5% output for mountain lion adds a north-south linkage from the Los Padres National Forest near Hopper Mountain, through Happy Camp Park in the Santa Susana Mountains, across Highway 118 at Alamos Canyon, through the Tierra Rejada Valley, and ultimately into the Santa Monica Mountains through the Simi Hills via Liberty Canyon. This route is nearly entirely overlapped by the least cost path for mule deer (Fig. 12). These results likely reflect the broad habitat tolerances of all three focal species and the ecological relationships between mountain lion and mule deer. Because of the observed interspecific overlap when criteria were relaxed for mountain lion and our desire to maintain quantitative consistency among the three focal species, we adhered to a definition of "most permeable" as only the top 1% of modeled results. It should be noted, however, that even small increases in the output percentage criteria leads to inclusions of additional paths for each species, with all "least cost paths" broadly overlapping.

American badger (*Taxidea taxus*)

Justification for Selection: The Badger is a highly specialized species that requires open habitats with suitable soils for excavating large burrows (de Vos 1969, Banfield 1974, Zeiner et al. 1990, Sullivan 1996). Badgers require expansive wildlands to survive and are highly sensitive to habitat fragmentation. In fact, roadkill is the primary cause of mortality (Long 1973, Zeiner et al. 1990, Sullivan 1996).

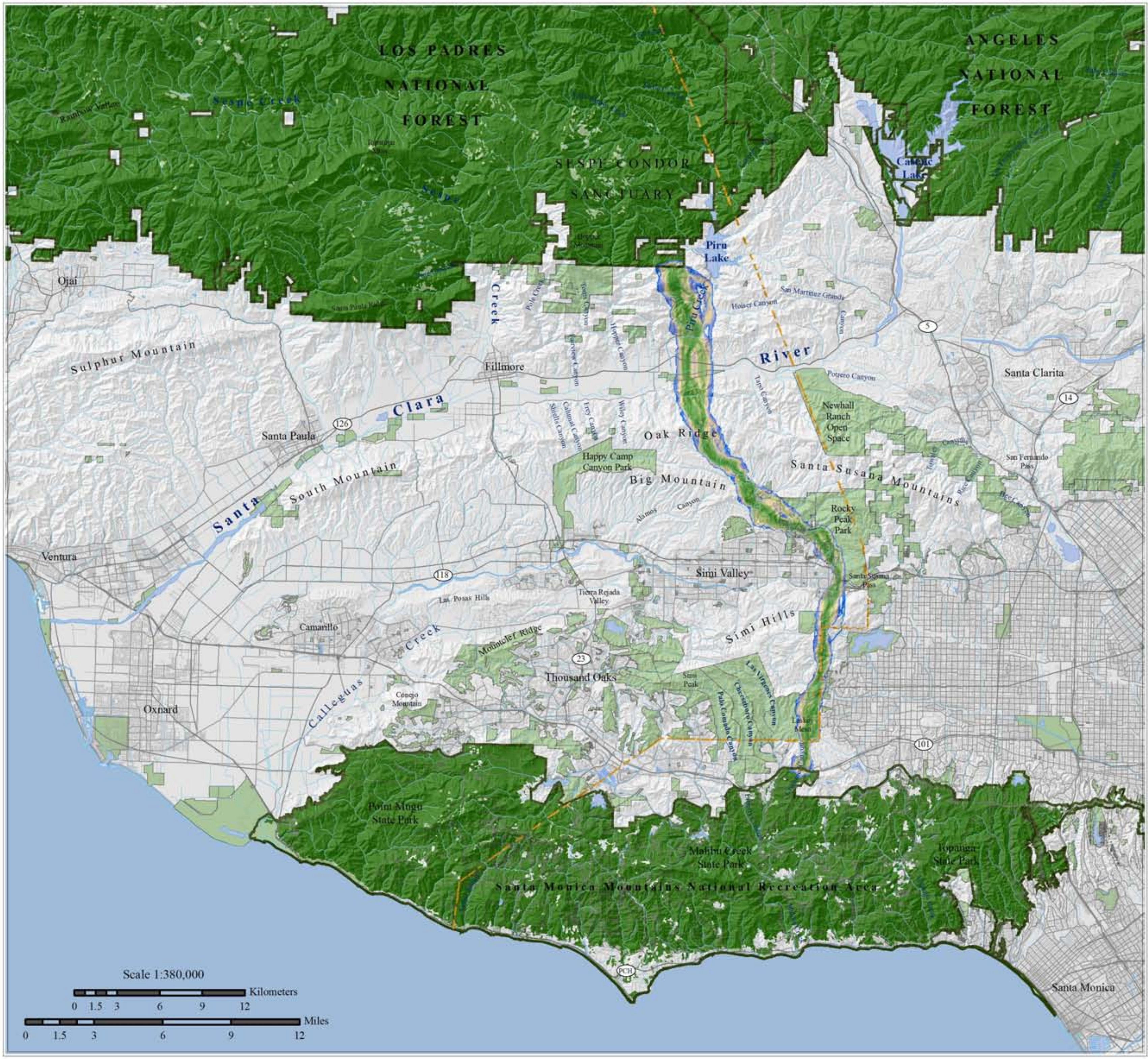
Conceptual Basis for Model Development: Badgers are associated with grasslands, prairies, and other open habitats that support abundant burrowing rodents (de Vos 1969, Banfield 1974, Sullivan 1996) but they may also be found in drier open stages of shrub and forest communities (Zeiner et al. 1990). They are known to inhabit forest and mountain meadows, marshes, riparian habitats, and desert communities including creosote bush, juniper, and sagebrush habitats (Long and Killingley 1983, Zeiner et al. 1990). The species is typically found at lower elevations (Zeiner et al. 1990) in flat, rolling or steep terrain but it has been recorded at elevations up to 3600 m (12000 ft) (Minta 1993).

Badgers can disperse up to 110 km (68 mi; Lindzey 1978), and preferentially move through open scrub habitats, fields, and pastures, and open upland and riparian woodland habitats. Denser scrub and woodland habitats and orchards are less preferred. They avoid urban and intense agricultural areas. Roads are difficult to navigate safely. Please see Table 2 for model variable scorings for this species. Cost to movement for badger was defined by weighting these inputs as follows:

(Vegetation * 0.55) + (Elevation * 0.10) + (Topography * 0.20) + (Road Density *0.15)

Results & Discussion: One strong movement route emerged from the analysis for badger (Figure 11). The least cost corridor for badger extends from the Santa Monica Mountains and traverses the 101 Freeway at Crummer Canyon; it then heads across the grassland and oak savanna habitats of Laskey Mesa in the Simi Hills to cross the 118 Freeway at Santa Susana Pass and enters Rocky Peak Park. The badger route then heads in a northwest direction to follow the grasslands around the fringes of Simi Valley, then takes Tripas Canyon over to Oak Ridge and then down Smith Canyon, which leads to the Santa Clara River; crossing Highway 126 at Piru Creek and heading up the western bank of Piru Creek toward protected habitats in Los Padres National Forest. The least cost corridor for badger varies in width from 1.5 to 3 km (0.9 to 1.9 mi). It includes the most suitable habitat for this highly specialized species moving between protected cores areas, encompassing the gently sloping topography of the grassland and oak savanna habitats wherever possible.

Figure 11.
Least Cost Corridor
for
American badger
(Taxidea taxus)



Least Cost Corridor

- Highly Permeable
- Less Permeable
- Suitable Habitat*
- Target Areas
- Protected Lands
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*This analysis was run from medium to high suitable habitat within targeted protected areas.

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Mule deer (*Odocoileus hemionus*)

Justification for Selection: Mule deer were chosen as a focal species in part to help support viable populations of mountain lions, which rely on deer as their primary prey. Deer herds can decline in response to fragmentation, degradation or destruction of habitat from urban expansion, incompatible land uses and other human activities (Ingles 1965, Hall 1981, CDFG 1983). Mule deer are particularly vulnerable to habitat fragmentation by roads; in fact, nationally vehicles kill several hundred thousand deer each year (Romin and Bissonette 1996, Conover 1997, Forman et al. 2003).

Conceptual Basis for Model Development: Mule deer use forest, woodland, brush, and meadow habitats, and reach their highest densities in oak woodlands, riparian areas, and along edges of meadows and grasslands, although they also occur in open scrub, young chaparral, and low elevation coniferous forests (Bowyer 1986, USFS 2002). Access to a perennial water source is critical in summer.

Dispersal distances of up to 217 km (135 mi) have been recorded for mule deer (Anderson and Wallmo 1984). They preferentially move through habitats that provide good escape cover, preferring ridgetops and riparian routes as major travel corridors. Varying slopes and topographic relief are important for providing shade or exposure to the sun. They avoid open habitats, agricultural and urban land cover, and centers of high human activity, even in suitable habitat. Please see Table 2 for model variable scorings for this species. Cost to movement for mule deer was defined by weighting these inputs as follows:

(Vegetation * 65%) + (Topography * 20%) + (Road Density * 15%)

Results & Discussion: Two potential routes were identified for mule deer traveling between the Santa Monica and Sierra Madre Mountains (Figure 12). The more permeable of the two paths ranges in width from 2 to 6 km (1.2 to 3.7 mi). It extends from Liberty Canyon up Palo Comado and Cheeseboro Canyons to Simi Peak, and through the Tierra Rejada Valley utilizing the coastal sage and grassland habitats between the communities of Simi Valley, Thousand Oaks, and Moorpark. It then traverses the 118 Freeway at Faulker and Alamos Canyons, crosses over Big Mountain and Oak Ridge, and then takes Sheils, Calumat, Frey and Wiley Canyons down to the river and across Highway 126 to follow Pole Creek, Fairview and Toms Canyons into the Los Padres National Forest. The least cost corridor analysis also identified another potential route for mule deer that strongly resembles the output for mountain lion and badger. Both routes encompass medium to highly suitable habitat for mule deer.

Figure 12.
Least Cost Corridor
for
Mule deer
(Odocoileus hemionus)

Least Cost Corridor

- Highly Permeable
- Less Permeable
- Suitable Habitat*
- Target Areas
- Protected Lands
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*This analysis was run from medium to high suitable habitat within targeted protected areas.

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Patch Size & Configuration Analyses

Although, the permeability models and Least Cost Union delineate swatches of habitat that based on model assumptions and available GIS data are best suited to facilitate species movement between core habitat areas, they do not address whether suitable habitat in the Union occurs in large enough patches to support viable populations or whether patches are close enough together to allow for inter-patch dispersal; and they are based on only three of the 20 focal species. We therefore perform habitat suitability, patch size and configuration analyses to evaluate the configuration and extent of potentially suitable habitat in the Least Cost Union for all 20 focal species. This helps determine whether there is sufficient habitat within the Union to support each species, and whether that habitat is distributed in a pattern that allows the species to move between patches.

Specifically, the patch size and configuration analyses for all 20 focal species addresses, 1) whether the Least Cost Union provides sufficient live-in or move-through habitat to support individuals or populations of the species; 2) whether these habitat patches are within the species' dispersal distance; 3) whether any clearly unsuitable and non-restorable habitat (e.g., developed land) should be deleted from the Union; and 4) for any species not adequately served by the Least Cost Union, whether expanding the Union to incorporate more habitat would meet the species needs. The patch size and configuration analysis does not address existing barriers to movement (such as freeways) or land use practices that may prevent species from moving through the linkage. These issues are addressed in the next section.

The Least Cost Union contains suitable habitat to support either inter- or intra-generational movements between the Santa Monica and Sierra Madre ranges for 17 of the 20 modeled focal species: mountain lion, badger, mule deer, brush rabbit, desert woodrat, loggerhead shrike, California thrasher, acorn woodpecker, western toad, California kingsnake, coastal whiptail, chalcedon checkerspot butterfly, harvester ant, scorpion, California black walnut, Valley oak, and Bigberry manzanita. Outputs from the patch configuration analyses suggest that habitat patches in the Union are not isolated by distances too great for any of the focal species to disperse.

Three focal species appear to require additional habitat outside of the Least Cost Union for the Linkage Design to serve their movement needs: southern steelhead trout, cactus wren, and damselflies. To ensure that the Linkage Design accommodates all focal species, habitat was added to the Union in six general areas (Figure 13):

Conejo Mountain & Mountclef Ridge: This connection is dominated by coastal sage scrub and extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley. This addition was necessary to accommodate cactus wren, brush rabbit, desert woodrat, and western toad movement, but the majority of other focal species will also benefit from this connection, as will many other native species not specifically addressed by our analyses. Much of this area has already been conserved, so we added contiguous natural habitats where available and agricultural lands where necessary to achieve a minimum corridor width of 2 km making it more robust to edge effects.

Santa Clara River Mainstem: The Union was also modified to include riparian and upland habitat along the mainstem of the Santa Clara River from the coast to the eastern boundary of the Linkage Design to preserve a critical migration corridor for southern steelhead trout to reach its spawning and rearing grounds in Santa Paula, Sespe, and Piru Creek. This addition also provides habitat and connectivity for western toad, California kingsnake, and damselflies, and numerous other native species will benefit from this addition. The connection includes a 2-km (1.2-mi) riparian buffer (1 km to either side of the wash) to protect water quality within the linkage and downstream.

Santa Paula Creek: To accommodate southern steelhead trout and other species that use riparian habitats, the Union was modified to include Santa Paula Creek from its confluence with the Santa Clara River to the boundary of Los Padres National Forest. We also delineated a 2-km riparian buffer along the creek where best management practices should be implemented and restoration efforts undertaken.

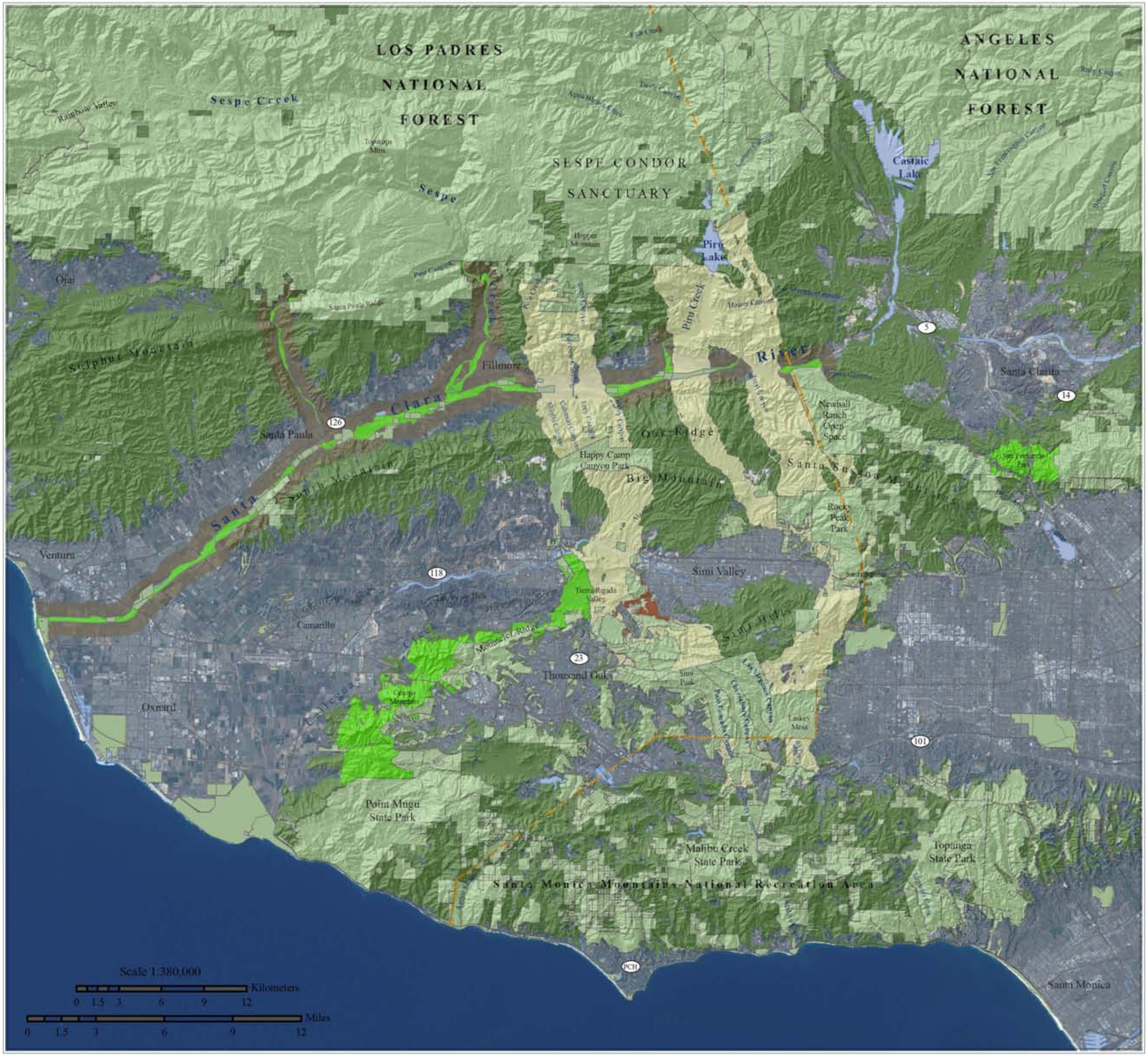
Sespe Creek: The Union was also modified to include Sespe Creek from its confluence with the Santa Clara River to the Los Padre National Forest boundary for southern steelhead trout. Numerous other focal species that use riparian habitats will also benefit from this addition, as will several other native species not addressed by our analyses. A 2-km wide riparian buffer was delineated to identify areas to focus habitat restoration efforts to improve habitat conditions and water quality.

Piru Creek: The Union was also modified to include the southern reaches of Piru Creek where it meets the Santa Clara River for southern steelhead trout and damselflies. Other species that use riparian habitats will also benefit from this addition.

San Fernando Pass: The San Fernando Pass is dominated by oak woodlands and savannas, coastal sage scrub, and chaparral, with walnut woodland and grasslands interspersed. This connection extends from the eastern Santa Susana Mountains, through the San Fernando Pass to the San Gabriel Mountains of the Angeles National Forest. Although our analyses were primarily focused on identifying a connection between the Santa Monica and Sierra Madre Ranges, it was evident from the results of the analyses that 18 out of the 20 focal species would benefit from maintaining connectivity through the pass. The San Fernando Pass was also previously identified as important for 11 of the 15 focal species modeled for the San Gabriel-Castaic Connection (Penrod et al. 2004). Consequently, this area was added to the Least Cost Union to provide broader regional connectivity to adjacent Missing Linkages Project study areas and remain consistent with the habitat needs of the focal species.

We deleted some areas of the Least Cost Union on the eastern side of the Tierra Rejada Valley that have already been converted to urban uses.

Figure 13.
Least Cost Union
Additions & Subtractions

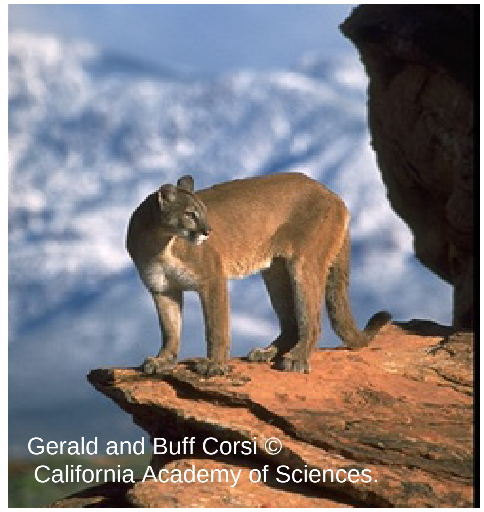


Least Cost Union
Addition
Subtraction
Riparian Buffer
Important Habitat Areas
Protected Lands
Lakes & Reservoirs
County Boundary
Roads

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org



Distribution & Status: Mountain lions (also known as puma or cougar) are widely distributed throughout the western hemisphere (Chapman and Feldhamer 1982, Currier 1983, Maehr 1992, Tesky 1995). The subspecies *F. c. californica* occurs in southern Oregon, California, and Nevada (Hall 1981), typically between 590-1,780 m (1,980-5,940 ft) in elevation (Zeiner et al. 1990). Since 2002, National Park Service scientists at Santa Monica Mountains National Recreation Area have been studying the ecology, behavior, and conservation of mountain lions in the Santa Monica Mountains, Simi Hills, and Santa Susana Mountains (Riley et al. 2006). Specific study objectives include determining how mountain lions use habitats across the region and specifically if mountain lions traverse between the highly fragmented habitats that remain, including across major roads and highways. To the extent that it has been possible, we have drawn upon the results from this ongoing work for information about conservation requirements for mountain lions in the planning area.

In 1990, the mountain lion population in California was estimated to be between 2,500-5,000 individuals. That same year, Proposition 117 was passed which prohibited hunting and granted puma the status of a California Specially Protected species, though depredation permits are still issued (Torres 2000).

Habitat Associations: The mountain lion is a habitat generalist, utilizing many brushy or forested habitats providing good cover (Spowart and Samson 1986, Zeiner et al. 1990). They use rocky cliffs, ledges, and vegetated ridgetops that provide cover when hunting prey (Chapman and Feldhamer 1982, Spowart and Samson 1986), especially mule deer, *Odocoileus hemionus* (Lindzey 1987). Den sites may be located on cliffs, rocky outcrops, caves, in dense thickets, or under fallen logs (Ingles 1965, Chapman and Feldhamer 1982). In southern California, most cubs are reared in thick brush (Beier et al. 1995). Mountain lions prefer vegetated ridgetops and stream courses as travel corridors and hunting routes (Spowart and Samson 1986, Beier and Barrett 1993), although movements across a variety landscape features has been documented (Riley et al. 2006).

Spatial Patterns: Home range size varies by sex, age, and the distribution of prey. A recent study in the Sierra Nevada documented annual home range sizes between 250 and 817 km^2 (61,776-201,885 ac; Pierce et al. 1999). Home ranges in southern California averaged 93 km^2 (22,981 ac) for 12 adult females and 363 km^2 (89,699 ac) for two adult males (Dickson et al. 2004). Male home ranges appear to reflect the density and distribution of females (Maehr 1992). Males occupy distinct areas and are tolerant of transients of both sexes, while the home range of females may overlap completely (Zeiner et al. 1990, Beier and Barrett 1993). Regional population counts have not been conducted but in the Santa Ana Mountain Range, Beier (1993) estimated about 1.05-1.2

adults per 100 km^2 (24,711 ac). Based on the ongoing studies of Riley et al. (2006), a small population of approximately four to eight individuals may occur in the Santa Monica Mountains south of the 101 Freeway.

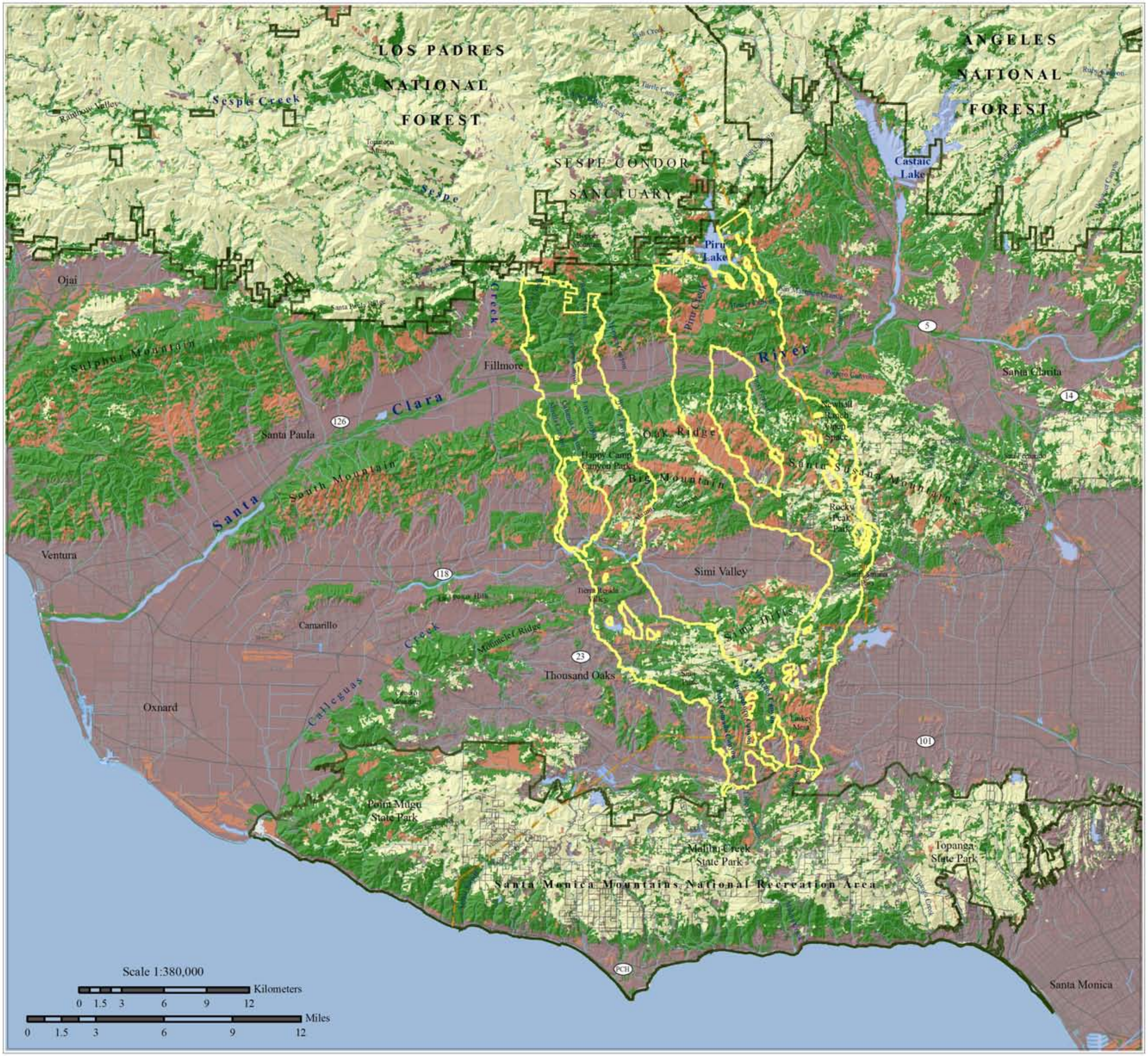
Mountain lions are capable of long-distance movements, and often move in response to changing prey densities (Pierce et al. 1999). Beier et al. (1995) found mountain lions moved 6 km (3.7 mi) per night and dispersed up to 65 km (40 mi). Dispersal plays a crucial role in cougar population dynamics, because recruitment into a local population occurs mainly by immigration of juveniles from adjacent populations, while the population's own offspring emigrate to other areas (Beier 1995, Sweanor et al. 2000). Juvenile dispersal distances average 32 km (20 mi) for females and 85 km (53 mi) for males, with one male dispersing 274 km (170 mi; Anderson et al. 1992). Dispersing lions may cross large expanses of nonhabitat, though they prefer not to do so (Logan and Sweanor 2001). To allow for dispersal of juveniles and the immigration of transients, lion management should be on a regional basis (Sweanor et al. 2000, Riley et al. 2006).

Conceptual Basis for Model Development: Puma will use most habitats above 590 m (1,936 ft) elevation provided they have cover (Spowart and Samson 1986, Zeiner et al. 1990). Road density is also a significant factor in habitat suitability for mountain lions. Core areas potentially supporting 50 or more individuals were modeled using patches $\geq$ 10,000 km^2 (2,471,053 ac). Patch size was classified as $\geq$ 200 km^2 (49,421 ac) but < 10,000 km^2. Dispersal distance for puma was defined as 548 km (340 mi), or twice the maximum reported dispersal distance of 274 km (170 mi).

Results & Discussion*:* All branches of the Least Cost Union contain suitable mountain lion habitat, with the eastern branch containing the most highly suitable contiguous habitat for lions moving between protected core areas (Figure 14). The habitat suitability model predicted low to medium suitable habitat in the vicinity of Laskey Mesa. However, given that dispersing lions may cross large expanses of non-habitat (Logan and Sweanor 2001); we conclude that the Least Cost Union is likely to serve this species. All potential cores and patches of suitable habitat are within the dispersal distance of this species (figure not shown). The patch size analysis for mountain lion (Figure 15) emphasizes the importance of maintaining connectivity between these ranges, as the Santa Monica, Simi Hills, and Santa Susana Mountains combined aren't large enough to support a minimum viable population, relying on an influx of individuals from core habitats in the Sierra Madre Ranges to sustain the population.

This species requires expansive roadless areas to survive and functional connectivity between subpopulations. In October 2004, NPS scientists found that two of the mountain lions they'd been tracking (P1 and P2) had produced a litter of four kittens (Riley et al. 2006). Current NPS research is now focused on monitoring the movements and dispersal routes of these four young lions because it is expected that, for at least the two males, they will need to disperse beyond the Santa Monica Mountains in order to establish individual and non-overlapping home ranges (Riley et al. 2006). Maintaining connections between large blocks of protected habitat may be the most effective way to ensure population viability (Beier 1993, 1995, Gaona et al. 1998, Riley et al. 2003, Riley et al. 2006). To maintain and protect habitat connections for mountain lions, we recommend that:

Figure 14.
Habitat Suitability
for
Mountain lion
(Puma concolor)



Degree of Suitability

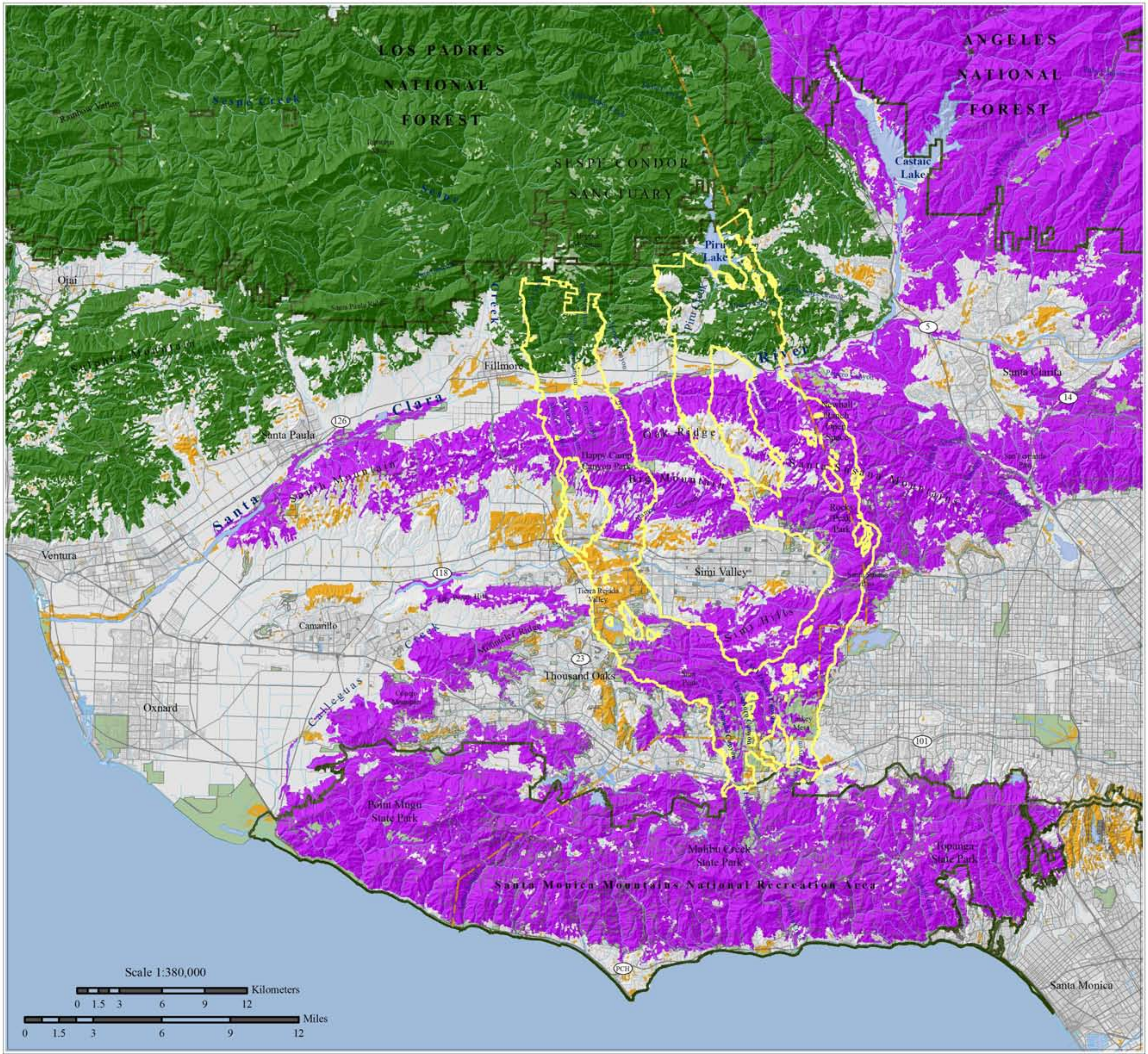
- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 15.
Potential Cores & Patches
for
Mountain lion
(Puma concolor)



- Core
- Patch
- < Patch
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

This page intentionally left blank.

- Existing road density be maintained or reduced in the Linkage Design. When transportation improvement projects do occur, planners should incorporate crossing structures to facilitate mountain lion movement across transportation barriers, particularly for multi-lane freeways such as Highways 101 and 118 (see Linkage Design Section).

- Lighting is directed away from the linkage and crossing structures. Species sensitive to human disturbance, like puma, avoid areas that are artificially lit (Beier 1995, Rich and Longcore 2006).

- Local residents are informed about the important role of carnivores to the system, the use of predator safe enclosures for domestic livestock and pets, and the habits of being thoughtful and safe stewards of the land.

American badger (*Taxidea taxus*)


Gerald and Buff Corsi © CA Academy of Sciences

Distribution & Status: Once a fairly widespread resident in open habitats of California, the badger is now uncommon throughout the state and is considered a California Species of Special Concern (Zeiner et al. 1990, CDFG 1995).

Habitat Associations: Badgers are habitat specialists, associated with grasslands, prairies, and other open habitats (de Vos 1969, Banfield 1974, Sullivan 1996) but they may also be found in drier open stages of shrub and forest communities (Zeiner et al. 1990). They are known to inhabit forest and mountain meadows, marshes, riparian habitats, and desert communities including creosote bush, juniper, and sagebrush habitats (Long and Killingley 1983, Zeiner et al. 1990). They are occasionally found in open chaparral (< 50% cover) but haven't been documented in mature stands of chaparral (Quinn 1990, Zeiner et al. 1990). Badgers prefer friable soils for excavating burrows and require abundant rodent populations (de Vos 1969, Banfield 1974, Sullivan 1996). The species is typically found at lower elevations (Zeiner et al. 1990) in flat, rolling, or steep terrain but it has been recorded at elevations up to 3,600 m (12,000 ft; Minta 1993).

Spatial Patterns: Home range sizes for this species vary both geographically and seasonally. Depending on location, male home ranges have been estimated to vary from 240-850 ha (593-2,100 ac) while females ranged from 137-725 ha (339-1,792 ac; Long 1973, Lindzey 1978, Messick and Hornocker 1981, Zeiner et al. 1990). In northwestern Wyoming, home ranges up to 2,100 ha (5,189 ac) have been reported (Minta 1993). In Idaho, home ranges of adult females and males averaged 160 ha (395 ac) and 240 ha (593 ac) respectively (Messick and Hornocker 1981). In Minnesota, Sargeant and Warner (1972) radio-collared a female badger, whose overall home range encompassed 850 ha (2,100 ac). However, her home range was restricted to 725 ha (1,792 ac) in summer, 53 ha (131 ac) in autumn and to a mere 2 ha (5 ac) in winter. In Utah, Lindsey (1978) found fall and winter home ranges of females varied from 137-304 ha (339-751 ac), while males varied from 537-627 ha (1,327-1,549 ac). Males may double movement rates and expand their home ranges during the breeding season to maximize encounters with females (Minta 1993). Lindzey (1978) documented natal dispersal distance for one male at 110 km (68 mi) and one female at 51 km (32 mi). A short-term pilot study of five badgers using radio telemetry in the Santa Monica Mountains found similar home range sizes and spatial patterns (Lupis et al. 1999).

Conceptual Basis for Model Development: Badgers prefer grasslands, meadows, open scrub, desert washes, and open woodland communities. Terrain may be flat, rolling or steep, but below 3,600 m (12,000 ft) elevation. Core areas capable of supporting 50 badgers are equal to or greater than 16,000 ha (39,537 ac). Patch size is ≥ 400 ha (988 ac) but < 16,000 ha. Dispersal distance for badgers was defined as 220 km (136 mi), twice the longest recorded dispersal distance (Lindzey 1978).

Results & Discussion: The model identified abundant suitable habitat for badger in the planning area, with the most highly suitable habitat in the central branch and the most contiguous habitat in the eastern branch of the Least Cost Union (Figure 16). The central branch contains extensive open grassland habitat that is preferred by this species and was delineated as the least cost corridor for badger (Figure 11). Although not included in the Least Cost Union, contiguous suitable habitat also extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley (Figure 16). The majority of suitable habitat within the planning area is contiguous, and thus was identified as core habitat for this species (Figure 17). All potential habitat is within badger's dispersal distance (figure not shown), although barriers to movement may exist between suitable habitat patches. The linkage is likely to serve the movement needs of this wide-ranging species.

Road mortality is the leading cause of death of badgers. Badger roadkill has been documented on Highway 118 at Santa Susana Pass (P. Edelman, pers. comm.) and along roads within the Tierra Rejada Valley (R. Sauvajot, pers. comm.). To restore and protect habitat connections for badger, we recommend that:

- Existing road density be maintained or reduced in the Linkage Design. When transportation improvement projects do occur, planners should incorporate crossing structures to facilitate badger movement across transportation barriers (see Linkage Design Section).

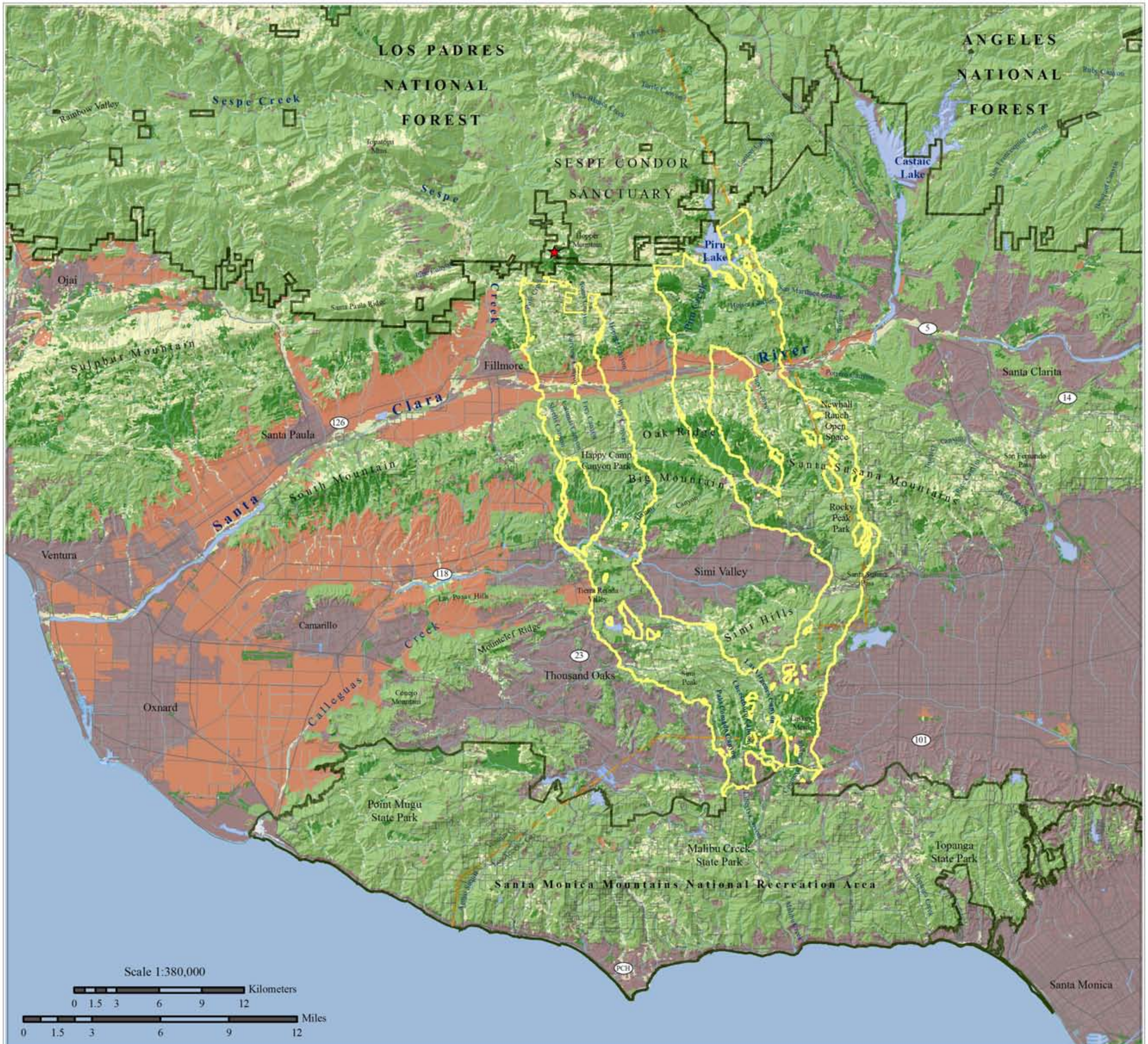
- Lighting is directed away from the linkage and crossing structures (Rich and Longcore 2006).

Figure 16.
Habitat Suitability
for
American badger
(Taxidea taxus)

Degree of Suitability

- High
- Medium to High
- Medium
- Low to Medium
- Low
- ★ Recorded Occurrence*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: CNDDB



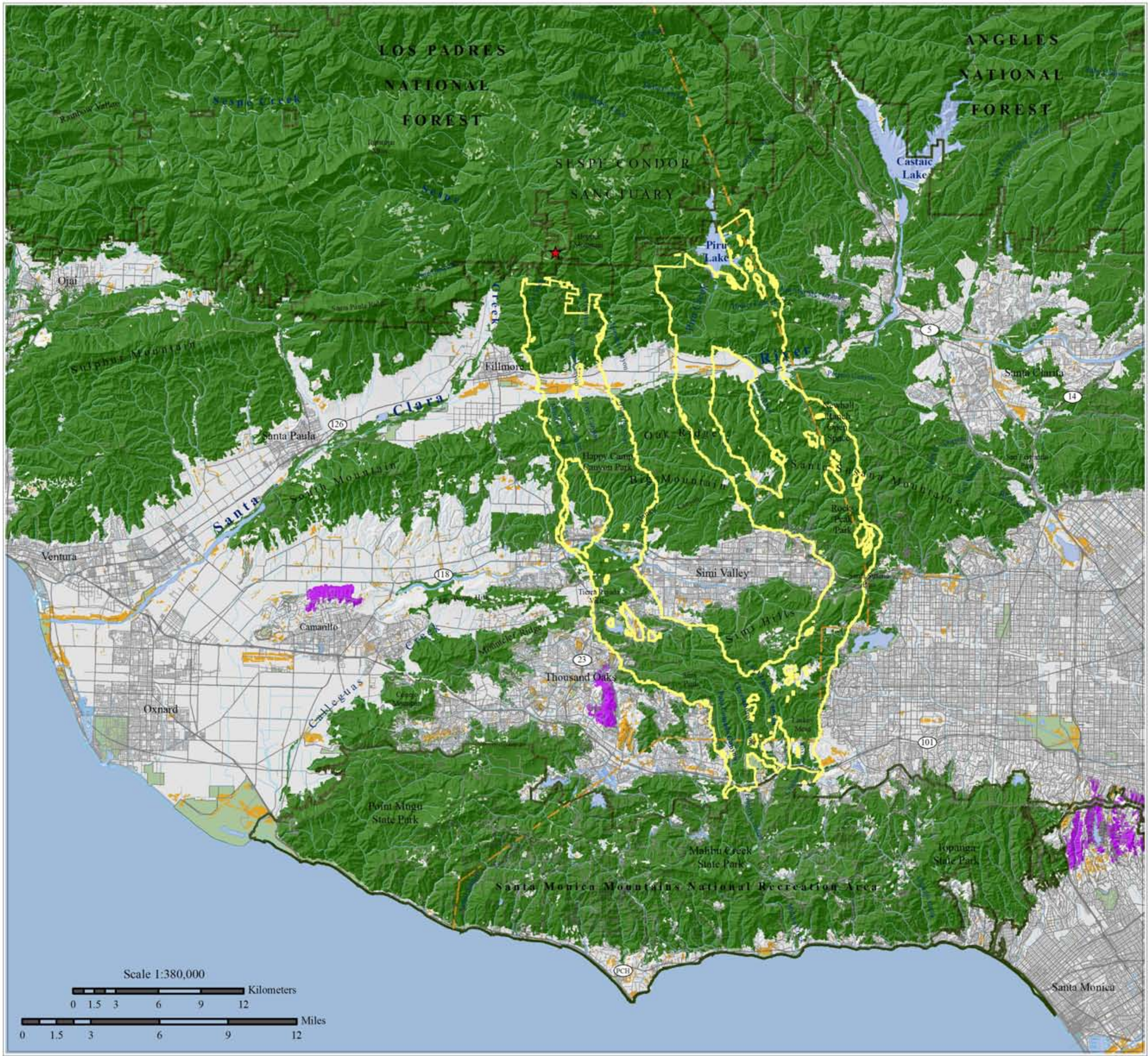
Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 17.
Potential Cores & Patches for American badger
(Taxidea taxus)

- Core
- Patch
- < Patch
- Recorded Occurrence*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: CNDDB



Map Produced By:

SOUTH COAST WILDLANDS

June 2006

www.scwildlands.org

Mule deer (*Odocoileus hemionus*)


Photo Courtesy of USFWS

Distribution & Status: Mule deer are widespread in California and are common to abundant in appropriate habitat; they are absent from areas with no cover (Longhurst et al. 1952, Ingles 1965, Zeiner et al. 1990). Mule deer are classified by CDFG as a big game animal.

Habitat Associations: This species requires a mosaic of habitat types of different age classes to meet its life history requirements (CDFG 1983). They use forest, woodland, brush, and meadow habitats, reaching their highest densities in oak woodlands, riparian areas, and along edges of meadows and grasslands (Bowyer 1986, USFS 2002). They also occur in open scrub, young chaparral and low elevation coniferous forests (Bowyer 1981, 1986, USFS 2002). A variety of brush cover and tree thickets interspersed with meadows and shrubby areas are important for food and cover. Thick cover can provide escape from predators, shade in the summer, or shelter from wind, rain and snow. Varying slopes and topographic relief are important for providing shade or exposure to the sun. Fawning occurs in moderately dense chaparral, forests, riparian areas, and meadow edges (CDFG 1983). Meadows are particularly important as fawning habitat (Bowyer 1986, USFS 2002).

Spatial Patterns: Home ranges typically comprise a mosaic of habitat types that provide deer with various life history requirements. Home range estimates vary from 39 ha (96 ac; Miller 1970) to 3,379 ha (8,350 ac; Severson and Carter 1978, Anderson and Wallmo 1984, Nicholson et al. 1997). Harestad and Bunnell (1979) calculated mean home range from several studies as 285.3 ha (705 ac). Doe and fawn groups have smaller home ranges, averaging 100-300 ha (247-741 ac), but can vary from 50 to 500 ha (124-1,236 ac; Taber and Dasmann 1958, CDFG 1983). Bucks usually have larger home ranges and are known to wander greater distances (Brown 1961, Zeiner et al. 1990). A recent study of 5 different sites throughout California, recorded home range sizes from 49 to 1,138 ha (121-2,812 ac; Kie et al. 2002).

Where deer are seasonally nomadic, winter and summer home ranges tend to largely overlap in consecutive years (Anderson and Wallmo 1984). Elevational migrations are observed in mountainous regions in response to extreme weather events in winter, or to seek shade and perennial water during the summer (Loft et al. 1998, CDFG 1983, Nicholson et al.1997, USFS 2002). Distances traveled between winter and summer ranges vary from 8.6 to 29.8 km (5.3-19 mi; Gruell and Papez 1963, Bertram and Rempel 1977, Anderson and Wallmo 1984, Nicholson et al. 1997). Robinette (1966) observed natal dispersal distances ranging from 97 to 217 km (60-135 mi).

Conceptual Basis for Model Development: Mule deer utilize a broad range of habitats, reaching their highest densities in oak woodlands. They require access to perennial water. Core areas potentially supporting 50 or more deer are equal to or greater than 16,000 ha (39,537 ac). Patch size was classified as ≥ 100 ha (247 ac) but < 16,000 ha. Dispersal distance was defined as 434 km (270 mi), or twice the maximum distance recorded.

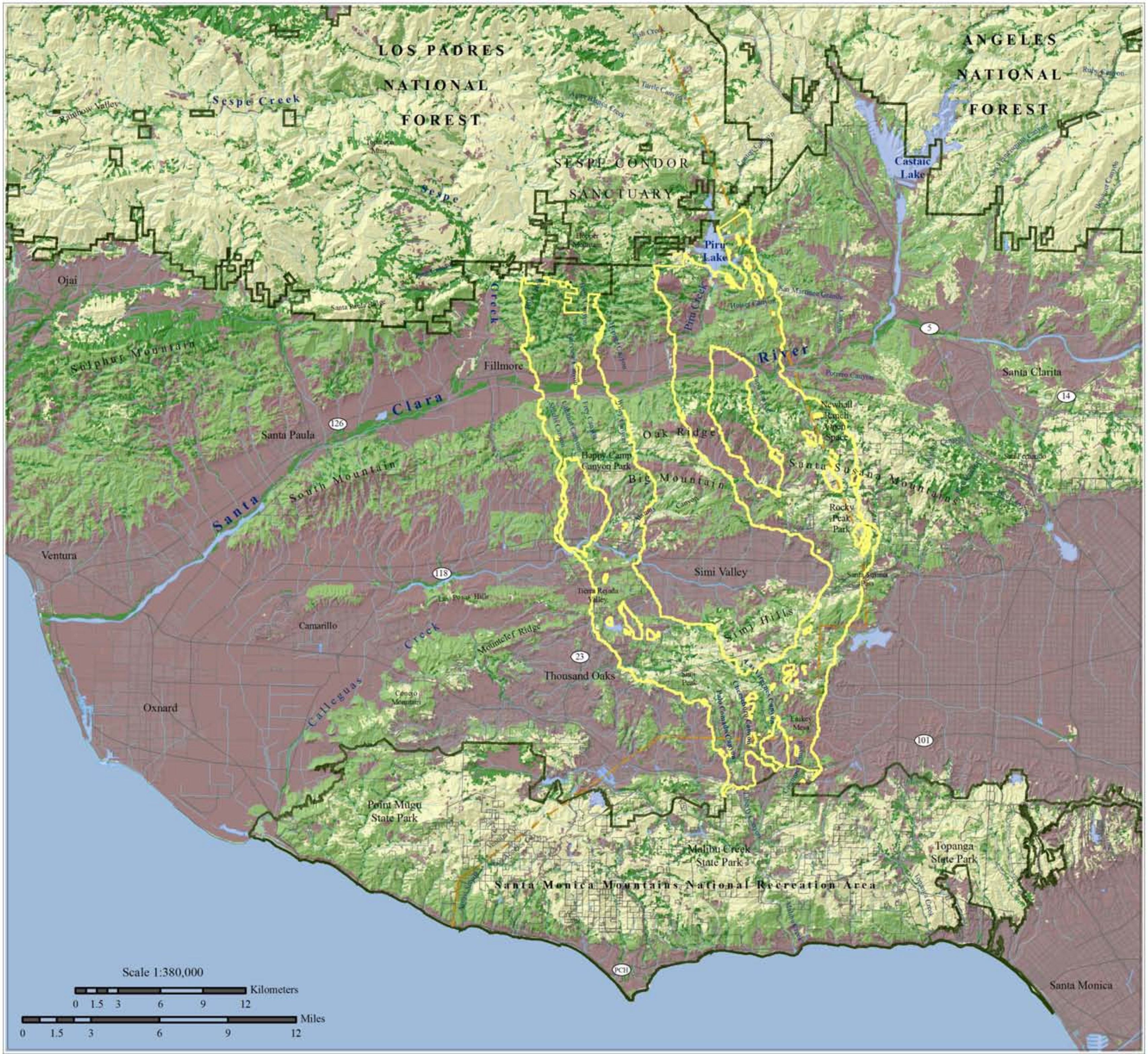
Results & Discussion: All branches of the Least Cost Union contain suitable habitat for mule deer, with the western and eastern branches providing the most contiguous connections (Figure 18). Although not included in the Union, highly suitable contiguous core habitat also extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley (Figures 18, 19). The majority of suitable habitat in the planning area was identified as potential core areas for mule deer, with all habitat in the Union identified as core areas except the area around Tierra Rejada Valley and an area along the Santa Clara River in the western branch of the Union (Figure 19). All core areas and patches of suitable habitat are within the dispersal distance of this species (figure not shown), although barriers to movement may exist between suitable habitat patches. We conclude that the linkage will likely serve the needs of mule deer traveling between these ranges.

Estimates of the number of deer killed annually on U.S. roads ranges from 720,000 to 1.5 million (Romin and Bissonette 1996, Conover 1997, Forman et al. 2003). Collisions with deer also result in the loss of human lives (Reed et al. 1975). To restore and protect habitat connections for mule deer, we make the following recommendations:

- Road barriers should be modified to accommodate mule deer movement. Though ungulates much prefer overpasses to underpasses (Gloyne and Clevenger 2001), they will utilize bridged undercrossings if they can see clearly to the other side. Crossing structures for mule deer should have natural flooring and no artificial lighting (Reed et al. 1975).

- Fencing (up to 4 m [12 feet] high) should be installed to reduce roadkill and guide deer to crossing structures. Escape ramps may also be installed in case deer get caught within road right-of-ways (Forman et al. 2003).

Figure 18.
Habitat Suitability
for
Mule deer
(Odocoileus hemionus)



Degree of Suitability

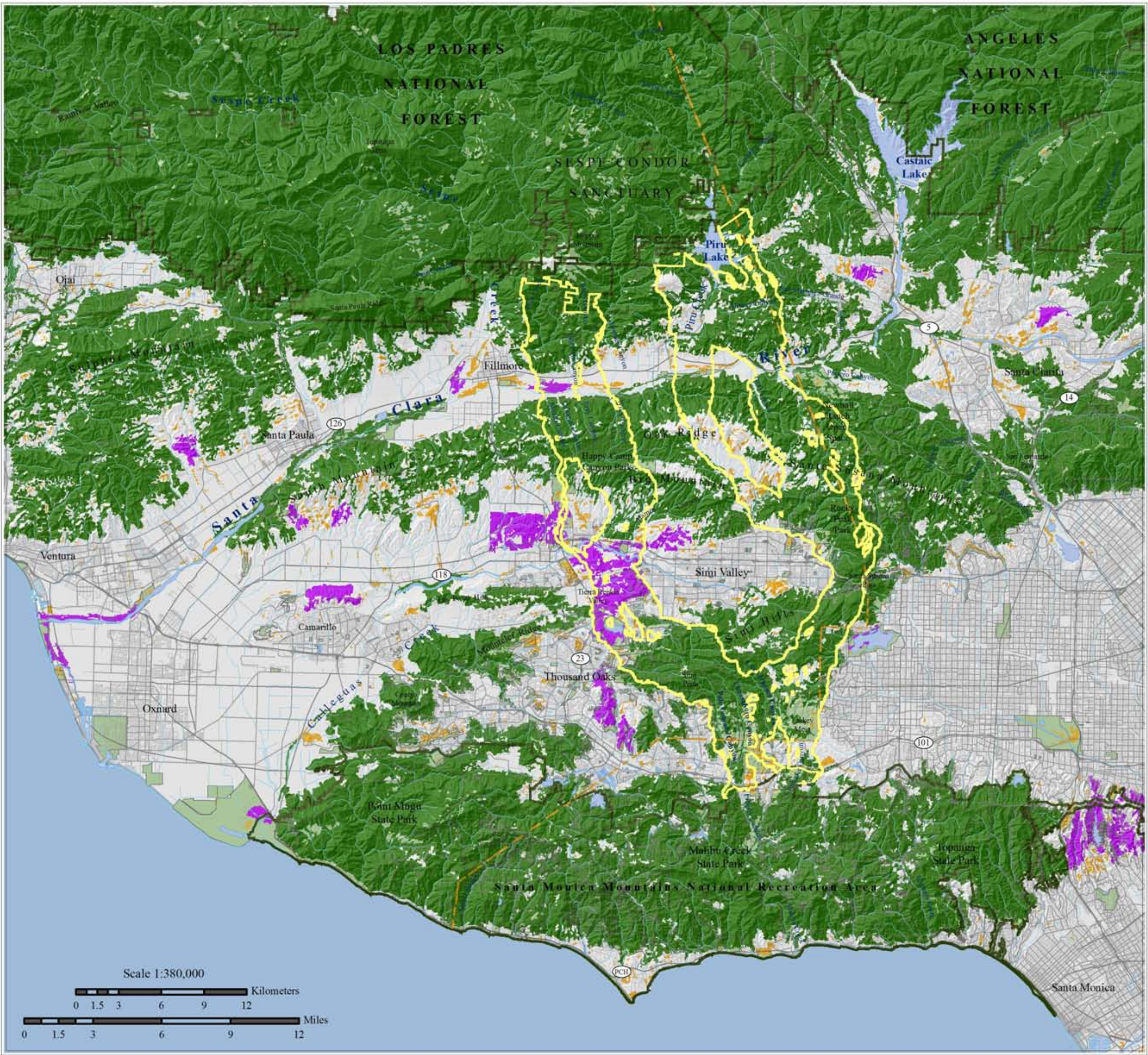
- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

N

Map Produced By:

SOUTH COAST
WILDLANDS
June 2006
www.scwildlands.org

Figure 19.
Potential Cores & Patches for Mule deer
(Odocoileus hemionus)



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Brush rabbit (*Sylvilagus bachmani*)

Justification for Selection: Brush rabbits are sensitive to habitat loss and fragmentation. Small, isolated habitat patches aren't likely to support viable populations of brush rabbits (Chapman 1971).

Distribution & Status: The brush rabbit occurs west of the Cascades and Sierra Nevadas from southern Oregon to Baja California, Mexico, excluding the dry Central Valley and southern arid regions (Hall 1981, Zeiner et al. 1990). Their elevational range extends from sea level to 2,070 m (6,791 ft; Chapman 1974).

The brush rabbit that occurs in the study area is not a special status species. However, the subspecies *riparius* of the San Joaquin Valley, California, is listed under the U.S. Endangered Species Act as endangered (USFWS 2000).

Habitat Associations: Brush rabbits may occur in riparian, coastal sage scrub, chaparral, grassland, and oak woodland habitats, but they are most commonly found in the dense, brushy cover of chaparral vegetation (Chapman 1974). They may also occur in early successional stages of oak and conifer habitats (Zeiner et al. 1990). They feed on a wide variety of grasses and forbs in grasslands, meadows, and riparian areas, but are never far from dense brushy cover (Orr 1940, Zeiner et al. 1990). Connell (1954) found that brush rabbits concentrate their activities at the edge of brush, suggesting that ecotonal habitat is better than continuous chaparral.

Spatial Patterns: In California, male home ranges averaged 1.5 ha (3.8 ac), and home ranges for females averaged 0.5 ha (1.3 ac; Connell 1954, Shields 1960). In Oregon, home ranges varied between .2 and .8 ha (.5 to 2.0 ac; Chapman 1971). Home ranges often conform to the size and shape of cover patches. Males apparently are not territorial; home ranges overlap. Females sometimes protect areas; Connell (1954) and Shields (1960) reported female territories 12-173 m (38-569 ft) in diameter.

Dispersal potential, though poorly documented, may be considerable. For example, a female eastern cottontail (*S. floridanus*) escaped from an enclosure and returned to its original capture site 3.7 km (2.3 mi) away (Hill 1967, Cannings and Hammerson 2004). A radio telemetry study of orientation and homing by brush rabbits in Oregon found homing ability extends up to 350 m (1,150 ft), and homing routes were largely restricted to brushy cover regardless of the direction or distance (Chapman 1971).

Conceptual Basis for Model Development: Movement in the linkage is assumed to be multigenerational. Brush rabbits may utilize a broad range of vegetation communities, reaching their highest densities in chaparral habitats. Potential core areas are equal to or greater than 38 ha (94 ac). Patch size was classified as $\geq$ 1 ha (2.47 ac) but < 38 ha. Dispersal distance was defined as 700 m (2,297 ft), or twice the maximum homing distance recorded.

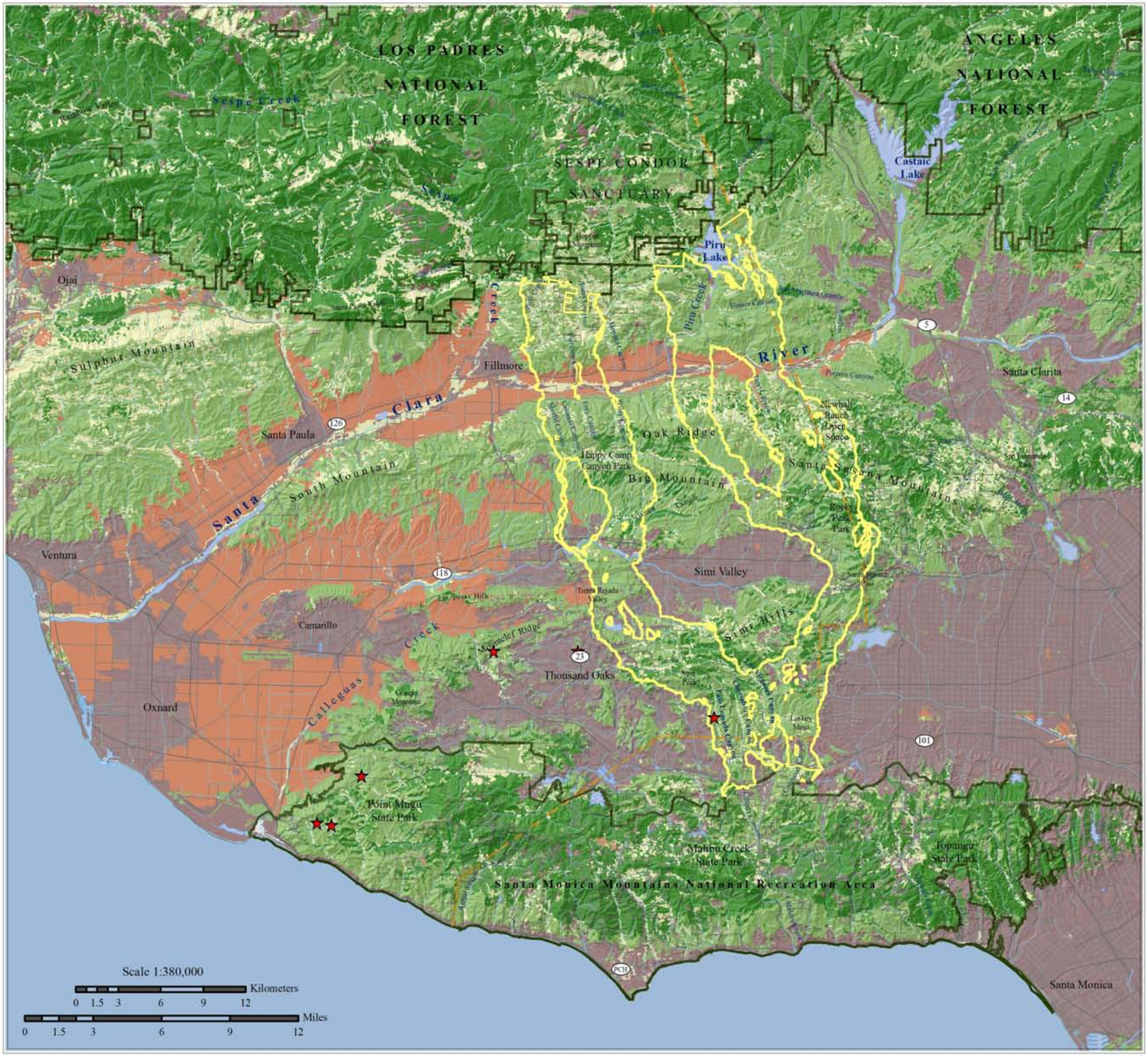
Results & Discussion: All branches of the Least Cost Union contain highly suitable habitat for brush rabbit (Figure 20). Although not included in the Union, highly suitable contiguous core habitat also extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley (Figures 20, 21). This species has been recorded in Palo Comado Canyon in the Union and on Mount Clef Ridge. The majority of suitable habitat identified in the planning area was delineated as potential core areas for brush rabbit, with all habitats in the Union identified as core habitat (Figure 21). All core areas and patches of suitable habitat are within the dispersal distance of this species (figure not shown), although barriers to movement may exist between suitable habitat patches. We conclude that the linkage will likely serve the needs of brush rabbit if habitat is added to the Union on Conejo Mountain and Mount Clef Ridge.

Little is known about the effects of habitat loss and fragmentation on the viability of brush rabbit populations. A computer simulation study of *S. transitionalis* metapopulations in response to habitat loss and environmental correlations (based on increased vulnerability to predation) showed a rapid decline or extinction of populations (Litvaitus and Villafuerte 1996). To maintain habitat connections and habitat suitability (e.g., maintaining early successional habitat) for brush rabbit, we recommend that:

- Crossing structures for small mammals be placed fairly frequently to facilitate movement across major transportation routes.

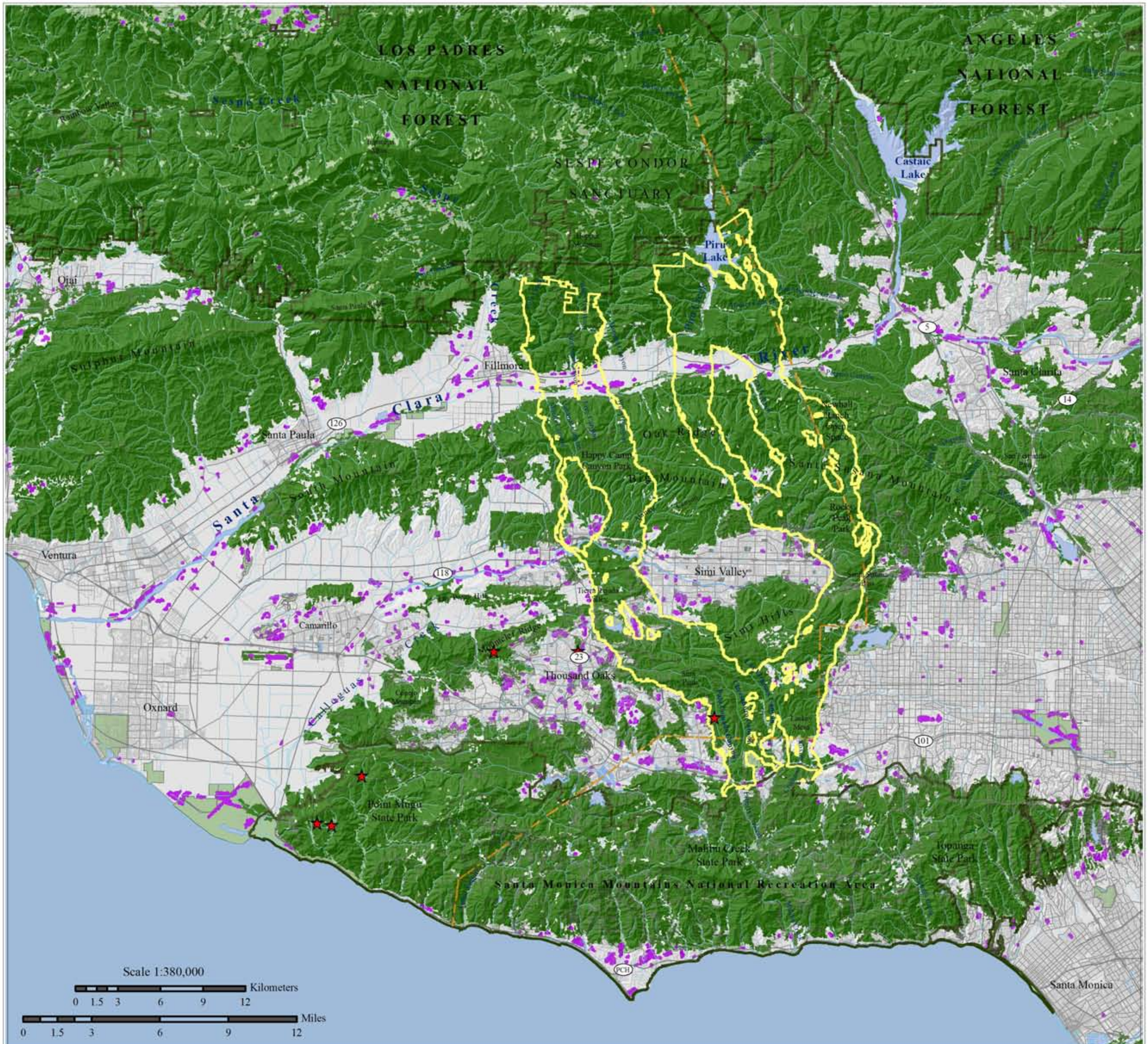
- Fire frequency is controlled to prevent type conversion of scrub habitats to nonnative annual grassland (Winter 2003).

Figure 20.
Habitat Suitability for Brush rabbit
(Sylvilagus bachmanni)



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 21.
Potential Cores & Patches
for
Brush rabbit
(Sylvilagus bachmanni)



- Core
- Patch
- < Patch
- Recorded Occurrence*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: National Park Service Ecological Monitoring Data

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Desert woodrat (*Neotoma lepida*)

Justification for Selection: This species is sensitive to habitat fragmentation, including in coastal sage scrub habitats of southern California (Bolger et al. 1997). Movement barriers include urban developments, roadways (particularly highways with continuous solid barriers that prevent rodent passage), and major water bodies. Woodrats are also sensitive to habitat alteration and disturbance such as may occur in areas of high fire frequency, unregulated off-road vehicle use, and other activities that reduce or damage vegetative cover (Sauvajot et al. 1998).

Distribution & Status: *Neotoma lepida* inhabits virtually all of southern California, with a range extending northward along the coast to the San Francisco Bay area and inland from Inyo County south throughout the Mojave Desert and from north-central Tulare County south through the Tehachapi and San Bernardino Mountains. They also occur in extreme northeastern California, on the Baja California peninsula in Mexico, and on several islands in the Gulf of California and the Pacific Ocean near Baja, as well as in southeastern Oregon, southwestern Idaho, Nevada, and western Utah (Zeiner 1990, Verts and Carraway 2002). There are 23 subspecies, *N. l. intermedia* occurs in the study area. Desert woodrats are typically associated with elevations below 2,900 m (9,514 ft) in California (Verts and Carraway 2002) and the subspecies within this study area is notable for occurring in the southern California coastal mountain ranges.

Habitat Associations: Desert woodrats may be found in sagebrush, chaparral, Joshua tree woodland, scrub oak woodland, pinyon-juniper woodland, riparian zones, creosote bush scrub, desert scrub and rocky slopes with scattered cactus, yucca, pine-juniper, and other low vegetation, and occasionally in salt marsh habitats (Zeiner 1990, Verts and Carraway 2002). In the study area, they are common in dense coastal sage and scrub habitats, including mixed and chamise-redshank chaparral (Lee 1963, MacMillen 1964). Woodrats are known for their large, multichambered dwellings, which they depend upon for shelter, storing food items, and refuge from predators (Carraway and Verts 1991, Matocq 2002). Desert woodrats occupy elaborate dens built of vegetative debris among shrubs, along cliffs, among rocks, and occasionally in trees (Lee 1963, MacMillen 1964). Thompson (1982) observed desert woodrats actively avoiding open areas that did not provide adequate refuge sites.

Spatial Patterns: In the Little San Bernardino Mountains, Thompson (1982) reported the average home range of desert woodrats to be 0.05 ha (.13 ac), which generally included one diurnal den and foraging habitat. In coastal sage scrub, home range has been reported to range from 0.04 to .2 ha (.1 to .5 ac; MacMillen 1964, Bleich and Schwartz 1975). Populations may be limited by the availability of nest-building materials (Linsdale and Tevis 1951, Brylski 1990).

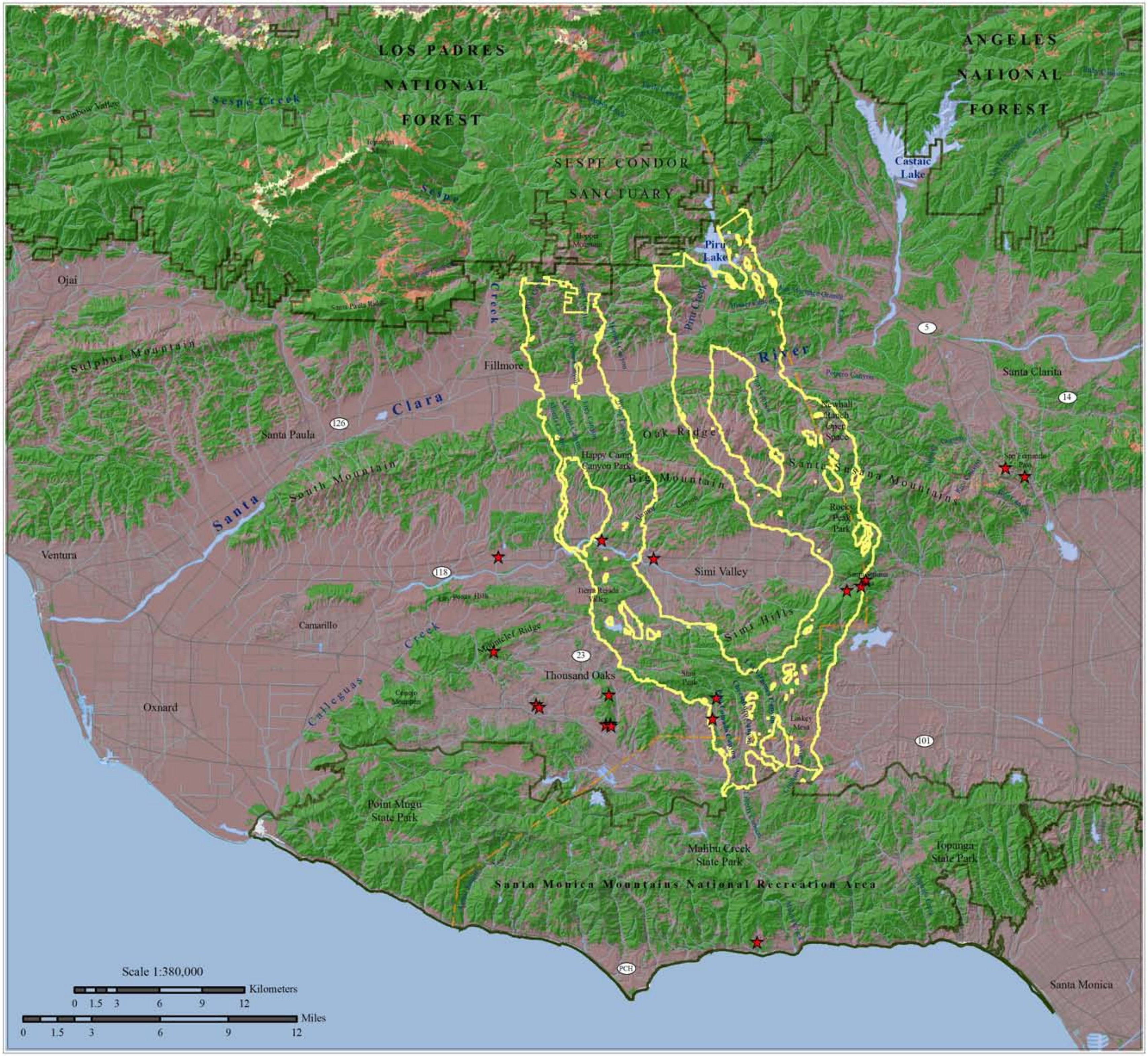
Natal site dispersal in the eastern Mojave Desert appears to be greater for male desert woodrats. Average linear movements in same habitat were about 14 m (46 ft) per night. In sagebrush-juniper habitat, males moved an average of 80 m (262 ft) per night, while female movements averaged 45 m (147 ft; Stones and Hayward 1968).

Conceptual Basis for Model Development: Movement in the linkage is assumed to be multigenerational. Desert woodrats are associated with chaparral, sagebrush, pinyon-juniper, riparian, and scrub habitats, and are typically found below 2,900 m elevation. Core areas were defined as $\geq$ 3 ha (7.41 ac). Patch size was defined as $\geq$ 0.1 ha (0.25 ac) and $<$ 3 ha. Dispersal distance was defined as 160 m (524 ft).

Results & Discussion: Potential habitat for the desert woodrat is widespread in the planning area, with both the western and eastern branches of the Least Cost Union containing highly suitable contiguous habitat for this species (Figure 22). The desert woodrat has been recorded in Palo Comado Canyon, Santa Susana Pass, and along the Arroyo Simi near Alamos Canyon in the Union, and on Mount Clef Ridge. The majority of suitable habitat was identified as potential cores areas for this species (Figure 23). Almost all of the potential core areas and patches of suitable habitat are within the defined dispersal distance of the woodrat (figure not shown), though barriers to movement may exist between suitable habitat patches. We conclude that the linkage is likely to serve the needs of this species for movement among populations if habitat is added to Union on Mount Clef Ridge. To protect and restore habitat connectivity for the desert woodrat, we recommend that:

- Crossing structures for small mammals be placed fairly frequently to facilitate movement across transportation routes.
- Natural hydrological processes are maintained or restored.
- Lighting is directed away from the linkage and crossing structures.
- Local residents are informed about the proper use of rodenticides and pesticides to reduce the likelihood of ingestion of these lethal substances on small mammals indigenous to the area.

Figure 22.
Habitat Suitability
for
Desert woodrat
(Neotoma lepida)



Degree of Suitability

- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Recorded Occurrence*
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

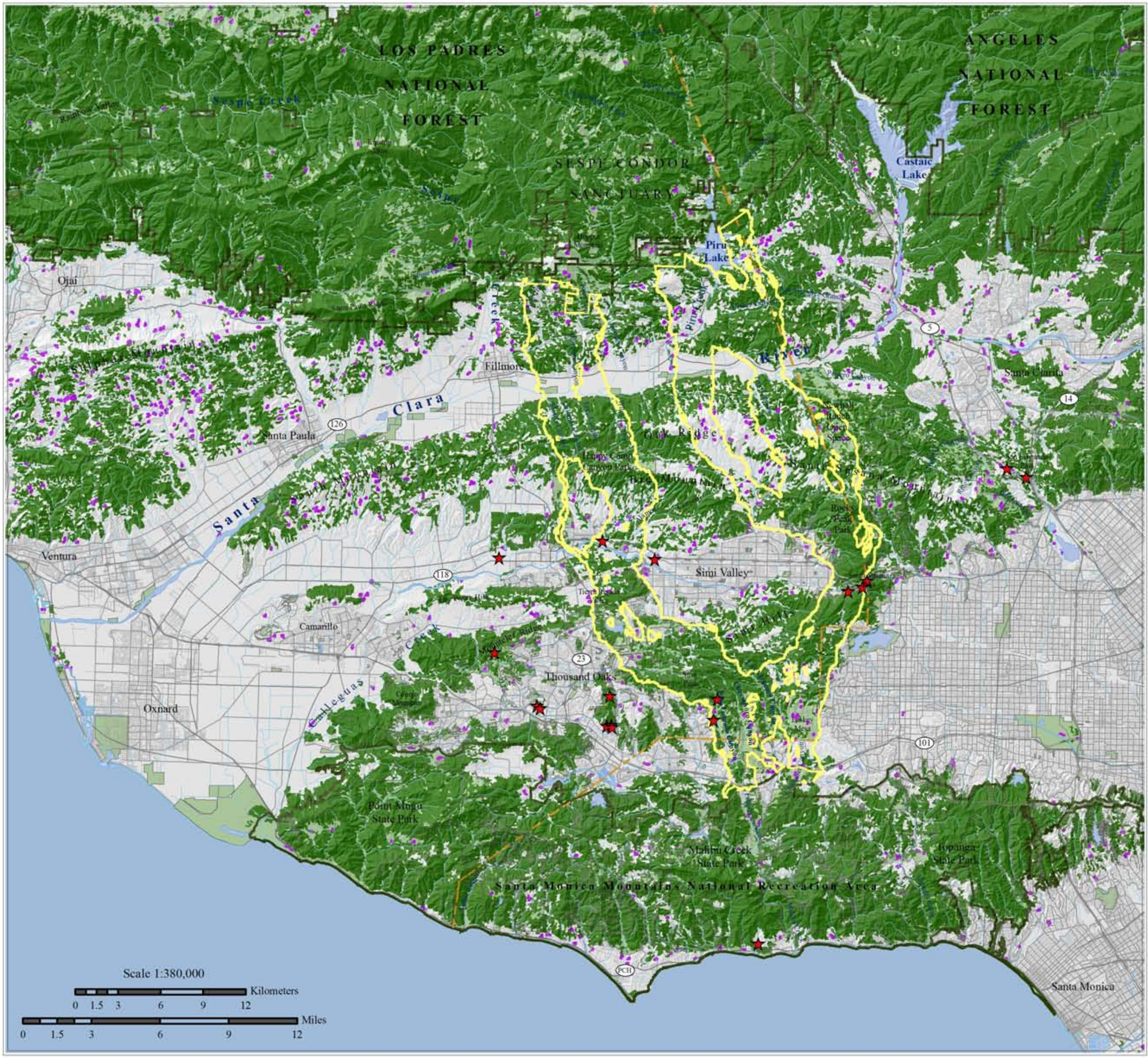
*Data Source: CNDDB and National Park Service Ecological Monitoring Data

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 23.
Potential Cores & Patches for Desert woodrat
(Neotoma lepida)



- Core
- Patch
- < Patch
- Recorded Occurrence*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: CNDDB and National Park Service Ecological Monitoring Data

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Loggerhead shrike (*Lanius ludovicianus*)

Justification for Selection: Loggerhead shrike is a resident species that requires a mosaic of open habitats with abundant prey to persist. They have been declining throughout North America since the 1960s (Robbins et al. 1986, Sauer et al. 2001). They are sensitive to habitat loss, fragmentation, and degradation (Fraser and Luukkonen 1986, Pruitt 2000).

Distribution & Status: Loggerhead shrike ranges throughout much of North America from southern Canada to northern Mexico. They are common residents and winter visitors in the lowlands and foothills of California (Faber et al. 1989, Zeiner et al. 1990). They are absent from heavily forested areas and higher elevations in the desert ranges, typically occurring below 1,524 m (5,000 ft) in elevation (Small 1994).

North American Breeding Bird Survey (BBS) data for the period 1966-2000 indicate a 71% population decline rangewide (-3.7% annually), with a decline of 75% in the western region (Sauer et al. 2001). Loggerhead shrike is designated as a federal and state Species of Special Concern (CDFG 2005).

Known or suspected threats to loggerhead shrike populations include habitat loss and degradation, fragmentation of suitable habitat, shooting, and pesticide and other toxic contamination (Fraser and Luukkonen 1986, Pruitt 2000). While there is evidence of some eggshell thinning in Illinois, there is no apparent eggshell thinning in California and Florida (Hands et al. 1989). Pesticides may pose a greater threat in reducing food availability (Yosef 1994, Yosef 1996). Threats to the grassland habitats preferred by loggerhead shrike include conversion to agriculture, overgrazing of livestock, spread of exotic species, urbanization and disrupted fire regimes (Knopf 1994, Knight et al. 1995, Saab et al. 1995, Vickery and Herkert 1999).

Habitat Associations: Loggerhead shrike prefers open country for hunting, with perches for scanning, and fairly dense shrubs and brush for nesting (Small 1994). They may utilize grasslands, pastures, savannah, pinyon-juniper woodlands, Joshua Tree woodlands, riparian woodlands, desert oases, desert scrub and washes, and to a lesser extent, agricultural fields and orchards (Small 1994). The highest density of shrike occurs in open-canopied valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, savannah, pinyon-juniper, juniper, desert riparian, and Joshua tree habitats (Zeiner et al. 1990, Small 1994). Shrikes are often found in open cropland, but only rarely occur in intensive agricultural areas where pesticides have limited their prey base (Zeiner et al. 1990). Loggerhead shrike isn't found on north slopes of mountain ranges, nor in pure chaparral (Small 1994), though they may use edges of denser habitats (Grinnell and Miller 1944, McCaskie et al. 1979, Garrett and Dunn 1981).

Spatial Patterns: Loggerhead shrikes are strongly territorial and aggressive during the breeding season. Shrikes maintain relatively large territories and all activities associated with reproduction (mating, foraging, brooding) occur within the territory (Yosef 1996). In mainland California, the average size of territories was 8.5 ha (21 ac), and ranged between 4.4 ha (10.9 ac) and 16 ha (39.5 ac; Yosef 1996). In Contra Costa and Kern counties, Miller (1931) found ten territories in open shrubland that averaged 7.6 ha (18.7 ac), and varied from 4.5 to 16 ha (11-40 ac). Typically, nesting territories are smaller in areas with a greater amount of good quality habitat (Kridelbaugh 1982).

Banding studies indicate that adult loggerhead shrikes exhibit some site fidelity and juveniles disperse widely (Yosef 1996). In Alberta, the average distance of juvenile dispersal was 6.7 km (4.2 mi) between years (Yosef 1996). Over a period of 3 years from the time of banding, loggerhead shrikes dispersed up to 70 km (43.5 mi) from their natal site (Yosef 1996). In Virginia, juveniles 10-13 weeks old moved an average of 5.5 km (3.42 mi) from their parents' territory to their fall territory (Blumton et al. 1989).

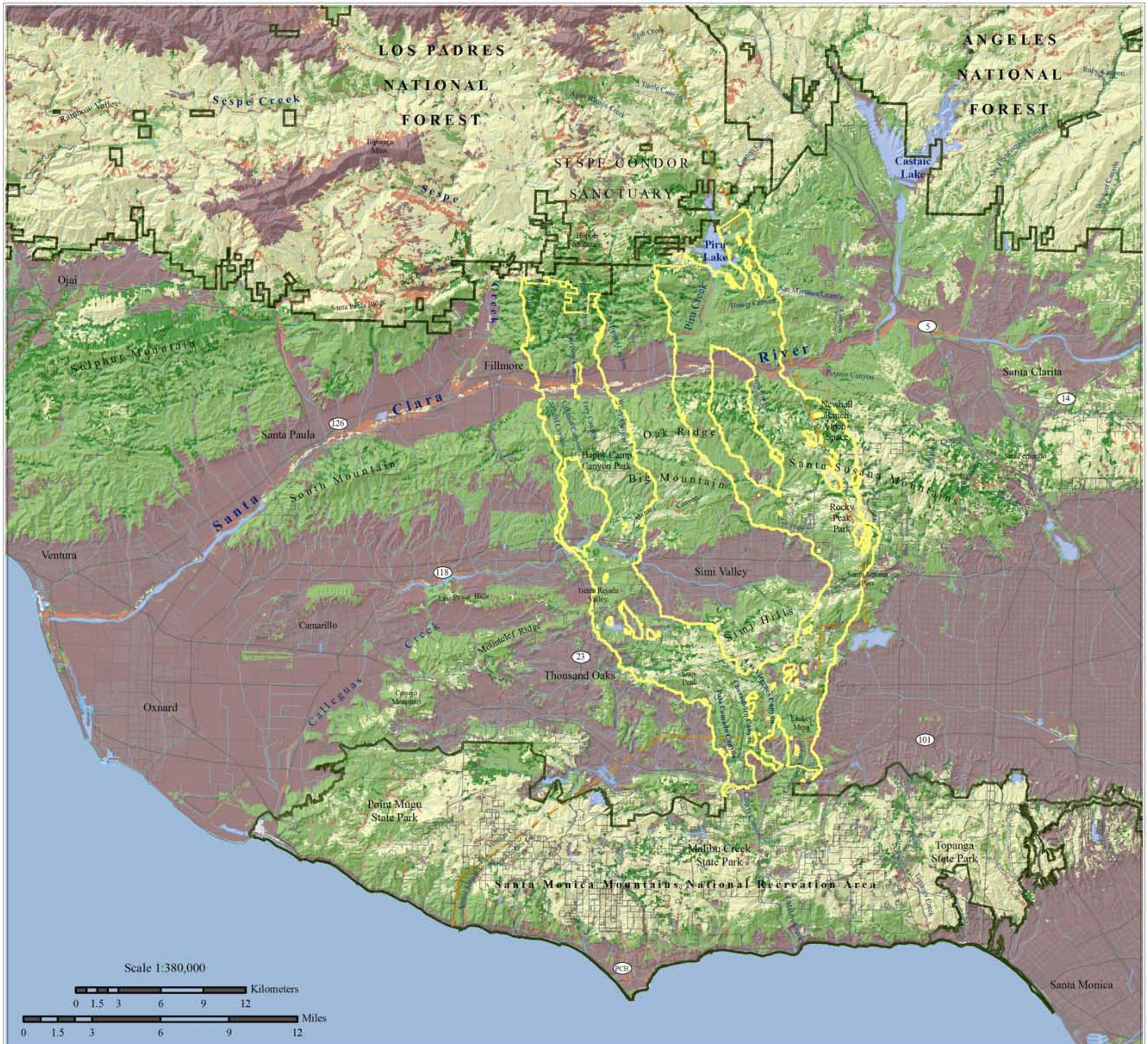
Conceptual Basis for Model Development: Loggerhead shrike prefers open habitat types, such as grassland and oak savanna but they may also be encountered in riparian, desert scrub and wash communities. Potential core areas were defined as greater than or equal to 213 ha (526 ac). Patch size was classified as $\geq$ 9 ha (22.2 ac) but less than 213 ha. Dispersal distance was defined as 13.4 km (8.3 mi).

Results & Discussion: All branches of the Least Cost Union contain highly suitable habitat for loggerhead shrike, with the most contiguous habitat occurring in the eastern branch of the Union (Figure 24). The majority of suitable habitat was identified as potential cores areas for this species (Figure 25). All potential core areas and patches of suitable habitat are within the defined dispersal distance of loggerhead shrike (figure not shown), though barriers to movement may exist between suitable habitat patches. We conclude that the linkage is likely to serve the needs of this species for movement among populations. However, loggerhead shrike would also benefit from the habitat connection that extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley (Figures 24, 25).

To protect and restore habitat connectivity for loggerhead shrike, we recommend that pesticide use is restricted in shrike habitat to avoid depressing the abundance of potential prey items. Shrikes are subject to pesticide poisoning due to their position in the food chain (Hands et al. 1989).

Figure 24.
Habitat Suitability
for
Loggerhead shrike
(Lanius ludovicianus)

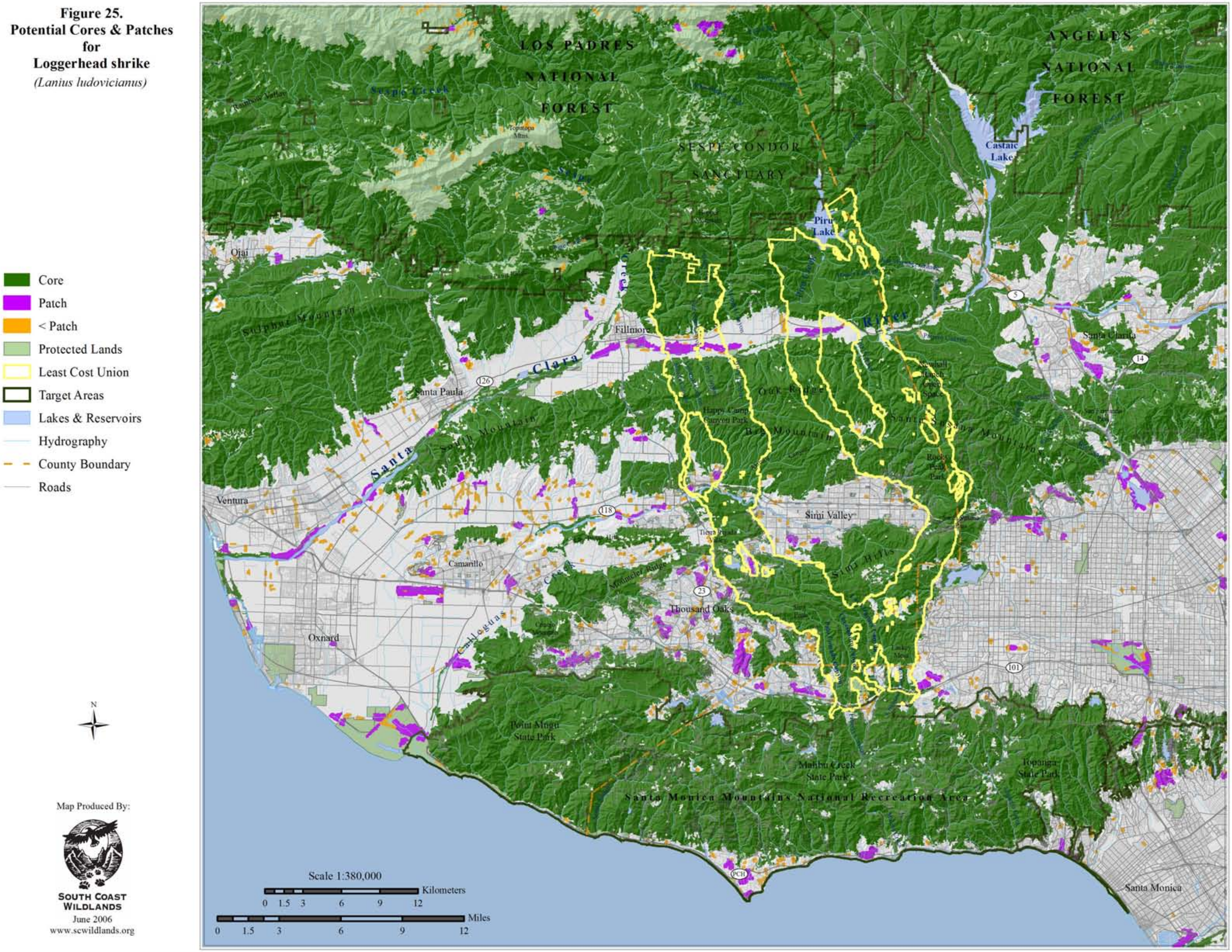
Degree of Suitability
- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads



Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 25.
Potential Cores & Patches
for
Loggerhead shrike
(Lanius ludovicianus)



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

California thrasher (*Toxostoma redivivum*)

Justification for Selection: This is one of the first species to disappear from isolated fragments (Soulé et al. 1988). Loss of habitat to urban and agricultural development constitutes the most serious threat to populations (Robertson and Tenney 1993, Cody 1998).

Distribution & Status: The California thrasher is endemic to the coastal and foothill areas of the California Floristic Province and into adjacent areas of northwest Baja California (Cody 1998). In southern California, it occurs in montane chaparral up to 2,000 m (6,000 ft; Zeiner et al. 1990). California thrasher is considered a sensitive species (CDFG 2005).

Habitat Associations: California thrasher is primarily associated with dense chaparral and sage scrub habitat though it may also occur in adjacent oak woodland and riparian habitats (Cody 1998). This species avoids oak woodland devoid of understory (Robertson and Tenney 1993), although it may use these habitats outside of the breeding season (Cody 1998). Some vegetation communities on desert slopes may also provide habitat, including pinyon-juniper and Joshua tree woodlands (Cody 1998).

Spatial Patterns: Home range size may be up to 20 ha (50 ac) in scrub oak desert habitat (Jehl 1978, Zeiner et al. 1990). In the Santa Monica Mountains, territories averaged 1.4 ha (3.5 ac) in size (Kingery 1962, Zeiner et al. 1990). California thrasher is mostly a sedentary resident species, although there may be some local movement in the nonbreeding season (Zeiner et al. 1990).

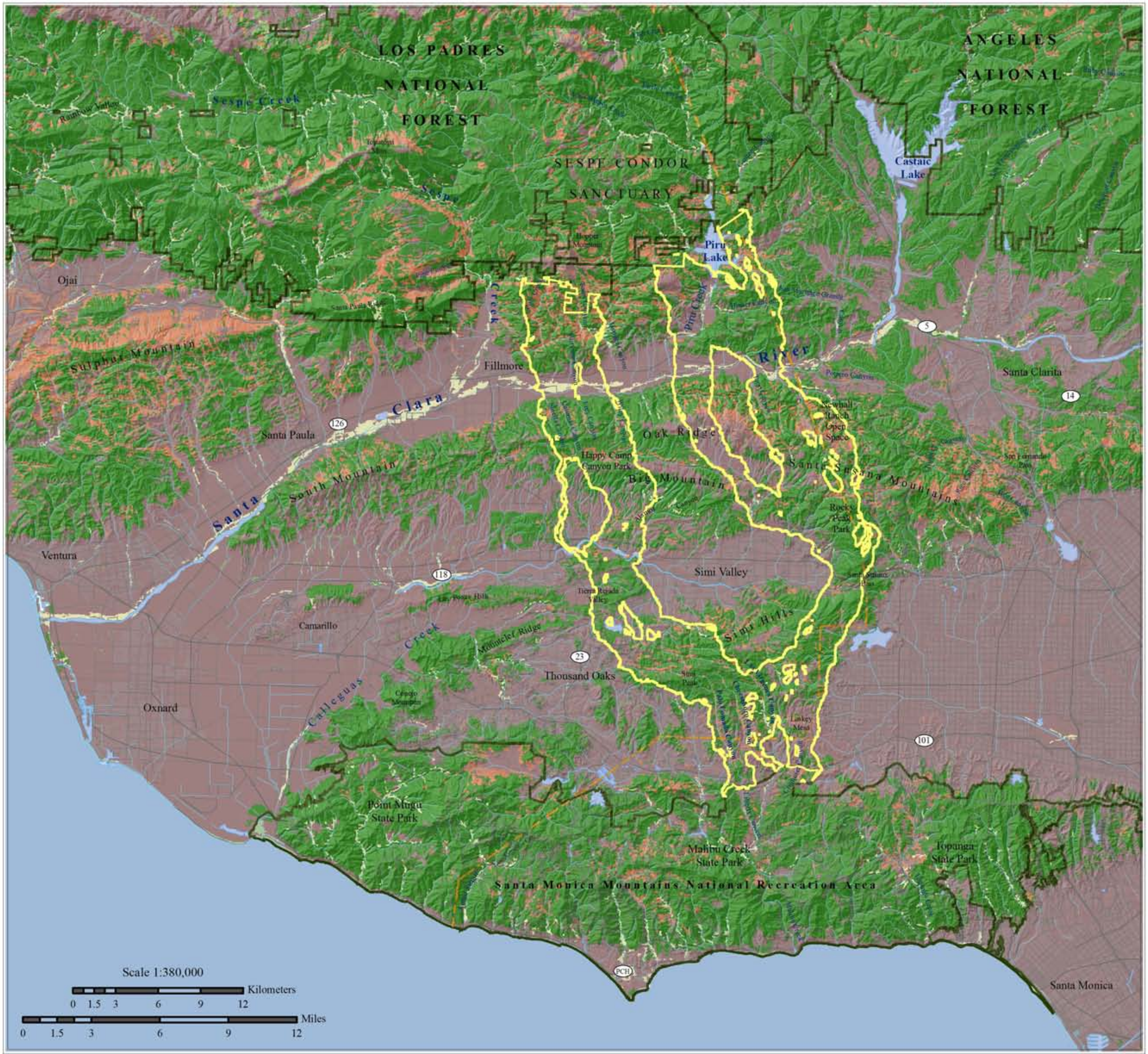
Conceptual Basis for Model Development: This species has a strong preference for chaparral and sage scrub vegetation, though it may also be found in riparian and oak woodland habitats. Core areas potentially supporting 50 or more individuals was defined as $\geq$ 300 ha (741.32 ac). Patch size was classified as $\geq$ 3 ha (7.41 ac) but < 300 ha. Dispersal distance was not estimated for this species.

Results & Discussion: All branches of the Least Cost Union contain highly suitable habitat for California thrasher, with the most highly suitable contiguous habitat occurring in the eastern branch of the Union (Figure 26). Another highly suitable habitat connection not included in the Union extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley (Figure 26). Indeed, the patch size analysis identified contiguous core habitat for this species in the area, while some potential core areas in the Union are separated by patches of suitable habitat (Figure 27). We conclude that the spatial configuration of suitable habitat within the Union will likely allow for intergenerational movement of thrashers between targeted protected areas (Figure 27).

It seems counterintuitive that birds, because they can fly, would need movement corridors to persist in fragmented landscapes (Machtans et al.1996). However, several studies have shown gaps in habitat may form barriers to songbird movement (Whitcomb et al. 1981, Lynch and Whigham 1984, Lens and Dhondt 1994, Machtans et al. 1996, Debinski and Holt 2000, Crooks et al. 2001). Haas (1995) studied the movement ecology of brown thrashers (*T. rufum*) and found that wooded corridors channeled movements between habitat patches. To protect and maintain habitat continuity between protected cores areas for California thrasher, we recommend that:

- Existing road density be maintained or reduced in the Linkage Design.
- Suitable native vegetation is provided in the vicinity of potential crossing points to facilitate movement across barriers (e.g. roads, developments, etc.).
- Habitat restoration efforts are initiated along the Santa Clara River to provide a 2 km wide habitat connection.

Figure 26.
Habitat Suitability for California thrasher
(Toxostoma redivivum)

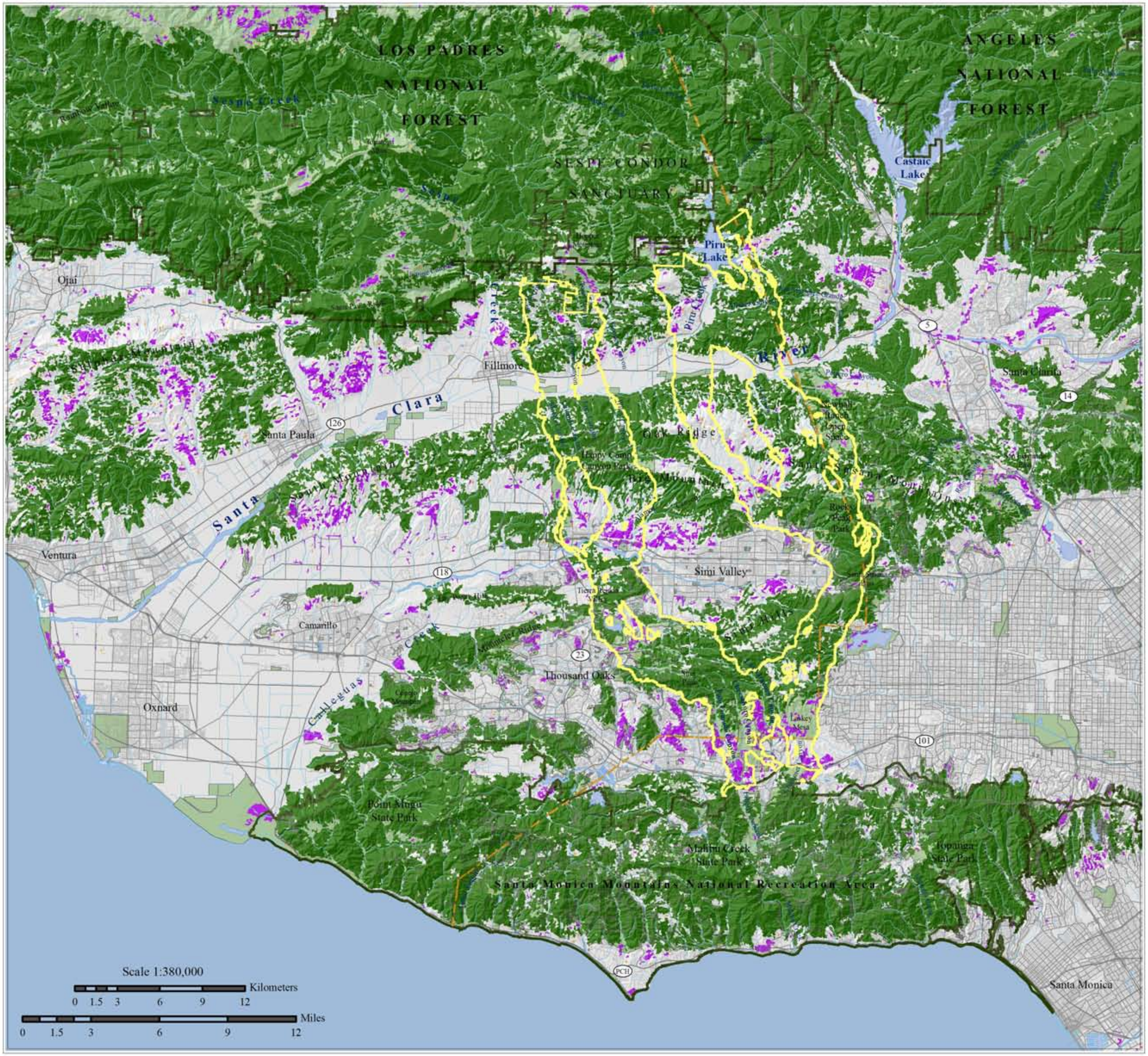


Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 27.
Potential Cores & Patches for California thrasher
(Toxostoma redivivum)

- Core
- Patch
- < Patch
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads



Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Cactus wren (*Campylorhynchus brunneicapillus*)

Justification for Selection: Habitat loss and fragmentation are a concern for this species (Soulé et al. 1988). Historically, the interior and coastal populations were connected through the San Gorgonio Pass in Riverside County, but the connection has been severed due to urbanization of the pass (Rea and Weaver 1990, Solek and Sziji 2004).

Distribution & Status: The cactus wren is widely distributed from southern California south to southern Baja, and in parts of Nevada, Utah, Arizona, New Mexico, and Texas south to Mexico (Dudek and Associates 2001). In California, the interior race is resident in the Mojave and Colorado deserts, from Mexico north to Inyo and Kern counties, while the coastal race is restricted to westward-draining slopes from Ventura County to San Diego County (Zeiner et al. 1990, Solek and Sziji 2004). Taxonomic affiliation of the coastal and interior populations is still being debated (Rea and Weaver 1990, Solek and Sziji 2004).

The coastal race is considered a California Species of Special Concern due to habitat loss, degradation, and fragmentation (Solek and Sziji 2004). Activities that are known to adversely impact the species include weed abatement projects, grading or clearing activities, and some recreational activities (Harper and Salata 1991, Solek and Sziji 2004). Overly frequent fire eliminates the dense, older cactus patches required as habitat. The domestic cat is the most dangerous predator (Anderson and Anderson 1963, Solek and Sziji 2004).

Habitat Associations: Cactus wrens may be encountered in coastal sage scrub, desert scrub, desert succulent scrub, Joshua tree, and desert wash habitats where cactus patches are present (Zeiner et al. 1990). In the planning area, cactus wrens are most often associated with relatively dense patches of prickly pear cactus (*Opuntia sp*.) They depend on thickets of xeric vegetation for cover and thermal relief. Nests are found in branching cacti, thorny scrub, and small trees (e.g., Joshua tree), with nests also used as roosts (Grinnell and Miller 1944, Anderson and Anderson 1957, Zeiner et al. 1990).

Spatial Patterns: The home range of cactus wrens may be maintained throughout the year (Anderson and Anderson 1963, Zeiner et al. 1990). In Arizona, Anderson and Anderson (1973) found an average home range size of 1.9 ha (4.8 ac), varying from 1.2-2.8 ha (2.9-6.9 ac; Zeiner et al. 1990). In San Diego County, California, Rea and Weaver (1990) found smaller home ranges from 0.8 to 2 ha, (2 to 4.9 ac) with an average of 1.3 ha (3.2 ac). On Camp Pendleton, home range size varied from 0.5-2 ha (1.2 to 4.9 ac; Solek and Sziji 2004).

Atwood (1998) found an average dispersal distance of 1.59 km (0.98 mi) for juvenile cactus wrens on the Palos Verdes Peninsula, but this isolated coastal population has limited dispersal options. In Arizona, Anderson and Anderson (1973) found juvenile females dispersed farther away from their natal territories than juvenile males (Solek and Sziji 2004).

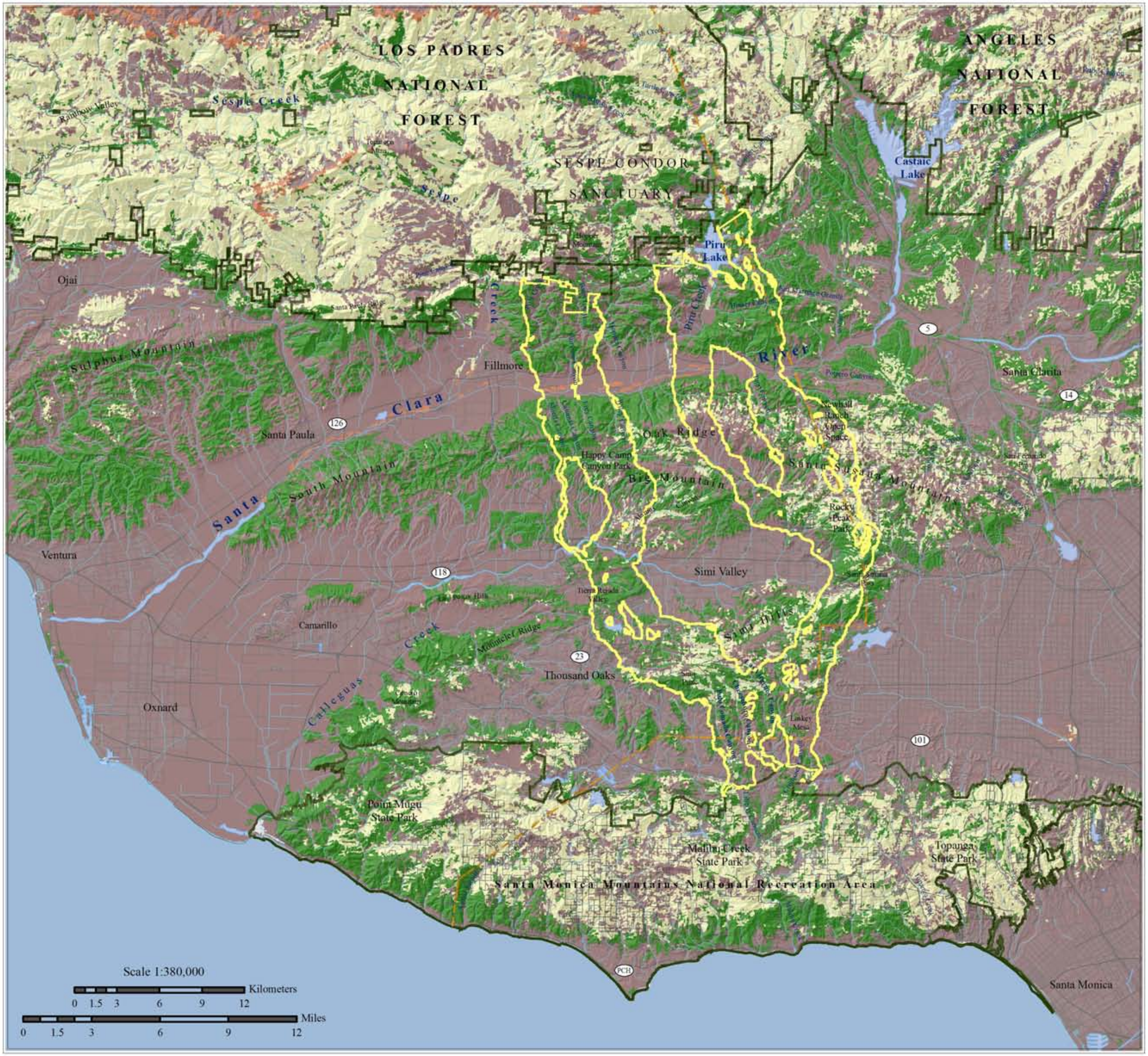
Conceptual Basis for Model Development: Cactus wrens prefer coastal sage scrub, desert scrub, desert succulent scrub, Joshua tree, and desert wash and alluvial habitats in the vicinity of cactus plants. Potential core areas were defined as greater than or equal to 33 ha (81.5 ac). Patch size was classified as $\geq$ 2 ha (4.9 ac) but less than 33 ha. Dispersal distance was defined as 3.18 km (2 mi).

Results & Discussion: The most highly suitable habitat for cactus wren closely follows the distribution of coastal sage scrub habitat in the planning area, particularly where coastal sage scrub co-occurs with cactus (Figure 28). The western branch of the Least Cost Union provides the most highly suitable habitat (in large part due to the presence of extensive cactus stands), while the eastern branch provides the most contiguous habitat (Figure 28). The western branch of the Union is likely to serve this species if the highly suitable core habitat that extends from the western Santa Monica Mountains over Conejo Mountain and Mountclef Ridge to the Tierra Rejada Valley is added to the Union to serve the needs of this species (Figure 29). Distances among all cores and patches of suitable habitat are within the dispersal distance of this species (figure not shown), but barriers may exist between suitable habitat patches.

To protect and restore habitat connectivity for cactus wren, we recommend that fire frequency be controlled to prevent type conversion of scrub habitats to nonnative annual grassland (Winter 2003) and that important cactus scrub areas be protected and maintained. Suitable native vegetation should be provided in the vicinity of potential crossing points to facilitate movement across barriers (e.g. roads, developments, etc.).

Figure 28.
Habitat Suitability
for
Cactus wren

(Campylorhynchus brunneicapillus)



Degree of Suitability

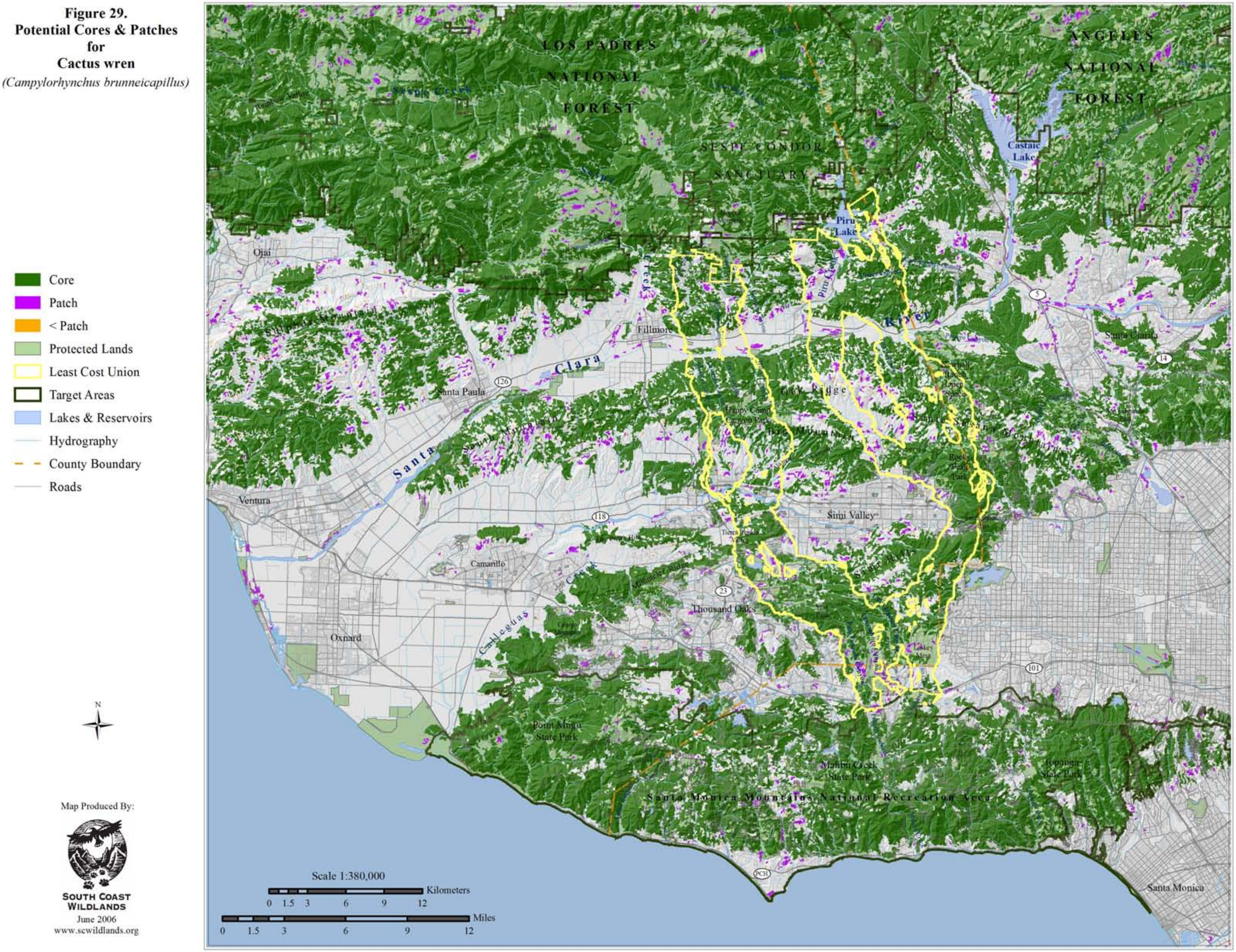
- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

N

Map Produced By:

SOUTH COAST
WILDLANDS
June 2006
www.scwildlands.org

Figure 29.
Potential Cores & Patches for Cactus wren
(Campylorhynchus brunneicapillus)



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Acorn woodpecker (*Melanerpes formicivorus*)

© Peter LaTourrette

Justification for Selection: The continued elimination of oaks is a threat to the existence of this species in California (Verner and Boss 1980, Zeiner et al. 1990). Overgrazing causes reduced regeneration of oaks. As a cavity nester, this species is also indicative of intact bird communities; they are highly susceptible to competition with invasive non-native birds such as feral parrots (Butler 2005) and European starlings, which are associated with degraded habitats.

Distribution & Status: Acorn woodpeckers occur from northwestern Oregon, California, the American Southwest, and western Mexico through the highlands of Central America, as far south as northern Columbia (Koenig and Haydock 1999). They are typically found below 2100 m (6,890 ft), though most good habitats are below 915 m (3,002 ft) in elevation (Zeiner et al. 1990). This species isn't considered sensitive by any government entities.

Habitat Associations: Acorn woodpeckers are residents of foothill and montane hardwood and hardwood-conifer habitats (Roberts 1979, Zeiner et al. 1990). The acorn woodpecker relies on large stands of old trees (Ligon and Stacey 1996). They excavate cavities in winter and spring in live trees or snags of oaks, sycamores, or conifers (Zeiner et al. 1990), though snags are preferred (Hooge et al. 1999). The acorn woodpecker is a highly specialized species that lives in close association with oaks, because they depend largely on acorns for their winter diet (Ritter 1938, MacRoberts 1970, Bock and Bock 1974; Hannon et al.1987, Koenig and Mumme 1987, Zeiner et al. 1990, Koenig and Haydock 1999).

Spatial Patterns: Acorn woodpeckers are cooperative breeders that live in social groups of 2 to 15 individuals (MacRoberts and MacRoberts 1976; Koenig et al. 1995, Hooge et al. 1999). Territory size is based on the key resource, the roost cavity and granary tree (Ligon and Stacey 1996). MacRoberts and MacRoberts (1976) found territory sizes from 3.5 to 9 ha (8.7 to 22.2 ac), while Swearingen (1977) found average territory size to be 4.7 ha (11.5 ac) in the Central Valley, with a range from 1.5 to 8.1 ha (3.8 to 20 ac). Smaller territory sizes have been recorded for the Coast Ranges (Zeiner et al. 1990).

On the western slope of the Sierras, upslope movement occurs in fall to mixed conifer habitat with black oak (Verner and Boss 1980, Zeiner et al. 1990). Dispersal distances of 0.22 $\pm$ 0.48 km (0.14 $\pm$ 0.3 mi) for males and 0.53 $\pm$ 0.52 km (0.32 $\pm$ 0.33 mi) for females have been recorded. The usual avian pattern of greater dispersal distance by females holds true for acorn woodpeckers (Koenig et al. 2000). The maximum-recorded dispersal distance for this species is 4.3 km (2.7 mi; Koenig et al. 2000).

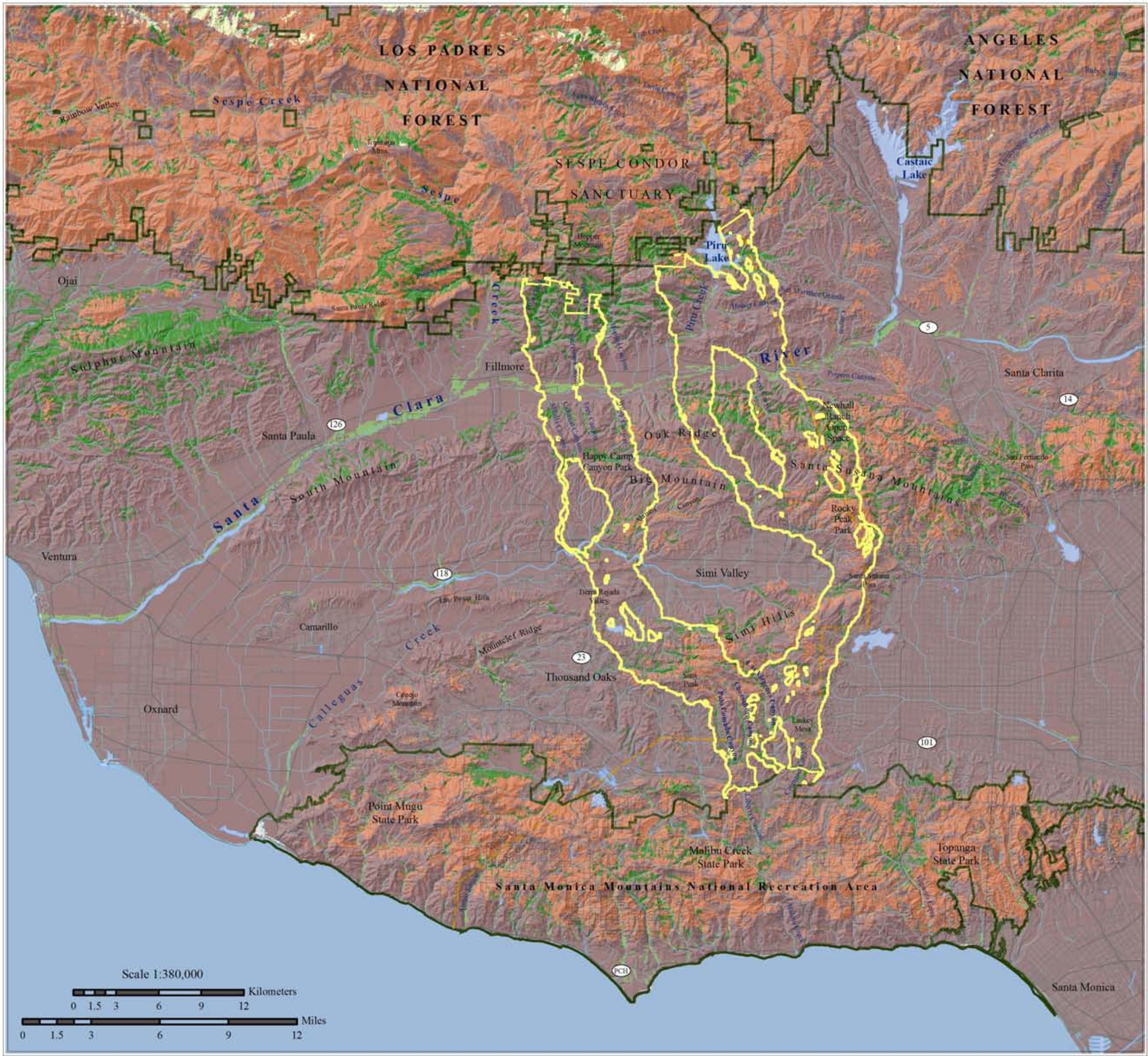
Conceptual Basis for Model Development: This species prefers mature oak woodlands and hardwood coniferous forest below 2100 m. Core areas potentially supporting 50 or more individuals were defined as $\geq$ 100 ha (247 ac). Patch size was classified as $\geq$ 3 ha (7.4 ac) but < 100 ha. Dispersal distance was defined as 8.6 km (5.3 mi), using twice the maximum reported distance of 4.3 km.

Results & Discussion: Oak woodlands and riparian habitats are fairly widespread in the planning area but are somewhat scattered in the Least Cost Union, limiting the amount of suitable habitat for acorn woodpecker (Figure 30). Several patches of highly suitable habitat were captured in the Union, with potential core areas limited to Happy Camp Canyon and the north facing slopes of Oak Ridge Mountain in the Santa Susana Mountains, and Pole and Toms canyons in the foothills of the Sierra Madre Range (Figure 31). All potential cores and patches of suitable habitat identified by the analysis are within the dispersal distance of this species (figure not shown). Acorn woodpecker movements will likely be accommodated by the Least Cost Union.

As cavity-nesting birds, acorn woodpeckers are susceptible to being extirpated by birds associated with urban areas, such as feral parrots and European starlings that can outcompete woodpeckers for nesting cavities. To protect and maintain habitat continuity between protected cores areas for acorn woodpecker, we recommend that:

- Suitable native vegetation is provided in the vicinity of potential crossing points to facilitate movement across barriers (e.g. roads, developments, etc.).
- Existing road density be maintained or reduced in the Linkage Design.
- Overgrazing is discouraged in oak woodlands to allow for regeneration.

Figure 30.
Habitat Suitability
for
Acorn woodpecker
(Melanerpes formicivorus)



Degree of Suitability

- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

N

Scale 1:380,000

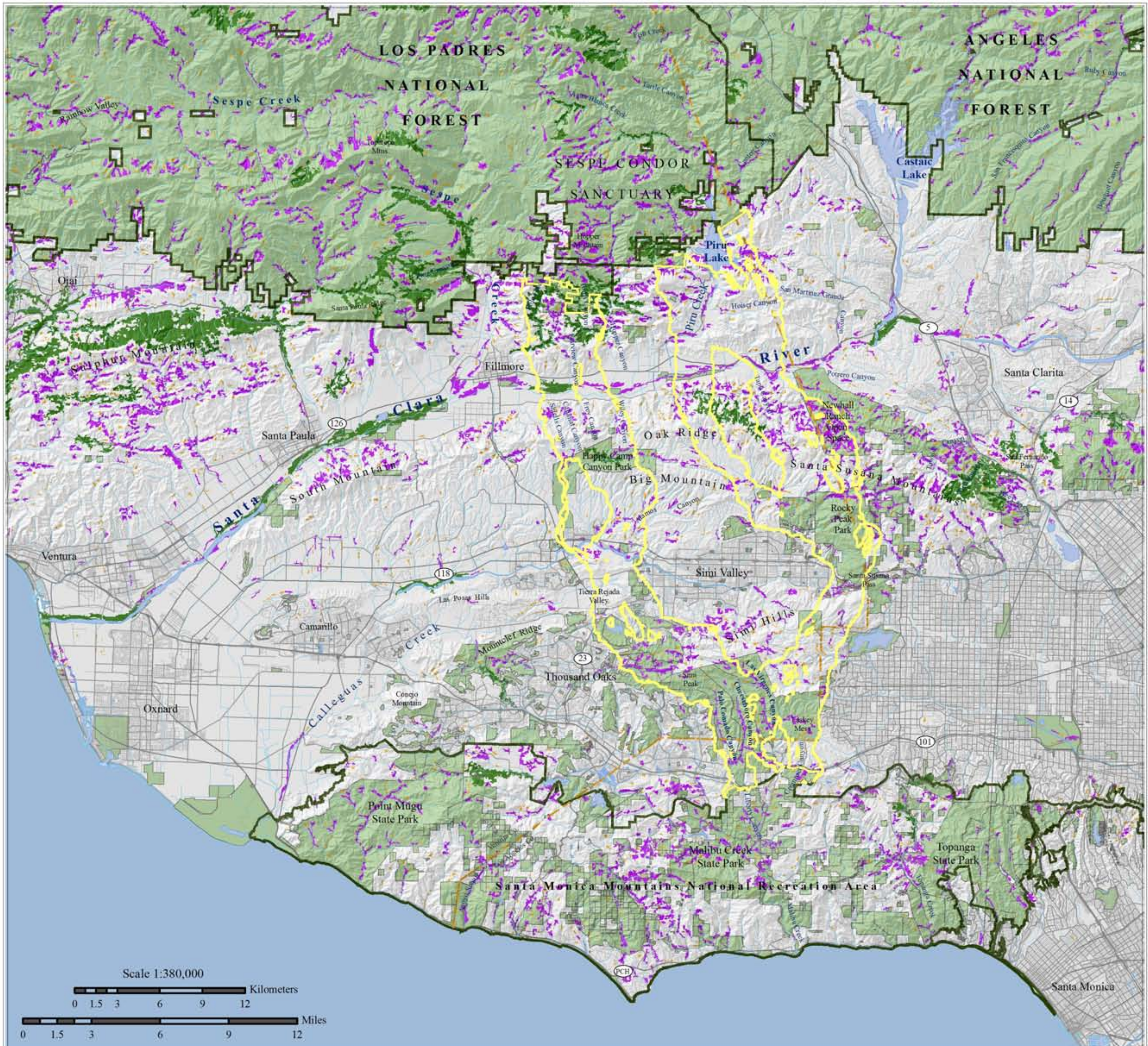
0 1.5 3 6 9 12 Kilometers

0 1.5 3 6 9 12 Miles

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 31.
Potential Cores & Patches
for
Acorn woodpecker
(Melanerpes formicivorus)



- Core
- Patch
- < Patch
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

N

Map Produced By:

SOUTH COAST
WILDLANDS
June 2006
www.scwildlands.org

Western toad (*Bufo boreas*)

Justification for Selection: This species is an indicator of the quality of habitat connections needed between slow moving aquatic habitat (chiefly ponds and quiet backwaters) and upland habitat. Along with other native amphibians, this species is likely sensitive to the effects of urban development in southern California (Riley et al. 2005).

Distribution & Status: The western toad ranges from western British Columbia and southern Alaska south through Washington, Oregon, and Idaho to northern Baja California, and east to Montana, western and central Wyoming, Nevada, high elevation areas in Utah, and western Colorado (Stebbins 1985). The western toad is not considered a special status species.

Habitat Associations: In California, western toads occur up to 3,048 m (10,000 ft) elevation in most habitats except deserts (Zeiner et al. 1988, Sullivan 1994). Upland habitats in the planning area include grasslands, coastal scrub, chaparral, and oak and riparian woodlands. Aquatic habitats include lakes, ponds, vernal pools, roadside ditches, irrigation canals, permanent and intermittent streams, and rivers (Zeiner et al. 1988). Eggs are laid in water 6 to 12 inches (30 cm) in depth (Olson 1992, Stebbins 1954).

Spatial Patterns: While there is substantial variation in home range, individuals living in low elevation areas are occasionally encountered up to 1000 m (3,281 ft) from potential breeding sites, and some have been tracked through a wide range of habitats up to 5 km (3.1 mi) from their breeding areas (Zeiner et al. 1988, Corn et al. 2001).

Dispersal distances among breeding sites have not been measured. After breeding, adult toads may move from 1 km to 5 km (0.62 to 3.1 mi) through a wide range of potentially inhospitable habitats (Zeiner et al. 1988, Corn et al. 2001). Tadpole dispersal is probably not significant; breeding adults in a population tend to lay their eggs at the same location (Sullivan 1994) and their tadpoles clump in large masses until they metamorphose (Nussbaum et al. 1983).

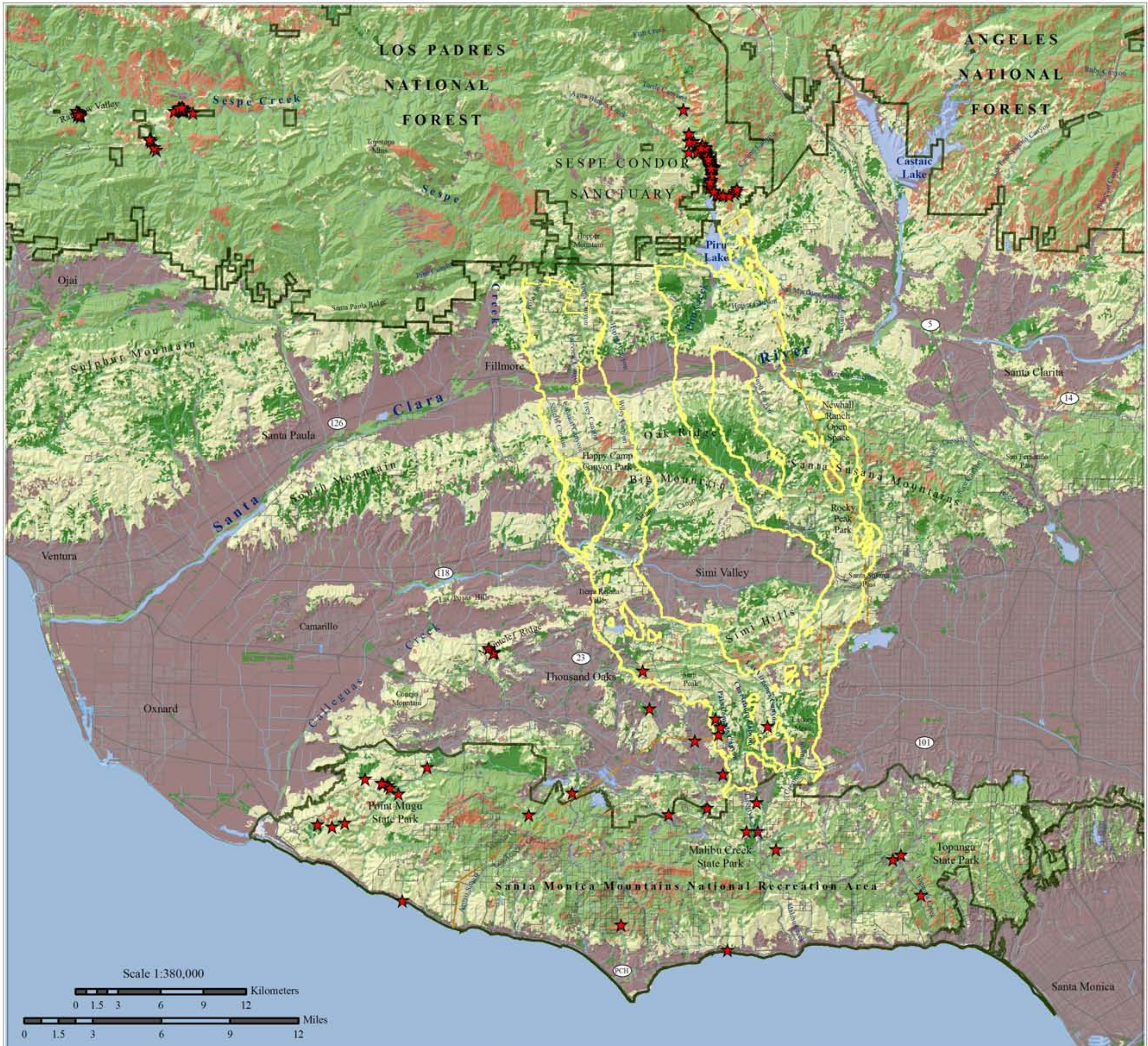
Conceptual Basis for Model Development: Western toads prefer grassland, coastal scrub, chaparral, and oak and riparian woodland habitats. Minimum patch size needed for 2 toads is less than the 30-m minimum mapping unit. Because habitat quantity is a poor predictor of population density in toads, we did not designate a minimum patch size but included all suitable habitat as potential core areas. Dispersal distance used is 10 km (6.2 mi; twice the maximum reported distance an individual moved from a breeding site).

Results & Discussion: All three branches of the Least Cost Union contain fairly contiguous suitable habitat for western toad, with the central branch containing the most highly suitable habitat (Figure 32). The western toad has been recorded in Liberty, Las Virgenes and Palo Comado canyons, and to the west of Simi Peak in the Union, and on Mount Clef Ridge. All suitable habitat identified in the planning area was delineated as potential core areas for this species (Figure 33). Distances among all cores and patches of suitable habitat are within the dispersal distance of this species (figure not shown), but barriers may exist between suitable habitat patches. We conclude that the Union will likely to serve the movement needs of western toad, though habitat added to the Union on Conejo Mountain and Mount Clef Ridge will also benefit this species.

To protect and restore habitat connectivity for the western toad, we recommend that:

- Riparian habitats needed for breeding and movement are restored.
- Invasive species be eradicated that destroy breeding habitat (e.g., giant reed) and prey on tadpoles (e.g., bullfrogs and fish).
- Road barriers be modified, where necessary, to allow amphibians to move along stream courses.
- Water quality that is compromised by agricultural, urban, and industrial runoff be restored.

Figure 32.
Habitat Suitability for Western toad
(Bufo boreas)



Degree of Suitability

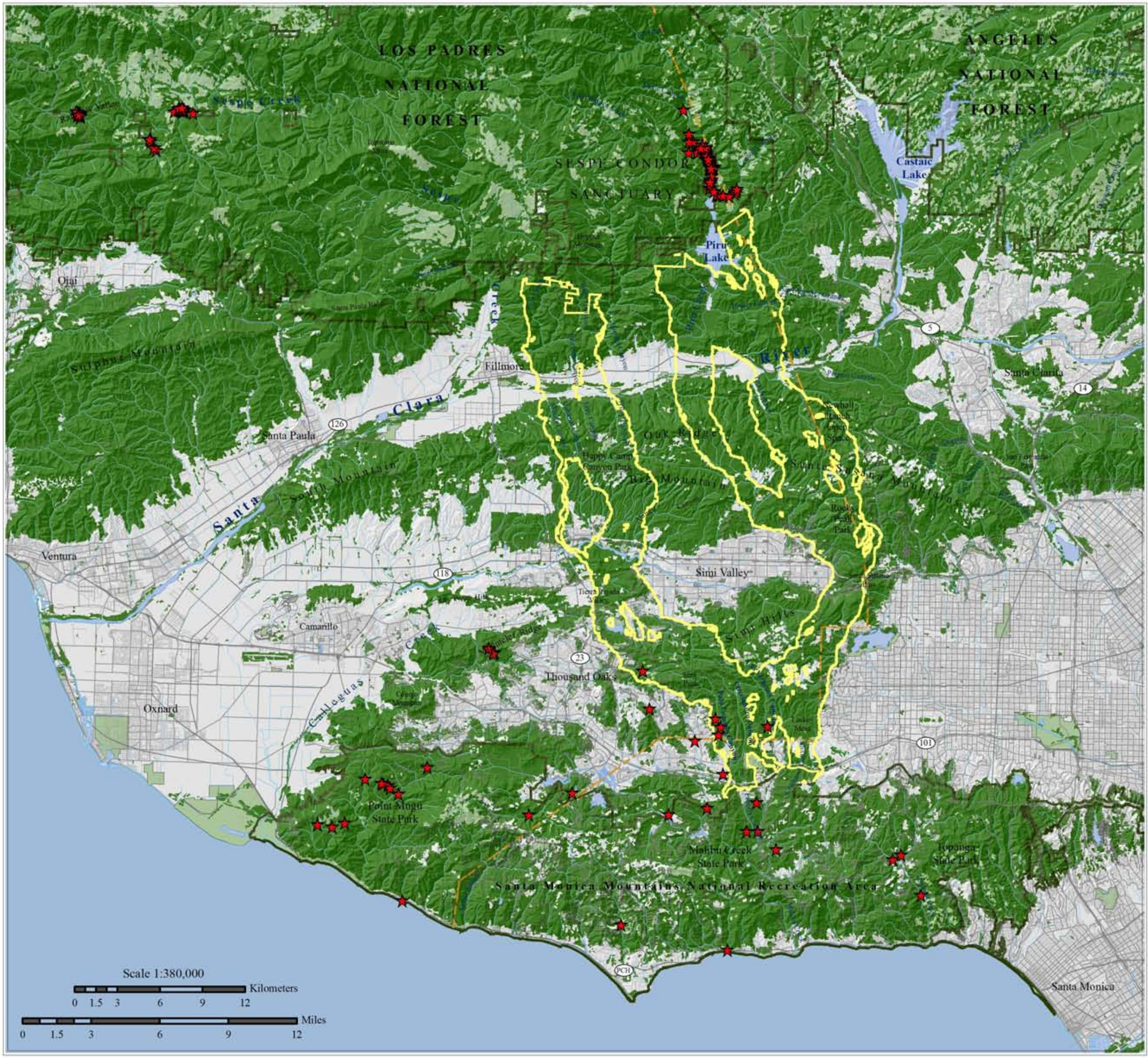
- High
- Medium to High
- Medium
- Low to Medium
- Low
- Protected Lands
- Recorded Occurrence*
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: USFS and National Park Service Ecological Monitoring Data

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 33.
Potential Cores & Patches
for
Western toad
(Bufo boreas)



Core
Recorded Occurrence*
Protected Lands
Least Cost Union
Target Areas
Lakes & Reservoirs
Hydrography
County Boundary
Roads

*Data Source: USFS and National Park Service Ecological Monitoring Data

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

California kingsnake (*Lampropeltis getula*)

Justification for Selection: This species is attracted to warm roads in the evening in late spring and summer, making them particularly susceptible to roadkill (McGurty 1988). This species is also likely sensitive to urban-caused habitat fragmentation in the study area (Busteed 2003).

Distribution & Status: California kingsnake ranges throughout the western United States, from Baja California to Oregon and southern Utah to western Arizona. Elevation ranges from sea level to 2,100 m (7,000 ft; Stebbins 1985, Zeiner et al. 1988).

While this subspecies is not considered a special status species, kingsnakes are declining in the wild due to heavy collecting pressure, habitat loss and degradation (McGurty 1988). Regulatory agencies have instituted a law to ban the taking of this species from the wild, but kingsnakes, in all their striking variations, are still, unfortunately, a hot commodity.

Habitat Associations: California kingsnake may utilize meadows, grassland, oak woodland, open coniferous forest, chaparral, and coastal scrub habitats but they are most abundant in valley-foothill riparian and other habitats occurring in the vicinity of rivers and streams (Zeiner et al. 1988). When inactive, kingsnakes seek cover in rocky outcrops, rodent burrows and under surface objects such as flat rocks, logs, and boards. At montane localities with cold winters, individuals hibernate in rodent burrows and in deep fissures in rock accumulations (Zeiner et al. 1988).

Spatial Patterns: Research on home range size, density estimates and movement ecology for California kingsnake is lacking. Although, this species is presumed to seasonally migrate over relatively short distances to and from winter hibernacula, no distance estimates were found in the literature.

Conceptual Basis for Model Development: Movement between protected core areas in the linkage is multigenerational. Suitable habitat for the kingsnake was defined as valley-foothill riparian, riparian woodland, wet meadow, grassland, coastal sage, chaparral, oak woodland, and coniferous forests. Since no data are available on the home range size of this species, all suitable habitat patches were delineated as potential cores areas. Dispersal distance was not estimated for this species.

Results & Discussion: Highly suitable habitat for kingsnake is fairly widespread in both targeted protected areas and the Least Cost Union (Figure 34). All suitable habitat is considered potential core areas (Figure 35). The spatial configuration of suitable habitat for kingsnake suggests that all branches of the Union will likely to serve the movement needs of this species.

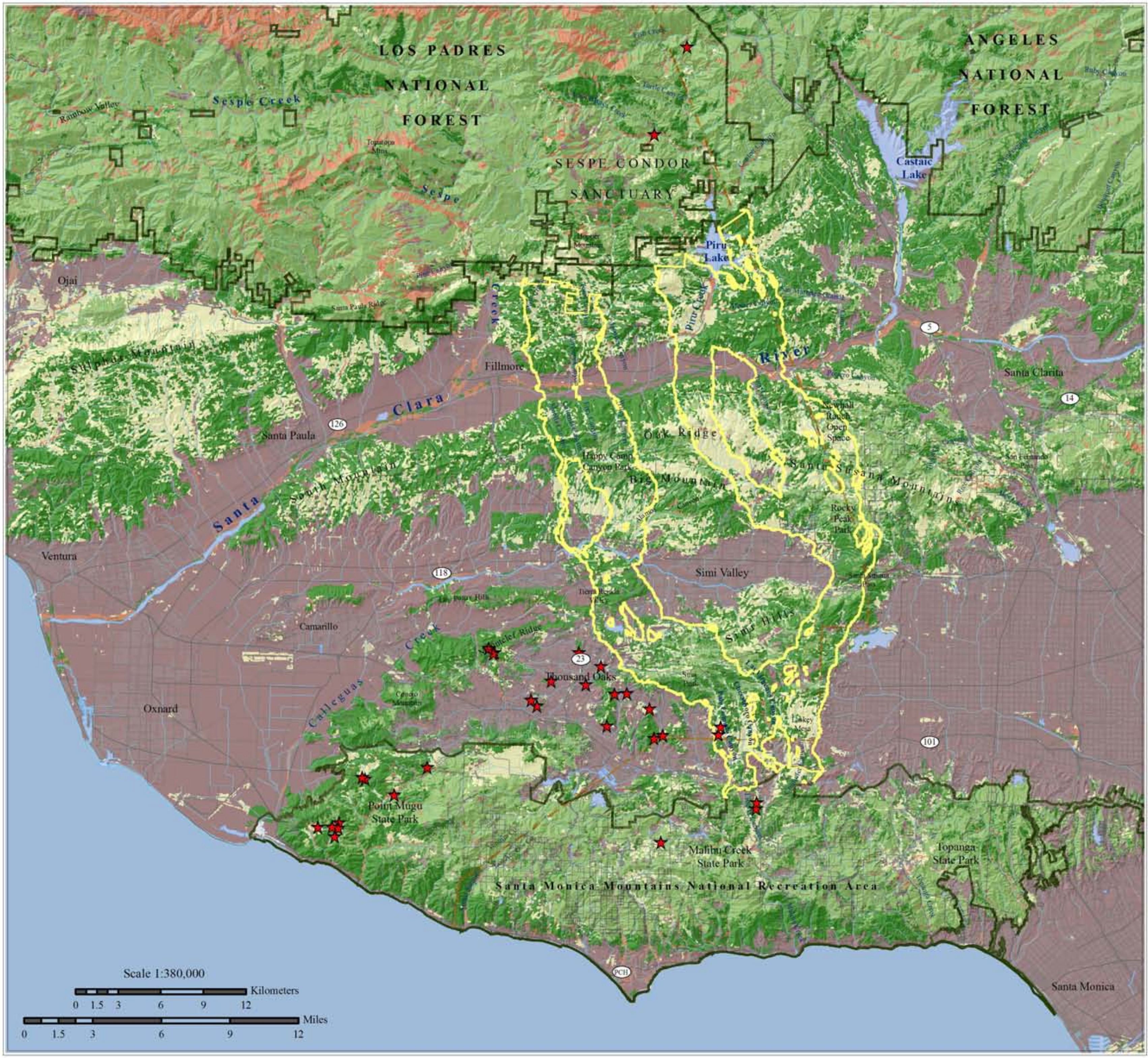
Snakes are particularly vulnerable to roadkill, since they preferentially aggregate on or near warm roads to thermoregulate (Trombulak and Frissell 2000). To protect and restore habitat for California kingsnake, we recommend that:

- Riparian buffers of 1 km are added along each riparian route in the linkage.
- Road barriers are modified to allow kingsnakes to move along water courses and suitable upland habitats.
- Anti-poaching laws are enforced.

Figure 34.
Habitat Suitability
for
California kingsnake
(Lampropeltis getula)

High
Medium to High
Medium
Low to Medium
Low
Protected Lands
Recorded Occurrence*
Least Cost Union
Target Areas
Lakes & Reservoirs
Hydrography
County Boundary
Roads

*Data Source: USFS and National Park Service Ecological Monitoring Data

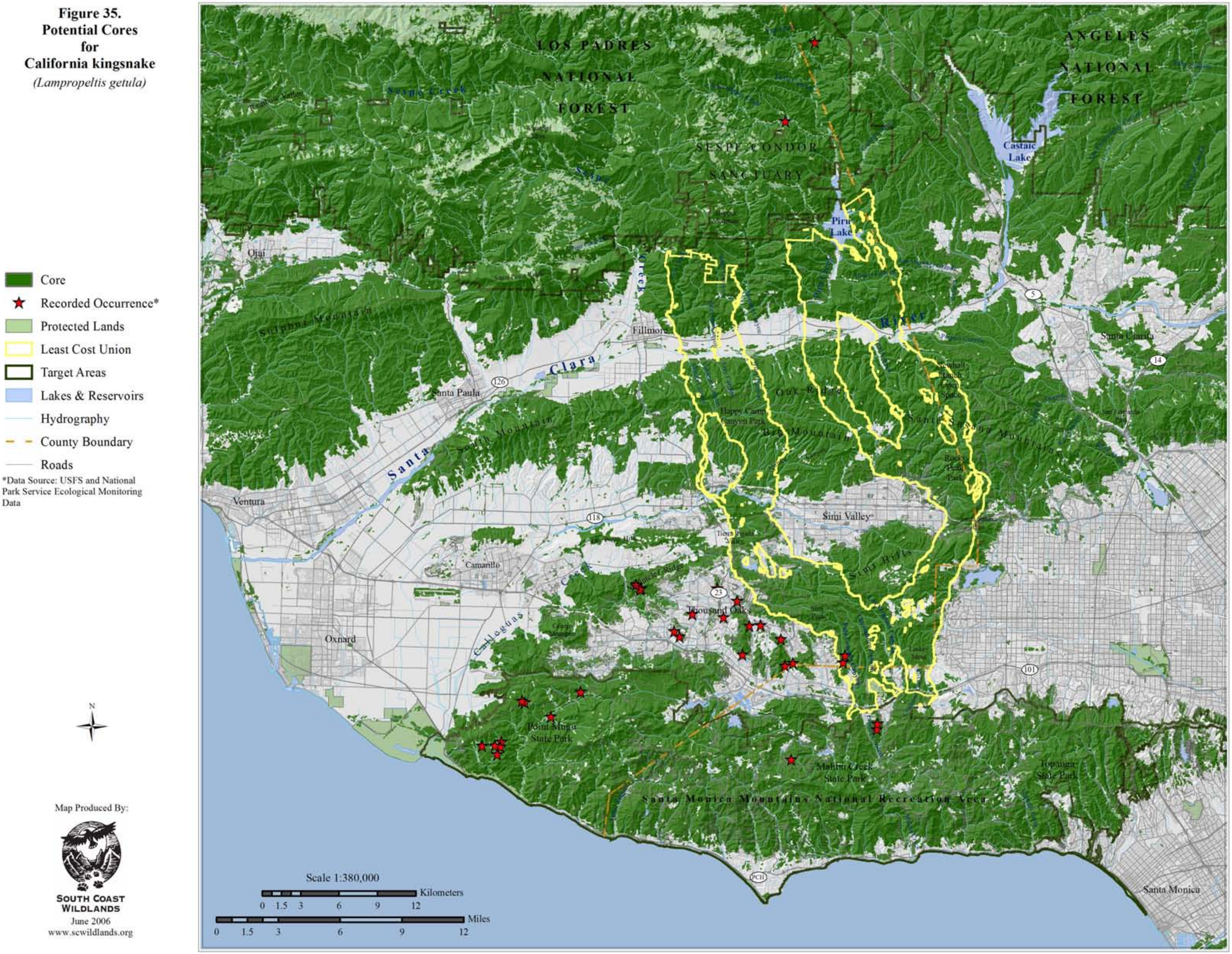


Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 35. Potential Cores for California kingsnake

(Lampropeltis getula)



Map Produced By:

SOUTH COAST WILDLANDS

June 2006

www.scwildlands.org

Coastal whiptail (*Aspidoscelis tigris stejnegeri*)


© 2004 Dr. Daniel L. Geiger

Justification for Selection: Whiptails utilize patches and need continuous open spaces for movement between core areas. Edge effects limit dispersal. They are habitat generalists, but susceptible to habitat fragmentation, roads, highways, and extremely impervious environments (R. Fisher, pers. comm.).

Distribution & Status: Coastal whiptails are widely distributed, but uncommon over much of their range in California, except in desert regions where they are abundant in suitable habitats (Zeiner et al. 1988). They are found throughout the state except in the humid northwest, along the humid outer Coast Ranges, and in mountainous regions above 2,290 m (7,500 ft).

Habitat Associations: Coastal whiptails occur in a variety of habitats including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, mixed conifer, pine-juniper, chamise-redshank chaparral, mixed chaparral, desert scrub, alkali scrub, and alluvial fans (Zeiner et al. 1988). Whiptails spend little time in open areas, but will cross barren spaces in order to reach the cover of dense shrubs in sparsely vegetated areas (Zeiner et al. 1988). They are often found associated with sandy areas along gravelly arroyos or washes (Stebbins 1954). Loose soil for foraging and nest construction may be an important habitat element (Zeiner et al. 1988). Vitt and Ohmart (1977) reported that the diet of whiptails may change seasonally to reflect the abundance of seasonally available prey items, which may include a wide variety of ground-dwelling invertebrates including grasshoppers, beetles, ants, termites, insect larvae and spiders (Stebbins 1954).

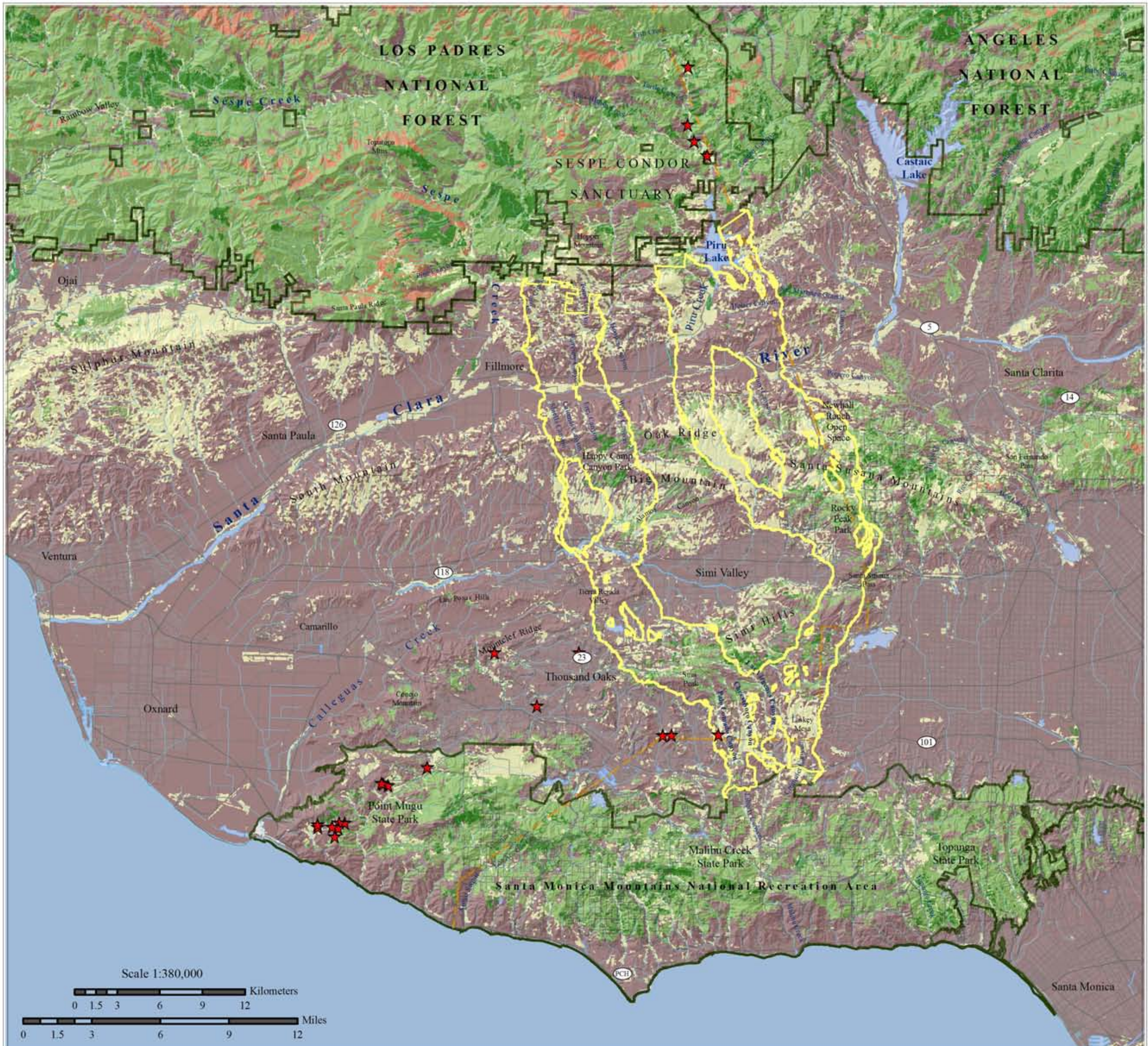
Spatial Patterns: Average home ranges for whiptails (excluding wandering individuals) have been calculated by Milstead (1957) to be about .1 ha (.26 ac). Jorgensen and Tanner (1963) have reported home range sizes of .7 ha (.18 ac) for males and .04 (.1 ac) for females. Observed overlaps in the home ranges of adult whiptails, and apparent lack of aggressive behavior between individuals suggest that there is a lack of male territoriality in this species (Milstead 1957).

Little is known about dispersal distances for this species but they are capable of making extensive movements, sometimes moving hundreds of meters from one location to another (Jorgensen and Tanner 1963, McCoy 1965, Anderson 1993). Most or all essential habitat requirements are apparently found within the normal area of activity (Zeiner et al. 1988). When long-distance movements do occur they are unpredictable and related to food availability.

Conceptual Basis for Model Development: Movement in the linkage is multi generational. Coastal whiptail prefers oak woodland, hardwood-conifer, valley-foothill riparian, mixed conifer, pine-juniper, chaparral, scrub, and alluvial fan habitats, below 2,290 m. Potential core areas were defined as greater than or equal to 2.5 ha (6.18 ac). Patch size was classified as $\geq$ 0.2 ha (0.49 ac) but less than 2.5 ha. Dispersal distance was defined as 400 m (1,312 ft).

Results & Discussion*:* All three branches of the Least Cost Union contain medium to high suitable habitat for the whiptail, with the central and eastern branches containing the most contiguous habitat (Figure 36). The whiptail has been recorded in Palo Comado Canyon in the Union, and on Mount Clef Ridge. Almost all suitable habitat identified in the planning area was delineated as potential core areas for this species (Figure 37). Distances among all cores and patches of suitable habitat are within the dispersal distance of this species (figure not shown), but barriers may exist between suitable habitat patches. We conclude that the linkage will likely serve the movement needs of the whiptail.

Figure 36.
Habitat Suitability for Coastal whiptail
(Cnemidophoris tigris stejnegeri)



Degree of Suitability

- High
- Medium to High
- Medium
- Low to Medium
- Low
- Recorded Occurrence*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

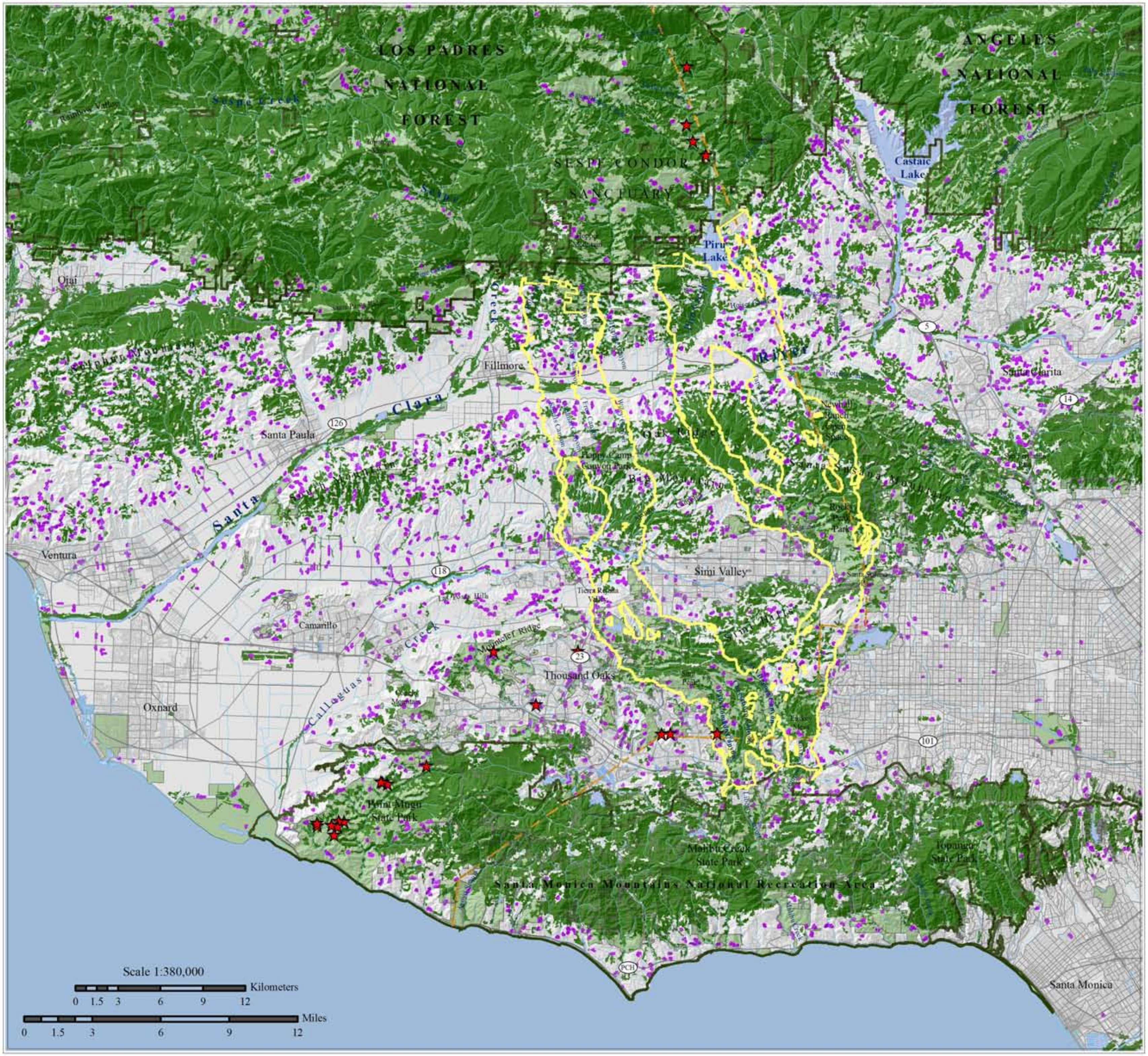
*Data Source: USFS and National Park Service Ecological Monitoring Data

Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Figure 37.
Potential Cores & Patches
for
Coastal whiptail
(Cnemidophoris tigris stejnegeri)

- Core
- Patch
- < Patch
- Recorded Occurrence*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: USFS and National Park Service Ecological Monitoring Data



Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Southern steelhead trout (*Oncorhynchus mykiss mykiss*)

www.caltrout.org

Justification for Selection: Steelhead trout possess unique adaptations, represent an important part of the state's anadromous resources and, because the steelhead inhabits an entire river ecosystem, and requires clean, cool water year-round, it serves as a vital indicator of the overall health of the aquatic ecosystems of southern California coastal watersheds (Finney and Edmondson 2002, Titus et al. 1999).

In original population numbers, steelhead could have been considered a keystone species, and appear to be keystone food resources for vertebrate predators and scavengers in some regions (Willson and Halupka 1995). A growing body of evidence indicates that chemical nutrients delivered by spawned-out carcasses can play a critical role in sustaining the productivity of riparian and lacustrine ecosystems, perhaps including the next generations of juvenile salmon (Richey et al. 1975, Kline et al. 1990). Variation in anadromous fish populations can have major effects on the productivity, phenology and metapopulation dynamics of wildlife and hence on regional biodiversity (Willson and Halupka 1995). The loss of southern steelhead trout from many historically used streams in the planning area has certainly affected these ecosystems. However, increasing opportunities and interest exist to restore steelhead populations in streams throughout the region and waterway connectivity is a key requirement for success.

Distribution & Status: Historically, the steelhead trout was found in the North Pacific Ocean from the Kamchatka Peninsula in Asia to the northern Baja peninsula, and likely inhabited most coastal streams in Washington, Oregon and California as well as many inland streams in these states and Idaho (McPhail and Lindsey 1970). During the twentieth century, over 23 indigenous and naturally reproducing stocks of steelhead are believed to have been extirpated, and many more are thought to be in decline (NMFS 2000a). Presently, the species distribution extends from the Kamchatka Peninsula, east and south along the Pacific coast of North America, to at least Malibu Creek in southern California. A recent discovery of steelhead in San Mateo Creek on the border of Orange and San Diego Counties has confirmed the ability of the steelhead to repopulate areas of its historic range significantly south of Malibu Creek (CDFG 2000, Finney and Edmondson 2002).

The Southern California steelhead population has declined by 99% since the turn of the century (Titus et al. 1999). All naturally spawned populations and their progeny in rivers from the Santa Maria River, San Luis Obispo, to Malibu Creek, Los Angeles County are considered endangered. On August 18th, 1997, the National Marine Fisheries Service issued a Final Rule listing two Evolutionarily Significant Units (ESUs) (Southern California and Upper Columbia River) as endangered and three ESUs (Central California Coast, South-Central California Coast, and Snake River Basin) as threatened.

The major cause of decline of steelhead in California is freshwater habitat loss and degradation, from inadequate stream flows, blocked access to historic spawning and rearing areas by dams, and human activities like land development, logging, mining and agriculture that discharge sediment and debris into watercourses (Jantz et al. 1990, CalTrout 1999). In particular, habitat degradation from urbanization and urban runoff pollution has resulted in sediment in streams clogging spawning gravel, harming the natural reproduction and productivity of the steelhead (Jantz et al. 1990, CalTrout 1999).

Habitat Associations: Unlike juvenile salmon that typically migrate to the ocean after just a few months of freshwater rearing, juvenile steelhead trout reside in coastal streams from one to three years (Finney and Edmondson 2002). Steelhead use all segments of a river or stream system to complete the freshwater phase of their life-history: estuaries to acclimate to salinity changes, the middle reaches of the main stem to reach tributaries, and headwaters tributaries to spawn and rear (Finney and Edmondson 2002). Steelhead require cool, clean water year-round to sustain themselves and need cool, clean, well-oxygenated water flowing over clean gravel to breed and develop (McEwan and Jackson 1996).

Major streams in southern California originate in the coastal mountains and often cross broad low-elevation alluvial flats which present inhospitably warm and fluctuating temperatures and the streams themselves may be intermittent. The higher-elevation headwaters or well-shaded reaches, therefore, are the primary spawning and rearing areas for steelhead today. The optimum water depth for steelhead spawning is approximately 36 cm (14 in) and ranges from about 15 to 91 cm (6 to 36 in; Bovee 1978). Fry typically use water approximately 20 cm (8 in) in depth and can use water 5 to 81 cm (2 to 32 in) deep, while older juveniles typically use a water depth of about 38 cm (15 in) but can use water 5 to 152 cm (2 to 60 in) deep (Bovee 1978).

The ability of some southern steelhead to survive in warm (>70^{o} F [21^{o} C]) isolated pools (Higgins 1991) possibly is due to greater physiological tolerances to higher temperatures and lower oxygen levels than are shown by other steelhead stocks. It has been surmised that steelhead in southern California also rely heavily on estuaries, because many of their streams seasonally had very low flows or dried completely in the alluvial fan areas (Higgins 1991). Evidently large numbers of juvenile southern steelhead often could be caught in coastal lagoons in the 1930s and earlier (Swift et al. 1993). Most of the estuaries today are much shallower and warmer than they were originally.

Spatial Patterns: Steelhead trout typically migrate to marine waters after spending 2 years in fresh water. Then they reside in marine waters for typically 2 or 3 years prior to returning to their natal stream as 4 or 5-year olds. In California, most steelhead spawn from December through April, often making their way past normally dry sections of rivers, small streams, and tributaries during the winter rainstorms that increase in-stream flows (Finney and Edmondson 2002). This ability to migrate, spawn, hatch, rear, and mature in subsequently hydrologically isolated and marginal aquatic environments until the next storm event re-establishes a migration corridor between the inland and marine environment makes the steelhead uniquely able to exist in the southern extent of their range (Finney and Edmondson 2002).

Migration and life-history patterns of southern California steelhead depend more strongly on rainfall and streamflow than is the case for steelhead populations farther north (Titus et al 1999). River entry ranges from early November through June with peaks in January and February. Average rainfall is substantially lower and more variable in this ESU than in regions to the north, resulting in increased duration of sand berms across the mouths of streams and rivers and, in some cases; complete dewatering of the marginal habitats (NOAA 1996). Environmental conditions in marginal habitats may be extreme (e.g., elevated water temperatures, droughts, floods, and fires) and presumably impose selective pressures on steelhead populations.

Steelhead in general are known to have well-developed homing abilities (Moyle 1976), although it has been suggested that southern steelhead commonly stray from their natal streams (Higgins 1991). Straying, if it actually occurs at significant levels in southern steelhead, may be selectively advantageous because it would allow spawners to opportunistically utilize more favorable streams when their natal streams dried up or were blocked by sand berms (Higgins 1991).

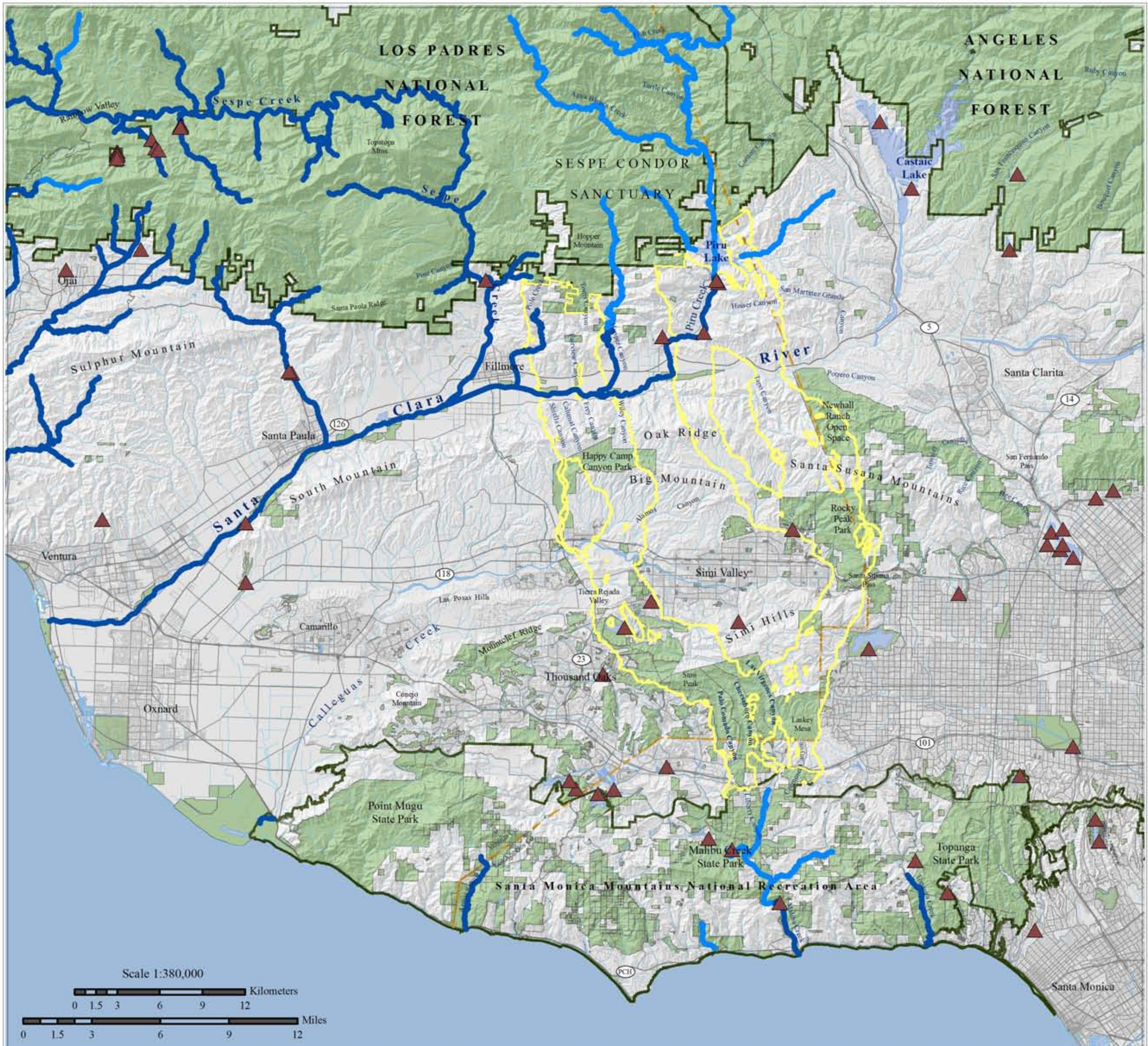
Conceptual Basis for Model Development: Steelhead trout can move 40 km (25 mi) from the ocean to the upper reaches of the watershed when surface waters are sufficient. Dams, diversions and road crossings are significant barriers to movement.

Results & Discussion: The current known extent of southern steelhead trout in the planning area includes the Ventura River and San Antonio Creek in the Ventura Watershed, Santa Clara River, Santa Paula Creek, and Sespe Creek in the Santa Clara River Watershed, and Malibu Creek, Arroyo Sequit, and Topanga Creek in the Santa Monica Bay Watershed (Figure 38). Historically, steelhead moved further up the Santa Clara River to spawning and rearing areas in upper Piru Creek, prior to the reservoir being built for Piru Lake (McEwan and Jackson 1996). The Least Cost Union would promote steelhead movement up Santa Paula, Sespe, and Piru creeks in the Santa Clara River Watershed if habitat is added to the Union along these drainages, barriers are removed, and habitat restoration efforts are undertaken (Figure 38). Habitat was also added to the Union along the mainstem of the Santa Clara River to maintain connections from the coast to the inland drainages. Steelhead trout were also historically present further up Malibu Creek before Rindge Dam was erected (McEwan and Jackson 1996). If barriers are removed and habitat restoration efforts undertaken, the linkage would promote steelhead movement from the coast to the confluence of Malibu and Las Virgenes creeks in the Malibu Creek Watershed (Figure 38).

Restoration of steelhead trout populations will require removal of or modifications to dams, diversions and other barriers; sustaining winter/spring flows to allow for migration; and improving water quality. Fish ladders have been installed on the Vern Freeman Dam on the Santa Clara River and on the Harvey Dam on Santa Paula Creek to assist steelhead trout making the journey upstream. Both need some modification since they were constructed based on a design used for salmon in northern parts of their range. Comprehensive data has recently been collected (Stoecker and Kelley 2005) on impediments to southern steelhead trout in the Santa Clara River Watershed and the feasibility of restoring healthy steelhead runs in historically occupied habitat.

In the Santa Monica Bay Watershed, plans are underway to remove the now defunct Rindge Dam on Malibu Creek, which will increase steelhead habitat from 4.0 stream km to at least 12 km (2.5 to 7.5 mi), allowing them to reach their historical spawning grounds (McEwan and Jackson 1996). Comprehensive data has also recently been collected in

Figure 38.
Potential habitat
for
Southern steelhead trout
(Oncorhynchus mykiss)



Occupied Habitat*
Potential Spawning & Rearing Habitat*
Protected Lands
Least Cost Union
Target Areas
Dams
Lakes & Reservoirs
Hydrography
County Boundary
Roads

*Data Source: National Marine Fisheries Service (NOAA Fisheries)

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

the Santa Monica Mountains on barriers to movement for steelhead trout and potential spawning and rearing habitat was also identified (Caltrout 2006).

The single greatest limiting factor in the recovery of southern steelhead is the network of regional dams and other fish passage barriers (McEwan and Jackson 1996). Steelhead trout are no longer able to reach important upstream reproduction and nursery areas in most of the major coastal drainages south of San Francisco Bay (Titus et al. 1999). To restore the full range of fish fauna to southern California aquatic systems and their watersheds, the priorities should be to focus on restoring fish passage to historic spawning and rearing areas, address watershed-wide degradation of aquatic ecosystems, and ensure adequate representation of southern California interests in all state and federal programs designed to address the recovery of steelhead in California (Finney and Edmondson 2002).

The National Marine Fisheries Service, charged with the conservation and recovery of anadromous fish, has developed guidelines for the design of stream crossings to aid upstream and downstream passage of migrating salmonids (2000b). Preferred crossings in order of preference are 1) bridge (with no encroachment into the channel 100-year flood plain); 2) streambed simulation strategies: bottomless arch, embedded culvert design, or ford; embedded round metal culvert, concrete box culvert, or compound culvert designs. Substrate and flow conditions within the crossing mimic that natural streambed above and below the structure; 3) non-embedded culvert: less than 0.5%slope; and 4) baffled culvert, or structure designed with a fishway: slopes greater than 0.5% (NMFS 2000b).

To maintain and restore steelhead runs in the planning area, we recommend that:

- Barriers are removed or fish passages constructed across barriers to allow steelhead access to additional spawning and rearing habitat (Higgins 1991, McEwan and Jackson 1996, Stoecker and Kelley 2005, Caltrout 2006).

- A centralized information sharing system is created that can be utilized by all agencies, land managers, academic institutions, and other researchers working on the conservation and recovery of southern steelhead trout (Finney and Edmondson 2002).

- Overgrazing is discouraged. Unrestricted or mismanaged grazing strategies can destroy habitat, erode banks and pollute the water (Caltrout 1999).

- Water removal (groundwater pumping, impoundments, diversions) is prohibited from occupied or potentially restorable steelhead streams to leave minimum flows for fish in both streams and lagoons (McEwan and Jackson 1996).

- Estuaries are rehabilitated through better watershed management practices to reduce the input of sediments and to increase freshwater inflows (McEwan and Jackson 1996).

- All suggestions by Stoecker and Kelley (2005) and Caltrout (2006) to restore habitat connectivity and integrity for steelhead trout be implemented.

Chalcedon checkerspot butterfly (*Euphydryas chalcedona*)

Justification for Selection: Chalcedon checkerspot is considered an indicator species for undisturbed coastal sage scrub (Hogue 1993). It is also a primary pollinator for many plant species, and may functionally increase the size of a plant's available gene pool in proportion to the flight range of the pollinator and enhance the speed of dissemination of novel genes (Ballmer unpub).

Distribution & Status: Chalcedon checkerspot have enormous geographic variation, with 38 subspecies named (Scott 1986). They are treated by some as three separate species: *Euphydryas anicia*, *E. chalcedona*, and *E. colon. E chalcedona* is found from Alaska south along the Pacific coast through California and Arizona to Baja California and Mexico, east to Montana, the Dakotas, Wyoming, Colorado, and New Mexico. The species is primarily associated with the coastal foothills (Orsak 978)

Habitat Associations: Chalcedon checkerspots can be found in desert hills, chaparral, coastal sage scrub, oak woodlands, grasslands, open forest and alpine tundra from the Upper Sonoran Zone to the Alpine Zone (Scott 1986, Hogue 1993, Heath 2004).

Food plants for the chalcedon checkerspot includes many members of the figwort family (*Scrophulariaceae*), especially bush monkeyflower (*Mimulus aurantiacus*) and coast figwort (*Scrophularia californica*), as well as paintbrushes (*Castilleja* spp.), and Penstemon (*Penstemon antirrhinoides, P. cordifolia*) (Orsak 1978). Caterpillar hosts include penstemon and paintbrush, and species from several other plant families including Caprifoliaceae, Boraginacea and Rosaceae (Orsak 1978). Adults are readily attracted to moisture and also to flowers of buckwheats (*Eriogonum* spp.) and yerba santa (*Eriodictyon crassifolium*) in many areas of southern California (Orsak 1978).

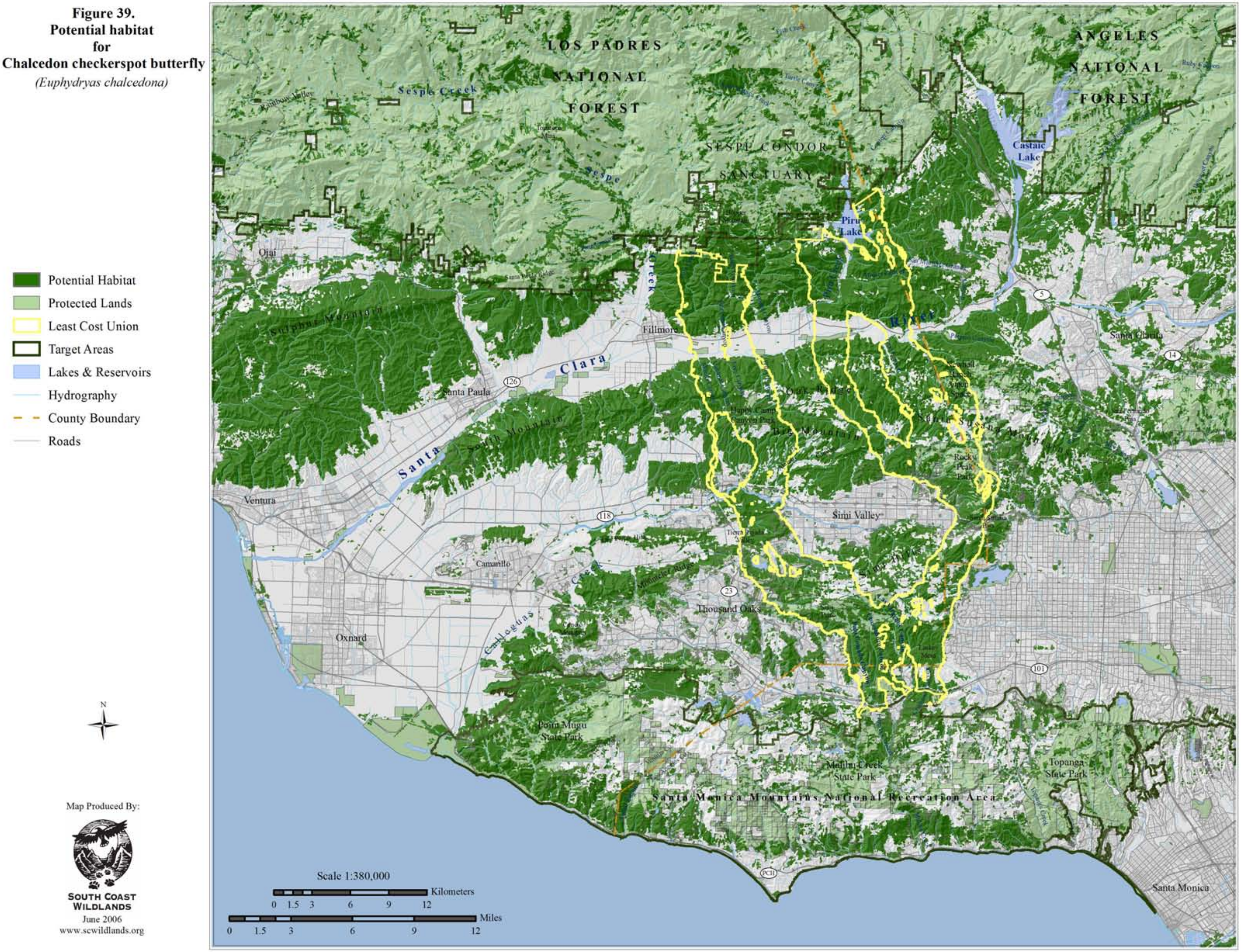
Spatial Patterns: Flight time is from March through June, and September through November. Flight distances between recaptures averaged 65 m (213 ft) at one site, 146 m (479 ft) at another, for males, but only 18 m (59 ft) for females (Scott 1986).

The average life span for males is 9-10 days in nature. Males seek females all day, by patrolling all over the habitat or by perching (especially on hilltops, but often on exposed vegetation in clearings), depending on the locality.

Conceptual Basis for Model Development: Movement through the linkage is multi-generational. Potential habitat for the chalcedon checkerspot butterfly include chaparral, coastal sage scrub, oak woodlands, grasslands, and open forest.

Results & Discussion: Potential habitat for the chalcedon checkerspot butterfly is widespread in the planning area, with all branches of the Least Cost Union containing suitable habitat (Figure 39). Habitats in the Union are expected to support intergenerational movements of this species between targeted core areas. The checkerspot butterfly would also benefit from a connection across Conejo Mountain to Mount Clef Ridge and the Tierra Rejada Valley. To ensure the long-term survival of the chalcedon checkerspot butterfly in the planning area, habitat integrity, host plant colonies and nectar sources need to be maintained and restored.

Figure 39. Potential habitat for Chalcedon checkerspot butterfly
(Euphydryas chalcedona)



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Damselflies (*Odonata - Zygoptera* spp.)

Jo-Ann Ordano © California Academy of Sciences

Justification for Selection: A mature ecosystem often contains a diversity of invertebrates with overlapping functions, which contribute to community stability and resilience. Damselflies serve as food for fish, birds and frogs (Smith and Pritchard 1956). Adults feed on mosquitoes and gnats (Powell and Hogue 1979). Invertebrates are integral components of communities, without their functional presence, the structure and productivity of most, if not all, habitats would collapse (Ballmer unpub).

Distribution & Status: Damselflies are widespread wherever there is permanent, clean freshwater. About 40 species of the *Zygoptera* are found in California (Manolis 2003). The most common damselflies are the bluets of the Coenagrionidae Family.

Habitat Associations: Damselflies are aquatic in the nymphal or larval state and as adults are terrestrial or aerial. Adults stay close to the water in which they will lay their eggs. Nymphs (a.k.a. naiads) are predaceous water dwellers, eating immature insects, crustaceans, tadpoles, fish and young salamanders (Essig 1926).

Broad-winged damselflies (Family Calopterygidae), such as the common Ruby Spot *(Hetaerina americana*) are likely to be seen only near rapidly flowing streams in the mountain canyons surrounding the Los Angeles Basin. Dancers (Family Coenagrionidae) are normally seen around small streams in the mountains, most commonly in the San Gabriel and Santa Monica Mountains (Hogue 1993).

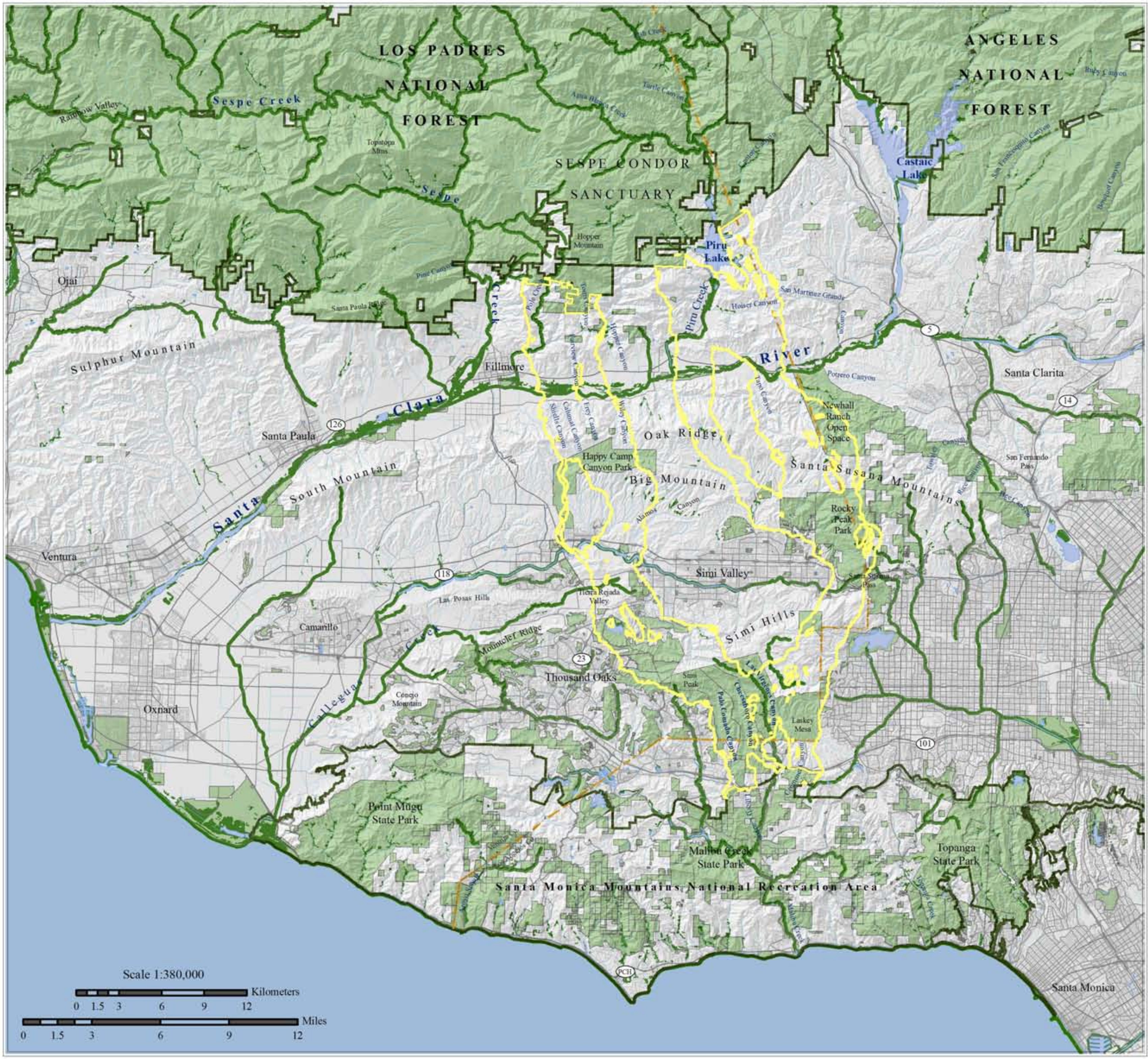
Spatial Patterns: Adult damselflies are not strong fliers and are usually found near the bodies of water in which they breed (Hogue 1993).

Conceptual Basis for Model Development: Movement in the linkage is multi generational. All perennial streams were identified as potential habitat for damselflies.

Results & Discussion: Habitat for damselflies is limited to clean perennial freshwater streams, which are limited in the planning area. Streams identified as potential habitat (Figure 40) are perennial but water quality is impaired in several of these drainages, which are listed under Section 303(d) of the Clean Water Act. Habitats in the Union are not sufficient to accommodate this species. We added habitat to the Union along the Santa Clara River, Santa Paula Creek, Sespe Creek, and Piru Creek to support the needs of damselflies. Please see the Impediments to Streams section for recommendations to protect and restore habitat for damselflies and other riparian dependent species.

Figure 40.
Potential habitat
for
Damselflies
(Odonata - Zygoptera spp.)

- Potential Habitat
- Protected Lands
- Least Cost Union
- Target Areas
- Hydrography
- Lakes & Reservoirs
- County Boundary
- Roads



Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Harvester ant (*Pogonomyrmex rugosus*)

Justification for Selection: Harvester ants exert dominant influences on the landscape in pinyon-juniper, grassland coastal sage, and desert habitats, where these species extensively rework the soil, contribute to soil nutrient heterogeneity, and alter herb and shrub cover (MacMahon et al. 2000).

The soil excavations of ant colonies, and numerous other soil-dwelling arthropods, help to aerate the soil and to move organic particulates from the soil surface to greater depths (Ballmer unpub). Some ants also sequester quantities of seeds under ground, providing a seed bank for some plant species. Harvester ants aid in seed dispersal for some plants (Ballmer unpub). Harvester ant seed predation continuously alters the distribution and relative abundance of flower types in California grasslands (Moldenke 1976). This, along with varying rainfall, causes great variation from year to year of floral productivity.

Distribution & Status: Harvester ants are found in western Oklahoma, western Texas, southeastern and southwestern Colorado, New Mexico, southern Utah, Arizona, southern and central Nevada, southern California and Mexico. Western harvester ants are more common at higher elevations. They are known up to 2,743 m (9,000 ft).

Harvester ants, like all native ants, are threatened by the invasion of Argentine Ants (*Linepithema humile*). Agriculture, flood control, and urbanization promote biological invasions by Argentine ants that eliminate native ant colonies. The coast horned lizard, a sensitive species that is declining, is highly dependent on native ants for sustenance (Pianka and Parker 1975, Montanucci 1989, Suarez et al. 2000, Suarez and Case 2002, Fisher et al. 2002).

Habitat Associations: Harvester ants are characteristic or indicator species of dry river beds: washes, arroyos, and basins below mountains where water is seldom present, vegetation is partly riparian, partly coastal sage scrub, but very sparse (Hogue 1993). During long dry periods, coastal sage may infringe and isolated chaparral species may occur (Hogue 1993).

Founding queens of *P. rugosus* have a higher tolerance for dessication and hence this species dominates in drier soil microhabitats consisting of coarser soils (Johnson 2000).

Spatial Patterns: Harvester ants form colonies composed of 1,000-22,000+ individuals and typically collect vast quantities of seeds and dead insects during the warmer seasons of the year (MacKay 1981). In most habitats harvester ant colonies are fairly regularly spaced, a common sign of territorial behavior in other groups of animals. In southern Arizona, *P. rugosus* colonies were found to be spaced at an average of 17 m

(56 ft) apart (Holldobler 1974). Harvester ant colonies can occupy the same nest for 20 years (Gordon 1991, 1992).

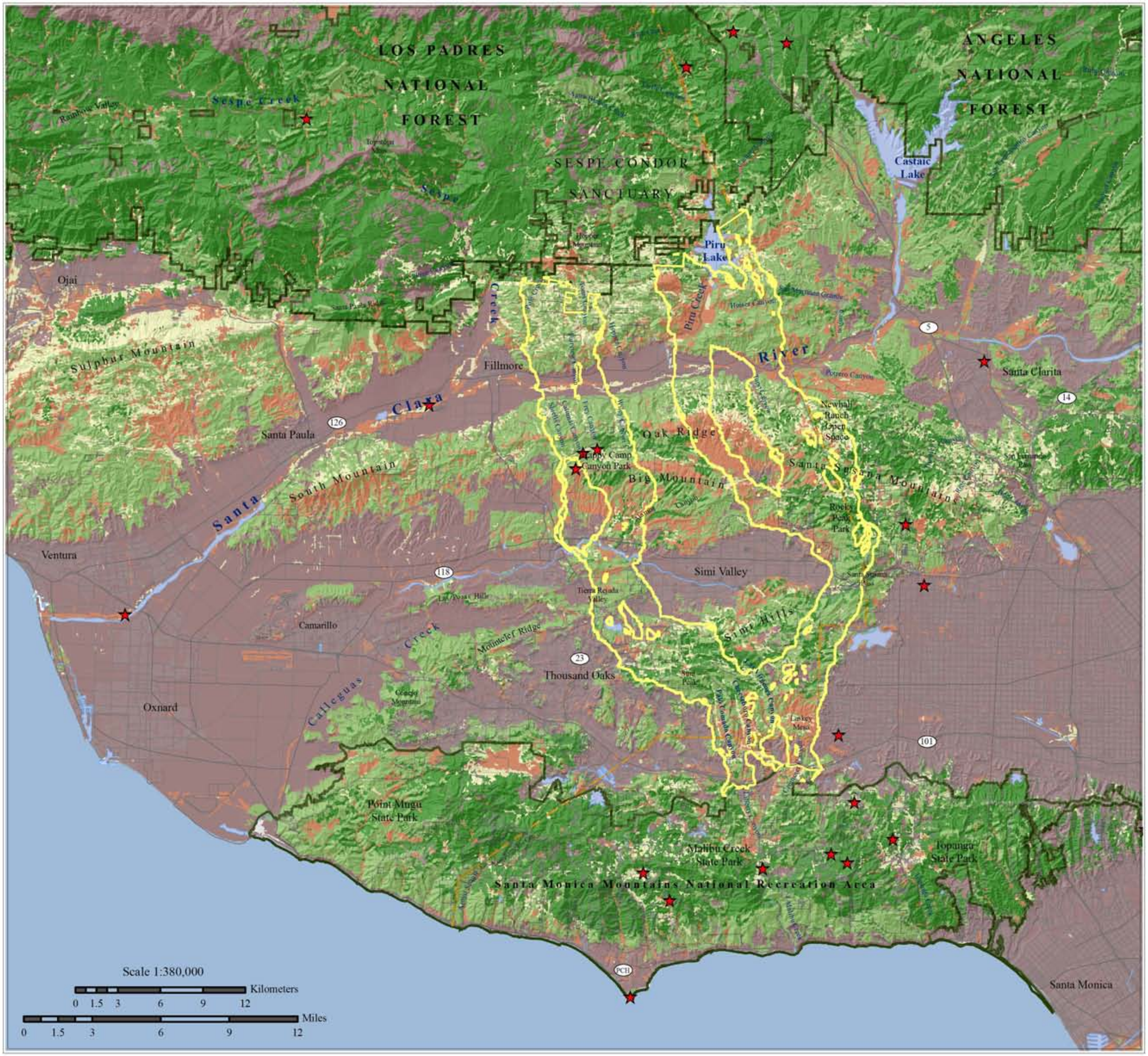
P. rugosus had random dispersion patterns in the Chihuahuan Desert, where intra- and interspecific encounters were infrequent (Whitford et al. 1976). Neighborhood interactions affect establishment, survivorship, and colony spacing within habitats where colony densities are high, whereas at broader scales, variability in soils, vegetation, or land-use practices affects the density and distribution of *Pogonomyrmex* spp. (MacMahon et al. 2000).

Conceptual Basis for Model Development: We modeled potential habitat for coast horned lizard as a surrogate for harvester ant. Horned lizards may use alluvial fans, alkali flats, alkali desert scrub, dunes, open coastal scrub and chaparral, grassland, and clearings in coniferous forests, broadleaf woodlands, and riparian woodlands. They avoid urban and agricultural developments and areas of high road density.

Results & Discussion*:* Potential habitat for the harvester ant is widespread in the linkage planning area. All branches of the Least Cost Union contain suitable habitat for this species (Figure 41), with documented occurrences of coast horned lizard in the western branch of the Union in the Santa Susana Mountains. With habitat restoration, we believe that the Least Cost Union will serve this species. The harvester ant would also benefit from the Conejo Mountain and Mount Clef Ridge additions to the Union.

To maintain connectivity for harvester ants, we recommend that no additional agriculture, flood control, or urbanization be permitted in the Linkage Design. Irrigation of landscapes encourages the spread of Argentine ant populations into natural areas, where they cause a halo of local extinctions of native ant populations extending 200 m (656 ft) into native vegetation (Suarez et al. 1998, Bolger et al. 2000). We suggest protection and restoration of contiguous swaths of natural habitats with buffers of at least 1 km (0.62 mi) to maintain the integrity of the linkage.

Figure 41.
Habitat Suitability
for
Harvester ant
(Pogonomyrmex rugosus)



Degree of Suitability

- High
- Medium to High
- Medium
- Low to Medium
- Low
- Coast horned lizard occurrences*
- Protected Lands
- Least Cost Union
- Target Areas
- Lakes & Reservoirs
- Hydrography
- County Boundary
- Roads

*Data Source: CNDDB, USFS

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Burrowing scorpion (*Anuroctonus phaiodactylus*)

Justification for Selection: Predatory species like the burrowing scorpion are considered the charismatic megafauna of the arthropod world (T. Longcore, pers. comm.), exerting important influence over the invertebrate community.

Distribution & Status: The burrowing scorpion is found in Nevada, California, western Utah, and Baja California, Mexico. The burrowing scorpion has no special status.

For these organisms, roads, concrete-lined ditches, irrigation canals, expanses of irrigated land (e.g. agriculture, golf course), and other non-habitats can be effective barriers to movement and/or direct causes of mortality (Ballmer unpub).

Habitat Associations: The burrowing scorpion needs contiguous coastal sage and or chaparral habitats with undisturbed soil (T. Longcore, pers. comm.). This species is generally nocturnal, moving about at night in search of soft-bodied insects for food. They usually feed on beetles, cockroaches, crickets, centipedes, spiders, sun spiders, and other ground dwellers (Hogue 1993).

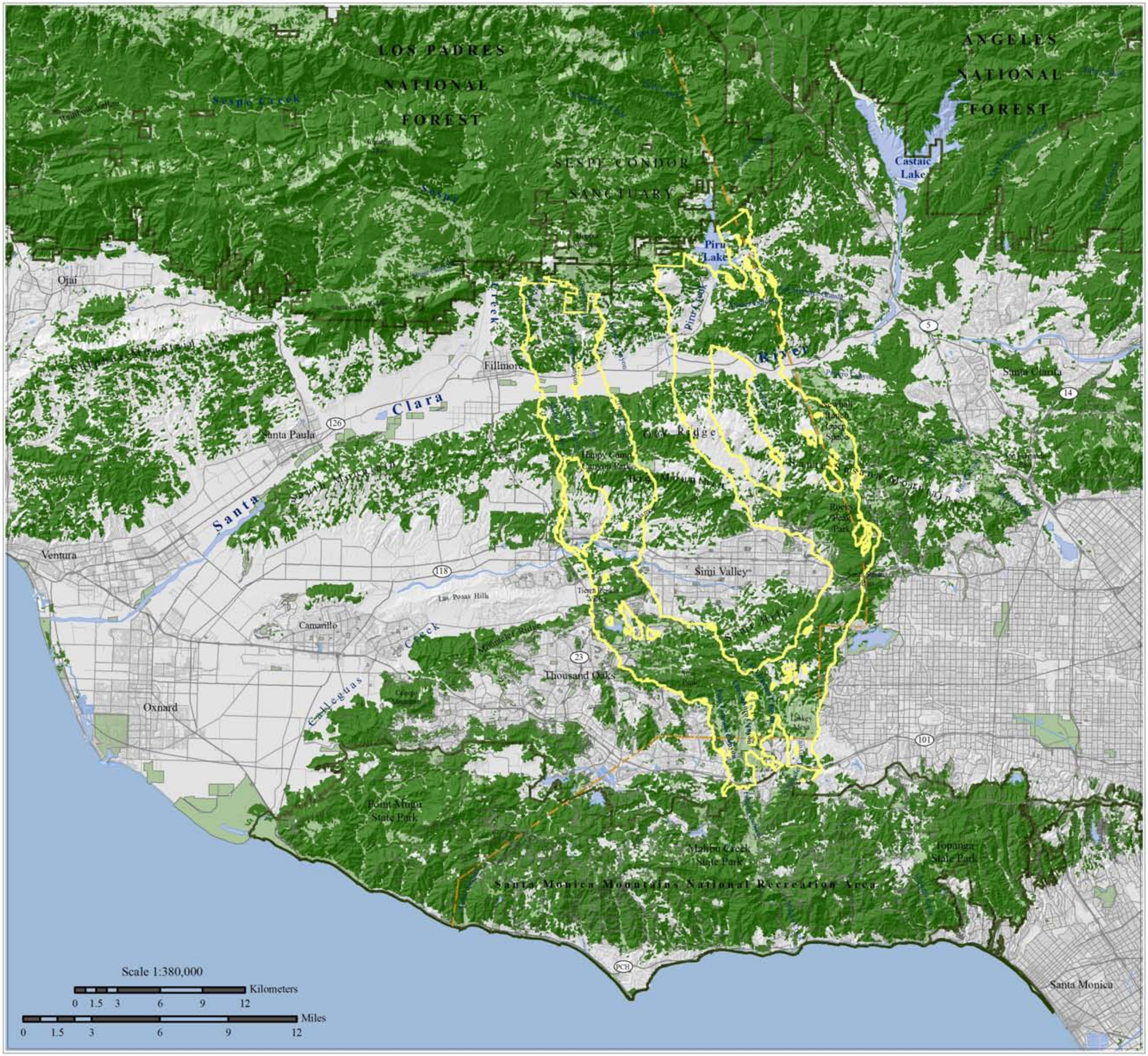
Spatial Patterns: The burrowing scorpion is a ground-dwelling species that may occur in low densities and wander relatively great distances in search of mates. Burrowing scorpions dig burrows, often in colonial aggregations and ambush prey from the mount of its burrow during the night, retreating into its shelter during the day or when startled or threatened (Hogue 1993).

Conceptual Basis for Model Development: Movement in the linkage is multi generational. We modeled potential habitat for this species as coastal sage scrub and chaparral habitats.

Results & Discussion: Potential habitat for the burrowing scorpion is widespread in the planning area, with all branches of the Least Cost Union providing suitable habitat (Figure 42). The western and eastern branches of the Union provide the most contiguous habitat for this species. However, since one of the few natural communities this species utilizes is coastal sage scrub, the burrowing scorpion would certainly benefit from adding the coastal sage connection from Conejo Mountain to Mount Clef Ridge and the Tierra Rejada Valley. We conclude that, with the suggested additions, the linkage will likely serve this species. We suggest habitat restoration in areas of the Linkage Design historically occupied by coastal sage scrub. Lighting should be directed away from the linkage and crossing structures for this nocturnally active species (Rich and Longcore 2006).

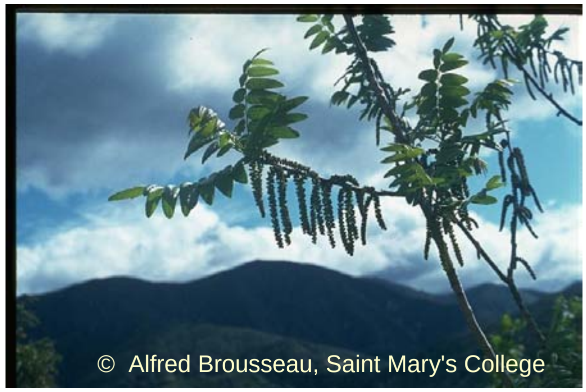
**Figure 42.
Potential habitat
for
Scorpion**
(Anuroctonus phaiodactylus)

Potential Habitat
Protected Lands
Least Cost Union
Target Areas
Lakes & Reservoirs
Hydrography
County Boundary
Roads



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

California black walnut (*Juglans californica*)


© Alfred Brousseau, Saint Mary's College

Justification for Selection: California black walnut is considered one of California's rare and imperiled natural communities, severely threatened by habitat fragmentation and degradation (CNPS 2001). Walnut trees provide habitat and a highly nutritious food source for wildlife (Anderson 2002).

Distribution & Status: California black walnut is endemic to the state and is restricted to a narrow band within the southern California coastal foothills, from the Transverse Range in Santa Barbara County south to the Peninsular Ranges of San Diego County (Hickman 1993, CNPS 2001, Anderson 2002). The elevational range extends from near sea level in the Santa Monica Mountains to 1,067 m (3,500 ft) in the San Bernardino Mountains (Anderson 2002).

In the linkage planning area, California black walnut occurs extensively in the Santa Clarita River drainage near Sulphur Mountain, in the Simi Hills and Santa Susana Mountains, and on the northern slope of the Santa Monica Mountains (Quinn 1989). A unique forest association of bigcone Douglas-fir (*Pseudotsuga macrocarpa*), oaks, and walnut occurs on the northeast side of the Santa Susana Mountains and a magnificent oak–walnut forest, dominated by coast live oak (*Quercus agrifolia*), covers more than 5 square miles on the north face of Sulphur Mountain (Anderson 2002).

The California black walnut forest community is a much fragmented, declining natural community that is rare in southern California due to habitat loss and degradation caused by urbanization and grazing (CNPS 2001). California walnut woodlands appear to have low regeneration, which is likely caused by a combination of livestock grazing, invasion of nonnative annual grasses, seedling predation, and disease. California walnut woodlands are designated as a sensitive natural community (CDFG 2005) and are not well-represented on public lands (Stephenson and Calcarone 1999).

Habitat Associations: California black walnut occurs along slopes and in canyons within chaparral, coastal sage scrub, grassland, and cismontane woodlands (CNPS 2001, Anderson 2002). It usually occupies mesic areas (riparian corridors, floodplains, and north-facing slopes) and prefers soils with high clay content (Quinn 1990, Hickman 1993, Stephenson and Calcarone 1999, CNPS 2001), but it may also be found in dry situations where it is sustained by ground-water supplies (Faber et al. 1989). It can be the dominant tree in the canopy or can occur in mixed stands with other hardwoods.

Spatial Patterns: California black walnuts are wind pollinated from male catkins found on the same tree. They flower from March to May and their fruits reach full maturity in the fall (Quinn 1989). Seedlings appear in the spring and mature rapidly in moist sunny locations (Swanson 1976). California black walnut prefers north- and east-facing slopes (Anderson 2002).

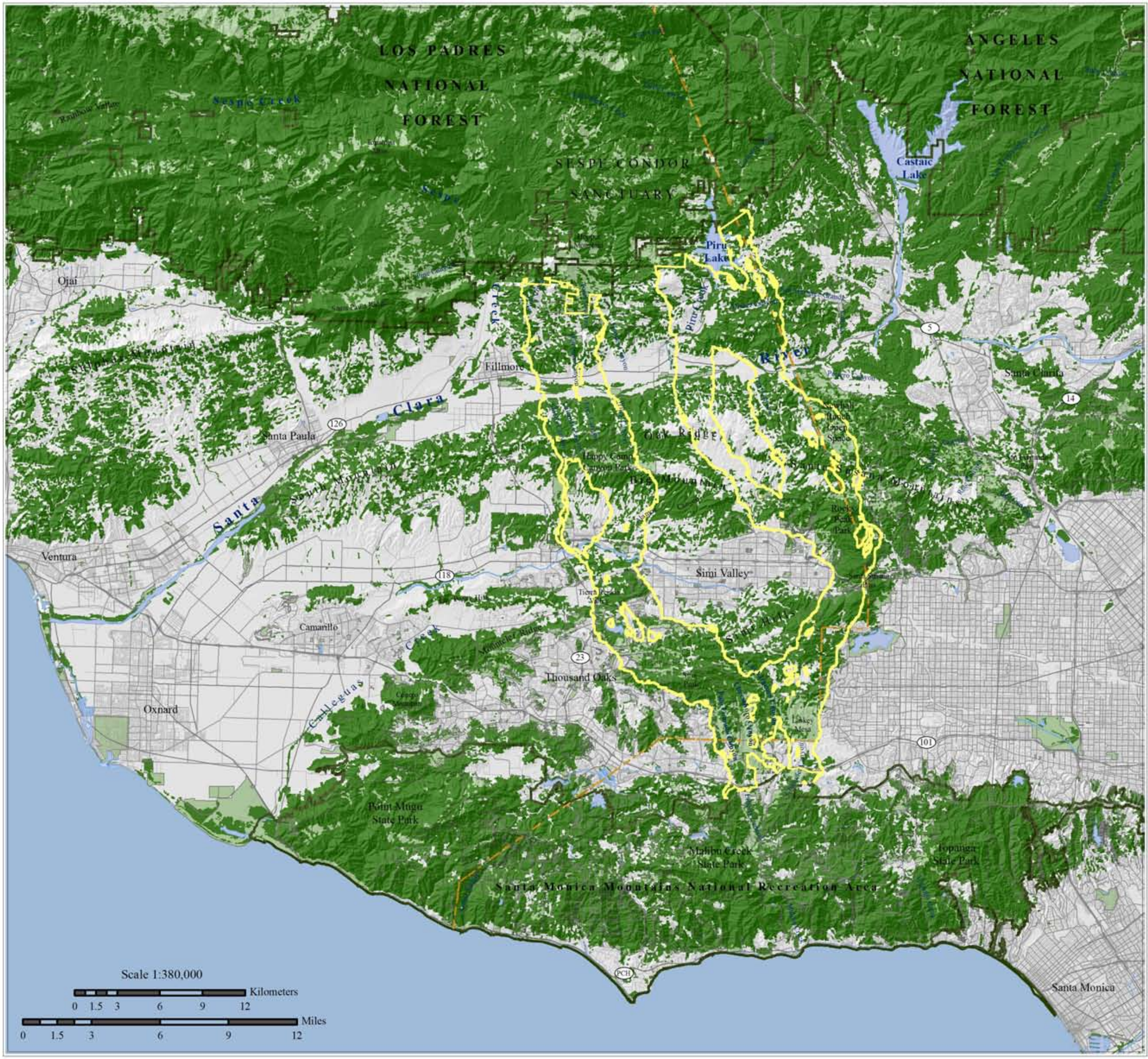
Streams may provide for direct transport of seeds and movement of wildlife that act as seed dispersal agents. The fruit of the walnut is stored, buried or eaten by both California ground squirrels (*Spermophilus beecheyi*) and western gray squirrels (*Sciurus griseus*) (Quinn 1989). Seeds may also be transported by coyotes up to 16 km (10 mi) (S. Riley pers. comm.) and by crows or ravens up to 1.6 km (1 mi; K. Garrett, pers. comm.).

Conceptual Basis for Model Development: California black walnut may be found in chaparral, coastal sage scrub, grassland, and cismontane woodlands below 1,067 m.

Results & Discussion: Potential habitat for walnut is widespread in the planning area, with both the western and eastern branches of the Least Cost Union providing fairly contiguous patches of suitable habitat for germination and establishment of black walnut, as well as live-in and move-through habitat for potential seed dispersers (Figure 43). We conclude that the Union will likely serve the needs of this species.

Development on private lands and loss of suitable habitat for establishment (south slope drainages, north-slope hillsides) appears to be the primary threat to this community, so protection is needed on private lands, as well as a concerted effort to bring some of the best examples of remaining stands under permanent protection. Research needs to be conducted to better determine current distribution, and the effect of fire regimes and nonnative grasses on regeneration of California walnut (Stephenson and Calcarone 1999).

Figure 43.
Potential habitat
for
California black walnut
(Juglans californica)



Potential Habitat
Protected Lands
Least Cost Union
Target Areas
Lakes & Reservoirs
Hydrography
County Boundary
Roads

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Valley oak (*Quercus lobata*)

Justification for Selection: Valley oak riparian forests and woodlands are intensively used by wildlife. Valley oak riparian forest has the most complex structure of any vegetation type in California, and as a result, is among the most diverse in terms of the animal life it supports (Pavlik et al. 2000). Collectively, valley oak riparian forests support 67 nesting bird species (Gaines 1980, Schlorff and Bloom 1984). Valley oak woodlands are used by 21 species of amphibian (8 of special status in California), 31 reptiles (12 of special status in CA), 142 bird species (28 of special status in CA), and 74 mammals (24 of special status in CA) (CDFG 2005). To date, valley oak has not shown symptoms of Sudden Oak Death, which may make them even more critical to the long term viability of oak woodland-dependent wildlife (California Partners in Flight 2002).

Distribution & Status: Valley oak is endemic to California, occurring below 1,700 m (5,600 ft) in the Coast Ranges, Sierra Nevada foothills, and Central Valley from Tehama County south, and reaching its southern limit in the San Fernando and Santa Clarita Valleys and the Santa Monica Mountains in Los Angeles County (Griffin and Critchfield 1972, Thomas 1987, Pavlick et al. 2000). Valley oak forms extensive woodlands, particularly in the Central Valley, but in the South Coast Ranges, valley oak is a minor component of several plant communities (Griffin and Critchfield 1972).

Historically, valley oak forests and woodlands were much more extensive (Bartolome 1987). In 1998, the California GAP Analysis Project estimated valley oak to cover a total of 287,323 ha (709,991 ac) in the state (Davis et al. 1998). In the central and south coast bioregions, an estimated 275 ha (680 ac) of valley oak woodland occur on public lands, representing only 8% of the total extent of this community in the southern part of the state (Stephenson and Calcarone 1999). Rapid expansion of agriculture, vineyards, and urban development, in addition to restricted recruitment within remnant stands, has seriously reduced the amount of valley oak woodlands (Griffin 1971, Bolsinger 1988, Adams et al. 1992, Stephenson and Calcarone 1999). Valley oak woodlands and forests are designated as sensitive natural communities by the state (CDFG 2005).

Seedling regeneration is low and may jeopardize the long-term viability of valley oak woodlands; many stands are reported to lack trees younger than 75-125 years (Pavlick et al. 2000). Factors limiting the recruitment and regeneration of valley oaks include drought stress, predation by deer, ground squirrels, gophers, insects and livestock, soil cultivation around mature trees, lowering of the water table caused by groundwater pumping, and competition from annual herbaceous species and nonnative grasses (Griffin 1976, Griggs 1990, Danielsen and Halvorson 1991, Stephenson and Calcarone 1999). Mature trees are sensitive to over watering, saline irrigation runoff, lowered water tables, pruning, grade changes, and blankets of asphalt covering the root system (Griffin 1973, Rossi 1980).

Habitat Associations: Valley oaks may occur on valley floors and moderate slopes, in open grasslands, savannah and woodlands, and in riparian areas in chaparral (Stephenson and Calcarone 1999). Valley oak grows on intermittently flooded or seasonally saturated soils in valley floors and on alluvial or residual soils in lower foothill communities, with slopes less than 35 percent (Allen et al. 1991, Sawyer and Keeler-Wolf 1995).

Spatial Patterns: Valley oak is wind pollinated and animal dispersed. Male flowers are arranged in long catkins that produce wind-borne pollen, usually March-April (Roberts 1995). Acorns mature and drop to the ground in the fall, and germination usually occurs soon afterwards (Roberts 1995). Seed-caching animals, such as scrub jay, Stellar's jays, yellow-billed magpies and California ground squirrel, are important because acorns buried by these animals have a greater chance of germination and successful establishment (Griffin 1976, Carmen et al. 1987). Acorns can be moved 0.62 to 1.2 km (1-2 mi) by birds, but germination and establishment may be restricted to nodes beneath existing oaks.

Conceptual Basis for Model Development: Valley oaks may occur in open grasslands, savannah and woodlands, and in riparian areas in chaparral below 1,700 m. Dispersal distance was defined as 1.2 km.

Results & Discussion: Potential habitat for Valley oak is somewhat restricted in the planning area, though it is well distributed in the Least Cost Union (Figure 44). We conclude that the Union is likely to serve this species, as sufficient suitable habitat exists for germination and establishment of Valley oak, and for birds and small mammals that disperse acorns (e.g., scrub jay, ground squirrel) to move through habitats in the Union.

Oak woodlands should be managed at the landscape level to accommodate species interactions at multiple scales and prevent the invasion of protected habitat patches by exotic plants and animals (Sisk et al. 1997). Linking and buffering large contiguous areas of oak woodland and associated habitats are priorities for protection and restoration because fragmentation alters bird species composition, favoring nest predators and exotic competitors (Merelender et al. 1998, Purcell and Verner 1999). To protect and restore habitat for Valley oak, we recommend that:

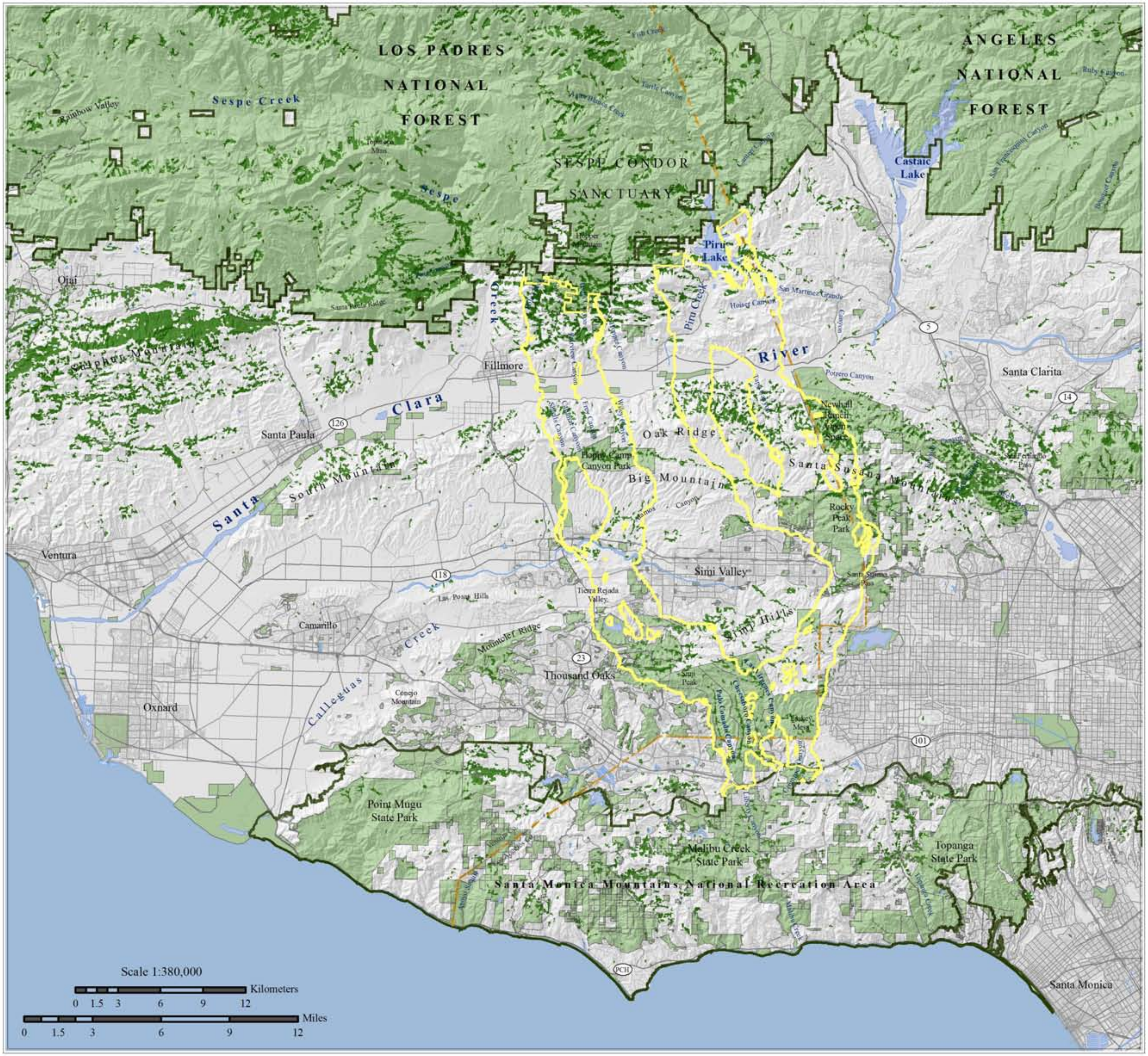
- Sites with intact oak regeneration and decay processes and diverse age class structures should be preserved to insure viable future habitat (California Partners in Flight 2002).

- Seedlings and saplings be protected from overgrazing (California Partners in Flight 2002).

- Ecologically sensitive fire management activities, including carefully planned low-intensity prescribed burns may also contribute to improved oak recruitment and may prevent large, higher intensity fires that destroy oak woodlands (Standiford and Tinnin 1996).

- Light and Pedroni (2001) recommended creation of policies on oak woodland conservation that regard the oak woodland as the functional unit.

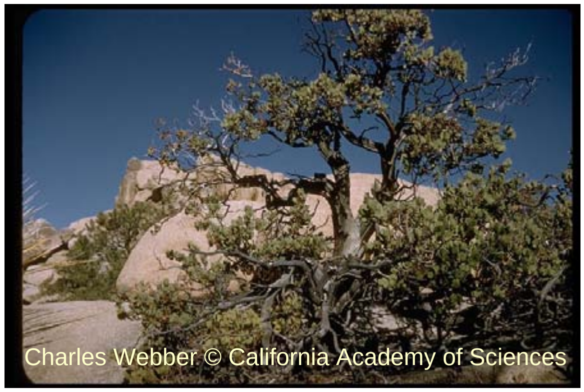
Figure 44.
Potential habitat
for
Valley oak
(Quercus lobata)



Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Bigberry manzanita (*Arctostaphylos glauca*)



Justification for Selection: Bigberry manzanita may be impacted by disruption of ecological processes in linkage areas, particularly changes in fire frequency associated with urban development adjacent to linkages.

Distribution & Status: Bigberry manzanita is distributed from Mount Diablo in Contra Costa County, California south through the South Coast, Transverse, and Peninsular ranges and interior regions of the Sierra Juarez and Sierra San Pedro Martir to central Baja California (Eastwood 1934, Minnich and Howard 1984, Vasek and Clovis 1976). Bigberry manzanita is typically found on dry slopes below 1500 m (4500 ft; Munz 1959) but has been recorded at elevations up to 1890 m (6200 ft; Hickman 1993).

Habitat Associations: Bigberry manzanita is associated with intact chaparral, Joshua tree woodland, and pinyon-juniper woodland (CNPS 2001). It is usually not a dominant chaparral species except in mixed chaparral of the San Gabriel and San Bernardino mountains (Minnich and Howard 1984). It occasionally forms dense, pure stands or codominates with Eastwood manzanita in manzanita chaparral (Hanes 1977). Bigberry manzanita also occurs in singleleaf pinyon (*Pinus monophylla*)-Utah juniper (*Juniperus osteosperma*) communities bordering the Sonoran and Mojave deserts (Vasek and Clovis 1976).

Bigberry manzanita has no statistically significant association with aspect or degree of slope (Hanes 1971). Bigberry manzanita grows in soils derived from granite, limestone, quartz diorite, or serpentine and that range in texture from sandy loam with considerable coarse fragment to loam (Hellmers et al. 1955, Horton and Kraebel 1955, Hanes and Jones 1967).

Spatial Patterns: Bigberry manzanita have limited localized dispersal. Birds, rodents, and coyotes eat the fruits and various seed-eating rodents consume the seeds (Horton and Wright 1944, Keeley 1977). Seeds are transported by coyotes, as well as cedar waxwing and related chaparral birds (Wishner pers comm., Sauvajot pers comm.)

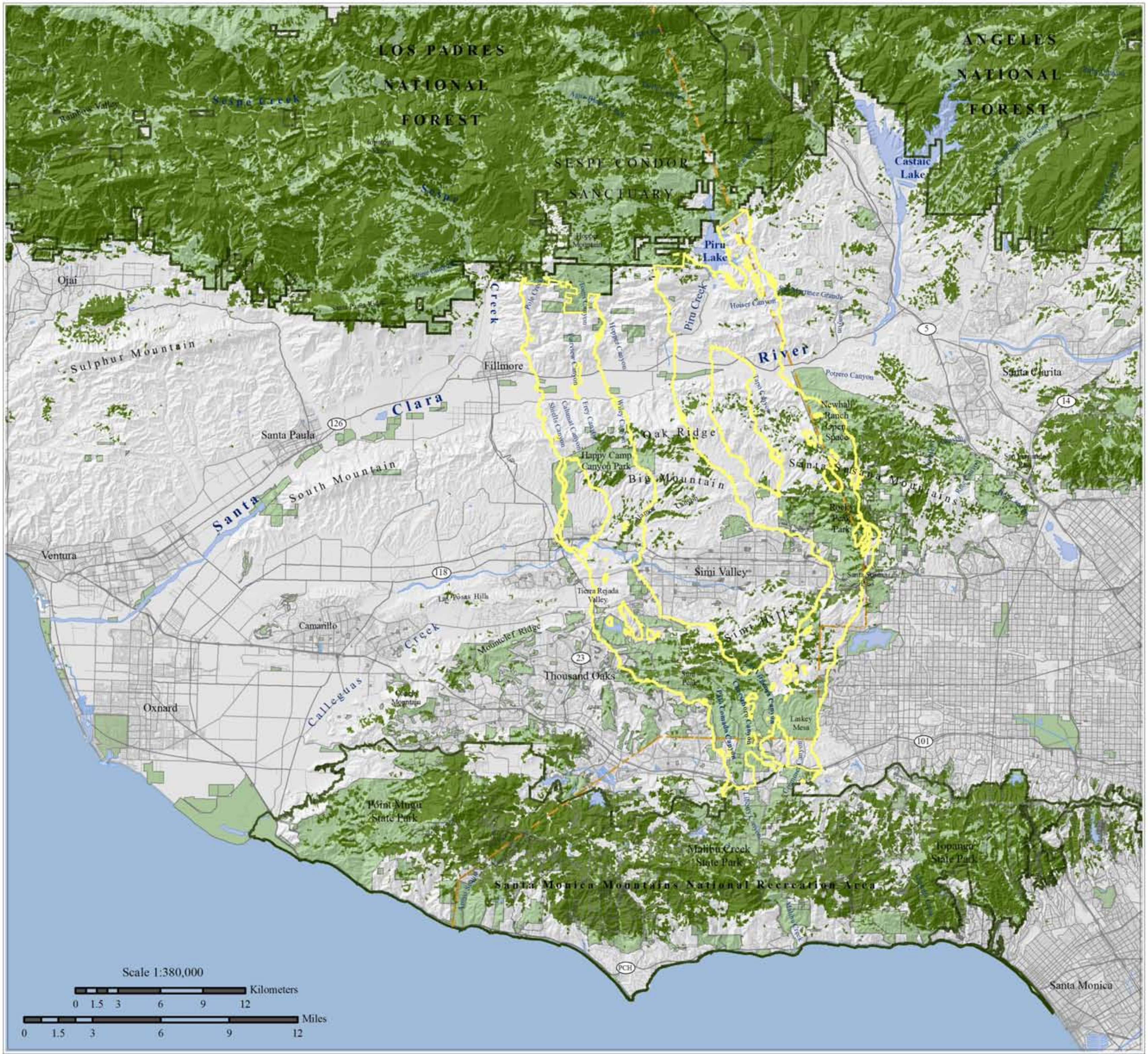
Bigberry manzanita is an obligate post fire seeder, with germination after fire scarification of the stone (Wright and Bailey 1982, Minnich and Howard 1984). It is best adapted to high-intensity, long-interval (100+ years) fires (Keeley and Hays 1976, Keeley and Keeley 1977), but can be destroyed by repeated short-interval fires (Dunn et al. 1988).

Conceptual Basis for Model Development: Bigberry manzanita may be found in chaparral and pinyon-juniper woodlands below 1,890 m. Coyotes and chaparral birds may disperse the fruit up to a few miles.

Results & Discussion: Potential habitat for Bigberry manzanita in the planning area closely follows the distribution of chaparral habitats (Figure 45). While potential germination habitat for the manzanita is not widespread in the Least Cost Union, the linkage is still likely to serve the needs of this species by facilitating movements of the primary seed dispersers (e.g., coyote).

**Figure 45.
Potential habitat
for
Bigberry manzanita**
(Arctostaphylos glauca)

Potential Habitat
Protected Lands
Least Cost Union
Target Areas
Lakes & Reservoirs
Hydrography
County Boundary
Roads



Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

This chapter is the heart of the report. It summarizes the goals of the Linkage Design and presents a map and description of the land within it. However, assessing and maintaining linkage function requires us to also identify barriers to movement, including land uses that may hinder or prevent species from moving through the linkage. Much of this chapter therefore describes existing barriers within the linkage and recommends actions to improve linkage function.

Goals of the Linkage Design

To accommodate the full range of target species and ecosystem functions, the Linkage Design (Figure 46) should 1) provide live-in and move-through habitat for multiple species, 2) support metapopulations of smaller species, 3) ensure availability of key resources, 4) buffer against edge effects, 5) reduce contaminants in streams, 6) allow natural processes to operate, and 7) allow species and natural communities to respond to climatic changes. We elaborate on these goals below.

The Linkage Design must be wide enough to provide live-in habitat for species with dispersal distances shorter than the linkage. Harrison (1992) proposed a minimum corridor width for a species living in a linkage as the width of one individual's territory (assuming territory width is half its length). Thus, our minimum corridor width of 2 km should accommodate species with home ranges of up to about 8 km^2 (3 mi^2). This would accommodate all focal species except the largest, such as mountain lion, mule deer and badger.

The Linkage Design must support metapopulations of less vagile species. Many small animals, such as western toad, whiptail, kingsnake, desert woodrat, and many invertebrates, may require dozens of generations to move between core areas. These species need a linkage wide enough to support a constellation of populations, with movements among populations occurring over decades. We believe 2 km is adequate to accommodate most target species living as metapopulations within the linkage area.

The Linkage Design was planned to provide resources for all target species, such as host plants for butterflies and pollinators for plants. For example, many species commonly found in riparian areas depend on upland habitats during some portion of their life cycle, such as some butterflies that use larval host plants in upland areas and drink from water sources as adults.

The Linkage was also designed to buffer against "edge effects" even if adjacent land becomes developed. Edge effects are adverse ecological changes that enter open space from nearby developed areas, such as weed invasion, artificial night lighting, predation by house pets, increases in human-associated or opportunistic species like house mice (*Mus musculus*), elevated soil moisture from irrigation, pesticides and pollutants, noise, trampling, and domesticated animals that attract native predators. Edge effects have been best-studied at the edge between forests and adjacent agricultural landscapes, where negative effects extend 300 m (980 ft) or more into the forest (Debinski and Holt 2000, Murcia 1995) depending on forest type, years since the edge was created, and other factors (Norton 2002). The best available data on edge effects for southern California habitats include reduction in leaf-litter and declines in populations of some species of birds and mammals up to 250 m (800 ft) in coastal scrub (Kristan et al. 2003), collapse of native plant and animals communities due the invasion of argentine ants up to 200 m (650 ft) from irrigated areas (Suarez et al. 1998), and predation by house cats which reduce small vertebrate populations 100 m (300 ft) from the edge (K. Crooks, unpublished data). Domestic cats may affect wildlife up to 300 m (980 ft) from the edge based on home range sizes reported by Hall et al. (2000). The proximity of human activities near natural areas can also result in indirect impacts and habitat alteration from trail proliferation, higher fire frequencies, etc., and these changes in turn may impact native species (Buechner and Sauvajot 1996). These impacts can be partially mitigated by maintaining high quality habitat in conservation areas, particularly adjacent to human-developed areas (Sauvajot et al. 1998).

Upland buffers are needed adjacent to riparian vegetation or other wetlands to prevent aquatic habitat degradation. Contaminants, sediments, and nutrients can reach streams from distances greater than 1 km (0.6 mi) (Naicker et al. 2001, Maret and MacCoy 2002, Scott 2002), and fish, amphibians, and aquatic invertebrates often are more sensitive to land use at watershed scales than at the scale of narrow riparian buffers (Goforth 2000, Fitzpatrick et al. 2001, Stewart et al. 2001, Wang et al. 2001, Scott 2002, Willson and Dorcas 2003, Riley et al. 2005).

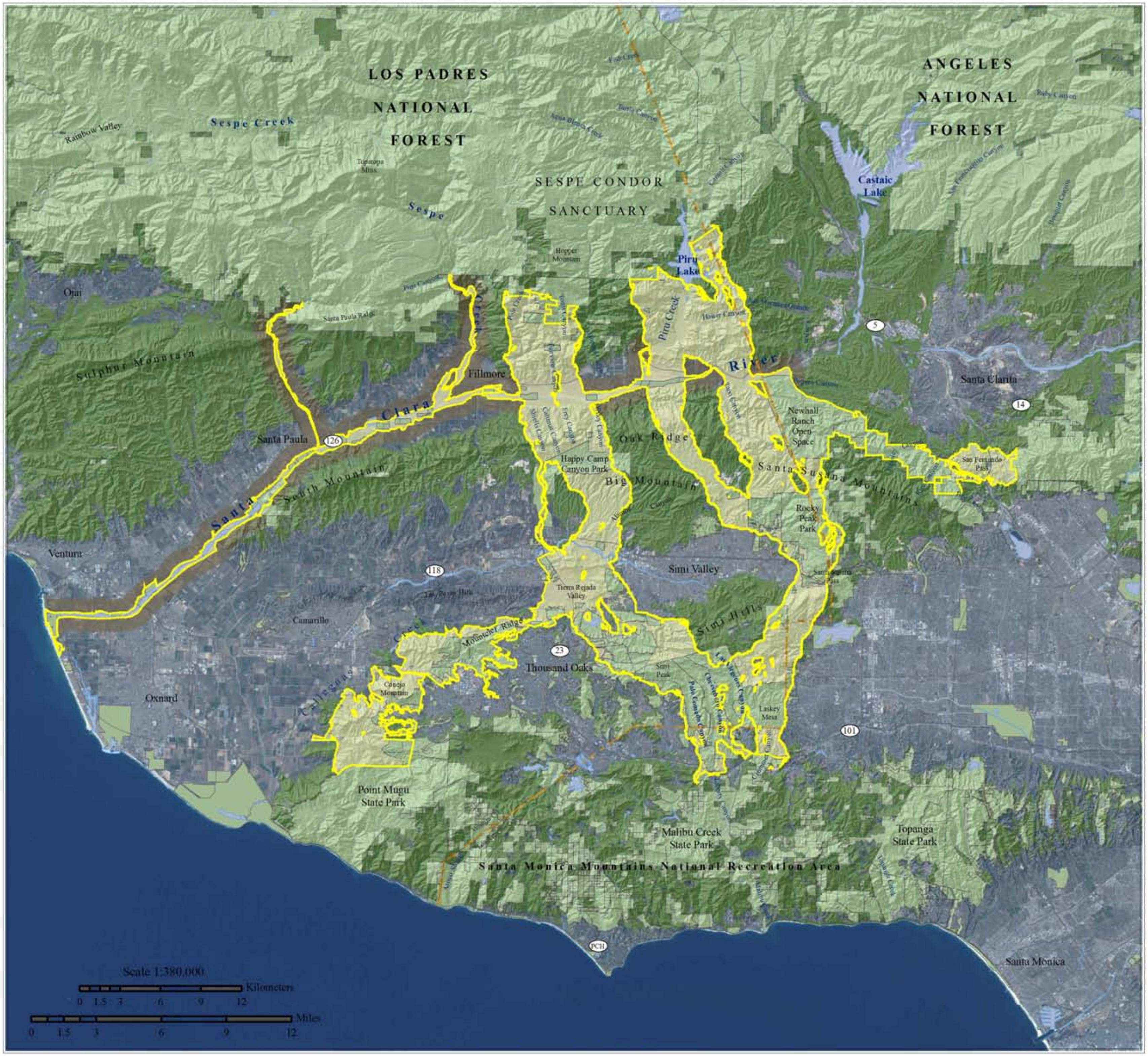
The Linkage Design must also allow natural processes of disturbance and recruitment to operate with minimal constraints from adjacent urban areas. The Linkage should be wide enough that temporary habitat impacts due to fires, floods, and other natural processes do not affect the entire linkage simultaneously. Wider linkages may be more robust to changes in disturbance frequencies that are caused by human actions. Before human occupation, naturally occurring fires (due to lightning strikes) were rare in southern California (Radtke 1983). As human populations in the region soared, fire frequency has also increased dramatically (Keeley and Fotheringham 2000). Although fire can reduce the occurrence of exotic species in native grasslands (Teresa and Pace 1998), it can have the opposite effect in some shrubland habitats (Giessow and Zedler 1996), encouraging the invasion of non-native plants, especially when fires are too frequent. While effects of altered fire regimes in this region are somewhat unpredictable, wider linkages with broader natural communities should be more robust to these disturbances than narrow linkages.

The Linkage Design must also allow species to respond to climate change. Plant and animal distributions are predicted to shift (generally northwards or upwards in elevation in California) due to global warming (Field et al. 1999). The linkage must therefore accommodate elevational shifts by being broad enough to cover an ecologically meaningful range of elevations as well as a diversity of microhabitats that allow species to colonize new areas.

Description of the Linkage Design

For most species, U.S. Route 101 and State Routes (SR) 23, 118, and 126 are the most obvious barriers between core reserves in the Santa Monica and Sierra Madre mountains, while Interstate 5 (I-5) and SR-14 impede movement between the Santa

Figure 46.
Linkage Design



Linkage Design
Protected Lands
Riparian Buffer
Important Habitat Areas
Hydrography
Lakes & Reservoirs
County Boundary
Roads

N

Map Produced By:

SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

Susana and San Gabriel Mountains. The Linkage Design has several major swaths or branches of habitat to accommodate the diverse species and ecosystem functions it is intended to serve (Figure 46).

Liberty Canyon (Figure 47) was delineated by the landscape permeability analysis for mule deer, but also provides connectivity and suitable habitat for mountain lion, badger, brush rabbit, desert woodrat, loggerhead shrike, California thrasher, western toad, California kingsnake, western whiptail, and harvester ant. This branch of the linkage is dominated by coastal sage, oak woodland, and grassland habitats, with riparian forests along drainages. Liberty Canyon has been a major focus of conservation efforts to maintain connectivity between the Santa Monica Mountains and the Simi Hills, and much research has been done to document the importance of this connection to wildlife movement (Soulé 1989, Kohn et al. 1999, Edelman 1991, Sauvajot et al. 2000, Allen 2001, Riley et al. 2003, Ng et al. 2004, Riley et al. 2006a). The National Park Service is engaged in ongoing carnivore research in this region and continues to monitor wildlife movement, particularly that of mountain lions, including 4 juveniles that have been collared with GPS tracking devices. Biologists at the National Park Service are currently working with Caltrans to assess options for possible enhancement of a wildlife crossing at Liberty Canyon along the 101 Freeway. Liberty Canyon was also featured in a documentary in 2003 by National Geographic News Today, entitled *Struggling to Link Land for Cougars in California*.

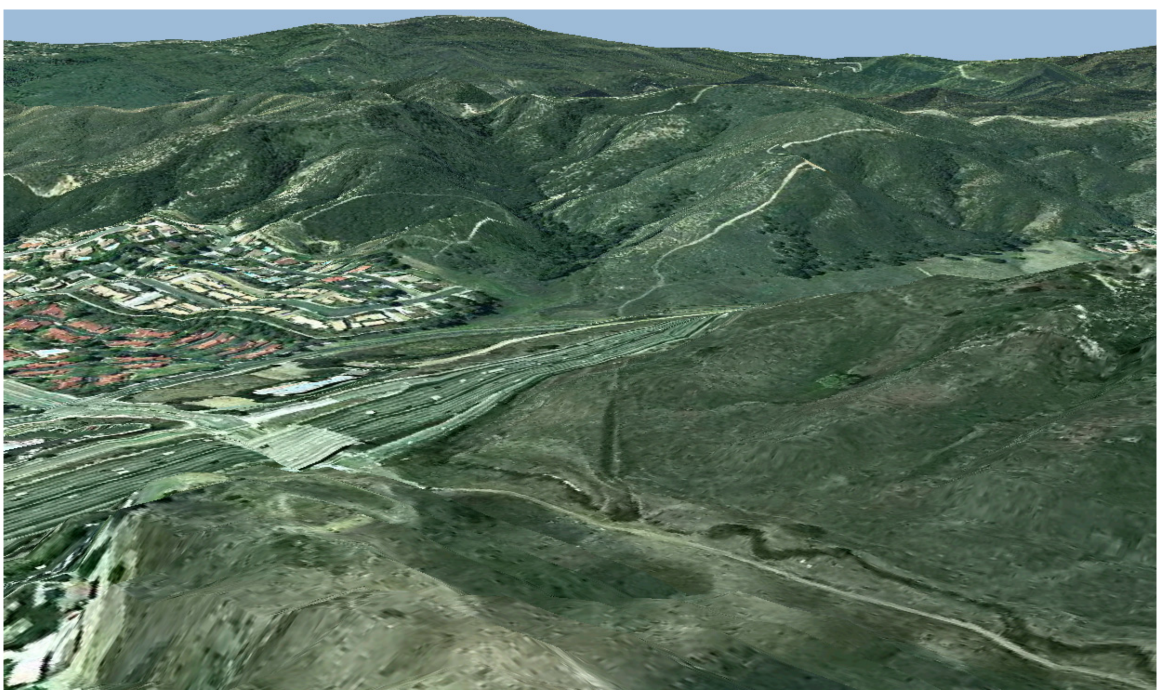


Figure 47. Looking southwest at Liberty Canyon, with the existing bridge the 101 Freeway visible on the left side of the photo. Most natural habitats in this photo are already protected from habitat conversion.

East of Liberty Canyon, Las Virgenes Creek flows from the Simi Hills under the 101 Freeway (Figure 48). Although restricted by development for a stretch south of the freeway, this is the best riparian connection between the Simi Hills and the Santa Monica Mountains. Las Virgenes Creek has a well-developed riparian forest with cottonwood, sycamores, and various willows in the canopy with a dense understory of mulefat, blackberry, and other herbaceous species. The majority of upper Las Virgenes Creek, north of the freeway is included as part of the Santa Monica Mountains National Recreation Area and is protected from habitat conversion, though a section of the creek has been channelized for flood control purposes. South of the freeway, the creek flows through some commercial and residential development in the city of Calabasas for a few kilometers (1.2 mi). The creek banks have been stabilized through this area for flood control purposes but the creek bottom remains natural. Although somewhat degraded through this stretch, the creek is still dominated by native plant species in large part because the Resource Conservation District (RCD) of the Santa Monica Mountains helped coordinate a riparian restoration project here a few years ago. Malibu Creek State Park begins just south of this area, protecting the rest of the creek from habitat conversion. The Las Virgenes Creek connection is especially critical for species that are dependent on riparian habitats for breeding and movement, such as southern steelhead trout, western toad, and damselflies, but other species that use riparian corridors as travel routes (e.g., desert woodrat, brush rabbit, bobcat) will also benefit from maintaining and restoring connectivity here.

Figure 48. Las Virgenes Creek flowing south from the Simi Hills, under the 101 Freeway, through a stretch of development, and then flowing wild to its confluence with Malibu Creek.

Crummer Canyon (Figure 49) is in the eastern branch of the linkage, extending from the Santa Monica Mountains to the Simi Hills. This branch of the linkage was delineated by the landscape permeability analyses for mountain lion, badger and mule deer, and suitable habitat also occurs for brush rabbit, acorn woodpecker, loggerhead shrike, western toad, western whiptail, chalcedon checkerspot butterfly, valley oak, and California black walnut. There is a well-developed riparian forest in Crummer Canyon, surrounded by oak savanna, coastal sage, and grassland habitats in the uplands. Crummer Canyon flows off of Laskey Mesa in the Simi Hills. The mesa is part of Ahmanson Ranch, a recent conservation investment by the state that protects 1,138 ha (2,811 ac); it is managed by the Santa Monica Mountains Conservancy and is now called the Upper Las Virgenes Open Space Preserve. Immediately south of the freeway, contiguous dedicated open space occurs all the way to Malibu Creek State Park.

Figure 49. Looking south down Crummer Canyon from Laskey Mesa in the Simi Hills, across the 101 Freeway to the Santa Monica Mountains.

The next branch of the Linkage Design encompasses Conejo Mountain and Mount Clef Ridge (Figure 50). This branch extends from Pt. Mugu State Park in the western Santa Monica Mountains, following Conejo Creek across the 101 freeway, then through Wildwood Park and over Mount Clef Ridge, and across SR-23 to the Tierra Rejada Valley. This branch of the Linkage Design is dominated by coastal sage scrub, which is designated by the State as a sensitive natural community, providing the most contiguous connection for species associated with this rare plant community. This branch of the linkage was added primarily to serve the needs of the cactus wren, which as its name implies, is highly dependent on stands of cactus for breeding and foraging habitat. There are large stands of prickly pear cactus (*Opuntia* spp) on both sides of the 101 Freeway in this area. In addition to the cactus wren, this branch of the linkage is expected to serve almost all other focal species identified by regional ecologists, including mountain lion, badger, mule deer, brush rabbit, desert woodrat, California thrasher, loggerhead shrike, western toad, California kingsnake, chalcedon checkerspot butterfly, scorpion, and California black walnut. A number of stepping stones of protected land have already been secured in this area as part of the Rim of the Valley Corridor and Conejo Open Space Conservation Agency parklands, including Wildwood Park, and a number of other parcels of dedicated open space. There are also current efforts within the city of Thousand Oaks to protect habitat on Mount Clef Ridge. The minimum width of 2 km was imposed here to ensure that the functional processes of the linkage are protected. Agricultural lands in the Las Posas Hills and Tierra Rejada Valley border the northern boundary of this branch of the linkage, and some agricultural lands were included in the Linkage Design to maintain the minimum corridor width in this area.

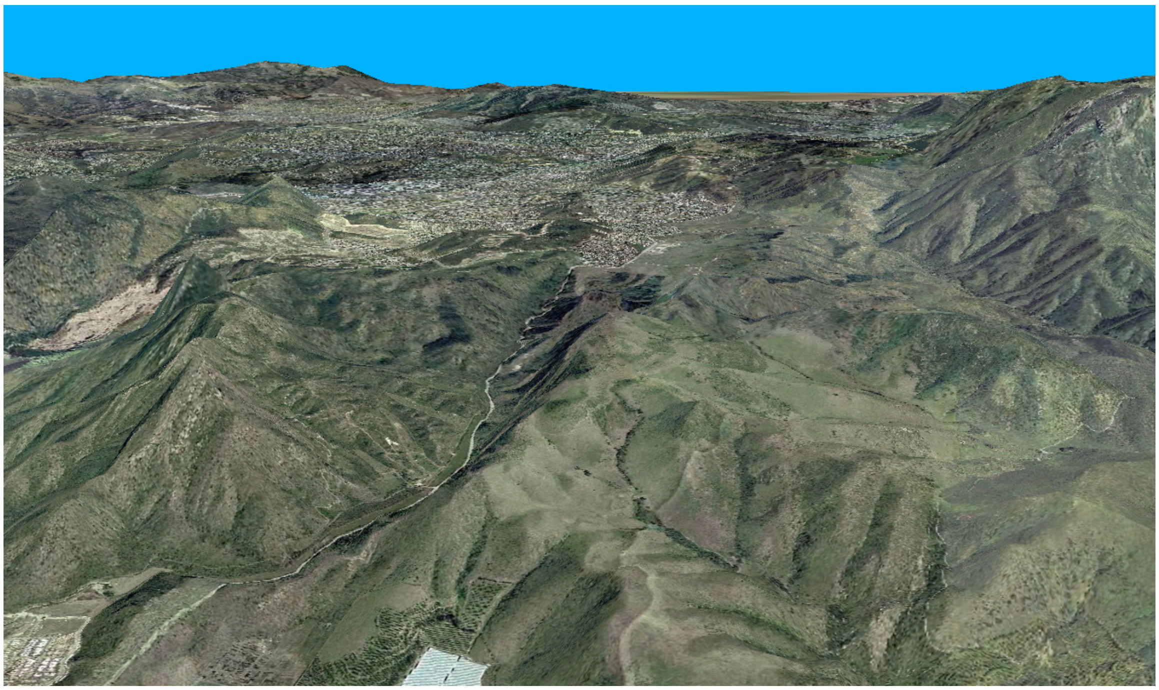


Figure 50. Looking east towards Thousand Oaks, with Conejo Mountain at the right of the photo, the 101 Freeway visible toward the center, and Wildwood Park and Mount Clef Ridge to the left.

The Alamos Canyon area of the Linkage Design is in the western branch of the linkage, and extends from Happy Camp Canyon Park near Big Mountain and Oak Ridge in the Santa Susana Mountains to protected lands south of SR-118 in the western Simi Hills near the Tierra Rejada Valley. From here, there is a contiguous connection of protected habitat all the way to Malibu Creek State Park in the Santa Monica Mountains. This branch of the linkage was delineated by the landscape permeability analysis for mule deer. It follows Alamos Canyon, which flows out of the Santa Susana Mountains through large areas of riparian forests dominated by coast live oak, sycamore, cottonwood, and willows before emptying into the broad bajada of the Arroyo Simi (Figure 51). From the Arroyo Simi, an animal traveling southbound would encounter the grassland and coastal sage habitats of the Tierra Rejada Valley and to the west of the Wood Ranch Reservoir to reach the Simi Hills (Figure 51). This branch of the Linkage Design includes both riparian and upland habitats that serve the movement needs of diverse species including mountain lion, badger, mule deer, brush rabbit, desert woodrat, loggerhead shrike, acorn woodpecker, western toad, western whiptail, harvester ant, valley oak, black walnut and Bigberry manzanita. LSA Associates, Inc. (2004) was recently contracted by Caltrans to monitor wildlife movement along SR-118 to identify opportunities to enhance habitat connectivity in support of an approved transportation project along this route. In their study, several species, including bobcat, mule deer, and mountain lion were documented moving through this area (LSA 2004). Some habitats immediately south of SR-118 in Alamos Canyon have been protected as open space, but additional habitat must be secured to ensure the viability of this connection. The Nature Conservancy and the Santa Monica Mountains Conservancy have been working with local agencies, including the cities of Simi Valley and Moorpark, and landowners in the area to maintain the Alamos Canyon connection.

Figure 51. Looking north toward the Santa Susana Mountains, with Wood Ranch Reservoir in the foreground, agriculture and open space in the Tierra Rejada Valley, and Happy Camp, Faulkner, and Alamos Canyons flowing from the Santa Susanas.

The Rocky Peak area of the Linkage Design (Figure 52) is in the eastern branch of the linkage and was delineated by the least cost corridor analyses for mountain lion, badger, and mule deer, but it also provides live-in and or move-through habitat for virtually every other focal species modeled, with the exception of steelhead trout. The landscape in this area of the linkage is quite remarkable, with striking rocky outcrops surrounded by coastal sage and chaparral, with oak woodlands and riparian forests along canyon bottoms. Much research has been conducted to document wildlife movement in this area, including two of our focal species, mountain lion and mule deer that have been confirmed using various passageways across or under SR-118 (Edelman 1991, Ng

2000, LSA 2004, Riley et al. 2006). A proposed and already approved project for the Rocky Peak Interchange is what prompted the wildlife movement studies undertaken by Caltrans (LSA 2004). Alternatives are being considered, including moving the interchange to outside of the Linkage Design and maintaining and enhancing existing structures within the linkage to maintain existing conservation investments. Conservation planning efforts in this area of the Linkage Design have been very successful. Several existing protected areas occur here, including Rocky Peak Park north of SR-118, which is overseen by the Santa Monica Mountains Conservancy, Santa Susana State Historic Park administered by California State Parks, and Corriganville Park managed by the Simi Valley Open Space District.

Figure 52. Looking southwest from Rocky Peak Park in the Santa Susana Mountains north of SR-118, toward Corriganville Park and the Santa Susana State Historic Park south of the freeway.

Three separate branches were identified between the Santa Susana Mountains and the Sierra Madre Ranges of Los Padres National Forest (Figure 53). The western branch extends from the Santa Susana Mountains near Alamos Canyon and encompasses habitats between Sheils and Wiley Canyon down to the Santa Clara River, and then takes in habitat from Pole Creek to Tom’s Canyon north of SR-126. As described previously, this branch of the linkage was delineated by landscape permeability analysis for mule deer but several focal species that utilize coastal sage and oak woodland habitat will benefit from maintaining connectivity here. The central branch was delineated by the analysis for badger, a grassland specialist. It stretches from the extensive grasslands on Oak Ridge in the Santa Susana Mountains down several canyons lined with dense oak woodlands, to coastal sage and agriculture bordering the Santa Clara River, to grassland and riparian habitats in Piru Creek. The eastern branch of the linkage was delineated by the landscape permeability analysis for mountain lion, as well the two other modeled species. This branch of the linkage extends from Hoiser Canyon in the Sierra Madre Ranges, crosses the Santa Clara River, and encompasses habitat in Tapo, Salt, and Potrero Canyons in the Santa Susana Mountains. All three branches of the linkage include agricultural lands that line the Santa Clara River in this area. The eastern branch has the least amount of agriculture and is dominated by coastal sage scrub and grassland habitats with oak woodlands and riparian foresters interspersed.

Figure 53. Looking south from the Sierra Madre Ranges to the Santa Susana Mountains and on to the Simi Hills. On the left is the eastern branch that extends from Hoiser to Tapo Canyons. The central branch extends from Piru Creek to Smith Canyon. Both the eastern and central branches converge at Rocky Peak. The western branch extends from Hopper Mountain to the Alamos Canyon area.

Three riparian connections were added to the Linkage Design, primarily to accommodate steelhead trout movement and promote the recovery of this species (Figure 54). Of course, other focal species that require riparian and aquatic habitats for breeding or foraging, or use riparian corridors as travel routes will also benefit from protecting and restoring these riparian corridors and adjacent upland habitats, as will several other species not addressed by our analyses, including listed and sensitive species such as arroyo toad, two-striped garter snake, and western pond turtle. The Santa Clara River addition extends from the estuary at the ocean all the way through the Linkage Design to its eastern boundary, serving primarily as a migration corridor for steelhead trout to reach their spawning and rearing grounds in Piru, Sespe, and Santa

Paula Creeks. Most of Piru Creek was included in the central branch of the linkage, but we added lower Piru to its confluence with the Santa Clara River, and all of Sespe and Santa Paula Creeks from the River to protected habitats in the Sierra Madre Ranges of Los Padres National Forest. These additions include a 2-km (1.2-mi) riparian buffer (1 km to either side of the stream or river; see Figure 46) to support species habitat requirements and protect water quality within the linkage and downstream. These riparian connections provide live-in and move-through habitat for several species and help maintain natural hydrological and fluvial processes important to sustaining habitat quality.

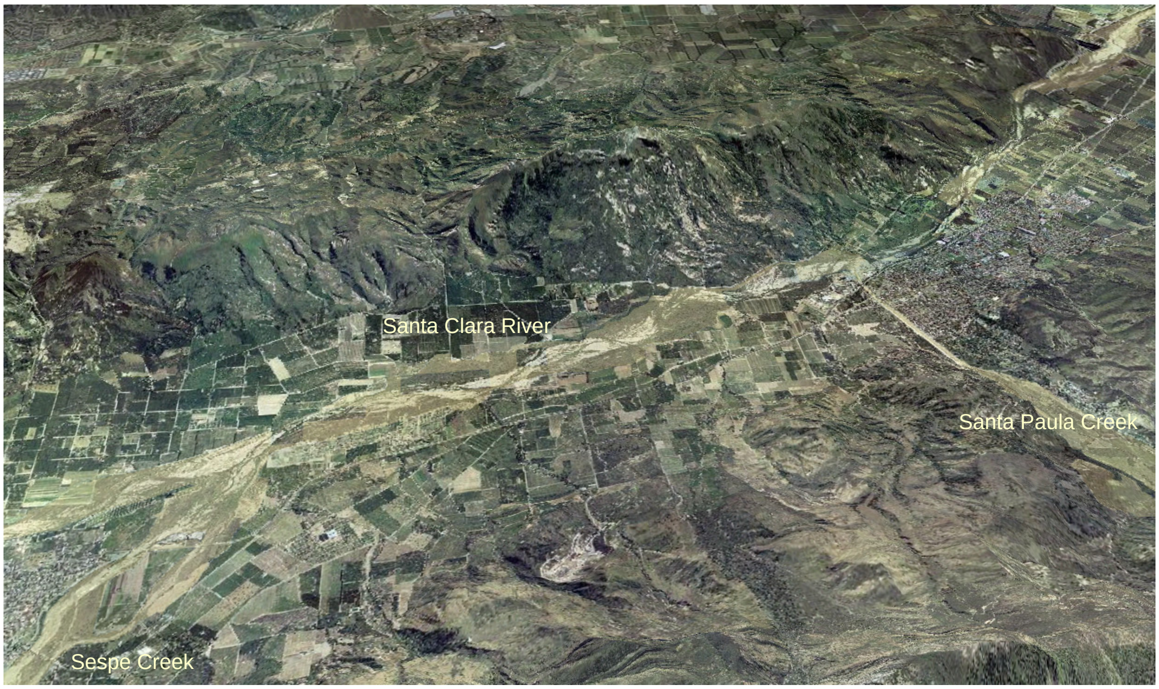


Figure 54. Looking south from the Sierra Madre Mountains toward the Santa Susana Mountains. The Santa Clara River is at the center of the photo, with the confluence of Sespe Creek and the River visible at the lower left, and the confluence of Santa Paula and the River on the right.

Given the marked gradient between the Santa Monica Mountains at the coast and the higher elevations in the Sierra Madre Ranges, the Linkage Design encompasses a diversity of natural communities, including 14 different major vegetation types (Table 3). Although natural vegetation comprises most of the Linkage Design, urban development covers roughly 2% of its area, mostly around the choke-point in the Tierra Rejada Valley where natural habitats are constricted by development in Thousand Oaks and Simi Hills, and between Liberty and Crummer Canyons in Calabasas. Agriculture covers 5% of the linkage, primarily along the Santa Clara River and near the Los Posas Hills and the Tierra Rejada Valley. Habitats in the linkage intergrade between those found in the two targeted core areas, with coastal scrub, chaparral, oak woodland, and grassland representing the primary habitat types. Coastal sage scrub is by far the most common vegetation community, covering 47% of land in the Linkage Design. As the name of this rare plant community implies, it occupies coastal facing slopes throughout the linkage planning area.

A diversity of wetland habitats occur throughout the linkage and core areas, including riparian forests, woodlands, and scrubs, alluvial fans, washes, springs, and seeps. Santa Paula, Sespe, Piru, Pole, Tom's, and Hoiser creeks all emanate from the Sierra Madre Ranges and empty into the Santa Clara River. Sheils, Calumat, Frey, Wiley, Smith, Tapo, Salt, and Potrero creeks flow from the Santa Susana Mountains into the Santa Clara River. Other significant riparian habitat in the Linkage Design occurs along Alamos Canyon and Hummingbird Creek which originate in the Santa Susana Mountains and empty into the Arroyo Simi, and along Liberty, Las Virgenes, and Crummer canyons which begin in the Simi Hills and flow toward the Santa Monica Mountains. In this xeric region, riparian habitats support a disproportionately large number of both aquatic and terrestrial species and are key to movement through the Linkage Design for numerous focal species.

Table 3. Approximate Vegetation and Land Cover in the Linkage Design

	Total Area Linkage Design		**Area Protected in Linkage Design**		**% Protected**	**% of Total Area**
Land Cover Types	***Acres***	***Hectares***	***Acres***	***Hectares***		
Agriculture	5693	2304	740	299	13%	5%
Annual Grassland	17954	7266	5579	2258	31%	14%
Barren	3898	1578	805	326	21%	3%
Chamise-Redshank Chaparral	1637	663	691	280	42%	1%
Coastal Oak Woodland	12325	4988	4662	1887	38%	10%
Coastal Scrub	58763	23781	20492	8293	35%	47%
Desert Wash	296	120	0	0	0%	0.002%
Mixed Chaparral	15614	6319	7581	3068	49%	12%
Montane Hardwood	7	3	0	0	0%	0.00006%
Montane Hardwood-Conifer	206	83	174	71	84%	0.2%
Montane Riparian	3818	1545	910	368	24%	3%
Saline Emergent Wetland	17	7	17	7	100%	0.01%
Urban	2863	1159	191	77	7%	2%
Valley Foothill Riparian	1250	506	509	206	41%	1%
Valley Oak Woodland	1007	407	727	294	72%	1%
Water	263	107	171	69	65%	0.2%
TOTAL	***125613***	***50834***	***43249***	***17502***	***34%***	***100%***

All branches of the Linkage Design include substantial public ownerships that protect natural habitats from development. However, other uses may still threaten the integrity of these habitats, and should be carefully managed on these lands. For example, use of off-road vehicles, mining, and livestock grazing can impact these habitats, especially riparian habitats and fluvial processes. The final Linkage Design encompasses 50,834 ha (125,613 ac), of which approximately 34% (17,502 ha or 43,249 ac) currently enjoys some level of conservation protection, mostly in land overseen by the Santa Monica Mountains Conservancy, National Park Service, California State Parks, The Nature Conservancy, Mountain Recreation and Conservation Authority, Conejo Open Space Conservation Agency, Eastern Ventura County Conservation Authority, and the Rancho Simi Recreation and Park District.

Removing and Mitigating Barriers to Movement

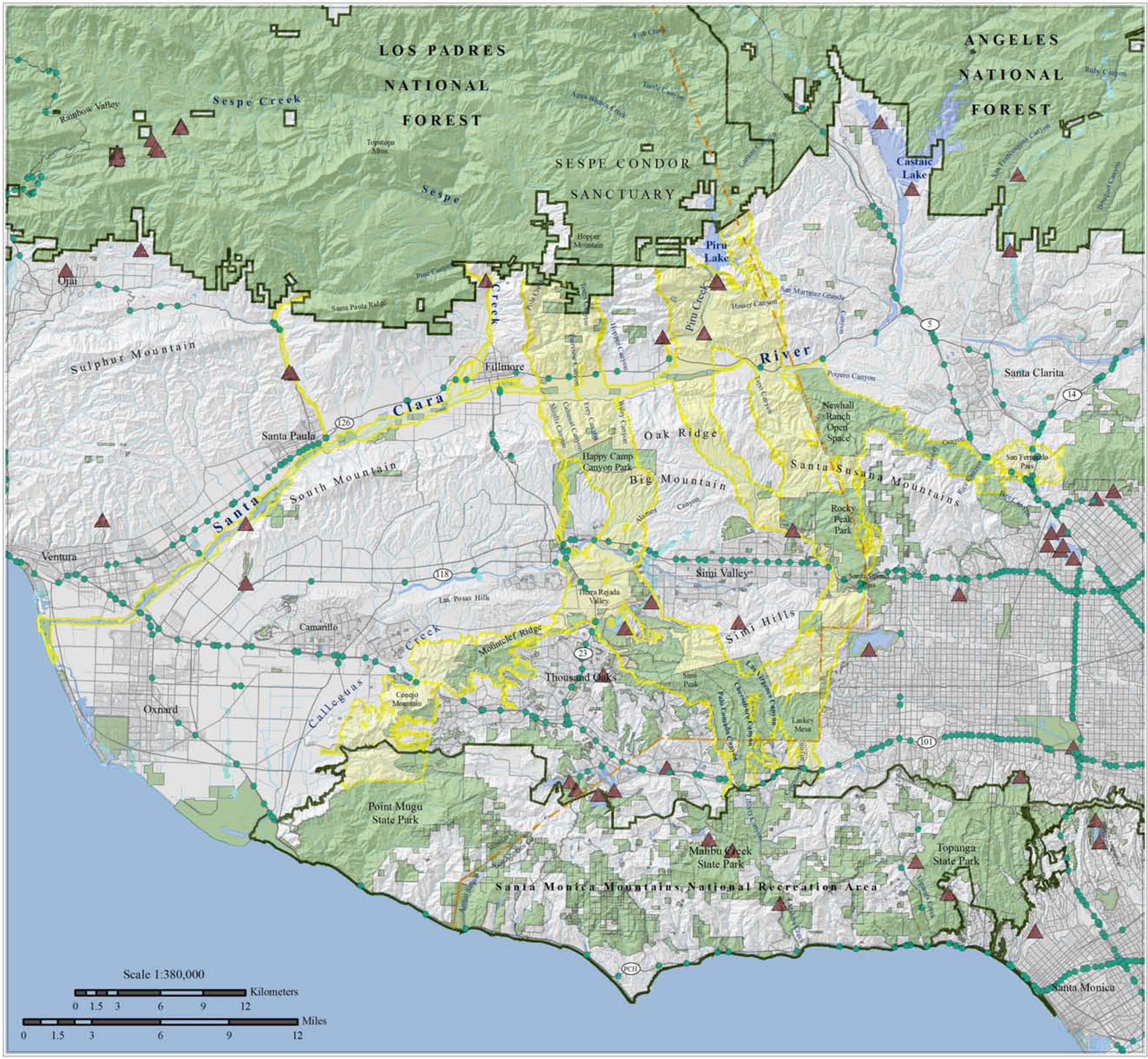
Five types of features impede species movements through the Linkage: roads, railroads, and impediments to stream flow, urban and agricultural development, and recreational activities. This section describes these impediments and suggests where and how their effects may be minimized to improve linkage function.

This discussion focuses on methods to facilitate movement of terrestrial species across roads, and on structures to facilitate stream flow under roads. Although some documents refer to such structures as "corridors" or even "linkages," we use these terms in their original sense to describe the entire area required to link the landscape and facilitate movement between large protected core areas. Crossing structures represent only small portions, or choke points, within an overall habitat linkage or movement corridor. Investing in specific crossing structures may be meaningless if other essential components of the linkage are left unprotected. Thus it is essential to keep the larger landscape context in mind when discussing existing or proposed structures to cross movement barriers. This broader context also allows awareness of a wider variety of restoration options for maintaining functional linkages. Despite the necessary emphasis on crossing structures in this section, we urge the reader to keep sight of the primary goal of conserving landscape linkages to promote movement between core areas over broad spatial and temporal scales.

Roads as Barriers to Upland Movement: Wildland fragmentation by roads is increasingly recognized as one of the greatest threats to biodiversity (Noss 1983, Harris 1984, Wilcox and Murphy 1985, Wilcove et al. 1986, Noss 1987, Reijnen et al. 1997, Trombulak and Frissell 2000, Forman and Deblinger 2000, Jones et al. 2000, Forman et al. 2003). Roads kill animals in vehicle collisions, create discontinuities in natural vegetation (the road itself and induced urbanization), alter animal behavior (due to noise, artificial light, human activity), promote invasion of exotic species, and pollute the environment (Lyon 1983, Noss and Cooperrider 1994, Forman and Alexander 1998). Roads also fragment populations by acting as semi-permeable to impermeable barriers for non-flying animals (e.g., insects, fish, amphibians, reptiles, and mammals) and even some flying species (e.g., butterflies and low-flying birds). The resulting demographic and genetic isolation increases extinction risks for populations (Gilpin and Soulé 1986). For example Ernest et al. (2003) has documented little flow of mountain lion genes between the Santa Ana and Palomar ranges (where I-15 is the most obvious barrier), and between the Sierra Madre and Sierra Nevada (where I-5, and urbanization along SR-58, are the most obvious barriers). Within this planning area, Riley et al. (2006a) have documented genetic isolation of bobcats and coyotes in subpopulations separated by the 101 Freeway. Fragmentation also results in smaller populations, which are more susceptible to extinction due to demographic and environmental stochasticity.

The impact of a road on animal movement varies with species, context (vegetation and topography near the road), road type, and level of traffic (Clevenger et al. 2001). For

Figure 55. Infrastructure in the Planning Area



Linkage Design
Protected Lands
Bridges/Culverts
Dams
Roads
Canal/Aqueduct
Hydrography
Target Areas
County Boundary
Lakes & Reservoirs

Map Produced By:
SOUTH COAST WILDLANDS
June 2006
www.scwildlands.org

example, a road on a stream terrace can cause significant population declines in amphibians that move between uplands and breeding ponds (Stephenson and Calcarone 1999), but a similar road on a ridgeline may have negligible impact. Most documented impacts on animal movement concern paved roads. Dirt roads may actually facilitate movement of some species, such as mountain lions (Dickson et al. 2004), while adversely impacting other species, such as snakes that sun on them and may be crushed even by infrequent traffic.

Roads in the Linkage Design: At the time of this report, there are 339.93 km (211.22 mi) of paved roads in the Linkage Design (Table 4). There are several major transportation routes (i.e., I-5, US Route 101, and SR-14, 23, 118, and 126) that pose substantial barriers to movement (Figure 55). A survey of these roads found a variety of existing structures (i.e., bridges, pipes, and culverts) that might be useful for implementing road mitigation projects (Figure 55).

Table 4. Major transportation routes in the Linkage Design.

Road Name	Length (km)	Length (mi)
U.S. Route 101	5.62	3.49
Interstate 5	3.44	2.14
State Route 126	12.07	7.50
State Route 23	6.58	4.09
State Route 118	7.37	4.58
State Route 14	2.35	1.46
All Other Paved Roads	302.51	187.97
Total Length of Paved Roads	**339.93**	**211.22**

Types of Mitigation for Roads: Forman et al. (2003) suggest several ways to minimize the impact of roads on linkages by creating wildlife crossing structures and reducing traffic noise and light, especially at entrances to crossing structures. Wildlife crossing structures have been successful both in the United States and in other countries, and include underpasses, culverts, bridges, and vegetated land bridges. Most structures were initially built to accommodate streamflow, but research and monitoring have also confirmed the value of these structures in facilitating wildlife movement. The main types of structures, from most to least effective, are vegetated land-bridges, bridges, underpasses, and culverts.

There are approximately 50 vegetated wildlife overpasses (Figure 56) in Europe, Canada, and the U.S. (Evink 2002, Forman et al. 2003). They range from 50 m (164 ft) to more than 200 m (656 ft) in width (Forman et al. 2003).

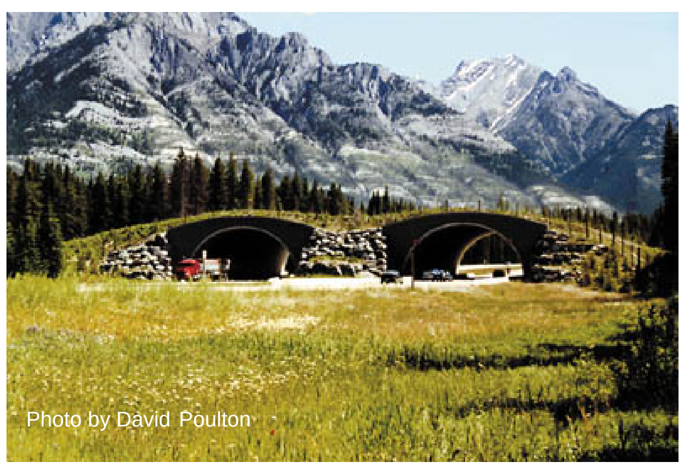


Figure 56. An example of a vegetated land bridge built to enhance movement of wildlife populations.

Soil depths on overpasses range from 0.5 to 2 m, allowing growth of herbaceous, shrub, and tree cover (Jackson and Griffin 2000). Wildlife overpasses can maintain ambient conditions of rainfall, temperature, light, vegetation, and cover, and are quieter than underpasses (Jackson and Griffin 2000). In Banff National Park, Canada, some large mammal species preferred overpasses to other crossing structures (Forman et al. 2003) although in some cases, underpasses were used equally or preferred (Clevenger and Waltho 2006). Similarly, woodland birds used overpasses significantly more than they did open areas without an overpass. Other research indicates overpasses may encourage birds and butterflies to cross roads (Forman et al. 2003). Overpass value can be increased for small, ground-dwelling animals by supplementing vegetative cover with branches, logs, and other cover (Forman et al. 2003).

Bridges over waterways are also effective crossing structures, especially if wide enough to permit growth of both riparian and upland vegetation along both stream banks (Jackson and Griffin 2000, Evink 2002, Forman et al. 2003). Bridges with greater openness ratios are generally more successful than low bridges and culverts (Veenbaas and Brandjes 1999, Jackson and Griffin 2000). The best bridges, termed *viaducts* (Figure 57), are elevated roadways that span entire wetlands, valleys, or gorges, but are cost-effective only where topographic relief is sufficient to accommodate the structure (Evink 2002).

Figure 57. A viaduct in Slovenia built to accommodate wildlife, hydrology, and human connectivity.

Although inferior to bridges, culverts can be effective crossing structures for some species (Jackson and Griffin 2000). Only very large culverts are effective for carnivores and other large mammals (Figure 58). Gloyne and Clevenger (2001) suggest that underpasses for ungulates should be at least 4.3 m (14 ft) high and 8 m (26 ft) wide, with an openness ratio of 0.9 (where the openness ratio = height x width/length). Earthen flooring is preferable to concrete or metal (Evink 2002).

Figure 58. Culvert on German highway, with rail for amphibians and fence for larger animals.

For rodents, pipe culverts (Figure 59), about 1 ft in diameter without standing water are superior to large, hard-bottomed culverts, apparently because the overhead cover makes them feel secure against predators (Clevenger et al. 2001, Forman et al. 2003).

In places where a bridged undercrossing or vegetated overcrossing is not feasible, placing pipe culverts alongside box culverts can help serve movement needs of both small and large animals. Special crossing structures that allow light and water to enter have been designed to accommodate amphibians (Figure 60). Retaining walls should be installed, where necessary, along paved roads to deter small mammals, amphibians, and reptiles from accessing roadways (Jackson and Griffin 2000). Concrete retaining walls are relatively maintenance free, and better than wire mesh, which must be buried and regularly maintained.

Figure 59. Pipe culvert designed to accommodate small mammals.

Figure 60. Amphibian tunnels allow light and moisture into the structure.

Noise, artificial night lighting, and other human activity can deter animal use of a crossing structure (Yanes et al. 1995, Pfister et al. 1997, Clevenger and Waltho 1999, Forman et al. 2003, Clevenger and Waltho 2006), and noise can deter animal passage (Forman et al. 2003). Shrub or tree cover should occur near the entrance to the structure (Evink 2002). Existing structures can be substantially improved with little investment by installing wildlife fencing, earthen berms, and vegetation to direct animals to passageways (Forman et al. 2003). Regardless of crossing type, wildlife fencing is necessary to funnel animals towards road crossing structures and keep them off the road surface (Falk et al. 1978, Ludwig and Bremicker 1983, Feldhammer et al. 1986, Forman et al. 2003). Earthen one-way ramps can allow animals that wander into the right of way to escape over the fence (Bekker et al. 1995, Rosell Papes and Velasco Rivas 1999, Forman et al. 2003).

Recommendations to Mitigate the Effects of Road Barriers in the Linkage Design: Following standard practice (Clevenger and Wierzchowski 2005) where a road bisects a major wildland, we recommend crossing structures at intervals of 1.5 to 2 km (0.9 to 1.3 miles), or at least one major structure (either bridged undercrossings or wildlife overpasses) per branch of the Linkage Design. The precise timing and location for constructing new or improved crossing structures may not be critical, and can consider cost, feasibility, and other factors. For cost efficiency, crossing improvements need not be made immediately, but can be incorporated into future road upgrade projects, such as lane additions or ramp remodeling in the vicinity of the Linkage Design. Vegetated overpasses or open bridges, supplemented by culverts for smaller species, should be sited along natural travel routes and spaced less than 2 km (1.3 mi) apart on average, with a maximum spacing between adjacent structures not to exceed 2.8 km (1.8 mi). Excellent examples of roads retrofitted with large crossing structures at similar intervals include SR-260 between Payson and Forest Lakes, Arizona; the Trans-Canada Highway in Banff National Park, Canada; I-75 through the Everglades in Florida; and I-4 near Daytona Beach, Florida. It is also important that the entire road be fenced to funnel animals toward crossing structures. The Ventura County Planning Division recently completed a report entitled, Roads and Biodiversity Project: Guidelines for Safe Wildlife Passage (2005) that provides excellent suggestions for improving connectivity across transportation barriers.

Recommended Crossing Structures on U.S. Route 101: Although a number of freeways pass through the Linkage Design, the 101 Freeway is likely the most substantial impediment to movement. A few crossing structures that may be adequate to accommodate some wildlife movement currently exist, while others need to be improved or built.


Figure 61. Looking toward the Simi Hills through the Liberty Canyon underpass.

Liberty Canyon: The most permeable route of the least cost corridor for mule deer crossed the 101 Freeway here and suitable habitat exists in this area for the majority of the selected focal species. Liberty Canyon is one of the few remaining areas along the 101 Freeway where habitat is still contiguous on both sides of the freeway. There is an existing bridge (Figure 61), measuring 4.9 m (16.1 ft) high, 46.7 m (153.2 ft) wide, and 44.3 m (145.3 ft) long. Deer utilize this structure regularly to cross between ranges, as do coyotes, and raccoons (Ng et al. 2004). Although none of the mountain lions radio-collared by the National Park Service in the Santa Monica Mountains have yet crossed the freeway to reach the Simi Hills, one lion moved to within 500 meters of this structure (Riley et al. 2006b). The National Park Service, California State Parks, Santa Monica Mountains Conservancy, and other local open space agencies have been working to preserve and restore the connection between Liberty Canyon and other protected areas. The National Park Service is also working with Caltrans to assess options for improving habitat connectivity at Liberty Canyon. We recommend providing a wildlife-specific crossing structure at this location to prevent co-location of vehicle traffic and animal movement options (the current situation). This could be accomplished with a wildlife underpass or overpass, and could take advantage of existing topography and infrastructure already in place (e.g. existing drainage culvert, see below). Habitat restoration in the immediate vicinity of a wildlife crossing structure is also recommended, as well as fencing to direct animals away from the freeway and towards the crossing structure.

Immediately west of the bridge is a drainage culvert (Figure 62) for the intermittent creek that flows through Liberty Canyon. The structure is roughly 1 m in diameter and about 190 m long. Ng et al. (2004) recorded raccoon, opossum, spotted skunk, and striped skunk using this passage to cross the freeway. Various willows, mule fat, and poison oak occur along the drainage with coastal sage scrub, and oak woodland and savannas in the surrounding uplands. The Santa Monica Mountains Conservancy has already initiated habitat restoration efforts along the creek. There is currently a fence obstructing the path from the riparian zone to the structure. We recommend removing this fence and upgrading this structure to a larger, more wildlife-friendly crossing with natural flooring, possibly as part of a future transportation improvement project or linked to the crossing structure recommended above.

Figure 62. Drainage culvert at Liberty Canyon.

Las Virgenes Creek: Las Virgenes Creek offers the best connection for riparian dependent species traveling between the Simi Hills and the Santa Monica Mountains. The creek flows from the Simi Hills under the 101 Freeway through a multi-chambered concrete tunnel (Figure 63), measuring 98.9 m (324.5 ft) long, 4.8 m (15.8) wide, and 4.0 m (13.1 ft) high. The structure runs diagonally under the freeway, limiting visibility to the other side. Immediately south of the freeway, the creek is directed through a concrete channel for a distance of roughly 76 m (250 ft). This is flood control for the office complex and shopping center that abut the creek in this area. After flowing through a bridge under Agoura Road (Figure 64), the creek bottom is again natural, though degraded and constricted for about 1 km (0.6 mi) before reaching Malibu Creek State Park and eventually emptying into Malibu Creek bound for the ocean. For much of its length, the creek is dominated by a well-developed riparian forest, with mature cottonwood, sycamore, and willows in the canopy and a dense understory of herbaceous plant

Figure 63. Las Virgenes Creek flowing through a concrete tunnel under the 101 freeway.

Figure 64. A channelized portion of Las Virgenes Creek flowing under a bridge for Agoura Road.

species. Ng et al. (2004) documented movement of bobcat and raccoon through this structure. We recommend upgrading the concrete tunnel under the freeway to a large bridged underpass that provides visibility to the other side and natural flooring during the next transportation improvement project in this area. We also suggest precluding any further development in the uplands along the creek, removing the concrete from the creek bottom between the freeway and Agoura Road, and continuing and expanding riparian restoration to improve habitat conditions in degraded sections of Las Virgenes Creek (See Impediments to Streams Section). The RCD of the Santa Monica Mountains implemented a stream restoration project in this area previously and this work has resulted in significant improvements immediately between Lost Hills Road and existing residential developments.

Crummer Canyon: The least cost corridors for mule deer, badger and mountain lion all traversed the 101 Freeway at Crummer Canyon, though no useable infrastructure to accommodate wildlife movement currently exists. The trash guard at the entrance of an existing culvert precluded a full evaluation of this structure (Figure 65); the trash guard itself prevents use by most medium-sized and large wildlife species. At its entrance, the concrete structure appears to be a box culvert, which measures 1.8 m (6 ft) in height and width, but about 0.9 m (3 ft) in it becomes a circular pipe approximately 1.5 m (5 ft) in diameter that immediately heads to the west, so there is no visibility to the other side. The creek runs below both Mureau Road and the 101 Freeway and likely passes through an elaborate pipe system to reach contiguous protected lands immediately south of the freeway that stretch all the way to Malibu Creek State Park. With the tremendous investments in conserving land on both sides of the freeway here, including the Ahmanson Ranch acquisition, we strongly recommend installing a wildlife-friendly undercrossing here that is tall enough and sufficiently wide to provide a view to the other side, with earthen substrate flooring. Installing ecological infrastructure here would benefit a number of other focal species, in addition to those mentioned above, including brush rabbit, California kingsnake, western whiptail, and western toad.

Figure 65. Concrete culvert with trash guard draining Crummer Canyon.

Conejo Grade: In the western branch of the linkage, there is a concrete box culvert (Figure 66) that measures 2.2 m (7.2 ft) wide, 2.6 m (8.5 ft) high, and 45 m (148 ft) long. The structure was built in 1936, likely to facilitate movement of cattle. This structure ultimately links Point Mugu State Park and Conejo Mountain in the western Santa Monica Mountains to Wildwood Park and other protected open space on Mount Clef Ridge. Ng et al. (2004) recorded raccoon and opossum using this structure but all species that utilize coastal sage scrub will benefit from maintaining connectivity here. Fencing in the immediate vicinity of the structure may preclude current use by other wildlife species (Ng 2000, Ng et al. 2004). We suggest enlarging this structure to provide better visibility to the other side and removing fencing that may impede wildlife use. Directional fencing should also be used to help animals find and utilize the structure. In addition or as an alternative, another wildlife-friendly crossing structure is recommended along the 101 Freeway at the Conejo Grade. The existing topography could be utilized to install an excellent crossing structure that would connect very high quality habitat on either side of the freeway in an area known to be utilized by target species. Indeed, a dispersing male mountain lion was recently recorded in the area, immediately adjacent to the 101 Freeway, but he did not actually cross the road (Riley et al. 2006b). Recommended dimensions for undercrossing(s) along the Conejo Grade are at least 4.3 m (14 ft) high and 8 m (26.ft) wide to encourage use by mule deer (Gloyne and Clevenger 2001) and other species, and the flooring should be a natural substrate.

Figure 66. Large concrete box culvert at Conejo Grade.

Recommended Crossing Structures on State Route 23: Caltrans is working in cooperation with the National Park Service to monitor wildlife movement at several culverts under SR-23 as part of an effort to improve habitat connectivity along this stretch of highway. Proposed improvements will include clearing tunnels and culverts and installing wildlife-proof fencing with escape gates to direct animals off of the road and through underpasses. Implementation is slated to occur in the next several months as mitigation for a lane addition along SR-23. The pipe culvert to the right (Figure 67) is located north of the Tierra Rejada Valley; it measures 2.6 m (8.5 ft) high, 2.2 m (7.2 ft) wide, and 133.4 m (437.7 ft) long. Ng et al. (2004) recorded bobcat, coyote, raccoon, and opossum utilizing this structure to travel between habitats on either side of SR-23. Rural residential and agricultural lands are interspersed with dedicated parks and open space in this part of the linkage but opportunities remain to protect habitat and enhance wildlife movement between Los Angeles Avenue and Olsen Road. We strongly encourage

Figure 67. Pipe culvert north of Tierra Rejada, typical of most crossing structures on SR-23.

protection of remaining natural habitats and applying conservation measures to maintain the rural character of the Tierra Rejada Valley.

Recommended Crossing Structures on State Route 118: As part of a transportation improvement project on SR-118, Caltrans contracted with LSA Associates Inc. (2004) to monitor wildlife movement at several existing structures between the cities of Moorpark and Chatsworth to identify recommendations to improve habitat connectivity as mitigation for the transportation project. These and other recommendations are now being discussed as part of an informal working group of land management and other agencies (the Ventura County State Route 118 Wildlife Corridor Multi-Agency Working Group). Below we describe conditions and suggestions for improving wildlife movement along SR-118 consistent with the Linkage Design.

Figure 68. Double pipe culverts at Alamos Canyon West convey flow to the Arroyo Simi.

Alamos Canyon West: This potential passageway is located along an unnamed drainage that empties into the Arroyo Simi. The structure consists of double pipe culverts, each measuring 3.1 m (10 ft) in diameter and approximately 243.8 m (800 ft) in length (Figure 68). There is no visibility to the other side because the culvert drops at about a 45 degree angle at the northern entrance. In addition to no visibility due to the slope of the culvert, vegetative debris collects on the southern side of SR-118 following storm events. In preparation of post-fire storms, Caltrans cleared the culvert and removed riparian vegetation approximately 61 m (200 ft) downstream (Amy Pettler, Caltrans, pers. comm. *in* LSA 2004). Upland vegetation north and south of the culvert is dominated by California buckwheat (*Eriogonum fasciculatum*), sagebrush (*Artemisia californica*), and chaparral yucca (*Yucca whipplei*), while Freemont cottonwood (*Populus fremontii* ssp. *fremontii*), various willows (*Salix* sp.), and rushes (*Juncus* sp.) occur along the drainage. LSA (2004) recommended that either the twin culverts be replaced with an open bridged structure or the pitch at the northern entrance of the culvert be regraded to allow visibility to the other side. We concur with these recommendations. We also suggest maintaining riparian vegetation to facilitate movement of species associated with riparian and aquatic habitats, such as damselflies, desert woodrat, and western toad. LSA documented a variety of mammals in the general vicinity north and south of this crossing, but did not document movement of these target species through the passageway.

Alamos Canyon: The least cost corridor for mule deer crosses SR-118 using Alamos Canyon. This excellent bridged underpass provides a clear view to the other side and measures roughly 4.9 m (16 ft) high, 41.8 m (137 ft) wide, and 48.9 m (160 ft) long (Figure 69). There is an asphalt road on one side of the structure that is not in use. The openness of this structure and the gap between the north and southbound lanes allows natural light and moisture to enter the passageway supporting well-developed coastal sage vegetation on natural substrate to one side of the structure. Dominant vegetation in the vicinity of the structure consists of California buckwheat, sagebrush, chaparral coyote brush (*Baccharis pilularis*), and yucca, while oak (*Quercus* spp.), mule fat (*Baccharis salicifolia*), elderberry (*Sambucus* spp.), and laurel sumac (*Malosma laurina*) occur along the drainages.

Figure 69. Looking north toward the Santa Susana Mountains through the first-rate bridged crossing at Alamos Canyon.

In addition to being the most permeable route for mule deer, Alamos Canyon provides suitable habitat for a number of focal species, including mountain lion, badger, brush rabbit, loggerhead shrike, California thrasher, chalcedon checkerspot butterfly, and scorpion. A variety of wildlife have been documented using this well-designed structure, including mountain lion (Psomas 2002), bobcat (Psomas 2002, LSA 2004), coyote (Ng 2000, LSA 2004),) mule deer, striped skunk, raccoon (Ng 2000), small mammals and birds (LSA 2004).

LSA (2004) recommended removing the paved road surface and replacing it with decomposed granite. If this road is used for maintenance activities then we agree with this suggestion. If the road is not needed for vehicular access, complete removal of the pavement and restoration of natural vegetation is recommended. LSA also recommended installing gates to reduce human traffic (e.g., illegal dumping, homeless camps) in the area (2004). This recommendation has been implemented successfully as gates have been installed and these activities weren't noted during recent fieldwork.

It is critical that this structure be maintained and that lands near it are protected for use by wildlife. We advise acquisition of open space or conservation easements of contiguous natural habitats between Happy Camp Canyon Park and protected areas in the Simi Hills and Tierra Rejada Valley to enhance the ecological integrity of this linkage.

Alamos Canyon East: This potential passageway consists of a 1.83 m (6 ft) diameter pipe culvert, extending approximately 183 m (600 ft) under SR-118 (Figure 70). This structure is located roughly 150 m (492 ft) east of the bridged structure described above. LSA (2004) documented use of this structure by bobcat, skunk, opossum, and raccoon, and recorded a variety of medium and large-sized mammals in the vicinity of this structure, both north and south of SR-118. Natural habitats occur on either side of the freeway, though no vegetation occurs in the structure itself. We suggest increasing vegetative cover near the entryways of the passage to provide cover for wildlife. LSA (2004) recommended enlarging this culvert to at least a 2.4 m by 2.4 m (8 ft by 8 ft) concrete box culvert or arch with natural substrate flooring by “tunnel jacking” (NRCC 2002) during the next transportation improvement project in this area. If this recommendation is implemented, we also suggest installing smaller pipe culverts along side the enlarged structure to encourage movement of small mammals, amphibians and reptiles.

Figure 70. Pipe culvert at Alamos Canyon east.

Hummingbird Creek: Hummingbird Creek is dominated by Fremont cottonwood (*Populus fremontii*), various willows, and mule fat, with oak savanna and chaparral in the uplands. It flows under SR-118 through a concrete-lined channel that measures 3.8 m (12.5 ft) in height, 3.9 m (12.8 ft) in width and 144.9 m (475.4 ft) in length (Figure 71). The functionality of this linkage is already compromised due to the dense residential and commercial development along Kuehner Drive on the south side of SR-118. However, natural habitats are still contiguous on either side of the structure. Although constrained, this is one of the few riparian connections along this stretch of the freeway and it should be maintained and enhanced to facilitate movements of riparian dependent species. In addition, bobcat, raccoon, and striped skunk have been documented using this structure (Ng 2002) and other target species have been recorded via scent stations and diagnostic sign (LSA 2004).

Figure 71. Looking south through the arched culvert at Hummingbird Creek.

The westernmost boundary of Rocky Peak Park is along North Kuehner Drive and the Hummingbird Creek connector trail begins at the Kuehner Drive/SR-118 intersection. White Oak Park and Hummingbird Creek Trail areas are located north of and parallel to SR-118 and are contiguous with Corriganville and Rocky Peak Parks to the east. We recommend maintaining and enhancing the remaining natural habitats in this area with appropriate measures to confine light and noise pollution to home sites. We agree with LSA (2004) that the highway fence south of the freeway should be relocated to direct animals toward Corriganville Park to the east. Riparian and upland habitats, particularly south of the freeway, should be restored and allowed to persist to provide habitat and cover for wildlife. Recreational activity is high in this area, including hiking, mountain biking, and off-road vehicle use. Recreation should be limited to the currently permitted passive activities, such as hiking and birding.

Corriganville: The least cost corridors for mountain lion, badger, and mule deer all cross SR-118 at Corriganville Park. At this location, there is a large concrete box culvert that measures 58.3 m (191.3 ft) in length, 4.6 m (15.1 ft) wide, and 4.7 m (15.4 ft) high, linking Corriganville Park south of SR-118 with Rocky Peak Park north of SR-118 (Figure 72). Coastal sage scrub is the dominant plant community on both sides of the structure. Several researchers have confirmed use of this passage by wildlife. Mountain lion have been documented using the Corriganville Tunnel on several occasions (Edelman 1991, Ng 2000, LSA 2004, Riley et al. 2006b). Ng also recorded mule deer, coyote, bobcat, raccoon, and striped skunk using this structure. LSA (2004) captured a mountain lion on film that had been radio-collared as part of a National Park Service study. This young male appears to have used this structure to cross SR-118 at least 18 times over the course of the study (Riley et al. 2006b).

Figure 72. Several target species have been documented using this box culvert to travel between habitats north and south of SR-118.

In addition to providing habitat for wildlife, both Corriganville and Rocky Peak Parks are used recreationally by hikers, bicyclists, equestrians, and youth groups that also use this structure to go between the two parks. To maintain the integrity of this passageway, we recommend that the park facilities remain rustic (e.g., dirt parking lots) without night lighting or fencing that could deter or block wildlife movement; ideally, park use in the vicinity of the crossing structure would be limited to daytime use. To restrict human activities near the crossing structure, especially from dusk to dawn, LSA (2004) proposed installing a locking security fence at the parking lot entrance to Corriganville Park and at Foothill Park to regulate access.

Rocky Peak: The least cost corridor for mule deer crossed SR-118 at Rocky Peak Road, which is located approximately 0.80 km (0.5 mi) east of the Corriganville structure described above. This roadway overpass connects Santa Susana State Historic Park south of SR-118, with Rocky Peak Park to the north. The paved road crosses over SR-118 as a bridge structure, measuring 18.3 m (60 ft) in width and approximately 39.6 m (130 ft) in length (Figure 73). Dominant plant communities in the vicinity of the structure include coastal sage scrub and chamise chaparral. LSA (2004) documented coyote, bobcat, raccoon, and skunk utilizing this structure, in addition to vehicles, equestrians, hikers, and cyclists. Caltrans biologists documented mule deer at Rocky Peak Road over three field seasons (pers. comm. Amy Pettler, Caltrans, April 9, 2004 *in* LSA 2004).

Figure 73. Looking south from Rocky Peak Park toward Santa Susana State Historic Park at the bridge for Rocky Peak Road over SR-118.

A transportation improvement project for the Rocky Peak Road interchange is currently being evaluated. Under existing conditions, Rocky Peak Road can only be accessed from SR-118 via the westbound off-ramp, while access to SR-118 from Rocky Peak Road is limited to the eastbound on-ramp from Santa Susana Pass Road. The proposed project would include installation of an eastbound off-ramp and a westbound on-ramp. The earthen fill for this improvement project is in place (Figure 73), but no other infrastructure has been built. LSA (2004) proposed an alternative to completing this project that Caltrans is taking into consideration. They suggested constructing on-off ramps at Iverson Road or Movie Lane instead of at Rocky Peak Road to meet project goals of an additional interchange for emergency vehicles turn-around and to accommodate traffic projections. This alternative would enhance the existing site for use by wildlife, particularly if it included closing the existing on-off ramps at Rocky Peak Road. The existing bridge could be converted to a vegetated land bridge, with native shrubs and trees tall enough to block lighting and reduce noise from traffic. As LSA suggested, if necessary, one lane could be converted to decomposed granite for emergency vehicle access (2004).

Santa Susana Arch: This structure is located approximately 1.61 km (1 mi) east of Rocky Peak Road, linking Santa Susana State Historic Park south of SR-118 with Joughin Dedicated Open Space and Rocky Peak Park north of the freeway. The passageway is a concrete arch shaped culvert with a flat bottom, measuring 1.5 m (5 ft) high, 1.8 m (6 ft) wide, and approximately 152.4 m (500 ft) long (Figure 74). LSA (2004) captured this family of raccoons on film on several occasions during their study, as they frequently utilized this structure to cross under the freeway. Several rodents were also recorded but were not identified to species. Residential development occurs on the eastern bluff above the canyon north of SR-118, while the canyon itself and habitats to the west are protected as part of Rocky Peak Park and Joughin Open Space. Coast live oak, poison oak (*Toxicodendron diversilobum*), sycamore (*Platanus racemosa*), and cottonwood line the drainage with laurel sumac and other coastal scrub species in the uplands. We concur with LSA (2004) that enhancing vegetative cover at the culvert entrances would encourage additional wildlife to use this passage.

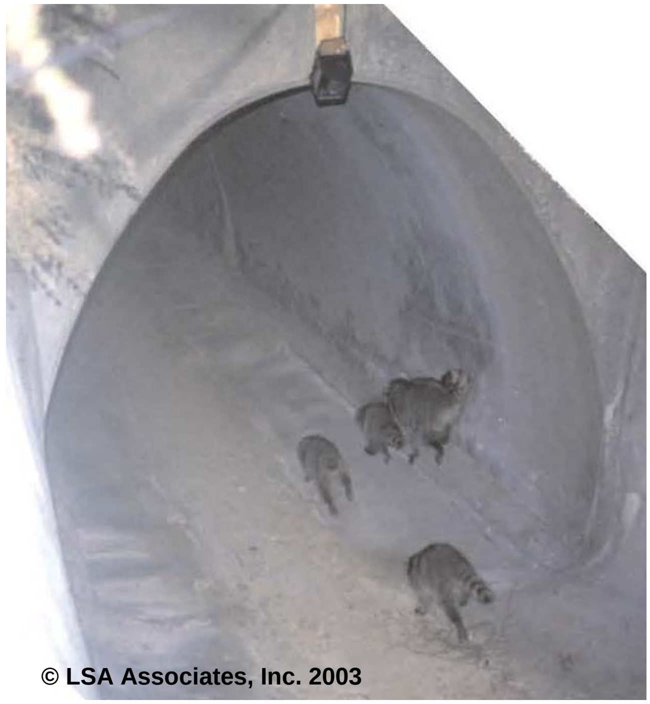


Figure 74. A family of raccoons utilizing the Santa Susana Arch passage under SR-118.

Recommended Crossing Structures on State Route 126: A great majority of the Santa Clara River Valley has been in agriculture since the late 1800's but opportunities remain to restore functional connectivity here. Although most of SR-126 was built at grade, several existing structures facilitate various levels of animal movement across this transportation barrier.

Figure 75. Looking south toward the Santa Susana Mountains under the bridge for Santa Paula Creek on SR-126.

Santa Paula Creek: Santa Paula Creek flows under SR-126 through a bridge structure (Figure 75), measuring roughly 53 m (173.9 ft) wide, 6 m (19.7 ft) high, and 11 m (36.1 ft) in length. The lower stretch of the creek is channelized for flood control for a distance of approximately 1.5 km through the community of Santa Paula. This creek is included in the Linkage Design to support the movement needs of southern steelhead trout, though several other focal species will benefit from restoring this connection. In a recent survey of steelhead trout habitat in the Santa Clara River Watershed, upper Santa Paula Creek and its tributaries (Sisar and Bear creeks) received the highest habitat quality score, but other stream barriers must be addressed to access the 18.5 miles of historic steelhead habitat in this subwatershed (Stoecker and Kelley 2005). We strongly support implementation of all recommendations identified in this report. Please see the section on stream barriers for additional suggestions to improve habitat conditions in riparian zones.

Sespe Creek: A portion of Sespe Creek is designated as a Wild and Scenic River and much of the upper watershed is designated as Wilderness. Multi-chambered concrete bridges span both Sespe Creek and the Sespe Creek Overflow (Figure 76) on SR-126, with each bridge measuring roughly 4.6 m (15 ft) high, 220 m (721.8 ft) wide, and 24 m (78.7 ft) long. In lower Sespe Creek, bank stabilization borders the community of Fillmore and upland habitats have long been converted to agriculture but overall the creek remains wild. Sespe Creek is the most productive of all the steelhead trout streams in southern California. Stoecker and Kelley (2005) identified 123 miles of

Figure 76. Looking down Sespe Creek toward its confluence with the Santa Clara River (left). Looking south toward Santa Susana Mountains through overflow bridge (right).

habitat historically accessible to steelhead trout in this subwatershed. However, to reach this habitat, migration barriers on the mainstem of the Santa Clara River must be addressed. Please see the Impediments to Streams section for recommendations to restore functional connectivity in riparian zones. In addition to supporting steelhead trout, Sespe Creek provides habitat for many other special status species (e.g., red-legged frog, arroyo toad, and western pond turtle) and provides for the movement needs of several riparian and terrestrial focal species.

Hopper Mountain to Oak Ridge: This branch of the linkage was delineated by the landscape permeability analysis for mule deer. It is dominated by coastal sage scrub, with valley oak and coast live oak woodlands lining the canyons and grasslands interspersed. These natural habitats are separated by agricultural crops that line the Santa Clara River. From the foothills north of SR-126 to the Santa Clara River south of the freeway, there is a distance ranging from 0.45 to 2.2 km (0.3 to 1.4 mi) that is occupied by agriculture, and south of the river for another 0.25 to 0.6 km (0.16 to 0.35 mi). There are a number of small drainage culverts in this stretch of the highway, sited every 300 to 500 m (0.19-0.31 mi), with average dimensions of 0.76 m (2.5 ft) high and 0.91 m (3 ft) wide, similar to the one depicted in Figure 77. We recommend maintaining these structures, acquisition or conservation easements of any large parcels, and restoration of natural habitats that have been converted to agriculture.

Figure 77. An example of a drainage culvert on State Route 126.

Piru Creek: The least cost corridors for badger, mountain lion, and mule deer crossed SR-126 using Piru Creek and upland habitats to the east. Piru Creek flows under SR-126 through a multi-chamber concrete bridge (Figure 78), measuring roughly 4.6 m high (15 ft), 126 m (413.4 ft) wide, and 11 m (36.1 ft) long. South of the freeway, the creek and the immediate uplands on the eastern bank are dominated by alluvial fan sage scrub with willow, mule fat, and other riparian plant species in wetter sites, while north of the freeway there is very little vegetative cover until above Piru Creek Road where there is a well-developed riparian forest stretching to the Santa Felicia Dam (see Impediments to Streams section). Piru Creek, although altered and degraded by dams and diversions, still provides habitat for several special status aquatic and semi-aquatic species, including steelhead trout, and should be a focus of riparian restoration efforts. Piru Creek also provides habitat connectivity for mountain lion, badger, brush rabbit, desert woodrat, kingsnake, and western toad.

Figure 78. Looking up Piru Creek toward the Sierra Madre Ranges.

East of Piru Creek, agriculture is the dominant land cover along SR-126 and the Santa Clara River in this branch of the linkage. From the foothills north of SR-126 to the Santa Clara River south of the freeway, there is a distance ranging from 0.45 to 1.4 km (0.27 to 0.83 mi) that is occupied by agriculture, and south of river for another 0.1 to 0.49 km (0.06 to 0.30 mi) before reaching natural habitats. About 1 km (0.62 mi) east of Piru Creek, there is a 2-lane dirt road that passes beneath SR-126 via an arched culvert built for agricultural operations at Camulos Ranch (Figure 79). Small drainage culverts also occur every 300 to 500 m (0.19-0.31 mi) under SR-126, comparable to the one portrayed in Figure 80, where bobcat and raccoon tracks were noted during field surveys. This is the best connection for grassland specialists, such as badger, between the Santa Susana Mountains and the Sierra Madre Ranges. We recommend maintaining these structures, acquisition or conservation easements of any large parcels in this area, and habitat restoration of areas that have been converted to agriculture.

Figure 79. 2-lane arched culvert at Camulos Ranch.

Figure 80. Example of concrete drainage culverts.

Tapo Canyon: The eastern branch of the linkage between Tapo and Potrero Canyons is dominated by fairly contiguous natural habitats, including coastal sage scrub, chaparral, grassland, oak woodlands and riparian forests, with just a patch of agriculture both above and below SR-126 for about a 0.67 km (0.41 mi) stretch along the highway. There is a one-lane dirt road that goes under the highway through an arched culvert for agricultural operations on Newhall Ranch (Figure 81), along with several small drainage culverts (Figure 82). These structures should be maintained and enhanced during the next transportation improvement project. We strongly recommend maintaining the wild character of this branch of the linkage, one of the last remaining areas where natural habitats are still contiguous between the Santa Susana Mountains and the Sierra Madre Ranges. We suggest acquisition of open space or conservation easements, and habitat restoration where necessary to enhance the ecological integrity of the linkage.

Figure 81. 2-lane arched culvert at Newhall Ranch.

Figure 82. Typical example of concrete drainage culverts.

Recommended Crossing Structures on Interstate 5: The San Fernando Pass is dominated by oak woodlands, interspersed with coastal sage scrub and chaparral, providing contiguous habitat for the majority of focal species. The 4-lane bridged underpass for The Old Road (Figure 83), likely facilitates some degree of animal movement due to the proximity of natural habitats on either side of the structure. There is a trailer park to the right of the photo that impedes access to the underpass and connectivity is reduced in this area due to traffic speed and volumes. The bridge measures roughly 20 m (66 ft) high, 23 m (75 ft) wide, and 11 m (36 ft) long. The Weldon Road overpass (Figure 84), lies roughly 1.5 km to the north, with dimensions measuring 13 m (43 ft) wide and 67 m (220 ft) long. This structure appears only to serve a fairly active paintball facility. The connectivity value of this structure could be improved by converting this structure to a vegetated land bridge, with native shrubs and trees tall enough to block lighting and reduce noise from the traffic below. One lane could be reserved for access to the paintball facility. Open space acquisition or protection of conservation easements in this area would also enhance its ecological linkage value.

Figure 83. Interstate 5 bridged underpass for The Old Road.

Figure 84. The bridged overpass for Weldon Road over Interstate 5.

Recommended Crossing Structures on State Route 14: There is a 2-lane bridged underpass for the Sierra Highway (Figure 85) that measures roughly 10 m (33 ft) high, 38 m (125 ft) wide, and 9 m (30 ft) long. Sierra Highway is a quiet road at this point, especially at night, and we expect this structure accommodates some level of wildlife movement. Open space acquisition or protection of conservation easements, and measures to confine light and noise to developed areas in this area would enhance its ecological linkage value.

There is also an excellent bridged underpass for Los Pinetos Canyon that connects contiguous natural habitats on either side of the freeway (Figures 86, 87). This structure measure approximately 7 m (23 ft) high, 42 m (138 ft) wide, and 24 m (79 ft) long. The property in the area of Los Pinetos Canyon is owned by the City of Santa Clarita. To the east of SR-14, there is a partially paved abandoned road up the canyon, slightly visible in Figure 86, though it doesn't pass beneath the bridge. To the west of the freeway and just south of the structure there is an abandoned industrial park, though an animal traveling through the structure would encounter dense oak woodlands and coastal sage habitats, not the industrial park. Open space acquisition or protection of conservation easements in this area would significantly enhance its ecological linkage value. We suggest habitat restoration of vegetation leading up to the structure and placement of some boulders, logs, and other cover through the structure to provide safe passage for smaller species.

Figure 85. The SR-14 bridged underpass for Sierra Highway.

Figure 86. Looking toward the San Gabriel Mountains at the Los Pinetos Bridge on SR-14.

Other Recommendations Regarding Paved Roads within the Linkage Design:

Transportation agencies have the opportunity to use road improvement projects as opportunities to replace culverts with bridges (expansive enough to allow vegetation to grow) and use earthen substrate flooring. In locations where a bridge is not feasible and only a culvert can be provided, connectivity for small species (e.g. small mammals,

Figure 87. Looking west to the San Fernando Pass at the Los Pinetos Bridge on SR-14.

amphibians, and reptiles) may be enhanced by installing smaller culverts (designed to remain free of water) parallel to the main culvert.

- The ecological value of crossing structures can be improved by encouraging the growth or restoring woody vegetation leading up to both sides of crossing structures to provide cover for wildlife and to direct their movement toward the crossing structure. Work with the USFS, CNPS, local RCDs, or other agencies and organizations for guidance on how to restore riparian communities and vegetative cover at passageways.

- Installation of appropriate wildlife fencing along major roads and freeways is critical to guide animals to crossing structures and keep them off road surfaces. Install escape structures, such as earthen ramps or one-way gates, to allow animals to escape if they get trapped within roadway rights-of-way.

- Smaller retaining walls or fine mesh fencing can be used to guide amphibians and reptiles to crossing structures.

- On freeways and other paved roads, minimizing artificial night lighting, and directing the light onto the roadway and away from adjacent wildlands can help increase wildlife use of crossing structures.

- Where wildlife is expected, reduce traffic speeds and install signage to alert drivers to watch for wildlife.

Roads as Ephemeral Barriers: Structures designed for wildlife movement are increasingly common. In southern California, 26 wildlife crossing structures were installed along 22-miles of SR-58 in the Mojave Desert specifically for desert tortoise movement (Evink 2002). In the South Coast Ecoregion, the Coal Canyon interchange on SR-91 is now being converted, through a partnership with Caltrans, California State Parks, and Hills for Everyone, from a vehicle interchange into a wildlife underpass to facilitate movement between the Chino Hills and the Santa Ana Mountains. About eight wildlife underpass bridges and viaducts were installed along SR-241 in Orange County, although urbanization near this toll road has compromised their utility (Evink 2002). Elsewhere, several crossing structures, including three vegetated overpasses, have been built to accommodate movement across the Trans-Canada Highway in Banff National Park (Clevenger et al. 2001). In south Florida, 24 underpasses specifically designed for wildlife were constructed along 64km (38 mi) of Interstate 75 in south Florida. The structures are readily used by endangered Florida panthers and bears, and have reduced panther and bear roadkill to zero on that route (Lotz et al. 1996, Land et al. 2001). Almost all of these structures were retrofitted to existing highways rather than part of the original road design. This demonstrates that barrier or filter effects of existing roads are at least partially reversible with well-designed improvements.

Representatives from Caltrans have attended each of the workshops of the South Coast Missing Linkages effort, and the agency is incorporating wildlife crossing improvements into its projects with a focus in important linkage areas. For example, in February 2003 Caltrans started removing pavement from the Coal Canyon interchange in Orange

County and transferred the property to California State Parks expressly to allow wildlife movement between Cleveland National Forest and Chino Hills State Park.

Implementing these recommendations will take cooperation among land managers, planners, land conservancies and other non-profits, and transportation agencies. We urge them to work together to develop a long-term coordinated plan to ensure that wildlife-crossing structures are aligned in a way that maximizes their utility to animals. We recognize that it is unrealistic to expect the crossing structures to be built at the same time. However, an overall plan will ensure that, for instance, a planned crossing structure adjoins protected lands or land targeted for conservation.

Rail Line Barriers to Movement

Like highways, railroads can also impede plant and animal movement (Messenger 1968, Niemi 1969, Klein 1971, Stapleton and Kiviat 1979, Muehlenbach 1979, Lienenbecker and Raabe 1981, Forman 1995), though there are some differences. Railroads tend to follow straighter lines than roads and scatter deleterious particles widely over the land bordering the rail line (Forman and Boerner 1981, Forman et al. 2003). Mortality rates are likely a great deal lower per train than per vehicle on roads, though trains have been derailed from collisions with large mammals. Grain spilled from trains can attract deer and bears to feed on the rail line; such events have caused significant mortality to grizzly bears in Montana (Federal Register Feb 11 2004. 69: 6683-6685; C. Servheen, University of Montana, personal communication). Freight trains transporting cargo can also disperse non-native seeds, insects, and perhaps small mammals along railroad networks (Thomson 1940, Stapleton and Kiviat 1979, Forman et al. 2003).

Existing Rail Lines in the Linkage Design Area: Currently there are 2 railroads in the vicinity of the Linkage Design. Railroad construction began in 1887 in the Santa Clara River Valley, with a line extending from Saugus to Santa Paula, Ventura, and Santa Barbara, and new agricultural towns of Piru, Fillmore and Sespe sprang up as rail construction progressed. By the 1960's, much of the agricultural products were being transported by truck. In 1979, floods washed out sections of the line between Piru and Saugus and in 1984 the line was abandoned east of Piru. Newhall Land & Farming Company purchased the right of way between Rancho Camulos and Saugus and most of the tracks were removed. The Ventura County Transportation Commission plans to eventually rebuild the railroad through to Santa Clarita for use by MetroLink (Sperry, undated material).

In 1901, Southern Pacific built another line to the south of the original route, extending from Camarillo, through Moorpark and Simi Valley, then through the Santa Susana tunnel (7,369 ft) completed in 1904, to the San Fernando Valley (Sperry undated material). The tracks run parallel to SR-118 and are utilized by Simi Union Pacific Railroad for freight service, and Amtrak and Metrolink for passenger service. In the western branch of the linkage, at Alamos Canyon, the tracks run between the freeway and Los Angeles Avenue forming a band of parallel impediments to animal movement in this stretch of the linkage. Currently, there is bridge for the railroad (Figure 88) that conveys the flow of the unnamed tributary that runs through the Alamos Canyon West double culverts. There is also a concrete box culvert under Los Angeles Avenue that directs this flow to the Arroyo Simi. In the eastern branch, the tracks run south of the freeway at grade for approximately 0.5 km before entering the Santa Susana Pass railroad tunnel for the rest of the linkage.

Figure 88. Railroad bridge across unnamed drainage in Alamos Canyon.

Recommendations to Mitigate the Effects of Rail Lines in the Linkage Design: Although the railroad is probably not a complete barrier, in concert with nearby SR-118 and Los Angeles Avenue, the railroad contributes to reduced connectivity in this area. We recommend a policy of using any railroad realignment as an opportunity not simply to mitigate loss of wildland connectivity, but to improve it. Ameliorating the adverse affects of railroads is similar to that for roads, providing viaducts, bridged underpasses, and tunnels (Reed and Schwarzmeier 1978, Borowske and Heitlinger 1981, Forman 1995). We suggest that crossing structures should be (a) aligned with crossing structures on SR-118 and SR-126, (b) integrated with sound walls to reduce noise, and (c) integrated with fences where beneficial to guide animals toward crossing structures.

Implementing these recommendations will take cooperation among the rail line operators and transportation agencies. We urge them to work together to develop a long-term coordinated plan to ensure that wildlife-crossing structures are aligned in a way that maximizes their utility to animals. A coordinated plan will ensure that, for instance, a planned crossing structure on SR-118 does not abut an impermeable section of the railroad for which no crossing structure is planned.

Impediments to Streams

Organisms moving through rugged landscapes often use riparian areas as travel routes. For example, many butterflies and frogs preferentially move along stream corridors (Orsack 1977, Kay 1989, USGS 2002). Although western pond turtles are capable of overland movements of up to 0.5 km (0.3 mi) (Holland 1991), they preferentially move along stream courses (Bury 1988). Even large, mobile vertebrates, such as mountain lions, have shown preferences for moving along riparian corridors (Beier 1995, Dickson et al. 2004).

For plants and animals associated with streams or riparian areas, impediments are presented by water diversions and extractions, road crossings, exotic species, water recharge basins, farming in streambeds, gravel mining, and concrete structures that stabilize stream banks and streambeds. Increased runoff can also create permanent streams in areas that were formerly ephemeral; permanent waters can support aggressive invasive species, such as bullfrogs and exotic fish that prey on native aquatic species, and giant reed or arundo (*Arundo donax*) that supplants native plant communities (Fisher and Crooks 2001, Riley et al. 2003).

Impediments to Streams in the Linkage Design: The Linkage Design encompasses several connections for species associated with riparian systems. The Santa Clara River is a prominent feature of the Linkage Design, providing connectivity between streams flowing from the Sierra Madre and Santa Susana Mountains. Piru, Tom's, Fairview, Sespe, and Santa Paula Creeks all originate from the Sierra Madre Ranges and empty into the Santa Clara River, while Sheils, Calumat, Frey, Wiley, Tapo, Salt, and Potrero Creeks all emanate from the Santa Susana Mountains and also flow into the Santa Clara River. From the Santa Susana Mountains to the Simi Hills, Alamos Canyon empties into the Arroyo Simi, which also drains the north slope of the Simi Hills. Hummingbird Creek also flows from the Santa Susana Mountains under SR-118 but terminates in Corriganville Park. Liberty, Las Virgenes, and Crummer Creeks all originate in the Simi Hills and flow into the Santa Monica Mountains, eventually emptying into Malibu Creek bound for the ocean. In times of high surface flows, these tributaries may provide avenues along which aquatic and semi aquatic species journey between the Santa Monica Mountains, Simi Hills, Santa Susan Mountains and the Sierra Madre Ranges. Today, riparian habitats are significantly reduced and or degraded in some places due to a combination of factors, including flood control, water diversions, ground and surface water extraction, water quality contamination, and exotic species invasions.

Several dams and diversions occur in the linkage planning area. The Vern Freeman Dam on the Santa Clara River near Saticoy was built in 1928 (Figure 89). It is a 6 m (20 ft) high concrete sill. A fish ladder was built in 1991 but is not functioning properly and needs to be addressed (Stoecker and Kelley 2005). On Santa Paula Creek, the lower reaches have been channelized for flood control by the Army Corps of Engineers (Figure 90). The Harvey Dam on Santa Paula Creek (Figure 91) occurs about 6.4 km (3.98 mi) upstream of the confluence with the Santa Clara River. Built in 1923, the Harvey Dam is 7 m (23 ft) high. The dam failed (Figure 92) in the winter floods of 2005 (Stoecker and Kelley 2005). The Santa Felicia Dam on Piru Creek was built in 1955; it is 64.92 m (213 ft) high (Figure 93). The Rindge Dam on Malibu Creek (Figure 94) was built in 1924, 4.18 km (2.6 mi) upstream of the estuary. A feasibility study is currently underway to remove Rindge Dam. Several other streams barriers occur in the planning area, including several Arizona crossings (low-water crossings) and ineffective road crossings. Comprehensive data have recently been collected on impediments to southern steelhead trout in the Santa Clara River Watershed (Stoecker and Kelley 2005) and in the Santa Monica Mountains (Caltrout 2006) to aid in recovery efforts of this critically endangered species. For more detailed information on stream barriers and recommended actions to improve riparian connectivity please refer to these studies. Due to limited groundwater and surface water supplies, diversions and extractions are a concern for the long-term viability of riparian and aquatic habitats in the Linkage Design.

In addition to loss of surface and groundwater, water quality is also a concern. The Linkage Design encompasses portions of 4 different watersheds (Santa Clara River, Calleguas Creek, Malibu Creek, and Los Angeles River) and each has several drainages that are listed as impaired under Section 303(d) of the Clean Water Act (http://www.waterboards.ca.gov/losangeles/html/programs/regional_programs.html#Watershed). Water quality in the Santa Clara River Watershed is impaired due to agricultural practices that notably increase salts and nitrogen in streams. Other impairments include ammonia, coliform, chloride, DDT, eutrophication, trash, DO, pH problems, and crude oil spills. The Calleguas Creek Watershed is extremely impaired. DDT, PCBs, other pesticides, and some metals have been detected in both sediment and biota collected from this watershed. Agricultural activities appear to be the main source of many of these pollutants, although the naval facility, residential and urban activities have also contributed. The Mugu Lagoon and the Calleguas Creek Estuary are both considered toxic hot spots. In the Malibu Creek Watershed, water quality is impaired by excess nutrients, coliform, trash, and metals. Nonpoint source pollution from human activities is strongly implicated including ill-placed or malfunctioning septic systems, runoff from horse corrals, and urban runoff. The portion of the Los Angeles River Watershed in the Linkage Design is in the undeveloped headwaters, while the middle and lower watershed are highly developed and impaired (LARWQCB 2004). These impaired riparian stretches are eligible for the development of intensive management plans called Total Maximum Daily Load (TMDL) plans. TMDL plans are enacted by the Los Angeles Regional Water Quality Control Board to determine the cause of water quality deterioration and then an implementation plan is developed to return water quality to targeted values.

Invasive species also need to be addressed in the Linkage Design. Although most riparian areas in the Linkage Design are dominated by cottonwood, sycamore and various willows (*Salix* spp.), or coast live oak (*Quercus* agrifolia), aggressive invasive species have invaded several of these systems. For instance, Arundo, an introduced plant species that escaped cultivation, has invaded stream courses in the arid southwest, out-competing native plant species and forming monocultures that provide little habitat value to wildlife. Several exotic species have invaded or been introduced to streams and rivers in the linkage, including bullhead catfish, green sunfish, African clawed frog, bullfrog, crayfish, and others. These predatory species can decimate native amphibian, reptile, and fish populations and eradication or control through ongoing management actions is crucial to the survival of many aquatic and semi aquatic species.

Figure 89. Vern Freeman Dam on the mainstem of the Santa Clara River.

Figure 90. Channelization of lower Santa Paula Creek for flood control.

Figure 91. Harvey Dam on Santa Paula Creek before 2005 floods.

Figure 92. Harvey Dam on Santa Paula Creek failed during the 2005 floods.

Figure 93. Santa Felicia Dam on lower Piru Creek.

Figure 94. Rindge Dam on Malibu Creek, currently being evaluated for removal.

Examples of Mitigation for Stream Barriers: Few restoration projects have focused on restoring the natural dynamics of riparian systems (Bell 1997), where annual floods are a major component of ecosystem function. Many riparian plants are pioneer species that establish quickly following soil disturbance by floods (Ohmart 1994), as long as threats like invasive species are controlled and physical processes restored (e.g., by removing dams and diversions or by mimicking natural flow regimes).

Continuity between upland and riparian vegetation is also important to maintaining healthy riparian communities. Many species commonly found in riparian areas depend on upland habitats during some portion of their lifecycle. Examples include butterflies that use larval host plants in upland habitat and drink water as adults and toads that summer in upland burrows. While the width of upland habitats needed beyond the stream's edge is unknown for many species, information on the western pond turtle suggests that a 1-km (0.6-mi) upland buffer (i.e., 0.5 km to either side of the stream) (Holland 1994) is needed to sustain populations of this species.

Measures to minimize development impacts on aquatic habitats often focus on establishing riparian buffer zones (Barton et al. 1985, Allan 1995, Wilson and Dorcas 2003). However, although these buffers are intended to prevent erosion and filter runoff of contaminants (U.S. Environmental Protection Agency), research suggests that current regulations are inadequate to protect populations of semiaquatic reptiles and amphibians (Wilson and Dorcas 2003). Buffers must contain enough upland habitat to maintain water-quality and habitat characteristics essential to the survival of many aquatic and semiaquatic organisms (Brosofske et al.1997, Wilson and Dorcas 2003). However, maintaining riparian buffers will not suffice for some species. For example, to preserve salamander populations in headwater streams, land use must be considered at the watershed level (Wilson and Dorcas 2003).

Recommendations to Mitigate the Effects of Streams Barriers in the Linkage Design: Several projects are already underway in the Linkage Design and core habitat areas to restore riparian connections. The goal of recovering steelhead trout populations has prompted discussions of removing obsolete dams, such as the Rindge Dam on Malibu Creek. Surveys have been conducted of impediments to southern steelhead trout and recommended actions identified in the Santa Clara River Watershed (Stoecker and Kelley 2005) and in the Santa Monica Mountains (Caltrout 2006). National Park Service, RCD of the Santa Monica Mountains, City of Malibu, and Caltrans have been working to restore connectivity for steelhead in Solstice Creek, removing check dams, replacing Arizona crossings with bridges, and modifying the two lowest culverts to optimize fish passage. Several other riparian restoration efforts have been carried out or are currently underway, including a highly successful project by the Mountains Restoration Trust to remove Arundo from Malibu Creek, and an Arundo removal project by the Ventura RCD in the Santa Clara River Watershed. The RCD in the Santa Monica Mountains has been leading an all volunteer effort to eradicate crayfish, invasive exotic predators from reaches of Topanga Creek. To enhance species use of riparian habitat and restore riparian connections through the Linkage Design area, we recommend:

- Wherever possible restore the natural historic flow regime or create a regime that provides maximum benefit for native biodiversity. Work with the NPS, USFS, NMFS, CDFG, BLM, departments of public works, water districts, watershed groups, and others to investigate the historic flow regimes and develop a surface and groundwater management program to restore and recover properly functioning aquatic and riparian conditions.

- Minimize the effects of road crossings in riparian zones. Coordinate with Caltrans, NPS, USFS, BLM, and CDFG, to further evaluate existing stream crossings and upgrade culverts, Arizona crossings (low-water crossings), bridges, and roads that impede wildlife movement. Use several strategies, including information on preferred crossings, designing new culverts, retrofitting or replacing culverts, general recommendations, post construction evaluation, maintenance, and long-term assessment (Carey and Wagner 1996, NFMS 2000, Evink 2002).

- Restore riparian vegetation in all drainages and upland vegetation within 1 km (0.6 mi) of streams and rivers. This may encourage plant and animal movement and increase water quality. Non-point sources of pollution should be identified and minimized.

- Discourage the construction of concrete-banked streams and other channelization projects.

- Remove exotic plants (e.g., Arundo) and animals (e.g., bullfrogs, African clawed frogs, crayfish) from washes, streams and rivers. Work with the Biological Resources Division at USGS, USFS, NPS, BLM, CDFG, RCDs, and other relevant agencies and organizations to survey streams and drainages for invasive species and develop a comprehensive removal strategy.

- Enforce existing regulations protecting streams and stream vegetation from illegal diversion, alteration, manure dumping, and vegetation removal. Agencies and laws with applicable jurisdiction include CDFG (Streambed Alteration Agreements), Army Corps of Engineers (Clean Water Act), and the Native Plant Protection Act.

- Prevent off-road vehicles from driving in riparian areas and washes and enforce closures, or, where necessary, re-route trails away from these sensitive areas. Review existing regulations relative to linkage goals and develop additional restrictions or recommend closures in sensitive areas.

- Aggressively enforce regulations restricting farming, gravel mining, suction dredging, and building in streams and floodplains.

- Increase and maintain high water quality standards. Work with the RCDs to help establish use of Best Management Practices for agricultural and rural communities in the Linkage Design and surrounding communities.

- Develop incentives and educational programs to encourage organic farming practices in the Santa Clara River Valley and the Tierra Rejada Valley to improve water quality.

- Support efficient water use and education programs that promote water conservation.

- Discourage development in flood prone areas.

- Support the protection of riparian and adjacent upland habitats on private lands. Pursue cooperative programs with landowners to improve conditions in riparian and upland habitats on private land in the Linkage Design.

- Distribute the brochure on Best Management Practices for Horse Owners, produced by the Santa Monica Mountains RCD, to all equestrian communities in the Linkage Design to improve water quality.

Other Land Uses that Impede Utility of the Linkage

Land management policies in the protected areas and the linkage can have substantial impact on habitat and movements of species through the Linkage Design area. It is essential that major land-management and planning entities (e.g., USFS, NPS, CSP, Los Angeles County, Ventura County, Cities, TNC, and SMMC) integrate the linkage plan into their policies and regulations.

Urban Barriers to Movement

Urban development, unlike roads or aqueducts, creates barriers that cannot be corrected by building crossing structures. Urban and suburban areas make particularly inappropriate landscapes for movements of most plants and animals (Marzluff and Ewing 2001). In addition to direct habitat removal, urban development creates edge effects that reach well beyond the development footprint. Most terrestrial mammals that move at night will avoid areas with artificial night lighting (Rich and Longcore 2006). Pet cats can significantly depress populations of small vertebrates near housing (Churcher and Lawton 1987, Crooks 1999, Hall et al. 2000). Irrigation of landscapes surrounding homes encourages the spread of Argentine ant populations into natural areas, where they cause a halo of local extinctions of native ant populations extending 200 m (656 ft) into native vegetation (Suarez et al. 1998, Bolger et al. 2000). Similar affects have been documented for amphibians (Demaynadier and Hunter 1998). Habitat disturbance caused by intense human activity (e.g., off-road vehicle use, dumping, camping and gathering sites) also tends to rise in areas surrounding urban developments (Buechner and Sauvajot 1996). Areas disturbed by human use show decreases in bird and small mammal populations (Sauvajot et al. 1998).

Urban Barriers in the Linkage Design Area: Urban developments comprise 2% of the Linkage Design area but several cities and communities occur just outside the boundary of the linkage, including Camarillo, Thousand Oaks, Westlake Village, Agoura Hills, Calabasas, and Hidden Hills along the 101 Freeway; Moorpark, Simi Valley, and Chatsworth along SR-118; mostly rural and large lot developments in the Tierra Rejada Valley along SR-23; Santa Paula and Fillmore along Highway 126; and Newhall and Sylmar bordering the I-5/SR-14 area. Most of these areas are largely impermeable to wildlife movement due to high-density development, high traffic volume, large numbers of pets, and light and noise pollution (e.g., some rural developments in the Tierra Rejada Valley may be an exception). The population in Ventura County is anticipated to grow by 31 percent by 2020 and Los Angeles is projected to increase by 25 percent (SCAG 1998). This projected growth should be appropriately distributed to accommodate wildlife movement through the Linkage Design if we hope to conserve biodiversity across the region.

There are several proposed developments in the vicinity of the linkage that are at various stages in the environmental review process. For example, in the vicinity of Alamos Canyon, The Canyons 2,880-acre residential development is proposed north of SR-118 and a business/industrial complex is proposed south of SR-118 (Psomas 2001, 2002, LSA 2004). The Simi Valley Landfill is just east of Alamos Canyon and is expected to expand (LSA 2004). The proposed development for Greenpark Village Runkle Canyon Specific Plan encompasses 1,600 acres with 1,150 acres of dedicated open space (Runkle Canyon Neighbors 2003, LSA 2004). Overall, these and other development projects have the potential to significantly impact the ecological integrity of the linkage unless they are properly designed to maintain habitat values and ecosystem functions in the linkage.

While topography, habitat, water supplies and other natural constraints limit opportunities for significant population growth in this region, the coastal area is a highly desirable place to live and there is no doubt that large-scale development projects will continue to be proposed. Fortunately, both Los Angeles and Ventura Counties have policies in place that limit development in sensitive habitat areas. The guiding principle of the Conservation and Open Space Element for the Santa Monica Mountains North Area Plan for managing the natural environment is “resource protection has priority over development”. Critical to the maintenance of these resources are the habitat linkages present in the region (County of Los Angeles 2000). Virtually all habitat within the linkage and targeted protected areas in Los Angeles County are proposed as Significant Ecological Areas (i.e., Santa Monica Mountains SEA, Santa Susana Mountains/Simi Hills SEA, and Santa Clara River SEA) in the general plan update (PCR 2000 a,b,c). In Ventura County, the Save Open Space and Agricultural Resources (SOAR) ordinance restricts the conversion of open space and agricultural land to urban uses outside of the City Urban Restriction Boundary (CURB). Any developments proposed outside of the CURB must be approved by voters, giving residents an opportunity to influence future landscape patterns. Since increased urbanization of currently undeveloped areas in the linkage could impact wildland connectivity, we recommend that any development that is proposed in the Linkage Design be limited and very carefully evaluated and/or planned to maintain landscape connectivity.

Examples of Mitigation for Urban Barriers: Urban developments, unlike roads, create movement barriers that cannot be readily removed, restored, or mitigated. Mitigating impacts from potential urban developments in key areas through acquisition or conservation easements is therefore generally the most effective option. Mitigation for existing urban developments focuses on designing and managing buffers to reduce penetration of undesirable effects into natural areas (Marzluff and Ewing 2001). Management in buffers can include fencing in pets, reducing human traffic in sensitive areas or constriction points, limiting noise and lighting, reducing traffic speeds, minimizing use of irrigation, encouraging the planting of locally native vegetation, minimizing the use of pesticides, poisons and other harmful chemicals, and increasing enforcement of existing regulations.

Recommendations for Mitigating the Effects of Urban Barriers in the Linkage Design Area: We suggest the following actions as possible ways to reduce impacts of urban, suburban, and rural developments in the Linkage Design area.

- Encourage open space acquisition or protection of conservation easements with willing land owners in the Linkage Design.

- Encourage homes abutting the linkage area to have minimal outdoor lighting, directed toward the home and yard rather than into the linkage. Homeowners should use fences to keep dogs and domestic livestock from roaming into the linkage area. Residents should be encouraged to keep cats indoors at all times.

- Develop a public education campaign, such as the On the Edge program developed by the Mountain Lion Foundation (www.mountainlion.org) and other organizations, which encourages residents at the urban wildland interface to become active stewards of the land by reducing penetration of undesirable effects into natural areas. Topics addressed may include: living with wildlife, predator-safe enclosures for livestock and pets, landscaping, water conservation, noise and light pollution.

- Provide educational programs for landowners to increase their appreciation of natural communities, and to convey the importance of habitat protection and the need for connecting wild areas.

- Distribute the brochure on Best Management Practices for Horse Owners, produced by the Santa Monica Mountains RCD, to all equestrian communities in the Linkage Design.

- Work with Los Angeles and Ventura Counties and all cities to discourage major new residential or urban developments in key areas of the Linkage Design. Where development does occur:

    - Encourage clustering in any proposed development and other smart growth policies to maximize the amount of preserved open space and maintain contiguous blocks of habitat. Include buffers or other measures adequate to maintain linkage function.

    - Encourage preservation of sensitive natural communities (Holland 1986, County of Los Angeles 2000, CDFG 2005), such as riparian forests and woodlands, oak woodland and savanna, walnut woodland, and grassland within proposed development sites.

    - Promote the use of drought tolerant native plants in landscaping in areas adjacent to the linkage and prohibit the use of invasive, non-native plants that can supplant native plants and reduce habitat integrity in the linkage.

Recreation

Recreational use is not inherently incompatible with wildlife movement, although, intense recreational activities have been shown to cause significant impacts to wildlife and plants (Knight and Cole 1995). Areas with high levels of off-road vehicle use are more readily invaded by invasive plant species (Davidson and Fox 1974), accelerate erosion and reduce soil infiltration (Iverson 1980), and alter habitat use by vertebrates (Brattstrom and Bondello 1983, Nicolai and Lovich 2000). Even such relatively low-impact activities as wildlife viewing, hiking, and horse back riding have been shown to displace wildlife from nutritionally important feeding areas and prime nesting sites (Anderson 1995, Knight and Cole 1995). The increased time and energy spent avoiding humans can decrease reproductive success and make species more susceptible to disease (Knight and Cole 1995). In addition, humans, horses, and pets can carry seeds of invasive species into natural areas (Benninger 1989, Benninger-Traux et al. 1992).

Recreation in the Linkage Design Area: There are several areas currently designated for recreation purposes in the Linkage Design, including Palo Comado, Cheeseboro, and Las Virgenes Canyons, Upper Las Virgenes Open Space Preserve, Wildwood Park, Tierra Rejada Park, Mt. McCoy Recreational Area, Rocky Peak Park, Corriganville Park, Santa Susana Historic State Park, Happy Camp Canyon Park, Towsley Canyon, and other dedicated parks and open space. The targeted core areas of the Santa Monica Mountains National Recreation Area and Los Padres National Forest provide a wide range of recreational opportunities, from nature-based dispersed recreational activities (e.g., hiking, bird watching) to high-density recreation in developed sites. The majority of recreational use is concentrated in areas with road access and is associated with developed facilities.

Examples of Mitigation for Recreation: If recreational activities are effectively planned, developed, managed, and monitored, most negative impacts can be avoided or minimized by limiting types of use, directing recreational activities away from particular locations, sometimes only for particular seasons, and with reasonable precautions.

Recommendations to Mitigate the Effects of Recreation in the Linkage Design Area: We provide the following initial recommendations that may help prevent or mitigate negative effects of recreation in the Linkage Design area:

- Monitor trail development and recreational use to provide a baseline and ongoing information for decisions regarding levels, types, and timing of recreational use.

- Consider recommendations from LSA (2004) to reposition some campsites and install fencing at Oak Park Campground to better facilitate wildlife movement under SR-118

- Work with regional monitoring programs, such as the California Resource Assessment Program, to collect information on special status species, species movements, and vegetation disturbance in areas of high recreational activity.

- Enforce existing regulations on recreational use.

- Work with the agencies and non-governmental organizations to develop and conduct on-the-ground, multi-lingual outreach programs to recreational users on how to lessen impacts in sensitive riparian areas.

- Prohibit off-road vehicles within the Linkage Design and limit off-trail activities to those that are consistent with maintaining functional habitat connectivity.

- Close, obliterate, and restore to natural habitat any unauthorized off-road vehicle routes and enforce closures.

- Enforce leash laws so that dogs are under restraint at all times.

- Work with park agencies and open space districts to develop recreational use plans that are consistent with Linkage Design objectives.

Land Protection & Stewardship Opportunities

A variety of land planning and resource conservation efforts are currently underway in the Linkage Design area. The South Coast Missing Linkages Project supports these efforts by providing information on linkages critical to achieving their conservation goals at a landscape scale. This section provides brief summaries of selected planning efforts, agencies, and organizations that may represent opportunities for collaborative conservation of Linkage Design objectives within the Santa Monica-Sierra Madre Connection. This list is not exhaustive, but provides a starting point for persons interested in becoming involved in preserving and restoring linkage function.

Arundo Task Force*:* The Ventura County and Los Angeles County task forces coordinate Arundo removal and control efforts. The Ventura RCD is spearheading the Santa Clara River Watershed Arundo Donax and Tamarisk Eradication Program funded through Proposition 13. This long-term project will map infested areas, monitor removal efforts, and conduct outreach to help restore watershed integrity, improve facultative filtration, remove large trash components in stream runoff, and improve groundwater recharge. For more information on the project go to: http://www.swrcb.ca.gov/rwqcb4/html/programs/nps/prop13_contract.html.

Bureau of Reclamation*:* Reclamation's Southern California Area Office (SCAO) is responsible for water conservation, reclamation and reuse projects to enhance water management practices throughout southern California. Reclamation is undertaking a collaborative effort with local entities to develop an effective water quality monitoring plan in the Santa Clara River Watershed that will identify impaired water bodies (pursuant to section 303(d) of the Clean Water Act), support the development of water quality recovery plans (Total Maximum Daily Load plans), and estimate the assimilative capacity for nutrients in the Santa Clara River Watershed. For more details, visit http://www.usbr.gov/lc/region/scao/sccwrrs2.htm.

California Coastal Coalition (CalCoast): is a non-profit advocacy group comprised of 35 coastal cities; five counties; AMBAG, BEACON, SANDAG and SCAG; along with business associations and allied groups committed to restoring California's coast through sand replenishment, increasing the flow of natural sediment, wetlands recovery and improved water quality. CalCoast was the co-sponsor, with the CA Shore and Beach Preservation Association, of the CA Public Beach Restoration Act (AB 64-Ducheny) which was signed into law in October of 1999. Visit http://www.calcoast.org to learn more about CalCoast.

California Department of Fish and Game: CDFG manages California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. Acquisition dollars for CDFG projects are authorized through the Wildlife Conservation Board as part of their

Concept Area Protection Plan (CAPP) process. For more information on the Department, visit their website at http://www.dfg.ca.gov.

California Department of Transportation: Caltrans strives to achieve the best safety record in the nation, reduce traveler delays due to roadwork and incidents, deliver record levels of transportation system improvements, make transit a more practical travel option, and improve the efficiency of the transportation system. Caltrans representatives have attended each of the South Coast Missing Linkages workshops and have shown leadership and a willingness to improve linkage function in the most important linkage areas. In February 2003, Caltrans started removing pavement from the Coal Canyon interchange on SR 91 in Orange County and transferred the property to California State Parks expressly to allow wildlife movement between the Santa Ana Mountains of the Cleveland National Forest and Chino Hills State Park. Caltrans is working to incorporate ecological infrastructure into a number of transportation improvement projects in the Linkage Design, including those planned for the 118, 101, and the 23 freeways. To find out more about the innovative plans being developed by Caltrans, visit their website at http://www.dot.ca.gov.

California Native Plant Society: The California Native Plant Society (CNPS) is a statewide non-profit organization of amateurs and professionals with a common interest in California's native plants. The Society seeks to increase understanding of California's native flora and to preserve this rich resource for future generations. Their members have diverse interests including natural history, botany, ecology, conservation, photography, drawing, hiking, and gardening. To learn more about native plants, go to www.lacnps.org .

California State Parks: California State Parks provides for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation. The Department is actively engaged in the preservation of the State's rich biological diversity through their acquisition and restoration programs. Ensuring connections between State Park System wildlands and other protected areas is one of their highest priorities. CSP is involved in the Coal Canyon habitat connection restoration project to preserve mountain lion movement under SR 91 at the north end of the Santa Ana Mountains. CSP administers critical lands in the linkage planning area, including Point Mugu State Park, Malibu Creek State Park, and Topanga State Park in the Santa Monica Mountains, and the Santa Susana State Historic Park. CSP co-sponsored the statewide Missing Linkages conference and is a key partner in the South Coast Missing Linkages effort. For more information, visit their website at http://www.parks.ca.gov.

California State Parks Foundation: The Foundation is the only statewide organization dedicated to preserving, advocating and protecting the legacy of California's State Parks. The Foundation supports environmental education, wildlife and habitat preservation, volunteerism, and sound park policy. Since its inception, the Foundation has provided over $110 million for projects and educational programs while building a statewide network of park supporters. These initiatives have helped the parks acquire more land, create more trails, restore wildlife habitat, build visitor centers, construct interpretive displays, and support family camping for underserved youth. CSPF is a partner in the

South Coast Missing Linkages. For more on their exciting programs, visit www.calparks.org.

California Wilderness Coalition: The California Wilderness Coalition builds support for threatened wild places on a statewide level by coordinating efforts with community leaders, businesspeople, decision-makers, local organizations, policy-makers, and activists. CWC was also a co-sponsor of the statewide Missing Linkages effort. For more information, visit them at http://www.calwild.org.

California Wild Heritage Campaign: The mission of the California Wild Heritage Campaign is to ensure the permanent protection of California's remaining wild public lands and rivers. Congresswoman Hilda Solis has introduced the Southern California Wild Heritage Act. The bill would significantly expand the National Wild and Scenic Rivers System and the National Wilderness Preservation System on federally managed public lands in Southern and Central California. A total of 13 new Wild and Scenic Rivers are included in the bill, totaling more than 312 miles, and 47 new Wilderness Areas and Wilderness Additions totaling 1,686,393 acres. The Campaign builds support for Wilderness and Wild and Scenic River protection by compiling a detailed citizen's inventory of California's remaining wild places; organizing local communities in support of those places; building a diverse, broad-based coalition; and educating the general public, government officials and the media about the importance of protecting California's wild heritage. For more information on the status of the Act, visit http://www.californiawild.org.

California Coastal Conservancy: The California Coastal Conservancy, established in 1976, is a state agency that uses entrepreneurial techniques to purchase, protect, restore, and enhance coastal resources, and to provide access to the shore. The Conservancy works in partnership with local governments, other public agencies, nonprofit organizations, and private landowners. To date, the Conservancy has undertaken more than 950 projects along the 1,100 mile California coastline and around San Francisco Bay. The Conservancy protects and improves coastal wetlands, streams, and watersheds; purchases and holds environmentally valuable coastal and bay lands; protects agricultural lands and supports coastal agriculture; and accepts donations and dedications of land and easements for public access, wildlife habitat, agriculture, and open space. Locally, the Conservancy has been very active in the Santa Clara River Watershed. For more information, visit http://www.coastalconservancy.ca.gov

California Trout, Inc. (CalTrout): CalTrout’s mission is to protect and restore wild trout and steelhead and their waters throughout California. Improving fishing opportunities was and remains important, but it is a secondary goal. CalTrout was the nation's first statewide conservation group supported by trout fishermen with an altruistic goal: to protect and restore trout and the beautiful places where they live. CalTrout is very active in the restoration of southern steelhead trout runs in the planning area. To learn more about their activities, go to http://www.caltrout.org.

Cities of Simi Valley, Moorpark, Thousand Oaks, Calabasas, Agoura Hills, Fillmore, and Santa Paula: These cities have jurisdiction in the vicinity of the linkage, and many are already engaged in protecting open space and maintaining wildlife movement corridors. Land planning, land use, and open space policies in each city’s General Plan can substantially influence implementation of the Linkage Design.

Cold Creek Docents: Since 1977, the Cold Creek Docents have been leading nature walks in the Cold Creek area of the Santa Monica Mountains. The Cold Creek Docents are dedicated: to educating the public, particularly school children, about the nature and cultural history of the Cold Creek watershed and its relationship to the Santa Monica Mountains and to worldwide ecological principles; to conducting hands-on programs that include geology, Chumash studies, ethnobotany, and chaparral ecology on Cold Creek area trails and at the Katherine Spensley Nature Education Center at UCLA Stunt Ranch Reserve; and to promoting appreciation, conservation, and stewardship of the Cold Creek watershed. For more information on their events or to become a docent, visit http://www.mountainstrust.org/docent.html.

Conejo Open Space Conservation Agency (COSCA): As the name implies, COSCA has been entrusted with the responsibility of preserving, protecting and managing open space resources in the Conejo Valley. COSCA was created in 1977 by a joint powers agreement between the City of Thousand Oaks (www.toaks.org) and the Conejo Recreation and Park District (www.crpd.org), enabling the two agencies to "jointly exercise their legal powers to create a jurisdictional framework for the conservation of natural open space lands, assure coordination of local land use and resource management decisions and establish an entity to focus community resources toward achievement of adopted General Plan goals." In this context, "open space" is defined as land which is in essentially a natural, undeveloped state, and does not include golf courses, developed park sites or landscaped greenbelts. For more information, visit http://www.conejo-openspace.org.

Conejo Open Space Foundation: The Foundation was formed in 1995 to promote and maintain the open space and trail system of the Conejo Valley and to educate residents as to their roles as custodians and protectors of the open space and the environment. To learn more, go to http://www.cosf.org.

County of Los Angeles: Los Angeles County is currently engaged in a 2025 General Plan update, which will likely include proposed revisions and expansions to existing Significant Ecological Areas (SEA). Three SEAs occur in the planning area: The Santa Monica Mountains SEA, which encompasses 99,431 acres and the Santa Susana Mountains/Simi Hills SEA, which covers 26,795 acres, and the Santa Clara River SEA (PCR 2000a,b,c); all three of these SEAs include several important wildlife movement areas. The General Plan update also provides an opportunity to ensure zoning in the Linkage Design is conducive to conserving linkage function. For more information on the General Plan update go to http://www.planning.co.la.ca.us.

County of Ventura: Ventura County uses growth management strategies, such as Save Open Space and Agricultural Resources (SOAR) to preserve farmland, open space and rural areas and limits growth to the City Urban Restriction Boundary (CURB) – SOAR requires countywide voter approval for any change to the County General Plan regarding agricultural, open space or rural land use designations. The County has several departments focused on the conservation of natural resources. Please visit http://www.countyofventura.org for more information.

Eastern Ventura County Conservation Authority: The Santa Monica Mountains Conservancy and the County of Ventura formed this joint powers authority (JPA) in 1990 to facilitate the opening and operation of Happy Camp Canyon Regional Park. Happy

Camp is a 3,000-acre wilderness area in the Rim of the Valley Trail Corridor between Moorpark and Simi Valley in the Santa Susana Mountains. Under an agreement with EVCCA, the Mountain Recreation Conservation Authority provides ranger services and volunteer trail assistance for the park. For more information on this JPA, go to http://smmc.ca.gov/EVCCA.html.

Environment Now: Environment Now is an active leader in creating measurably effective environmental programs to protect and restore California's environment. Since its inception, the organization has focused on the preservation of California's coasts and forests, and reduction of air pollution and urban sprawl. Environment Now uses an intelligent combination of enforcement of existing laws, and application of technology and process improvements to eliminate unsustainable practices. To find out more about their programs, visit their website at http://www.environmentnow.org

Farm Security & Rural Investment Act of 2002 (Farm Bill): This legislation responds to and provides funding for a broad range of emerging natural resource challenges faced by farmers and ranchers, including soil erosion, wetlands, wildlife habitat and farmland protection. Several programs have been developed through the Farm Bill including the Corridor Conservation Program, Farmland Protection Program, Wetlands Reserve Program, and Wildlife Habitat Incentives Program. To learn more about the Farm Bill, go to www.ers.usda.gov/features/farmbill/2002farmact.pdf

Friends of the Santa Clara River: The Friends have been actively engaged in watershed activities along the length of the river with a focus on the protection, enhancement, and management of the river's resources. The Friends are involved in several efforts including planning activities, habitat management, habitat restoration, and public education and outreach regarding the resource values of the river. The Friends own and manage a 230-acre river terrace property near the city of Santa Paula with over a mile of river frontage called the Hedrick Ranch Natural Area. Visit their website for more information at http://www.FSCR.org.

Los Angeles County Aquatic Resource In-Lieu Fee Mitigation Program: The purpose of this program is to provide a voluntary alternative compensatory mitigation option that results in better designed and managed aquatic resource restoration projects. Program funds may be used for activities directly related to aquatic habitat creation, restoration, or enhancement, to include exclusively the following activities: land acquisition; purchase of easements, purchase of water rights; development of mitigation and monitoring plans; permit fees; implementation of mitigation and monitoring plans; administrative costs; and long-term management of mitigation parcels. To find out more about this program, go to http://www.spl.usace.army.mil/regulatory/pn/200200035.pdf.

Malibu Creek Watershed Advisory Council: The Advisory Council is made up of a long list of representatives working to protect and preserve the health of the Malibu Creek Watershed and its adjoining watersheds. These representatives helped create the *1995 Natural Resources Plan*, which serves as a planning guide for overall watershed health. This Natural Resources Plan outlined 44 Action Items, later distilled to the Top Ten Watershed Restoration Priorities in the 2001 *Making Progress: Restoration of the Malibu Creek Watershed* report. Led by the RCD of the Santa Monica Mountains, the

Council meets every other month to discuss watershed-related issues pursuant to these priorities. Visit www.malibuwatershed.org to find out more.

Mountain Lion Foundation: The Mountain Lion Foundation works to ensure naturally sustaining populations of mountain lions. Using research, education, advocacy, legislation, and litigation, MLF works across the American West to stop unnecessary killing of mountain lions and to protect the ecosystems upon which they depend. MLF partners with groups whose mission directly impacts mountain lions and is proud to be a founding board member of South Coast Wildlands. MLF's Southern California office focuses on "Living with Lions" to reduce conflicts between people, pets and lions. MLF helps livestock owners build predator-safe enclosures, helps those suburban residents "On the Edge" understand how their personal choices may affect wildlife for miles around, as well as helps those working and playing "In the Wild" feel safer. For more information on the MLF's programs, visit their website at http://www.mountainlion.org.

Mountain Recreation and Conservation Authority (MRCA): The MRCA is a local partnership between the Santa Monica Mountains Conservancy, Conejo Recreation and Park District and the Rancho Simi Recreation and Park District. The MRCA is dedicated to the preservation and management of local open space and parkland, watershed lands, trails, and wildlife habitat. The MRCA manages and provides ranger services for almost 50,000 acres of public lands and parks that it owns and that are owned by the Santa Monica Mountains Conservancy or other agencies and provides comprehensive education and interpretation programs for the public. The MRCA works in cooperation with the Conservancy and other local government partners to acquire parkland, participate in vital planning processes, and complete major park improvement projects. The MRCA provides natural resources and scientific expertise, critical regional planning services, park construction services, park operations, fire prevention, ranger services, and educational and leadership programs for thousands of youth each year. To find out more, go to http://www.mrca.ca.gov/.

Mountains Restoration Trust (MRT): MRT is committed to preserving, protecting and enhancing the natural resources of the Santa Monica Mountains. MRT accomplishes this by working in several areas: land acquisition, cooperative planning, restoration, and offering education, and recreation programs. For nearly 20 years, MRT has offered a responsible approach to preservation and restoration based upon cooperative planning. MRT works with communities, land owners, and numerous governmental agencies to attain positive results in achieving preservation goals and public access. Visit http://www.mountainstrust.org to find out more.

National Parks Conservation Association: Their mission is to protect and enhance America's National Park System for present and future generations. NPCA plays a crucial role in ensuring that these special places are protected in perpetuity by advocating for the national parks and the National Park Service, educating decision-makers and the public about the importance of preserving the parks, helping to convince members of Congress to uphold the laws that protect the parks, supporting new legislation that addresses threats to the parks, fighting attempts to weaken these laws in the courts, and assessing the health of the parks and park management to better inform advocacy work. For more information, visit their website at http://www.npca.org.

National Park Service, Santa Monica Mountains National Recreation Area: The mission of the National Park Service (NPS) is "...to promote and regulate the use of the...national parks...which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Within this planning area, the NPS manages land within the Santa Monica Mountains National Recreation Area and is a key partner in the South Coast Missing Linkages Project. The Santa Monica Mountains are both ecologically and jurisdictionally fragmented so to achieve the NPS goals of resource protection, it is critical to understand and manage resources within the context of the surrounding landscape. Landscape linkages are critical to maintain ecological integrity in the Santa Monica Mountains and the Missing Linkages Project provides a scientific framework for assessing and identifying critical connections between the Santa Monica Mountains and surrounding ecosystems. In support of its resource protection mission and the objectives of the Missing Linkages Project, NPS scientists are engaged in numerous studies and monitoring programs related to habitat fragmentation, wildlife corridors, and landscape linkages. NPS rangers also provide educational and outreach programs about these issues to visitors and residents throughout the planning area. For more on NPS activities at Santa Monica Mountains National Recreation Area, see http://www.nps.gov/samo.

Rancho Simi Recreation and Park District: The District's mission is to provide a broad, well-rounded program of parks and recreation services for all District residents; to acquire land while available and at a reasonable price; to provide areas and facilities needed for indoor and outdoor recreation activities; to operate within an approved budget, offering recreation services at the most reasonable cost possible; to consistently strive to improve and expand recreation and park facilities through the use of property taxes, developers' fees, grants and major donations; to operate the District on a businesslike, economical basis in accordance with both accepted professional policy and taxpayer wishes; and to maintain facilities at a reasonable standard. The District covers 113 square miles which is bound by the Ventura County line on the east and south, west to the edge of the city limits of the City of Moorpark, and north to the Oak Ridge area of the Santa Susana Mountains. To find out more, go to http://www.rsrpd.org.

Regional Water Quality Control Board: The State WQCB strives to preserve, enhance and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations. The RWQCB oversees waters in the Linkage Design area. For more information, visit their website at http://www.swrcb.ca.gov.

Resource Conservation Districts (RCD): The federal district has 2 offices with responsibilities in this area: Ventura County RCD (www.vcrcd.org) and Santa Monica Mountains RCD (www.smmrcd.org). These non-profit agencies support conservation of natural ecosystems through programs that reduce the effects of on-going land-use practices on the environment. A major portion of their effort is to advise residents on the management of soil, water, soil amendments and other resources used for agriculture and home gardening. RCDs are supported by state and local grants. They provide leadership in partnership efforts to help people conserve, maintain, and improve our natural resources and environment. Programs include Emergency Watershed Protection, Environmental Quality Incentives, Resource Conservation and Development, Soil Survey Programs, Soil and Water Conservation Assistance, Watershed Protection, River Basin, and Flood Operations, Wetlands Reserve and Wildlife Habitat Incentives. They do not enforce regulations but instead serve the interests of local residents and businesses. To find out more about California's RCDs visit http://www.carcd.org.

San Fernando Valley Audubon Society: Their mission is to preserve and enhance the natural habitat within the San Fernando Valley to increase the public's awareness and appreciation of bird life and the natural environment; and to create a social environment that encourages individual development and participation (http://www.sanfernandovalleyaudubon.org).

Santa Clara River Enhancement and Management Plan*:* The purpose of the SCREMP is to provide a guidance document that addresses the preservation, enhancement, and sustainability of resources for the entire length of the river, encompassing all land within the 500-year floodplain. The plan identifies land in the Linkage Design as having significant regional conservation value and calls for maintaining existing habitat values and river channel connectivity (AMEC 2004). The plan developed from a highly collaborative process that involved numerous stakeholders that is coordinated by the Ventura County Watershed Protection District and Los Angeles County Department of Public Works. The plan may provide opportunities for protecting land along the river in the Linkage Design area. The plan can be viewed at http://sdgis.amec.com/scremp/index.htm.

Santa Clara River Trustee Council*:* The Trustee Council, made up of representatives from the U.S. Fish and Wildlife Service and the California Department of Fish and Game, is administering $1.5 million to fund ecological restoration projects in the Santa Clara River watershed in Ventura and Los Angeles counties. Ecological restoration projects include habitat improvement, and ecological research, monitoring, and educational efforts associated with habitat restoration. The funds are from the settlement of claims for natural resource damages resulting from an ARCO pipeline oil spill into the Santa Clara River. Several projects have been proposed that would contribute to the protection and restoration of habitats in the Linkage Design. For more information on the Council, visit http://www.ventura.fws.gov/ SCRiverPlan/SCR.

Santa Monica Bay Restoration Commission: In recognition of the need to restore and protect the Santa Monica Bay and its resources, the State of California and the U.S. Environmental Protection Agency established the Santa Monica Bay Restoration Project (SMBRP) as a National Estuary Program in December 1988. The Project was formed to develop a plan that would ensure the long-term health of the 266 square mile Bay and its 400 square mile watershed, located in the second most populous region in the United States. That plan, known as the Santa Monica Bay Restoration Plan, won State and Federal approval in 1995. Since then the SMBRP's primary mission has been to facilitate and oversee the implementation of the Plan (http://www.santamonicabay.org).

Santa Monica Mountains Conservancy: This state agency was created by the Legislature in 1979 and is charged with the primary responsibility for acquiring land with statewide and regional significance. Through direct action, alliances, partnerships, and joint powers authorities, the Conservancy's mission is to strategically preserve, protect, restore, and enhance treasured pieces of Southern California's natural heritage to form an interlinking system of parks, open space, trails, and wildlife habitats that are easily accessible to the general public. SMMC has been planning for habitat connectivity and acquiring land in the Linkage Design for the last few decades. The SMMC is a partner in the South Coast Missing Linkages effort. For more information on SMMC, visit them at http://www.smmc.ca.gov.

Santa Monica Mountains Natural History Association: The Association funds and supports walks, school programs and other interpretive activities at Leo Carrillo State Park and Point Mugu State Parks in the Santa Monica Mountains. These parks contain mountains, backcountry, beaches, canyons, woods, and ocean close to major urban centers. The association sponsors diverse programs that teach tidepooling and beach ecology. For more information about the Association and its many activities, go to http://www.parks.ca.gov/?page_id=22324.

Santa Monica Mountains Trails Council: The Santa Monica Mountains Trails Council is a volunteer, nonprofit organization dedicated to establishing and maintaining the public trail system throughout the Santa Monica Mountains, through advocacy and partnership with public and private sectors (http://www.smmtc.org).

Sierra Club's Santa Clara River Greenway Campaign*:* The stated goal of this effort is to bring the entire 500-year floodplain of the river from Fillmore to Acton into public ownership and protection. The campaign has identified a number of protection needs including water quality and quantity, plant and wildlife species habitats, movement corridors for wildlife, open space attributes and aesthetics, river fluvial dynamics, and agricultural resources (http://www.sierraclub.org).

Sierra Club's Southern California Forests Campaign: Sierra Club volunteers and staff have created the Southern California Forests Campaign to encourage public involvement in the 4 southern California Forest's Resource Management Plan revision process. The goals of the campaign are to reduce the threats to our forests and to enjoy, protect and restore them (http://www.sierraclub.org).

South Coast Wildlands: South Coast Wildlands is a non-profit group established to create a protected network of wildlands throughout the South Coast Ecoregion and is the key administrator and coordinator of the South Coast Missing Linkages Project. For all 15 priority linkages in the Ecoregion, South Coast Wildlands supports and enhances existing efforts by providing information on regional linkages critical to achieving the conservation goals of each planning effort (http://www.scwildlands.org).

South Coast Missing Linkages Project (SCML): SCML is an informal coalition of agencies, organizations and universities committed to conserving 15 priority landscape linkages in the South Coast Ecoregion. The project is administered and coordinated by South Coast Wildlands. Partners in the South Coast Missing Linkages Project include but are not limited to The Wildlands Conservancy, The Resources Agency California Legacy Project, California State Parks, California State Parks Foundation, United States Forest Service, National Park Service, Santa Monica Mountains Conservancy, Conservation Biology Institute, San Diego State University Field Station Programs, The Nature Conservancy, Environment Now, and the Zoological Society of San Diego's Conservation and Research for Endangered Species. For more information on this ambitious regional effort, go to http://www.scwildlands.org.

Southern California Wetlands Recovery Project*:* The Wetlands Recovery Project is a partnership of public agencies working cooperatively to acquire, restore, and enhance coastal wetlands and watersheds between Point Conception and the International border with Mexico. Using a non-regulatory approach and an ecosystem perspective, the Wetlands Recovery Project works to identify wetland acquisition and restoration priorities, prepare plans for these priority sites, pool funds to undertake these projects, implement priority plans, and oversee post-project maintenance and monitoring. The goal of the Southern California Wetlands Recovery Project is to accelerate the pace, extent, and the effectiveness of coastal wetland restoration in Southern California through developing and implementing a regional prioritization plan for the acquisition, restoration, and enhancement of Southern California's coastal wetlands and watersheds (http://www.coastalconservancy.ca.gov/scwrp).

The Nature Conservancy: TNC preserves the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. The Conservancy has protected more than 117 million acres of land and 5,000 miles of river around the world. The Conservancy has undertaken significant conservation and planning efforts in the planning area, including critical lands in the Santa Susana Mountains and along the main stem of the Santa Clara River. TNC has protected a total of 4,600 acres in its LA-Ventura project area. TNC is actively acquiring land and conservation easements in the Santa Clara River floodplain, having conserved over 2,500 acres thus far representing 10.5 miles of the river. TNC is a partner in the South Coast Missing Linkage Project. For more information on their activities, go to http://www.tnc.org.

The Wildlands Conservancy: The Wildlands Conservancy is a non-profit, member-supported organization dedicated to land and river preservation, trail development and environmental stewardship through education. Their Save the Saints Program brings together multiple land trusts and conservancies to identify key lands for acquisition within National Forest boundaries and lands contiguous with the Forests in the Santa Ana, San Gabriel, San Jacinto, and San Bernardino Mountains. TWC is a vital partner in the South Coast Missing Linkages project. For more information, please visit their website at http://www.wildlandsconservancy.org.

Topanga Canyon Docents: The Topanga Canyon Docents was started in 1974 by a group of friends and activists who wanted to share their love of nature and the Santa Monica Mountains. They lead public nature walks and give programs for school children. They're committed environmentalists who've created an extremely popular and fun educational program (http://tc-docents.org).

Transportation Equity Act of the 21st Century (TEA-21): This Act was enacted June 9, 1998 as Public Law 105-178. TEA-21 authorizes Federal surface transportation programs for highways and highway safety The Critter Crossings Program was developed to address roadkill, habitat fragmentation, and habitat loss due to public roads. This Act provides funding for ecological infrastructure, water quality improvements, restoration of wetlands and habitat (http://www.fhwa.dot.gov/tea21).

Trust for Public Land (TPL): TPL conserves land for people to enjoy as parks, gardens and other natural places, ensuring livable communities for generations to come. TPL's Western Rivers Program works to reestablish and protect the natural function of river systems. TPL has protected over 30,000 acres of river, wetland, and watershed lands in California (http://www.tpl.org).

US Army Corps of Engineers (ACOE): The mission of the ACOE is to provide quality, responsive engineering services for planning, designing, building and operating water resources and other civil works projects (Navigation, Flood Control, Environmental Protection, Disaster Response, etc.). The ACOE has conducted dam removal studies for the Rindge Dam on Malibu Creek and the Matilija Dam on Matilija Creek, a tributary of the Ventura River. They also are engaged in watershed planning efforts that may provide opportunities for restoration of natural water flow and riparian vegetation in the linkage. They recently completed a Reconnaissance Study of the Santa Clara River Watershed to determine federal interest in completing a Feasibility Study for a Santa Clara River Watershed Protection Plan that would cover the entire watershed (http://www.usace.army.mil).

US Fish and Wildlife Service (USFWS): The USFWS works to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people. The agency can provide support for prosecuting violations to the Endangered Species Act, law enforcement, permits, and funding for research on threatened and endangered species. The federal Endangered Species Act as amended (16 U.S.C. 1534) authorizes USFWS to acquire lands and waters for the conservation of fish, wildlife, or plants with the Land and Water Fund Act appropriations. The added protection provided by the Endangered Species Act may also be helpful for protecting habitat in the linkage from proposed development projects (http://www.fws.gov).

US Fish and Wildlife Service Partners for Fish and Wildlife Program This program supplies funds and technical assistance to landowners who want to restore and enhance wetlands, native grasslands, and other declining habitats, to benefit threatened and endangered species, migratory birds, and other wildlife. This program may be helpful in restoring habitat on private lands in the Linkage Design (http://partners.fws.gov).

US Forest Service: The mission of the USDA Forest Service is to sustain the health, diversity, and productivity of the Nation’s forests and grasslands to meet the needs of present and future generations. The four southern California Forests (Los Padres, Angeles, San Bernardino, and Cleveland) have recently finalized their Resource Management Plans. The Final Environmental Impact Statement and Forest Plans have identified connecting the four forests to the existing network of protected lands in the region as one of the key conservation strategies for protecting biodiversity on the forests. The USFS is allocated Land and Water Conservation Funds annually, which are designed to protect recreational open space, watershed integrity, and wildlife habitat and may be a source of funds for protecting land in the planning area. The Forest Service is taking a proactive role in habitat connectivity planning in the region as a key partner in the South Coast Missing Linkages Project. For more information, go to http://www.fs.fed.us/r5/scfpr.

US Geological Survey, Biological Resources Division: The Biological Resource Division (BRD) works with others to provide the scientific understanding and technologies needed to support the sound management and conservation of our Nation's biological resources. BRD develops scientific and statistically reliable methods and protocols to assess the status and trends of the Nation's biological resources. BRD utilizes tools from the biological, physical, and social sciences to understand the causes of biological and ecological trends and to predict the ecological consequences of management practices. BRD enters into partnerships with scientific collaborators to produce high-quality scientific information and partnerships with the users of scientific information to ensure this information's relevance and application to real problems. For more information, go to http://www.biology.usgs.gov.

Ventura Coast Keepers/Wishtoyo Foundation*:* The Ventura Coastkeepers is affiliated with the National Waterkeeper Alliance, dedicated to protecting, preserving and restoring marine habitat, coastal waters, and watershed integrity. The Keeper organizations fill the gap between water pollution laws and the government's ability to enforce them. Wishtoyo is a Native American organization that utilizes traditional Chumash cultural values and practices to foster environmental awareness (http://www.wishtoyo.org).

Ventura County Watershed Protection District: The mission of the Watershed Protection District is to protect life, property, watercourses, watersheds, and public infrastructure from the dangers and damages associated with flood and stormwaters. They are currently working on the following projects in the planning area: Matilija Dam Ecosystem Restoration Project, Calleguas Watershed Management Plan Present Condition Model Results, and SCREMP (http://publicworks.countyofventura.org/fc/).

Ventura County Open Space District: In November 1998, voters decisively approved Advisory Measure A “authorizing legislation” (AB 1145) to develop an Open Space District (OSD); the County has received State authorization but hasn’t yet implemented their OSD. The purpose of the proposed OSD is to preserve, enhance and/or restore the agricultural resources and natural qualities of Ventura County (e.g., ridgelines, scenic viewsheds, agricultural lands, wildlife corridors, natural habitat, greenbelts between the cities, hillsides, wetlands, rivers and streams, and natural parksites) for the enjoyment and benefit of present and future residents of the County. OSDs are similar to non-profit land trusts and conservancies, protecting land using a combination of techniques including outright purchase or purchasing the “right” to develop the land (in voluntary transactions) (http://www.ventura.org/planning/studies_eirs/open_space.htm).

Ventura Hillsides Conservancy: The mission of the Conservancy is to "preserve the hillsides, canyons, and open space that contributes to the unique character and natural environment of the City of San Buenaventura and the surrounding region for the benefit of present and future generations." (http://www.venturahillsides.org).

Wildlife Conservation Board: The Wildlife Conservation Board administers capital outlay for wildlife conservation and related public recreation for the State of California. The Board, while a part of the California Department of Fish and Game, is a separate and independent Board with authority and funding to carry out an acquisition and development program for wildlife conservation (http://www.dfg.ca.gov/wcb).

A Scientifically Sound Plan for Conservation Action

In southern California, humans have become significant agents of biogeographic change, converting habitat to urban and agricultural uses and altering the movements of organisms, nutrients, and water through the ecosystem. The resulting fragmentation of natural landscapes threatens to impede the natural processes needed to support one of the world's greatest biological warehouses of species diversity.

This interaction between human development and unparalleled biodiversity is one of the great and potentially tragic experiments of our time. It creates a unique challenge for land managers and conservation planning efforts – to mitigate these major impacts to once intact ecosystems. The conservation plan for the Santa Monica-Sierra Madre Connection addresses these challenges by presenting a scientific framework and set of recommendations that can guide regional conservation planning and patterns of development in a manner that best preserves landscape level processes in the region.

The prioritization of this linkage for conservation and the demarcation of lands suggested for protection in the linkage are based on the best available conservation techniques and expertise of biologists working in the region. This project provides a strong biological foundation and quantifiable, repeatable conservation design approach that can be used as the basis for successful conservation action.

Next Steps

This Linkage Design plan acts as a scientifically sound starting point for conservation implementation and evaluation. The plan can be used as a resource for regional land managers to understand their critical role in sustaining biodiversity and ecosystem processes. Existing conservation investments in the vicinity are already extensive including lands managed by the US Forest Service, National Park Service, California State Parks, Santa Monica Mountains Conservancy, The Nature Conservancy, and other open space agencies. Each land parcel located within the targeted protected core areas or the linkage itself serves a unique role in preserving some aspect of the connection. Incorporating relevant aspects of this plan into individual land management plans provides an opportunity to jointly implement a regional conservation strategy.

Additional conservation action will also be needed to address transportation barriers. Recommended tools include road renovation, construction of wildlife crossings, watershed planning, habitat restoration, conservation easements, zoning, acquisition, and others. These recommendations are not exhaustive, but are meant to serve as a starting point for persons interested in becoming involved in preserving and restoring linkage function. We urge the reader to keep sight of the primary goal of conserving landscape linkages to promote movement between targeted core areas over broad spatial and temporal scales, and to work within this framework to develop a wide variety of restoration options for maintaining linkage function. To this end, we provided a list of organizations, agencies and regional projects that provide collaborative opportunities for implementation.

Public education and outreach is vital to the success of this effort – both to change land use activities that threaten species existence and movement in the linkage and to generate an appreciation and support of the conservation effort. Public education can encourage recreational users and residents at the urban-wildland interface to become active stewards of the land and to generate a sense of place and ownership for local habitats and processes. Such voluntary cooperation is essential to preserving linkage function. The biological information, figures and tables from this plan are ready materials for interpretive programs. We have also prepared a 3D animation (Appendix C on the enclosed CD) that provides a landscape perspective of the linkage.

Successful conservation efforts are reiterative, incorporating and encouraging the collection of new biological information that can increase understanding of linkage function. We strongly support the development of a monitoring and research program that addresses movement (of individuals and genes) and resource needs of species in the Linkage Design area. The suite of predictions generated by the GIS analyses conducted in this planning effort provides a starting place for designing long-term monitoring programs.

The remaining wildlands in southern California form a patchwork of natural open space within one of the world's largest metropolitan areas. Without further action, our existing protected lands will become isolated in a matrix of urban and industrial development. Ultimately the fate of the plants and animals living on these lands will be determined by the size and distribution of protected lands and surrounding development and human activities. With this linkage conservation plan, the outcome of land use changes can be tailored to assure the greatest protection for our natural areas at the least cost to our human endeavors. We envision a future interconnected system of natural space where our native biodiversity can thrive.

Adams, T. E., P.B. Sands, W.H. Weitkamp, and N.K. McDougald. 1992. Oak seedling establishment on California rangelands. Journal of Range Management 45(1): 93-98. Ahlborn, G. 1988-1990. Mountain lion, *Felis concolor*. In: D.C. Zeiner, W.F. Laudenslayer Jr., K.E. Mayer, and M. White (eds.). California wildlife habitat relationships system. Volume III: Mammals. Sacramento: California Department of Fish and Game, California Interagency Wildlife Task Group.

Allan, J.D. 1995. Stream ecology: structure and function of running waters, Chapman and Hall, New York.

Allen, B.H., B.A. Holzman, and R.R. Evett. 1991. A classification system for California's hardwood rangelands. Hilgardia. 59(2): 1-45.

Allen, J.C. 2001. Summary of Ecological Findings for Malibu. California Coastal Commission.

AMEC Earth & Environmental. 2004. Santa Clara River Enhancement and Management Plan (SCREMP). Prepared for Ventura County Watershed Protection District, Los Angeles Department of Public Works, and SCREMP Project Steering Committee.

American Ornithologists' Union. 1998. Check-list of North American Birds. 7th edition. American Ornithologists' Union, Washington, D. C.

Anderson, S.H. 1995. Recreational disturbance of wildlife populations. In: Wildlife and recreationists, coexistence through management and research, edited by R.L. Knight and K.J. Gutzwiller. Island Press, Washington D.C.

Anderson, R. A. 1993. An analysis of foraging in the lizard, Cnemidophorus tigris. Pages 83-116 in J. W. Wright and L. J. Vitt, editors. Biology of whiptail lizards (genus Cnemidophorus). Oklahoma Museum of Natural History, Norman, Oklahoma.

Anderson, A.E., D.C. Bowden, and D.M. Kattner. 1992. The puma on the Uncompahgra Plateau, Colorado. Colorado Division of Wildlife, Technical Publication 40, Denver. 116pp.

Anderson, A.E, and O.C. Wallmo. 1984. Mammalian Species: *Odocoileus hemionus*. The American Society of Mammalogists. No. 219, pp. 1-9.

Anderson A.H., and A. Anderson. 1973. The cactus wren. University of Arizona Press, Tucson. 226pp.

Anderson, A.H., and A. Anderson. 1963. Life history of the cactus wren. Part IV: Competition and survival. Condor 65:29-43.

Anderson A.H., and A. Anderson. 1957. Life history of the cactus wren. Part I: Winter and pre-nesting behavior. Condor 59:274-296.

Anderson, E.N. 2002. Some preliminary observations on the California black walnut (Juglans californica). Fremontia; Vol. 30; 1; 12-19.

Atwood, J.L. 1998. Studies of California gnatcatchers and cactus wrens in southern California. Manomet Center for Conservation Sciences and the University of California, Irvine. 42pp.

Ballmer, G.R. Unpublished. The role of arthropods in habitat linkages. Habitat Connectivity Workshop, South Coast Missing Linakges Project. University of Redlands, CA, August 7th, 2002.

Ballmer, G.R., and G.F. Pratt. 1988. A survey of the last instar larvae of the Lycaenidae of California. Journal of Research on the Lepidoptera, Vol. 27, pp. 1-81.

Banfield, A.W.F. 1974. The mammals of Canada. University of Toronto Press, Toronto.

Barbour, M.G. 1987. Community ecology and distribution of California hardwood forests and woodlands. In: Plumb, T.R.; and N.H. Pillsbury, technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources. November

12-14, 1986; San Luis Obispo, CA. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station, Gen. Tech. Rep. PSW-100. Berkeley, CA. pp. 18-25.

Bartolome, J.W. 1987. California annual grassland and oak savannah. Rangelands. 9(3): 122-125. Barton, D.R., W.D. Taylor, and R.M. Biette. 1985. Dimensions of riparian buffer strips required to maintain trout habitat in southern Ontario (Canada) streams. North American Journal of Fisheries Management 5:364-378.

Barton, D.R., W.D. Taylor, and R.M. Biette. 1985. Dimensions of riparian buffer strips required to maintain trout habitat in southern Ontario (Canada) streams. North American Journal of Fisheries Management 5:364-378.

Baxter, C. 2001. An integrated approach to bird conservation in the Mississippi Alluvial Valley. Keynote Address. Riparian Habitat and Floodplains Conference March 12-14, 2001, Sacramento, California.

Beier, P. 2006. Impact of artificial night lighting on terrestrial mammals. Invited Chapter. In T. Longcore and C. Rich, editors, Environmental consequences of artificial night lighting. Island Press.

Beier, P., K. L. Penrod, C. Luke, W. D. Spencer, and C. Cabañero. 2005. South Coast Missing Linkages: Restoring connectivity to wildlands in the largest metropolitan area in the United States. Invited Chapter In K R. Crooks and MA Sanjayan, editors, Connectivity conservation: maintaining connections for nature. Oxford University Press.

Beier, P. and Noss, R.F. 1998. Do habitat corridors provide connectivity? Conservation Biology 12:1241-1252.

Beier, P. 1996. Metapopulation models, tenacious tracking, and cougar conservation. Pages 293-322 in D. R. McCullough, editor. Metapopulations and wildlife conservation. Island Press, Covelo, California.

Beier, P. 1995. Dispersal of juvenile cougars in fragmented habitats. Journal of Wildlife Management 5:228-237.

Beier, P., D. Choate, and R.H. Barrett. 1995. Movement patterns of mountain lions during different behaviors. Journal of Mammalogy 76:1056-1070.

Beier, P. and R. Barrett. 1993. The cougar in the Santa Ana Mountain Range, California. Final Report for Orange County Cooperative Mountain Lion Study.

Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. Conservation Biology 7:94-108.

Beier, P., and S. Loe. 1992. A checklist for evaluating impacts to wildlife movement corridors. Wildlife Society Bulletin 20:434-440.

Bekker, H., B. van den Hengel, H. van Bohmen, and H. van der Sluijs. 1995. Natuur over wegen (Nature across motorways). Ministry of Transport, Public Works and Water Management, Delft, Netherlands.

Bell, G P. 1997. Ecology and management of *Arundo donax*, and approaches to riparian habitat restoration in southern California. In J.H. Brock, M. Wade, P. Pysek, and D. Green: (eds.) Plant invasions: studies from North America and Europe. Backhuys Publications, Leiden, The Netherlands.

Benninger, M. C. 1989. Trail as conduits of movement for plant species in coniferous forests of Rocky Mountain National Park, Colorado. M.S. Thesis, Miami University.

Benninger-Truax, M.C., Vankat, J.L., and Schaefer, R.L. 1992. Trail corridors as habitat and conduits for movement of plant species in Rocky Mountain National Park, Colorado, USA. Landscape Ecology 6:269–278.

Bent, A.C. 1948. Life histories of North American nuthatches, wrens, thrashers, and their allies. U.S. National Museum Bulletin. 195. Washington, D.C.
Bent, A.C. 1950. Life histories of North American wagtails, shrikes, vireos, and their allies. U.S. Natl. Mus. Bull. 197. 411 pp.
Bertram, R.C., and R.D. Rempel. 1977. Migration of the North Kings deer herd. California Fish and Game 63:157-179.
Bleich, V. C., and O. A. Schwartz. 1975. Observations on the home range of the desert woodrat, *Neotoma lepida intermedia*. J. Mammal. 56:518-519.
Blumton, A. K., J. D. Fraser, and K. Terwilliger. 1989. Loggerhead shrike survey and census. Pages 116-118 in Virginia nongame and endangered wildlife investigative annual report, July 1, 1988 through June 30, 1989. Virginia Department of Game and Inland Fisheries, Richmond, Virginia.
Bock, C.E., and J.H. Bock. 1974. Geographical ecology of the acorn woodpecker: diversity versus abundance of resources. The American Naturalist. Vol. 108, No. 963, pp. 694-698.
Bolger, D.T., A.C. Alberts, R.M. Sauvajot, P. Potenza, C. McCalvin, D. Tran, S. Mazzoni, and M.E. Soulé. 1997. Response of rodents to habitat fragmentation in coastal southern California. Ecological Applications 7:552-563.
Bolger, D.T., A.V. Suarez, K.R. Crooks, S.A. Morrison, and T.J. Case. 2000. Arthropods in urban habitat fragments in the Southern California: area, age, and edge effects. Ecological Applications 10:1230-1248.
Bolsinger, C. L. 1988. The hardwoods of California timberlands, woodlands, and savannas. Portland, OR: U.S. Department of Agriculture Resource Bulletin. Bovee, K.D. 1978. Probability-of-use criteria for the family Salmonidae. Instream flow information paper 4. US Fish and Wildlife Service, FWS/OBS-78/07. 79 p.
Borowske, J.R. and M.E. Heitlinger. 1981. Survey of native prairie on railroad rights-of-way in Minnesota. Transportation Research Records (Washington) 822:22-6.
Bovee, K.D. 1978. *Probability of use criteria for the family Salmonidae*. Stream Flow Information Paper No. 4. U.S. Fish Wild. Serv. FWS/OBS-78/07.
Bowyer, R.T. 1986. Habitat selection by southern mule deer. California Fish and Game 72:153-169.
Bowyer, R.T. 1981. Management guidelines for improving southern mule deer habitat on Laguna-Morena demonstration area. USDA Forest Service, 40-9AD6-9-622.
Brattstrom, B.H., and M.C. Bondello. 1983. Effects of off-road vehicles noise on desert vertebrates. Pages 167-204 in R.H. Webb and H.G. Wilshire, editors. Environmental effects of off-road vehicles: impacts and management in arid regions. Springer-Verlag, New York.
Brehme, C.S. 2003. Responses of small terrestrial vertebrates to roads in a coastal sage scrub ecosystem. Master's Thesis, San Diego State University.
Brosofske, K.D., J. Chen, R.J. Naiman, and J.R. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in western Washington. Ecological Applications 7:1188-1200.
Brown, E.R. 1961. The black-tailed deer of Washington. Washing State Game Department, Bulletin No. 13. 124pp.
Brylski, P. 1990. Dusky footed woodrat, *Neotoma fuscipes*. in Zeiner, D., W. Laudenslayer, and M. White, editors. California Wildlife Habitat Relationship System, California Department of Fish and Game, California Interagency Wildlife Task Group.
Bury, R.B. 1988. Habitat relationships and ecological importance of amphibians and reptiles. Pages 61-76 in K. J. Raedeke, editor. Streamside management: riparian wildlife and

forestry interactions. Contribution 59 of the Institute of Forest Resources, University of Washington, Seattle, Washington, USA.
Buechner, M. and R.M. Sauvajot. 1996. Conservation and zones of human activity: the spread of human disturbance across a protected landscape. Pages 605-629 in R.C. Szaro and D.W. Johnston, editors. Biodiversity in Managed Landscapes: Theory and Practice. Oxford University Press, New York.
Busteed, G.T. 2003. Effects of habitat fragmentation on reptiles and amphibians in coastal sage scrub and grassland communities. M.S. Thesis. Department of Biology, California State University, Northridge.
Butler, C.J. 2005. Feral Parrots in the Continental United States and United Kingdom: Past, Present, and Future. Journal of Avian Medicine and Surgery 19(2):142-149.
California Department of Fish and Game. 2005a. Rare Find California Natural Diversity Database.
California Department of Fish and Game, Natural Diversity Database. 2005b. Special Vascular Plants, Bryophytes, and Lichens List. Quarterly publication, Mimeo. April 2005. 88 pp.
California Department of Fish and Game. 2001. Special Animals. State of California, The Resources Agency, Department of Fish and Game Wildlife Habitat Data Analysis Branch, California Natural Diversity Database, January 2001.
California Department of Fish and Game. 2000. Steelhead rainbow trout in San Mateo Creek, San Diego County, California. Report submitted to the National Marine Fisheries Service. 22 pp.
California Department of Fish and Game. 1999. Rare Find: California Natural Diversity Database.
California Department of Fish and Game. 1995. Wildlife Gallery Mammal Index: American Badger. http://www.delta.dfg.ca.gov/gallery/badger.html.
California Department of Fish and Game. 1994. 1992 annual report on the status of California state listed threatened and endangered animals and plants. Sacramento, CA.
California Department of Fish and Game. 1983. California's Wildlife, Mammals, Mule Deer. California Wildlife Habitat Relationships System, http://www.dfg.ca.gov/whdab/M181.html
California Native Plant Society. 2001. *Inventory of rare and endangered plants of California* (sixth edition). Rare Plant Scientific Advisory Committee, David P. Tibor, Convening Editor. Sacramento, CA: California Native Plant Society.
California Partners in Flight. 2002. Version 2.0. 2.0. The oak woodland bird conservation plan: a strategy for protecting and managing oak woodland habitats and associated birds in California (S. Zack, lead author). Point Reyes Bird Observatory, Stinson Beach, CA. http://www.prbo.org/calpif/plans.html.
California Wilderness Coalition. 2002. Farming for Wildlife and Profitability: A Report on Private Land Stewarship.
Callaway, R.M. 1992. Effect of shrubs on recruitment of *Quercus douglasii* and *Quercus lobata* in California. Ecology 73(6): 2118-2128.
Caltrout. 2006. Santa Monica Mountains Steelhead Habitat Assessment Final Project Report.
CalTrout. 1999. Conservation Plan for the New Millennium. California Trout, Inc.
Cannings, S. and G. Hammerson. 2004. NatureServe species account for *Sylvilagus bachmani.*
Carey, M. and P. Wagner. 1996. Salmon passages and other wildlife activities in Washington State. Trends in addressing transportation related wildlife mortality. Proceedings of the transportation related wildlife mortality seminar FL-ER-58-96. Florida Department of Transportation, Tallahassee, Florida.

Carmen, W.J., W.D. Koenig, and R.L. Mumme. 1987. Acorn production by five species of oaks over a seven year period at the Hastings Reservation, Carmel Valley, California. In: Plumb, T.R.; Pillsbury, N.H., technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 429-434.

Carraway, L.J., and B.J. Verts. 1991. *Neotoma fuscipes*. Mammalian Species, Vol. 386, pp. 1-10.

Casterline, M., E. Fegraus, E. Fujioka, L. Hagan, C. Mangiardi, M. Riley, and H. Tiwari. 2003. Wildlife Corridor Design and Implementation in South Ventura County. A Group Project submitted in partial satisfaction of the requirements for the degree of Master's in Environmental Science and Management. University of California Santa Barbara.

Chapman, J.A., and G.A. Feldhamer (eds.). 1982. Wild mammals of North America. The John Hopkins University Press. Baltimore, Maryland.

Chapman, J.A. 1974. Sylvilagus bachmani. In: Mammalian Species No. 34:1-4. Published by the American Society of Mammalogists.

Chapman, J.A. and A.L. Harman. 1972. The breeding biology of a brush rabbit population. Journal of Wildlife Management 36:816-823.

Chapman, J.A. 1971. Orientation and homing of the brush rabbit (Sylvilagus bachmani). Journal of Mammalogy 52:686-699.

Chase, M.K., W.B. Kristan III, A.J. Lynam, M.V. Price, and J.T. Rotenberry. 2000. Single species as indicators of species richness and composition in California coastal sage scrub birds and small mammals. Conservation Biology 14:474-487.

Churcher, J.B. and J.H. Lawton. 1987. Predation by domestic cats in an English village. Journal of Zoology 212:439-456.

City of Calabasas. 2000. Land Value Key to Open Space. Calabasas Newsletter Published by the City of Calabasas, July 2000.

Clevenger, A.P. and N. Waltho. 2006. Performance indices to identify attributes of highway crossing structures facilitating movement of large mammals. Biological Conservation 121:453-464.

Clevenger, A.P., and J. Wierzchowski. 2005. Maintaining and restoring connectivity in landscapes fragmented by roads. Chapter in K. R. Crooks and M. A. Sanjayan, editors. Connectivity conservation: maintaining connections for nature. Oxford University Press.

Clevenger, A.P., and N. Waltho. 1999. Dray drainage culvert use and design considerations for small-and medium-sized mammal movement across a major transportation corridor. Pp. 263-277 in G.L. Evink, P. Garrett, and D. Zeigler (eds.) Proceedings of the Third International Conference on Wildlife Ecology and Transportation. FL-ER-73-99. Florida Department of Transportation, Tallahassee, Florida.

Clevenger, A.P., B. Chruszez, and K. Gunson. 2001. Highway mitigation fencing reduces wildlife vehicle collisions. Wildlife Society Bulletin 29:646-653.

Close, C.L. and D.F. Williams. 1988. Habitat management for riparian brush rabbits and woodrats with special attention to fire and flood. Unpublished report, Endangered Species Recovery Program, Department of Biological Sciences. California State University, Stanislaus, Turlock.

Cody, M.L. 1998. The Birds of North America, No. 323, 1998 (Excerpts).

Cogswell, H.L. 1962. Territory size in three species of chaparral birds in relation to vegetation density and structure. PhD Thesis, University of California, Berkeley. 567pp.

Conard, S.G.; R.L. MacDonald, and R.F. Holland. 1980. Riparian vegetation and flora of the Sacramento Valley. In: Sands, Anne, editor. Riparian forests in California: Their ecology and conservation. Symposium proceedings May 14, 1977. University of California, Davis, Division of Agricultural Sciences, pp. 47-55.

Connell, J.H. 1954. Home range and mobility of brush rabbits in California chaparral. J. Mammal. 35:392-405.

Conover, M.R. 1997. Monetary and intangible valuation of deer in the United States. Wildlife Society Bulletin 25:298-305.

Conrad, C.E. 1987. Common shrubs of chaparral and associated ecosystems of southern California. Gen. Tech. Rep. PSW-99. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest, and Range Experiment Station. 86pp.

Corn, S., E. Muths, and S. Haire. 2001. Project description for examining an intact "metapopulation" of boreal toads (*Bufo boreas*): Use of habitat and large scale movements. www.mesc.usgs.gov/borealtoad/research.htm

County of Los Angeles. 2000. The Santa Monica Mountains North Area Plan. County of Los Angeles, Department of Regional Planning, James. E. Hartl, AICP, Director of Planning. Adopted October 24, 2000 by the Los Angeles County Board of Supervisors.

County of Ventura. 2005. Roads and Biodiversity Project: Guidelines for Safe Wildlife Passage. Prepared for Southern California Association of Governments; prepared by Ventura County Planning Division and Donald Bren School of Environmental Science and Management at UC Santa Barbara.

County of Ventura. 2002. Census and Demographic Information. http://www.ventura.org/planning/pdf/02ventco_demo_comp.pdf.

County of Ventura. 1998. Ventura County General Plan: Goals, Policies, and Programs. County of Ventura Resource Management Agency, Planning Division, Ventura, CA.

Craighead, A.C., E. Roberts, and F. L. Craighead. 2001. Bozeman Pass Wildlife Linkage and Highway Safety Study. Prepared for American Wildlands, http://www.wildlands.org/research.html.

Crooks, K.R., A.V. Suarez, and D.T. Bolger. 2004. Avian assemblages along a gradient of urbanization in a highly fragmented landscape. Biological Conservation 115:451-462.

Crooks, K.R., A.V. Suarez, D.T. Bolger, and M.E. Soulé. 2001. Extinction and colonization of birds on habitat islands. Conservation Biology 15:pp. 159-172.

Crooks, K. 1999. Mammalian carnivores, mesopredator release, and avifaunal extinctions in a fragmented system. Ph.D. Dissertation. University of California Santa Cruz.

Crooks, K. and M. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400:563-566.

Crooks, K.R., Jones, D. 1998. Monitoring Program for Carnivore Corridor Use in the Nature Reserve of Orange County. The Nature Reserve of Orange County (Unpublished Report).

Currier, M.J.P. 1983. *Felis concolor*. Mammalian Species No. 200, pp. 1-7.

Danielsen, K.C. and W.L. Halvorson. 1991. Valley oak seedling growth associated with selected grass species. In: Proceedings of the symposium on oak woodlands and hardwood rangeland management. General Technical Report GTR-PSW-126:9-13. Albany, CA: Pacific Southwest Research Station, USDA Forest Service.

Davidson, E., and M. Fox. 1974. Effects of off-road motorcycle activity on Mojave Desert vegetation and soil. Madroño 22:381-412.

Davis, F. W., D. M. Stoms, A. D. Hollander, K. A. Thomas, P. A. Stine, D. Odion, M. I. Borchert, J. H. Thorne, M. V. Gray, R. E. Walker, K. Warner, and J. Graae. 1998. The California Gap

Analysis Project--Final Report. University of California, Santa Barbara, CA. (http://www.biogeog.ucsb.edu/projects/gap/gap_rep.html)
Debinski, D.M., and R.D. Holt. 2000. A survey and overview of habitat fragmentation experiments. Conservation Biology 2:342-355.
Demaynadier, P.G., and M.L. Hunter, Jr. 1998. Effects of silvicultural edges on the distribution and abundance of amphibians in Maine. Conservation Biology 12:340-352.
Dennis, N.B., D. Ellis, J.R. Arnold, and D.L. Renshaw. 1984. Riparian surrogates in the Sacramento/San Joaquin and their habitat values. In: R.E. Warner and K.M. Hendrix, eds. California riparian systems: ecology, conservation, and productive management. University of California Press, Berkeley, California.
Dennis, R.L.H. 1993. Butterflies and Climate Change. Manchester University Press, Manchester.
De Vos, A. 1969. Ecological conditions affecting the production of wild herbivorous mammals on grasslands. In: Advances in ecological research. (Publisher unknown, place of publication unknown). On file at: U.S.D.A. Forest Service, Fire Sciences Laboratory, Intermountain Research Station, Missoula, Montana.
Dickson, BG, JS Jenness, and P. Beier. 2004. Influence of vegetation, roads, and topography on cougar movement in southern California. Journal of Wildlife Management 69(1):264-276.
Diffendorfer, J.E., M.S. Gaines, and R.D. Holt. 1995. The effects of habitat fragmentation on movements of three small mammal species. Ecology 76:827-839.
Downey, J.C. 1961. Myrmecophily in the Lycaenidae (Lepidoptera). Proceedings North Central Branch, Entomological Society of America. Vol. 16, pp. 14-15.
Dudek and Associates Species Accounts. 2001. Understanding the plants and animals of the Western Riverside County MSHCP: http://ecoregion.ucr.edu.
Dunn, P.H., S.C. Barro, W.G Wells, M.A. Poth, P.M. Wohlgemuth, and C.G. Colver. 1988. The San Dimas Experimental Forest: 50 years of research. Gen. Tech. Rep. PSW-104. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 49 p.
Eastwood, A. 1934. A revision of Arctostaphylos with key and descriptions. Leaflets of Western Botany. 1(11): 105-127.
Edelman, P. 1991. Critical Wildlife Corridor/Haibtat Linkage Areas between the Santa Susana Mountains, the Simi Hills and the Santa Monica Mountains. Prepared for The Nature Conservancy.
Emmel, T.C., and J.F. Emmel. 1973. The butterflies of southern California. Natural History Museum of Los Angeles County. Science Series 26:87, 135, 137.
Ernest, H.B., W.M. Boyce, V.C. Bleich, B. May, S.J. Stiver, and S.G. Torres. 2003. Genetic structure of mountain lion (*Puma concolor*) populations in California. Conservation Genetics 4:353-366.
Essig, E.O. 1926. Insects of North America. The Macmillan Co., New Yor, 1035 pp.
Evink, G.L. 2002. Interaction between roadways and wildlife ecology. National Academy Press, Washington, D.C.
Faber, P., E. Keller, A. Sands, and B.M. Massey. 1989. The ecology of riparian habitats of the southern California Coastal Region: A Community Profile. U.S. Department of the Interior, Fish and Wildlife Service, Research and Development, National Wetlands Research Center. Biological Report 85(7.27). Washington D.C.
Falk, N.W., H.B. Graves, and E.D. Bellis. 1978. Highway right-of-way fences as deer deterrents. Journal of Wildlife Management 42:646-650.

Farmland Mapping and Monitoring Program. 2002. Farmland Conversion Data. California State Division of Land Resource Protection. http://www.consrv.ca.gov/dlrp/fmmp/stats_reports/count_conversion_table.htm
Feldhammer, G.A., J.E. Gates, D.M. Harmon, A.J. Loranger, and K.R. Dixon. 1986. Effects of interstate highway fencing on white-tailed deer activity. Journal of Wildlife Management 50:497-503.
Field, C.B., G.C. Daily, S. Gaines, P.A. Matson, J. Melack, and N.L. Miller. 1999. Confronting climate change in California: ecological impacts on the Golden State. Union of Concerned Scientists and Ecological Society of America, Washington D.C.
Finney, K. and J. Edmondson. 2002. Swimming upstream: Restoring the Rivers and Streams of Coastal Southern California for Southern Steelhead and other Fishes. Prepared for the Southern California Steelhead Recovery Coalition.
Fisher, R.N., A.V. Suarez, and T.J. Case. 2002. Spatial patterns in the abundance of the coast horned lizard. Conservation Biology 16:205-215.
Fisher, R., and K. Crooks. 2001. Baseline biodiversity survey for the Tenaja Corridor and southern Santa Ana Mountains. U.S. Geological Survey Biological Resources Division and Department of Biology, San Diego State University, San Diego, California.
Fitzpatrick, F.A., B.C. Scudder, B.N. Lenz, and D.J. Sullivan. 2001. Effects of multi-scale environmental characteristics on agricultural stream biota in eastern Wisconsin. Journal of the American Water Resources Association, Vol. 37, pp.1489-1508.
Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Clevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine, and T.C. Winter. 2003. Road Ecology: Science and Solutions. Island Press, Washington, D.C.
Forman, R.T.T., and R.D. Deblinger. 2000. The ecological road-effect zone of a Massachusetts (U.S.A) suburban highway. Conservation Biology 14:36-46.
Forman, R.T.T., and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29:207-231.
Forman, R.T.T. 1995. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge University Press, Cambridge, England.
Forman, R.T.T. and R.E.J. Boerner. 1981. Fire frequency and the Pine Barrens of New Jersey. Bulletin of the Torrey Botanical Club 108:34-50.
Foster, M.L., and S.R. Humphrey. 1995. Use of highway underpasses by Florida panther and other wildlife. Wildlife Society Bulletin 23, 95-100.
Fraser, J. D., and D. R. Luukkonen. 1986. The loggerhead shrike. Pages 933-941 in R. L. DiSilvestro, editor. Audubon Wildlife Report 1986. Academic Press, New York.
Gaines, D.A. 1980. The valley riparian forests of California: their importance to bird populations. In: A. Sands, editor. Riparian forests in California: Their ecology and conservation: Symposium proceedings; May 14; 1977. University of California, Davis, CA: Division of Agricultural Sciences, pp. 57-85.
Garrett, K. and J. Dunn. 1981. Birds of southern California. Los Angeles Audubon Soc. 408 pp.
Gaona, P., P. Ferreras, and M. Delibes. 1998. Dynamics and viability of a metapopulation of the endangered Iberian lynx (*Lynx pardinus*). Ecological Monographs 68:349-370.
Garrett, K., and J. Dunn. 1981. Birds of southern California: status and distribution. Los Angeles Audubon Society. 408pp.
Gerber, L.R. E.W. Seabloom, R.S. Burton, and O.J. Reichman. 2003. Translocation of an imperiled woodrat population: integrating spatial and habitat patterns. Animal Conservation 6:309-316.

Giessow, J., and P. Zedler. 1996. The effects of fire frequency and firebreaks on the abundance and species richness of exotic plant species in coastal sage scrub. California Exotic Pest Plant Council. 1996 Symposium Proceedings. Berkeley, California.
Gilpin M. E. and M. E. Soulé 1986. Minimum viable populations: processes of species extinction. Pages 19-34 in Conservation biology: the science of scarcity and diversity. M.E. Soule (ed), Sinauer Associates, Inc. Sunderland, Mass
Gloyne, C.C., and A.P. Clevenger. 2001. Cougar (*Puma concolor*) use of wildlife crossing structures on the Trans Canada highway in Banff National Park, Alberta. Wildlife Biology 7:117-124.
Goforth, R.R. 2000. Local and landscape-scale relations between stream communities, stream habitat and terrestrial land cover properties. Dissertation Abstracts International Part B: Science and Engineering 8:3682.
Gordon, D.M., 1991. Behavioral flexibility and the foraging ecology of seed-eating ants. American Naturalist 138: 379–411.
Gordon, D.M., 1992. How colony growth affects forager intrusion between neighboring harvester ant colonies. Behav. Ecol. Sociobiol. 31, 417–427.
Griffin, J.R. 1976. Regeneration in *Quercus lobata* savannas, Santa Lucia Mountains, California. American Midland Naturalist 95:422-435.
Griffin, J.R. 1973. Xylem sap tension in three woodland oaks of central California. Ecology. 54(1): 152-159.
Griffin, J.R.; and W.B. Critchfield. 1972. The distribution of forest trees in California. Res. Pap. PSW-82. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 118pp.
Griffin, J. R. 1971. Oak regeneration in the upper Carmel Valley, California. Ecology 52(5): 862-868.
Griggs, F.T. 1990. Valley oaks: can they be saved? Fremontia 18:48-51.
Grinnell, J., and A.H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna No. 27, 608pp.
Gruell, G.E., and N.J. Papez. 1963. Movements of mule deer in northeastern Nevada. Journal of Wildlife Management 27:414-422.
Haas, C.D. 2000. Distribution, Relative Abundance, and Roadway Underpass Responses to Carnivores throughout the Puente-Chino Hills. MS Thesis, California State Polytechnic University, Pomona, CA. 110 pp.
Haas, C.A. 1995. Dispersal and use of corridors by birds in wooded patches on an agricultural landscape. Conservation Biology, Vo. 9, No. 4, pp. 845-854.
Hall, L.S., M.A. Kasparian, D. Van Vuren, and D.A. Kelt. 2000. Spatial organization and habitat use of feral cats (*Felis catus* L.) in Mediterranean California. Mammalia, Vol. 64, pp 19-28.
Hall, E. R. 1981. The mammals of North America. 2nd ed. Vol. 2. John Wiley and Sons. New York.
Hall, E. R., and K. R. Kelson. 1959. The mammals of North America. 2 Vols. The Ronald Press, New York. 1162pp.
Hall, E.R. 1946. Mammals of Nevada. University California Press, Berkeley. 710pp.
Hands, H. M., R. D. Drobney, and M. R. Ryan. 1989. Status of the loggerhead shrike in the northcentral United States. Missouri Coop. Fish Wildl. Res. Unit Rep. 15 pp.
Hanes, T.L. 1977. California chaparral. In: Barbour, Michael G.; Major, Jack, eds. Terrestrial vegetation of California. New York: John Wiley and Sons: 417-469.
Hanes, T.L. 1971. Succession after fire in the chaparral of southern California. Ecological Monographs. 41(1): 27-52.

Hanes, T.L. and H.W. Jones. 1967. Postfire chaparral succession in southern California. Ecology. 48(2): 259-264.
Hannon, S. J., R. L. Mumme, W. D. Koenig, S. Spon, and F. A. Pitelka. 1987. Poor acorn crop, dominance, and decline in numbers of Acorn Woodpeckers. Journal of Animal Ecology, Vol. 56, pp. 197-207.
Hanski, I., and M. Gilpin. 1991. Metapopulation Dynamics. Academic Press, London.
Harestad, A.S., and FL. Bunnell. 1979. Home range and body weight-a revelation. Ecology 60:389-402.
Harper, B. and L. Salata. 1991. A status review of the coastal Cactus Wren. U.S. Fish and Wildlife Service, Southern California Field Station, Laguna Niguel, California.
Harris, L.D., and P.B. Gallagher. 1989. New initiatives for wildlife conservation: the need for movement corridors. Pages 11-34 in G. Mackintosh, editor. Preserving communities and corridors. Defenders of Wildlife, Washington, D. C.
Harris, L.D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. University of Chicago Press, Chicago, Illinois.
Harris, R.R. and S.D. Kocher. 2001. Oak Management by County Jurisdictions in the Central Sierra Nevada, California. In: R.B. Standiford, D. McCreary, K.L. Purcell, technical coordinators. 2002. Proceedings of the fifth symposium on oak woodlands: oaks in California's changing landscape. 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 846 p.
Harris, R.T. 1975. Seasonal activity and microhabitat utilization in *Hyla cadaverina* (Anura: Hylidae). Herpetologica 31:236-239.
Harrison, R.L. 1992. Toward a theory of inter-refuge corridor design. Conservation Biology 6:293-295.
Heath, F. 2004. An Introduction to Southern California Butterflies. Mountain Press Publishing Company, Missoula, MT. 279pp.
Hehnke, M. and C.P. Stone. 1979. Value of riparian vegetation to avian populations along the Sacramento River System. In: R.R. Johnson and J.F. McCormick, technical coordinators. Strategies for protection and management of floodplain wetlands & other riparian ecosystems: Proc. of the symposium; 1978 December 11-13; Callaway Gardens, GA. General Technical Report WO-12. Washington, DC: U.S. Department of Agriculture, Forest Service: 228-235.
Hellmers, H., J.S. Horton, G. Juhren, and J. O'Keefe. 1955. Root systems of some chaparral plants in southern California. Ecology. 36(4): 667-678.
Hensley, M.M. 1954. Ecological relations of the breeding bird population of the desert biome in Arizona. Ecological Monographs 234:185-207.
Hickman, J.C. 1993. The Jepson Manual Higher Plans of California, University of California Press, Berkeley, Los Angeles, and London.
Higgins, P. 1991. Southern California Steelhead Recovery Assessment: San Mateo Creek, Santa Margarita River. Prepared for South Coast Chapter of Trout Unlimited.
Hill, E.P. 1967. Notes on the life history of the swamp rabbit in Alabama. Proceedings Annual Conference Southeast Association Game and Fish Comm. 21:117–123.
Hirth, H.F., R.C. Pendleton, A.C. King, and T.R. Downard. 1969. Dispersal of Snakes from a Hibernaculum in Northwestern Utah. Ecology 50:332–339.
Hogue, C.L. 1993. Insects of the Los Angeles Basin. Natural History Museum of Los Angeles County. Los Angeles, CA.

Holland, D.C. 1994. The western pond turtle: habitat and history. U.S. Department of Energy, Bonneville Power Administration, Portland, Oregon.
Holland, R.F. 1986. Preliminary Descriptions of the Terrestrial Natural Communities of California. State of California The Resources Agency Department of Fish and Game. 156pp.
Holland, R.F., and C.L. Roye. 1989. Great Valley riparian habitats and the National Registry of Natural Landmarks. In: D.L. Abell, technical coordinator. Proceedings of the California riparian systems conference: Protection, management, and restoration for the 1990's; 1988 September 22-24; Davis, CA. Gen. Tech. Rep. PSW-110. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 69-73.
Holldobler, B. 1974. Home range orientation and territoriality in harvesting ants. Proceedings of the Natural Academy of Science, USA. 71(8): 3274-3277.
Hooge, P.N., M.T. Stanback, and W.D. Koenig. 1999. Nest-site selection in the acorn woodpecker. The Auk , Vol. 116, No. 1, pp. 45-54.
Horton, J. S. and C.J. Kraebel. 1955. Development of vegetation after fire in the chamise chaparral of southern California. Ecology. 36(2): 244-262.
Horton, J.S and J.T. Wright. 1944. The wood rat as an ecological factor in southern California watersheds. Ecology. 25(3): 341-351.
Horwitz, E.L. 1978. Our nation's wetlands: an interagency task force report. Council on Environmental Quality, Washington D.C.
Hunter, R. 1999. South Coast Regional Report: California Wildlands Project Vision for Wild California. California Wilderness Coalition, Davis, California.
Ingles, L.G. 1965. Mammals of the Pacific states. Stanford University Press, Stanford, CA. 506pp.
Iverson, R.M. 1980. Processes of accelerated pluvial erosion on desert hillslopes modified by vehicular traffic. Earth Surface Processes 5:369-388.
Jackson, S.D. and C.R. Griffin. 2000. A Strategy for Mitigating Highway Impacts on Wildlife. Pp. 143-159 In Messmer, T.A., and B. West (eds.). Wildlife and Highways: Seeking Solutions to an Ecological and Socio-economic Dilemma. The Wildlife Society.
Jameson, Jr., E.W., and H.J. Peeters. 1988. California Mammals. University of California Press, Berkeley, Los Angeles, London. 403pp.
Jantz, L., R. Kadowaki, and B. Spilsted. 1990. Skeena River salmon test fishery, 1987. Canadian Data Report of Fisheries and Aquatic Sciences No. 804:151 p.
Jehl, J. R., Jr. 1978. Scrub oak-desert chaparral. Page 105 in W. T. Van Velzen, ed. Forty-first breeding bird census. American Birds, Vol. 32, pp. 49-125.
Jennings, M. R., and M. P. Hayes. 1994. Amphibian and reptile species of special concern in California. Final Report #8023 Submitted to the California Department of Fish and Game.
Johnson, D.H., L.D. Igl, J.A. Dechant, M.L. Sondreal, C.M. Goldade, M.P. Nenneman, and B.R. Euliss. 1998. Effects of management practices on grassland birds: Loggerhead Shrike. Northern Prairie Wildlife Research Center, Jamestown, ND.
Johnson, R.A. 2000. Reproductive Biology of the Seed–harvester Ants *Messor julianus* (Pergande) and *Messor pergandei* (Mayr) (Hymenoptera: Formicidae) in Baja California, Mexico J. of Hymenoptera Research. 9:377–384.
Johnson, R.A. 1992. Soil texture as an influence on the distribution of the desert seed–harvester ants *Pogonomyrmex rugosus* and *Messor pergandei* Oecologia (Berl.) 89: 118–124.
Jones, J.A., F.J. Swanson, B.C. Wemple, and K.U. Snyder. 2000. Effects of roads on hydrology, geomorphology, and disturbance patches in stream networks. Conservation Biology 14:76-85.

Jones, Z.F., and C.E. Bock. 2002. Conservation of grassland birds in an urbanizing landscape: a historical perspective. The Condor 104:643-651.

Jorgensen, C.D. and W.W. Tanner. 1963. The application of the density probability function to determine the home ranges of *uta stansburiana stansburiana* and *cnemidoporus tigris tigris*. Herpetologica 19:105-115.

Kamradt, D. 1995. Evaluating bobcat (Felis rufus) viability in the Santa Monica Mountains, California: GIS modeling and field validation. MS Thesis, California State University Northridge, CA. 77 pp.

Kay, D.W. 1989. Movements and homing in the canyon tree frog (*Hyla cadaverina*). The Southwestern Naturalist 34:293-294.

Keeley, J.E. 1977. Seed production, seed populations in soil, & seedling production after fire for 2 congeneric pairs of sprouting & nonsprouting chaparral shrubs. Ecology. 58: 820-829.

Keeley, J.E., and C.J. Fotheringham. 2003. Impact of past, present, and future fire regimes on North American Mediterranean shrublands. In: Fire and Climatic Change in Temperate Ecosystems of the Western Americas, edited by T.T. Veblen, W.L. Baker, G. Montenegro, and T.W. Swetnam. Springer-Verlag, New York.

Keeley, J.E. and R.L. Hays. 1976. Differential seed predation on two species of Arctostaphylos (Ericaceae). Oecologia. 24: 71-81.

Keeley, J.E, and S.C. Keeley. 1988. Chaparral. Pages 165-208 In: M.G. Barbour and W.D. Billings (eds.). North American terrestrial vegetation. Cambridge University Press, Cambridge, UK.

Keeley, J.E. and S.C. Keeley. 1977. Energy allocation patterns of a sprouting and a nonsprouting species of Arctostaphylos in the California chaparral. American Midland Naturalist. 98(1): 1-10.

Kelly. P.A. 1989. Population ecology and social organization of dusky footed woodrats. PhD Thesis, University of California, Berkeley.

Kie, J.G., Bowyer, R.T., Nicholson, M.C., Boroski, B.B., and E.R. Loft. 2002. Landscape heterogeneity at differing scales: Effects on spatial distribution of mule deer. Ecology 83:530-544.

Kingery, H.E. 1962. Coastal chaparral. Pages 534-535 in G. A. Hall, ed. Twenty-sixth breeding bird census. Audubon Field Notes, Vol. 16, pp. 518-540.

Klein, D.R. 1971. Reaction of reindeer to obstructions and disturbances. Science 173:393-398.

Kline, T.C., Jr., J.J. Goering, O.A. Mathisen, P.H. Poe, and P.L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon.I $\delta^{15}N$ and $\delta^{13}C$ evidence in Sashin Creek, southeastern Alaska. Canadian Journal of Fisheries and Aquatic Sciences 47:136-144.

Knight, R.L. and D.N. Cole. 1995. Wildlife responses to recreationists. In: R.L. Knight and K.J. Gutzwiller, eds. Wildlife and recreationists, coexistence through management and research. Island Press, Washington D.C.

Knight, R.L., G.N. Wallace, and W.E. Riebsame. 1995. Ranching the view: subdivisions versus agriculture. Conservation Biology 9:459-461.

Knopf, F.L. 1994. Avian assemblages in altered grasslands. Studies in Avian Biology 15: 247-257.

Koenig, W.D., P.N. Hooge, M.T. Stanback, and J. Haydock. 2000. Natal dispersal in the cooperatively breeding acorn woodpecker. The Condor, Vol. 102, pp. 492-502.

Koenig, W.D., and J. Haydock. 1999. Oaks, acorns, and the geographical ecology of acorn woodpeckers. Journal of Biogeography, Vol. 26, No. 1, pp. 159-165.

Koenig, W. D., P. B. Stacey, M. T. Stanback, and R. L. Mumme. 1995. Acorn Woodpecker (Melanerpes formicivorus). In The Birds of North America, No. 194 (A. Poole and F. B. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D. C.

Koenig, W. D., and R. L. Mumme. 1987. Population ecology of the cooperatively breeding Acorn Woodpecker. Monographs in Population Biology 24, Princeton University Press.

Kohn, M.H., E.C. York, D.A. Kamradt, G. Haught, R.M. Sauvajot, and R.K. Wayne. 1999. Estimating population size by genotyping faeces. Proc. Royal Soc. (Series B) 266: 657-663.

Kridelbaugh, A.L. 1982. An ecological study of loggerhead shrikes in Central Missouri. University of Missouri.

Kristan, W.B. III, A.J. Lynam, M.V. Price, and J.T. Rotenberry. 2003. Alternative causes of edge-abundance relationships in birds and small mammals of California coastal sage scrub. Ecography 26:29-44.

Kreuper, D.J. 1992. Effects of land use on western riparian ecosystems. In: D.M. Finch and P.W. Stangel, eds. Status and Management of Migratory Birds. U.S.D.A. Forest Service General Technical Report RM-229.

LaHaye, W.S., R.J. Gutierrez, and J.R. Dunk. 2001. Natal dispersal of the spotted owl in southern California: dispersal profile of an insular population. Condor 103:691-700.

Lee, A. K. 1963. The adaptations to arid environments in woodrats of the genus Neotoma. University of California Publication in Zoology 64:57-96.

Lens, L., and A.A. Dhondt. 1994. Effect of habitat fragmentation on the timing of crested tit Parus cristatus dispersal. The Ibis, Vol. 136, pp. 147-152.

Levins, R. 1970. Extinction. Pages 77-107 in M. Gerstenhaber, ed. Some Mathematical Questions in Biology. Lectures on Mathematics in the Life Sciences, Vol. 2. American Mathematical Society, Providence, RI.

Lienenbecker, H. and U. Raabe. 1981. Veg auf Bahnhofen des Ost-Munsterlandes. Berichte naturw. Ver. Bielefeld 25:129-41.

Light, R.H. and L.E. Pedroni. 2001. When Oak Ordinances Fail: Unaddressed Issues of Oak Conservation. In: R.B. Standiford, D. McCreary, K.L. Purcell, technical coordinators. 2002. Proceedings of the fifth symposium on oak woodlands: oaks in California's changing landscape. 2001 October 22-25; San Diego, CA. Gen. Tech. Rep. PSW-GTR-184. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 846 p.

Ligon, J.D, and P.B. Stacey. 1996. Land use, lag times and the detection of demographic change: the case of the acorn woodpecker. Conservation Biology, Vol. 10, No. 3, pp. 840-846.

Lindzey, F. 1987. Mountain lion. Pp. 656-668 In: M. Novak, J. Baker, M.E. Obbard, and B. Mllock, eds. Wild furbearer management and conservation in North America. Ontario Trappers Association. North Bay, Ontario.

Lindzey, F.G. 1978. Movement patterns of badgers in northwestern Utah. Journal of Wildlife Management 42:418-422.

Linsdale, J.M., and L.P. Tevis, Jr. 1951. The dusky-footed woodrat. University California Press, Berkeley, CA. 664pp.

Litvaitis, J.A. and R. Villafuerte. 1996. Factors affecting the persistence of New England cottontail metapopulations: the role of habitat management. Wildlife Society Bulletin 24:686-693.

Loft, E.R., D. Armentrout, G. Smith, D. Craig, M. Chapel, J. Willoughby, C. Rountree, T. Mansfield, S. Mastrup, and F. Hall. 1998. An assessment of mule deer and black-tailed deer habitats and population in California: with special emphasis on public lands administered by the Bureau of Land Management and the United States Forest Service. Sacramento, CA: California Department of Fish and Game, Wildlife Management Division.

Logan, K.A., and L.L. Sweanor. 2001. Desert Puma: evolutionary ecology and conservation of an enduring carnivore. Island Press, Washington, D.C.

Long, C.A. and C.A. Killingley. 1983. The badgers of the world. Charles C. Thomas Publishing, Springfield, Illinois.

Long, C.A. 1973. *Taxidea taxus*. Mammalian Species, Vol. 26, pp. 1-4.

Longcore, T. 2000. Ecological effects of fuel modification on arthropods and other wildlife in an urbanizing wildland. In: L.A. Brennan et al., eds. National Congress on Fire Ecology, Prevention and Management Proceedings, No. 1. Tall Timbers Research Station, Tallahassee, Florida.

Longhurst, W.M., Leopold, A.S., and R.F. Dasmann. 1952. A survey of California deer herds, their ranges and management problems. California Department of Fish and Game, Game Bulletin. No. 8. 163 pp.

Los Angeles Regional Water Quality Control Board (LARWQCB). 2004. Watershed Management Initiative Chapter. October 2004.

Lotz, M.A.; E.D. Land, and K.G. Johnson. 1996. Evaluation of state road 29 wildlife crossings. Final report, study no. 7583. Florida Game and Freshwater Fish Commission. Tallahassee, Florida. 15pp.

LSA Associates, Inc. 2004. Final Wildlife Corridor Assessment Ventura State Route 118. Prepared for CalTrans District 7 Division of Environmental Planning. Prepared by LSA Associates, Inc.

Ludwig, J., and T. Bremicker. 1983. Evaluation of 2.4-m fences and one-way gates for reducing deer-vehicle collisions in Minnesota. Transportation Research Record, Vol. 913, pp 19-22.

Lupis, S.G., T.K. Fuller, E.C. York, R.M. Sauvajot, and J. Fedriani. 1999. A preliminary evaluation of the American badger (Taxidea taxus) in the Santa Monica Mountains National Recreation Area, California. National Park Service Technical Report.

Lynch, J.F., and D.F. Whigham. 1984. Effects of forest fragmentation on breeding bird communities in Maryland, USA. Biological Conservation, Vol. 28, pp.287-324.

Lyon, L.J. 1983. Road density models describing habitat effectiveness for elk. Journal of Forestry 81:592-5.

MacArthur, R.H., and E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, NJ.

Machtans, C.S., M.A. Villard, and S.J. Hannon. 1996. Use of riparian buffer strips as movement corridors by forest birds. Conservation Biology, Vol. 10, No. 5, pp. 1366-1379.

MacKay, W.P. 1981. A comparison of the nest phonologies of three species of *Pogonomyrmex* harvester ants (Hymenoptera: Formicidae). Psyche 88: 25274.

MacMahon, J.A., J.F. Mull and T.O. Crist. 2000. Harvester ants (*Pogonomyrmex spp.*: Their community and ecosystem influences. Annual Review of Ecology and Systematics, November 2000, Vol.. 31, pages 265-291.

MacMillen, R. E. 1964. Population ecology, water relations and social behavior of a southern California semidesert rodent fauna. University of California Publication in Zoology, Vol. 71:1-59.

MacRoberts, M. H., and B. R. MacRoberts. 1976. Social organization and behavior of the acorn woodpecker in central coastal California. Ornithological Monographs, No. 21, 115pp.

MacRoberts, M. H. 1970. Notes on the food habits and food defense of the acorn woodpecker. Condor, Vol. 72, pp. 196-204.

Maehr, D.S. 1992. Florida panther: *Felis concolor* coryi. Pages 176-189 In: S.R. Humphrey, (ed.). Rare and endangered biota of Florida. Mammals: Volume 1. Florida Game and Fresh Water Fish Commission. Naples, Florida.

Manolis, T. 2003. Dragonflies and Damselflies of California. UC Press.

Mans, M.L. 1961. Coastal chaparral. Page 514-515 in G.I.A. Hall, editor. Twenty-fifth breeding bird atlas. Audubon Field Notes, Vol. 15.

Maret, T. and D. MacCoy. 2002. Fish assemblages and environmental variables associated with hard-rock mining in the Coeur d'Alene River Basin, Idaho. Trans. American Fisheries Society, Vol. 131, pp. 865-884. Bethesda, Maryland.

Marzluff, J.M., and K. Ewing. 2001. Restoration of fragmented landscapes for the conservation of birds: a general framework and specific recommendations for urbanizing landscapes. Restoration Ecology. 9:280-292.

Matocq, M.D. 2002a. Phylogeographical structure and regional history of the dusky-footed woodrat, *Neotoma fuscipes*. Molecular Ecology 11:229-242.

Matocq, M.D. 2002b. Morphological and molecular analysis of a contact zone in the Neotoma fuscipes species complex. J. Mammal. 83:866-883.

McBride, J.R.; and J. Strahan. 1984. Fluvial processes and woodland succession along Dry Creek, Sonoma County, California. Pages 110-119 In: Warner, R.E. and Hendrix, K.M., eds. California riparian systems: Ecology, conservation, and productive management: Proceedings of a conference; 1981 September 17-19; Davis, CA. Berkeley, CA: University of California Press.

McCaskie, G., P. De Benedictis, R. Erickson, and J. Morlan. 1979. Birds of northern California, an annotated field list. 2nd ed. Golden Gate Audubon Soc., Berkeley. 84 pp.

M'Closkey, R.T. 1976. Community Structure in Sympatric Rodents. Ecology 57:728-739

McCoy, C. J. 1965. Life history and ecology of Cnemidophorus tigris septentrionalis. Ph.D. thesis, University of Colorado, Boulder.

McCullough, Y.B. 1980. Niche separation of seven North American ungulates on the National Bison Range, Montana. PhD Dissertation, University of Michigan, Ann Arbor. 226pp.

McDonald, W. and C.C. St Clair. 2004. Elements that promote highway crossing structure use by small mammals in Banff National Park. Journal of Applied Ecology 41:82-93.

McEwan, D. and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game. 40 p.

McGurty, B.M. 1988. Natural History of the California Mountain Kingsnake Lampropeltis zonata. Proceedings of the Conference on California Herpetology. Edity by H.F. De Lisle, P.R. Brown, B. Kaufman, and B.M. McGurty. Southwestern Herpetologists Society.

McPhail, J.D. and C.C. Lindsey. 1970. Freshwater fishes of Northwestern Canada and Alaska. Fisheries Research Board of Canada Bulletin 173.

Merenlender, A. M., K. L. Heise, and C. Brooks. 1998. Effects of subdividing private property on biodiversity in California's north coast oak woodlands. Trans. Westerns Section of the Wildlife Society 34:9-20.

Meserve, P.L. 1976. Food relationships of a rodent fauna in a California coastal sage scrub community. Journal of Mammalogy 57:300-319.

Messenger, K.G. 1968. A railway flora of Rutland. Proceedings of the Botanical Society of the British Isles 7:325-344.

Messick, J.P., and M.G. Hornocker. 1981. Ecology of the badger in southwestern Idaho. Wildlife Monographs 76:1-53.

Miller, A. H. 1931. Systematic revision and natural history of the American shrikes (Lanius). Univ. Calif. Publ. Zool. 38:11-242.

Miller, F.L. 1970. Distribution patterns of black-tailed deer (*Odocoileus hemionus columbianus*) in relation to environment. Journal of Wildlife Management 51:.248-260.

Mills, L.S., and P.E. Smouse. 1994. Demographic consequences of inbreeding in remnant populations. American Naturalist 144:412-431.

Milstead, W.W. 1957. Observations on the natural history of four species of the whiptail lizard, cnemidophorus (Sauria:Teiidae) in Trans-Pecos Texas. Southwest Nat. 2:105-121.

Minnich, R. and L. Howard. 1984. Biogeography and prehistory of shrublands. In: DeVries, J.J., ed. Shrublands in California: literature review and research needed for management. Contribution No. 191. Davis, CA: University of California, Water Resources Center: 8-24.

Minta, S.C. 1993. Sexual differences in spatio-temporal interaction among badgers. Oecologia 96:402-409.

Mittermeier, R.A., N. Myers, J.B. Thomsen, G.A.B. de Fonceca, and S. Olivieri. 1998. Biodiversity hotspots and major tropical wilderness areas: approaches to setting conservation priorities. Conservation Biology 12:516-520.

Mittermeier, R.A., N. Myers, and C.G. Mittermeier (eds.). 1999. Hotspots: Earth's biologically richest and most endangered terrestrial ecosystems. CEMAX, Mexico City.

Moldenke. 1976. California pollination ecology. Phytologia 34(4): check 319-321…

Montanucci, R. R. 1989. The relationship of morphology to diet in the horned lizard genus *Phrynosoma*. Herpetologica 45:208-216.

Moorpark, City Department of Planning. 2004. North Park Village & Nature Preserve. Specific Plan EIR. Land use, Grading & Circulation. http://www.ci.moorpark.ca.us.

Morrison, M.L., L.S. Hall, J.J. Keane, A.J. Kuenzi, and J. Verner. 1993. Distribution and Abundance of birds in the White Mountains, California. Great Basin Naturalist 53:246-258.

Mossman, A.S. 1955. Reproduction of the brush rabbit in California. Journal of Wildlife Management 19:177-184.

Munz, P.A. 1974. A flora of southern California. University of California Press, Berkeley and Los Angeles, California.

Moyle, P.B. 1976. Inland fishes of California. Pp 131-132. University of California Press. Berkeley, CA 405 p.

Muehlenbach, V. 1979. Contributions to the synanthropic (adventive) flora of the railroads in St. Louis, Missouri, USA. Annals of the Missouri Botanical Garden 66:1-108.

Munz, P.A. and D.D. Keck. 1959. A California Flora. University of California Press.

Murcia, C. 1995. Edge effects in fragmented forests: implications for conservation. Trends in Ecology and Evolution 10:58-62.

Murray, K.F., and A.M. Barnes. 1969. Distribution and habitats of the woodrat Neotoma fuscipes in northeastern California. Journal of Mammalogy 50:43-48.

Nagy, K.A. 1994. Seasonal Water, Energy and Food Use by Free-Living, Arid-Habitat Mammals. Australian Journal of Zoology 42:55 – 63.

Naicker, K., E. Cukrowska, and T.S. McCarthy. 2001. Acid mine drainage arising from gold mining activity in Johannesburg, South Africa and environs. Environmental Pollution, Vol.122, No.1.

National Marine Fisheries Service. 2000a. Endangered and Threatened Species: Threatened Status for One Steelhead Evolutionarily Significant Unit (ESU) in California. Federal Register, Vol 65: No. 174. pp 54177-54178.

National Marine Fisheries Service. 2000b. Guidelines for Salmonid Passage at Stream Crossings. Final Draft Revised May 16, 2000. National Marine Fisheries Service Southwest Region.

National Research Council Canada. 2002. Construction and rehabilitation costs for buried pipe with a focus on trenchless technologies. By J. Q. Zhao and B. Rajani. IRC-RR-101. June. http://irc.nrc-cnrc.gc.ca/ircpubs.

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.6. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. (Accessed: September 2, 2005).

Ng, S.J., J.W. Dole, R.M. Sauvajot, S.P.D. Riley, and T.J. Valone. 2004. Use of highway undercrossings by wildlife in southern California. Biological Conservation 115, pp. 499-507.

Ng, S.J. 2000. Wildlife use of underpasses and culverts crossing beneath highways in southern California. MS Thesis, California State University Northridge, Northridge, CA. 58pp.

Nicholson, M.C., R.T. Bowyer, and J.G. Kie. 1997. Habitat Selection and survival of mule deer: tradeoffs associated with migration. Journal of Mammalogy 78:483-504.

Nicolai, N.C. and J.E. Lovich. 2000. Preliminary observations of the behavior of male, flat-tailed horned lizards before and after an off-highway vehicle race in California. California Fish and Game 86:208-212.

Niemi, A. 1969. On the railway vegetation and flora between Esbo and Inga, southern Finland. Acta Botanica Fennica 83:1-28.

NOAA. 1996. Status Review of West Coast Steelhead. NOAA-NWFSC Tech Memo-27. http://www.nwfsc.noaa.gov/publications/techmemos/index.cfm.

Norton, D.A. 2002. Edge effects in a lowland temperate New Zealand rainforest. DOC Science Internal Series 27. Department of Conservation, Wellington.

Noss, R.F., C. Carroll, K. Vance-Borland, and G. Wuerthner. 2002. A multicriteria assessment of the irreplaceability and vulnerability of sites in the Greater Yellowstone Ecosystem. Conservation Science, Inc.

Noss, R.F., and A.Y. Cooperrider. 1994. Saving nature's legacy: protecting and restoring biodiversity. Island Press, Washington, D.C.

Noss, R. F. 1992. The Wildlands Project: Land conservation strategy. Wild Earth (Special Issue), Vol. 1, pp. 10-25.

Noss, R. F. 1991. Landscape linkages and biodiversity. Pages 27-39 In: W. E. Hudson, ed. Washington, D.C.

Noss, R. F. 1987. Protecting natural areas in fragmented landscapes. Natural Areas Journal 7:2-13.

Noss, R. F. 1983. A regional landscape approach to maintain diversity. Bioscience 33:700-706.

Novak, P. 1989. Breeding ecology and status of loggerhead shrike (LANIUS LUDOVICIANUS) in New York. Master's thesis, Cornell Univ., Ithaca, New York.

Nussbaum, R.A., E.D. Brodie, Jr., and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University Press of Idaho.

O'Farrell, M.J. 1978. Home range dynamics of rodents in a sagebrush community. Journal of Mammalogy 59:657-668.

Ohmart, R.D. 1994. The effects of human-induced changes on the avifauna of western riparian habitats. Studies in Avian Biology No. 15, pp. 273-285.

Olson, D.H. 1992. Ecological susceptibility of amphibians to population declines. Pp 55-61 *in* R.R. Harris, D.C Erman, H.M. Kerner (Tech. Coord.) Proceedings of the symposium on

biodiversity of northwestern California. 1991 October 28-30. Santa Rosa , California. Report 29. Wildland Resources Center, Division of Agriculture and Natural Resources, University of California, Berkeley, California.
Orr, R.T. 1940. The rabbits of California. Calif. Acad. Sci. Occas. Pap. No. 19. 227 pp.
Orsak, L.J. 1978. The butterflies of Orange County, California. Center for Pathobiology, Miscellaneous Publication no. 3. Museum of Systematic Biology, Research Series no. 4. University of California, Irvine. 349 pp.
Parker, I., and W.J. Matyas. 1981. CALVEG: a classification of California vegetation. U.S. Department of Agriculture, Forest Service, Regional Ecology Group, San Francisco.
Patten, M.A., and D.T. Bolger. 2003. Variation in top-down control of avian reproductive success across a fragmentation gradient. Oikos 101:479-488.
Pavlick, B.M., P.C. Muick, S.G. Johnson, and M. Popper. 2000. Oaks in California. Los Olivos, CA: Cachuma Press.
PCR Services Corporation. 2000a. Biological Resources Assessment of the Proposed Santa Monica Mountains Significant Ecological Area. Prepared for: Los Angeles County Department of Regional Planning. Prepared by PCR Service Corporation, Frank Hovore and Associates, and FORMA Systems.
PCR Services Corporation. 2000b. Biological Resources Assessment of the Proposed Santa Susana Mountains/Simi Hills Significant Ecological Area. Prepared for: Los Angeles County Department of Regional Planning. Prepared by PCR Service Corporation, Frank Hovore and Associates, and FORMA Systems.
PCR Services Corporation. 2000c. Biological Resources Assessment of the Proposed Santa Clara River Significant Ecological Area. Prepared for: Los Angeles County Department of Regional Planning. Prepared by PCR Service Corporation, Frank Hovore and Associates, and FORMA Systems.
Penrod, K., C. Cabañero, P. Beier, C. Luke, W. Spencer, and E. Rubin. 2004. South Coast Missing Linkages Project: A Linkage Design for the San Gabriel-Castaic Connection. South Coast Wildlands, Idyllwild, CA. www.scwildlands.org.
Penrod, K, R Hunter, and M Merrifield. 2001. Missing Linkages: Restoring connectivity to the California landscape. California Wilderness Coalition, The Nature Conservancy, US Geological Survey, Center for Reproduction of Endangered Species, and California State Parks.
Peters, R.L., and R.F. Noss. 1995. America's Endangered Ecosystems. Defenders of Wildlife. <http://www.defenders.org/amee03.html> (22 December 2003).
Pianka, E. R., and W. S. Parker. 1975. Ecology of horned lizards: a review with special reference to *Phrynosoma platyrhinos*. Copeia 1975:141-162.
Pierce, B.M., V.C. Bleich, J.D. Wehausen, and R.T Bowyer. 1999. Migratory patterns of mountain lions: implication for social regulation and conservation. Journal of Mammalogy 80:986-992.
Pfister, H., V. Keller, H. Reck and B. Georgii. 1997. Bio-ökologische Wirksamkeit von Grünbrücken über Verkehrswege. Forschung, Strassenbau und Strassenverkehrstechnik 756. Bundesministerium für Verkehr, Bonn.
Porter, D, K., M.A. Strong, J. B. Giezentanner, and R.A. Ryder. 1975. Nest ecology, productivity, and growth of the loggerhead shrike on the shortgrass prairie. Southwest. Nat. 19:429-436.
Powell, J.A. 1975. Family Riodinidae. Pages 259-272. In: W.H. Howe, ed. The butterflies of North America. Doubleday Press, New York, NY.

Powell, J.A. and C.L. Hogue. 1979. California insects. University of California Press, Berkeley. 388 pp.

Pruitt, L. 2000. Loggerhead Shrike Status Assessment, USFWS report, USFWS. Bloomington, IN.

Psomas. 2001. Biological resources along the highway 118 right-of-way at Alamos Canyon. Simi Valley, Ventura County, California. Prepared for Unocal Corporation. Costa Mesa, California. May 24.

Psomas. 2002. Regional wildlife corridors, wildlife utilization, and open space in the Simi Valley region, Ventura and Los Angeles Counties, California, revised draft, June 17. Prepared for Unocal Land and Development Company by Psomas Natural Resources Group. Costa Mesa, California. June 17.

Purcell, K. L., and J. Verner. 1999. Nest predators of open and cavity nesting birds in oak woodlands. Wilson Bull. 111:251-256.

Quinn, R.D. 1990. Habitat preferences and distribution of mammals in California chaparral. Research Paper PWS-202. Pacific Southwest Research Station, Department of Agriculture, Forest Service, Berkeley, California.

Quinn, R. D. 1989. The Status of Walnut Forests and Woodlands (Juglans californica) in Southern California. Pages 42-54 in A.A. Schoenherr, editor. Proceedings of the 15th Annual Symposium of the Endangered Plant Communities of Southern California, California State University, Fullerton.

Radtke, K.W.H. 1983. Living more safely in the chaparral-urban interface. USDA Forest Service, Pacific Southwest Forest and Range Experimental Station. General Technical Report PSW-67.

Rea, A.M. and K. Weaver. 1990. The taxonomy, distribution, and status of coastal California Cactus Wrens. Western Birds 21:81-126.

Reed, D.F. 1981. Mule deer behavior at a highway underpass exit. Journal of Wildlife Management, 45, 542-543.

Reed, D.M. and J.A. Schwarzmeier. 1978. The prairie corridor concept: possibilities for planning large scale preservation and restoration. In Lewin and Landers (eds) Proceedings of the Fifth Midwest Prairie Conference, pp. 158-65. Iowa State University, Ames, Iowa, USA.

Reed, D.F., T.N. Woodard, and T.M. Pojar. 1975. Behavioral response of mule deer to a highway underpass. Journal of Wildlife Management 39:361-367.

Reijnen, R., R. Foppen, and G. Veenbaas. 1997. Disturbance by traffic of breeding birds: Evaluation of the effect and considerations in planning and managing road corridors. Biodiversity and Conservation 6:567-581.

Rich, C. and T. Longcore (eds). 2006. Ecological Consequences of Artificial Night Lighting. Island Press, Washington D.C.

Richey, J.E., M.A. Perkins, and C.R. Goldman.1975. Effects of kokanee salmon (*Onchorhynchus nerka*) decomoposition on the ecology of a subalpine stream. Journal of the Fisheries Research Board of Canada 32:817-820.

Riley, S.P.D., J.P. Pollinger, R.M. Sauvajot, E.C. York, C. Bromley, T.K. Fuller, and R.K. Wayne. 2006a. A southern California freeway is a physical and social barrier to gene flow in carnivores. Molecular Ecology 15: 1733-1741.

Riley, S.P.D., R.M. Sauvajot, J. Sikich, and E. York. 2006b. Mountain lion ecology, behavior, and conservation in the fragmented urban landscape of Santa Monica Mountains National Recreation Area and surrounding parklands, 2002-2006. National Park Service Technical Report submitted to the California Department of Parks and Recreation.

Riley, S.P.D., G.T. Busteed, L.B. Kats, T.L. Vandergon, L.F.S. Lee, R.G. Dagit, J.L. Kerby, R.N. Fisher, and R.M. Sauvajot. 2005. Effects of urbanization on the distribution and abundance of amphibians and invasive species in southern California. Conservation Biology 19: 1894-1907.

Riley, S.P.D., R.M. Sauvajot, T.K. Fuller, E.C. York, D.A. Kamradt, C. Bromley, and R.K. Wayne. 2003. Effects of urbanization and habitat fragmentation on Bobcats and coyotes in southern California. Conservation Biology 17:566-576.

Ritter, W. E. 1938. The California woodpecker and I. Univ. Calif. Press, Berkeley. 340pp. Riverside County Integrated Project. 2000. MSHCP Species Accounts. Prepared by Dudek and Associates for Riverside County, California.

Robbins, C. S., D. Bystrack, and P. H. Geissler. 1986. The breeding bird survey: its first fifteen years, 1965-1979. U.S. Fish and Wildlife Service Resource Publ. 157. Washington, D.C.

Roberts, F.M. 1995. *An illustrated guide to the oaks of the southern California floristic province, the oaks of coastal southern California and northwestern Baja California, Mexico*. Encinitas, CA: F.M. Roberts Publications.

Roberts, R.C. 1984. The transitional nature of northwestern California riparian systems. Pages 85-91 In: R.E. Warner, and K.M. Hendrix, eds. California riparian systems: Ecology, conservation, and productive management: Proceedings of the conference. 1981 September 17-19; Davis, CA. Berkeley, CA: University of California Press.

Roberts, W.G.; Howe, J.G., and J. Major. 1980. A survey of riparian forest flora and fauna in California. Pages 3-19 In: A. Sands, ed. Riparian forests in California: Their ecology and conservation: Symposium proceedings. Davis, CA: University of California, Division of Agricultural Sciences.

Roberts, R.C. 1979. Habitat and resource relationships in acorn woodpeckers. Condor, Vol. 81, pp. 1-8.

Roberson, D., and C. Tenney, eds. 1993. Atlas of the Breeding Birds of Monterey County, California. Monterey Pen. Audubon Soc., Carmel.

Robinette, W.L. 1966. Mule deer home range and dispersal in Utah. Journal of Wildlife Management 30:335-349.

Romin, L.A., and J.A. Bissonette. 1996. Deer-vehicle collisions: status of state monitoring activities and mitigation efforts. Wildlife Society Bulletin 24:276-283.

Rosell Papes, C. and J.M. Velasco Rivas. 1999. Manual de prevencio I correccio dels impactes de les infrastructures viaries sobre la fauna. Departament de Medi Ambient, Numero 4. Generalitat de Catalunya. Barcelona, Spain.

Rossi, R.S. 1980. History of cultural influences on the distribution and reproduction of oaks in California. In: Plumb, T.R., technical coordinator. Proceedings of the symposium on the ecology, management and utilization of California oaks; 1979 June 26-28; Claremont, CA. Gen. Tech. Rep. PSW-44. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 7-18.

Runkle Canyon Neighbors. 2003. Specific plan land use map dated July 2003. http://www.runklecanyon.com/landPlan.html.

Saab, V.A., C.E. Bock, T.D. Rich, and D.S. Dobkin. 1995. Livestock grazing effects in western North America, p. 311-353. *In* T.E. Martin and D.M. Finch (eds.), Ecology and management of Neotropical migratory birds. Oxford University Press, New York. Sakai, H.F. and B.R. Noon. 1993. Dusky-footed woodrat abundance in different aged forests in northwestern California. Journal of Wildlife Management 57:373-382.

Sampson, A.W. and B.S. Jespersen. 1963. California range brushlands and browse plants. Berkeley, CA: University of California, Division of Agricultural Sciences, California Agricultural Experiment Station, Extension Service. 162pp.
Sands, A. 1979. Public involvement in riparian habitat protection: A California case history. In: Johnson, R. Roy; McCormick, J. Frank, technical coordinators. Strategies for protection and management of floodplain wetlands and other riparian ecosystems: Proc. of the symposium; 1978 December 11-13; Callaway Gardens, GA. General Technical Report WO-12. Washington, DC: U.S. Department of Agriculture, Forest Service, pp. 216-227.
Santolini, R., G. Sauli, S. Malcevschi, and F. Perco. 1997. The relationship between infrastructure and wildlife: problems, possible solutions and finished works in Italy. Pp. 202-212 In K. Canters (ed.). Habitat Fragmentation and Infrastructure, proceedings of the international conference on habitat fragmentation and the role of ecological engineering. Ministry of Transport, Public Works and Water Management, Delft, The Netherlands.
Sargeant, A.B., and D.W. Warner. 1972. Movement and denning habitats of badger. Journal of Mammalogy 53:207-210.
Sauer, J. R., J. E. Hines, and J. Fallon. 2001. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2000. Version 2001.2.* USGS Patuxent Wildlife Research Center, Laurel, MD. Available at: http://www.mbr.nbs.gov/bbs/bbs.html.
Sauvajot, R.M., E.C. York, T.K. Fuller, H.S. Kim, D.A. Kamradt, and R.K. Wayne. 2000. Distribution and status of carnivores in the Santa Monica Mountains, California: preliminary results from radio telemetry and remote survey camerias. In: Keeley, J.E., M.B. Baer-Keeley, and C.J. Fotheringham (Eds.), Second interface between Ecology and Land Development in California. US Geological Survey, Sacramento, CA. pp. 113-123.
Sauvajot, R.M., M. Buechner, D. Kamradt, and C. Schonewald. 1998. Patterns of human disturbance and response by small mammals and birds in chaparral near urban development. Urban Ecosystems 2: 279-297.
Sawyer, J.O., and T. Keeler-Wolf. 1995. A Manual of California Vegetation. Sacramento, CA. California Native Plant Society. 471pp.
Schlorff, R.W. and P.H. Bloom. 1984. Importance of riparian systems to nesting Swainson's hawks in the Central Valley of California. In: R.E. Warner and K.M. Hendrix, eds. California riparian systems: Ecology, conservation, and productive management: Proceedings of a conference; 1981 September 17-19; Davis, CA. Berkeley, CA: University of California Press: 612-618.
Schonewald-Cox, C.M. 1983. Conclusions. Guidelines to management: A beginning attempt. Pages 141-145 in C.M. Schonewald-Cox, S.M. Chambers, B. MacBryde, and W.L. Thomas, eds. Genetics and Conservation: A Reference for Managing Wild Animal and Plant Populations. Benjamin/Cummings, Menlo Park, CA.
Schopmeyer, C. S. 1974. Alnus B. Ehrh. Pages 206-211 In: C.S. Schopmeyer, technical coordinator. Seeds of woody plants in the United States. Agric. Handb. 450. Washington, DC: U.S. Department of Agriculture, Forest Service.
Scott, J.A. 1986. The butterflies of North America: a natural history and field guide. Stanford University Press, Stanford, California. 583pp.
Scott, M. C. 2002. Integrating the stream and its valley: Land use change, aquatic habitat, and fish assemblages (North Carolina). Dissertation Abstracts International Part B: Science and Engineering, Vol. 63:51.
Severson, K.E., and A.V. Carter. 1978. Movements and habitat use by mule deer in the Northern Great Plains, South Dakota. Proceedings of the International Rangeland Congr., Vol. 1, pp. 466-468.

Shaffer, M.L. 1981. Minimum population sizes for species conservation. BioScience 31:131-134.
Shields, P.W.1960. Movement patterns of brush rabbits in northwestern California. J. Wildl. Manage. 24:381-386.
Singleton, P.H., W.L. Gaines, and J.F. Lehmkuhl. 2002. Landscape Permeability for Large Carnivores in Washington: A Geographic Information System weighted-distance and least-cost corridor assessment. USDA Forest Service, Pacific Northwest Research Station, Research Paper PNW-RP-549.
Sisk, T. D., N. M. Haddad, and P. R. Ehlich. 1997. Bird assemblages in patchy woodlands: modeling the effects of edge and matrix habitats. Ecological Applications 7:1170-1180.
Small, A. 1994. California Birds: Their status and distribution. Ibis Publishing Company. Vista, California. 342pp.
Smith, R.F. and A.E. Pritchard. 1956. Odonata. Pages 106-153 in R.L. Usinger, ed. Aquatic insects of California. University of California Press, Berkeley.
Solek, C. and L. Szijj. 2004. Cactus Wren (*Campylorhynchus brunneicapillus*). *In* The Coastal Scrub and Chaparral Bird Conservation Plan: a strategy for protecting and managing coastal scrub and chaparral habitats and associated birds in California. California Partners in Flight. http://www.prbo.org/calpif/htmldocs/scrub.html
Soulé, ME, and J Terborgh, editors. 1999. Continental conservation: scientific foundations of regional reserve networks. Island Press.
Soulé, M.E. 1989. USDI-National Park Service Proposed Land Exchange: Wildlife Corridors. Unofficially released report prepared for the Santa Monica Mountains National Recreation Area.
Soulé, M.E., D.T. Bolger, A.C. Alberts, R.M. Sauvajot, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral requiring birds in urban habitat islands. Conservation Biology 2:75-92.
Soulé, M.E., ed. 1987. Viable Populations for Conservation. Cambridge University Press, Cambridge, UK.
Southern California Association of Governments. 1998. SCAG County Population Forecasts provided by The El Toro Info site. http://www.eltoroairport.org/issues/population.html.
Sperry, R.B. Undated. History of the Santa Paula Branch. (Based in part on the writings of David F. Myrick). http://www.railserve.com/jump/jump.cgi?ID=830
Spowart, R.A. and F.B. Samson. 1986. Carnivores. Pages 475-496 In: A.Y. Cooperrider, R.J. Boyd, and H.R. Stuart (eds.). Inventory and monitoring of wildlife habitat. U.S. Department of the Interior, Bureau of Land Management, Service Center. Denver, Colorado
Standiford, R., and P. Tinnin (eds.). 1996. Guidelines for Managing California's Hardwood Rangelands. Publication of the Integrated Hardwood Range Management Program, University of California, Berkeley.
Stapleton, J. and E. Kiviat. 1979. Rights of birds and rights of way. American Birds 33:7-10.
Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. 2nd Ed., revised. Houghton Mifflin, Boston.
Stebbins, R.C. 1954. Amphibians and Reptiles of Western North America. McGraw-Hill Book Company, Inc. New York. 536pp.
Stein, B.A., L.S. Kutner, and J.S. Adams, Eds. 2000. Precious Heritage: the status of biodiversity in the United States. Oxford University Press. 399pp.
Stephenson, J.R. and G.M. Calcarone. 1999. Southern California mountains and foothills assessment: habitat and species conservation issues. General Technical Report GTR-

PSW-172. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture.
Stewart, J.S., L. Wang, J. Lyons, J.A. Horwatich, and R. Bannerman. 2001. Influences of watershed, riparian-corridor, and reach-scale characteristics on aquatic biota in agricultural watersheds. Journal of the American Water Resources Association 37:1475-1488.
Stoecker, M. and E. Kelley. 2005. Santa Clara River Steelhead Trout: Assessment and Recovery Opportunities. Prepared for The Nature Conservancy and The Santa Clara River Trustee Council. pp. 294.
Stones, R. C., and C. L. Hayward. 1968. Natural history of the desert woodrat, *Neotoma lepida*. American Midland Naturalist 80:458-476.
Suarez, A.V., and T.J. Case. 2002. Bottom-up effects on persistence of a specialist predator: ant invasions and horned lizards. Ecological Applications 12:291-298.
Suarez, A.V., J.Q. Richmond, and T.J. Case. 2000. Prey selection in horned lizards following the invasion of Argentine ants in southern California. Ecological Applications 10:711–725.
Suarez, A.V., D.T. Bolger, and T.J. Case. 1998. Effects of fragmentation and invasion on native ant communities in coastal southern California. Ecology 79:2041-2056.
Sudworth, G. 1967. Forest trees of the Pacific Slope (1967 reprint of 1908 edition). 455 pp Northern California black walnut. Rare plant status report.
Sullivan, J. 1996. *Taxidea taxus*. In: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, April). Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/.
Sullivan, J. 1994. Bufo boreas. In: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, February). Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/ 2002
Swanson, C. J. 1976. The Ecology and Distribution of Juglans californica in Southern California. Masters Thesis. California State University, Los Angeles
Sweanor, L.L., K.A. Logan, and M.G. Hornocker. 2000. Cougar dispersal patterns, metapopulation dynamics, and conservation. Conservation Biology 14:798-808.
Swearingen, E. M. 1977. Group size, sex ratio, reproductive success, and territory size in acorn woodpeckers. Western Birds, Vol. 8, pp. 21-24.
Swift, C.C., T.R. Haglund, M. Ruiz and R.N. Fisher. 1993. The Status and Distribution of Freshwater Fishes of Southern California. Bulletin of the Southern California Academy of Sciences. V. 92, n. 3.
Taber, R.D., and R.F. Dasmann. 1958. The black-tailed deer of the chaparral. California Department of Fish and Game, Game Bulletin 8:163.
Taylor, A.D. 1990. Metapopulation structure in predator-prey systems: an overview. Ecology 71:429-433.
Teresa, S. and B.C. Pace. 1998. Planning Sustainable Conservation Projects: Large and Small-Scale Vernal Pool Preserves Pages 255-262 *in:* C.W. Witham, E.T. Bauder, D. Belk, W.R. Ferren Jr., and R. Ornduff (Editors). Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference. California Native Plant Society, Sacramento, CA.
Termes, J. K. 1980. The Audubon Society Encyclopedia of North American Birds. Alfred A. Knopf, New York, New York. 1109pp.
Tesky, J.L. 1995. *Felis concolor*. In: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (2002, April). Fire Effects Information System, [Online]. Available: http://www.fs.fed.us/database/feis/.

Tewksbury, J.L., D.J. Levey, N.M. Haddad, S. Sargent, J.L. Orrock, A. Weldon, B.J. Danielson, J. Brinkerhoff, E.L. Damschen, and P. Townsend. 2002. Corridors affect plants, animals, and their interactions in fragmented landscapes. PNAS, Vol. 99, No. 20, pp. 12923-12926.

Thomas, T.W. 1987. Population structure of the valley oak in the Santa Monica Mountains National Recreation Area. In: T.R. Plumb and N.H. Pillsbury, technical coordinators. Proceedings of the symposium on multiple-use management of California's hardwood resources; 1986 November 12-14; San Luis Obispo, CA. Gen. Tech. Rep. PSW-100. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 335-340.

Thompson, S. D. 1982. Spatial utilization and foraging behavior of the desert woodrat, *Neotoma lepida*. Journal of Mammalogy 63:570–581.

Thomson, J.W. Jr. 1940. Relic prairie areas in central Wisconsin. Ecological Monographs 10: 685-717.

Titus, R.G., D.C. Erman, and W.M. Snider. 1999. History and status of steelhead in California coastal drainages south of San Francisco Bay. Department of Fish and Game, Environmental Services. Sacramento, CA. 261 pp.

Torres, S. 2000. Counting Cougars in California. Outdoor California, May-June.

Trombulak, S.C., and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.

USDA Forest Service. 2002. Southern California Forest Plan Revision Process, Species Reports for Scientific Review.

U.SDA, Forest Service. 1937. Range plant handbook. Washington, DC. 532pp.

U.S. Environmental Protection Agency (USEPA). 2003. Watershed Assessment Tracking, and Environmental Results (WATER) Database: United States Geological Survey (USGS). 1998a. 1995 National Water-Use Data Files for California Watersheds. http://ca.water.usgs.gov/archive/waterdata/

U.S. Geological Survey. 2002. Butterflies of North America, Butterflies of California. Northern Prairie Wildlife Research Center http://www.npwrc.usgs.gov

U.S. Fish and Wildlife Service. 2006. Recovery Plan for the Tidewater Goby (*Eucyclogobius newberryi*). U.S. Fish and Wildlife Service, Portland, Oregon. 208pp.

U.S. Fish and Wildlife Service. 2002. Recovery Plan for Southwestern Willow Flycatcher (Empidonax traillii extimus). Prepared by Southwestern Willow Flycatcher Recovery Team Technical Subgroup; prepared for Region 2 U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 178 pp. plus appendices.

U.S. Fish and Wildlife Service. 2001. Biological and Conference Opinions on the Continued Implementation of Land and Resource Management Plans for the Four Southern California National Forests, as Modified by New Interim Management Direction and Conservation Measures (1-6-00-F-773.2)

U.S. Fish and Wildlife Service. 2000. Final Rule to List the Riparian Brush Rabbit and the Riparian, or San Joaquin Valley, Woodrat as Endangered. February 23, 2000; 65 FR 8881 8890.

U.S. Fish and Wildlife Service. 2000. Draft Recovery Plan for the California Red-legged frog (Rana aurora draytonii). U.S. Fish and Wildlife Service, Portland, Oregon. 258 pp.

U.S. Fish and Wildlife Service. 2000. Loggerhead Shrike Status Assessment. Bloomington, IN 169 pp.

U.S. Fish and Wildlife Service. 1999. Arroyo southwestern toad (Bufo microscaphus californicus) recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. Vi +119pp.

U.S. Fish and Wildlife Service. 1998. Draft Recovery Plan for the least Bell's Vireo. U.S. Fish and Wildlife Service, Portland, Oregon. 139pp.
U.S. Fish and Wildlife Service. 1996. Recovery Plan for the California Condor. U.S. Fish and Wildlife Service, Portland, Oregon. 62 pp.
U.S. Fish and Wildlife Service. 1991. Minutes of Southern California Steelhead Meeting. USFWS office, Ventura, California. January 22, 1991. 9 pp.
Vasek, F.C. and J.F. Clovis. 1976. Growth forms in *Arctostaphylos glauca*. American Journal of Botany. 63(2): 189-195.
Veenbaas, G. and J. Brandjes. 1999. Use of fauna passages along waterways under highways. In: Proceedings of the third international conference on wildlife ecology and transportation, edited by G.L. Evink, P. Garrett, and D. Zeigler. FL-ER-73-99. Florida Department of Transportation, Tallahassee, Florida.
Verner, J. and A.S. Boss (tech. cords.) 1980. California wildlife and their habitats: western Sierra Nevada. General Technical Report PSW-37. Pacific Southwest Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service, Berkeley, California.
Verts, B., and L. Carraway. 2002. Neotoma lepida. *Mammalian Species*, 699: 1-12.
Vickery, P.D. and J.R. Herkert (eds). 1999. Ecology and conservation of grassland birds of the western hemisphere. Studies in Avian Biology 19.
Vitt, L.C. and R.D. Ohmart. 1977. Ecology and reproduction of lower Colorado river lizards: ii. *Cnemidophorus tigris* (Teiidae), with comparisons. Herpetologica 33:223-234.
Vogl, R.J. 1976. An introduction to the plant communities of the Santa Ana and San Jacinto Mountains. In: Latting, June, ed. Symposium proceedings: plant communities of southern California; 1974 May 4; Fullerton, CA. Special Publication No. 2. Berkeley, CA: California Native Plant Society, pp. 77-98.
Vogl, R.J. 1967. Fire adaptations of some southern California plants. In: Proceedings, Tall Timbers fire ecology conference; 1967 November 9-10; Hoberg, California. No. 7. Tallahassee, FL: Tall Timbers Research Station, pp. 79-109.
Walcheck, K.C. 1970. Nesting bird ecology of four plant communities in the Missouri River Breaks, Montana. Wilson Bulletin 82:370-382.
Walker, R. and L. Craighead. 1997. Analyzing Wildlife Movement Corridors in Montana Using GIS. ESRI User Conference Proceedings.
Wang, L., J. Lyons, P. Kanehl, and R. Bannerman. 2001. Impacts of urbanization on stream habitat and fish across multiple spatial scales. Environmental Management 28:255-266.
Weiss, S.B. 1999. Cars, cows and checkerspot butterflies: nitrogen deposition and management of nutrient poor grasslands for a threatened species. Conservation Biology 13:1476-1486.
Whitcomb, R.F., J.F. Lynch, M.K. Klimkiewwicz, C.S. Robbins, B.L. Whitcomb, and D. Bystrak. 1981. Effects of forest fragmentation on avifauna of the eastern deciduous forest. Pages 125-205 in Burgess, R.L., and D.M. Sharpe. Forest island dynamics in man-dominated landscapes. Springer-Verlag, New York.
Whitford, Johnson and Ramirez, 1976. Comparative ecology of the harvester ants *Pogonomyrmex barbatus* (F. Smith) and *Pogonomyrmex rugosus* (Emery). Insect. Soc. 23: 117–132.
Whitson, T.D., L.C. Burrill, S.A. Dewey, D.W. Cudney, B.E. Nelson, R.D. Lee, and R. Parker. 2000. Weeds of the West. Published in cooperation with the Western Society of Weed Science, the Western United States Land Grant Universities Cooperative Extension Services and the University of Wyoming. Jackson, WY 628pp.
Wilcove, D.D., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience 48:607-615.

Wilcove, D.S., C.H. McLellan, and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. Pages 879-887 In: M.E. Soulé, ed. Conservation Biology. Sinauer Associates, Sunderland, Massachusetts, USA.

Wilcox, B.A., and D.D. Murphy. 1985. Conservation Strategy: the effects of fragmentation on extinction. American Naturalist 125:879-887.

Willson, M.F. and K.C. Halupka. 1995. Anadromous fish as keystone species in vertebrate communities. Conservation Biology 9(3):489-497.

Wilson, J.D. and M.E. Dorcas. 2003. Effects of habitat disturbance on stream salamanders: Implications for buffer zones and watershed management. Conservation Biology 17: 763-771.

Winter, K. 2003. *In* CALPIF (California Partners in Flight). 2003, Version 2. The Coastal Scrub and Chaparral Bird Conservation Plan: A strategy for protecting and managing Coastal Sage and Chaparral habitats and associated birds in California (J. Lovio, lead author). Point Reyes Bird Observatory http://www.prbo.org/calpif/plans.html.

Wright, H.A. and A.W. Bailey. 1982. Fire ecology: United States and southern Canada. New York: John Wiley & Sons. 501 p.

Yanes, M., J.M. Velasco, and F. Suarez. 1995. Permeability of roads and railways to vertebrates: the importance of culverts. Biological Conservation 71:217-222.

Yosef, R. 1994. Evaluation of the global decline in the true shrikes (family Laniidae). Auk 111:228-233.

Yosef, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*). In A. Poole and F. Gill (eds.), The birds of North America, No. 231. Philadelphia, PA: the Academy of Natural Sciences and Washington, DC: the American Ornithologists' Union.

Yosef, R., and T. C. Grubb, Jr. 1994. Resource dependence and territory size in loggerhead shrikes (*Lanius ludovicianus*). Auk 111:465-469.

Zeiner, D.C., W.F. Laudenslayer, and K.E. Mayer (eds.). 1988. California's wildlife. Volume I: Amphibians and reptiles. California Statewide Wildlife Habitat Relationships System. Sacramento, CA: California Department of Fish and Game.

Zeiner, D. C., W. F. Laudenslayer, K. E. Mayer, and M. White. 1990. California's Wildlife Volume II: Birds. California Department of Fish and Game. Sacramento, CA.

Zeiner, D.C., W.F. Laudenslayer, and K.E. Mayer (eds.). 1990. California's wildlife. Volume 3: Mammals. California Statewide Wildlife Habitat Relationships System. Sacramento, CA: California Department of Fish and Game.

Zeiner, D.C., W. Laudenslayer, Jr., K. Mayer, and M. White, eds. 1990. California's wildlife. Vol. 2: Birds. California Department of Fish and Game, Sacramento, 732pp.

First	Last	Affiliation	Phone	Email
Paul	Beier	Northern Arizona University	928/523-9341	paul.beier@nau.edu
Anne	Berkley	United States Forest Service	626/574-5258	aberkley@fs.fed.us
Bill	Brown	United States Forest Service	626/574-5258	wjbrown@fs.fed.us
Clint	Cabanero	South Coast Wildlands Project	626/599-9585	clint@scwildlands.org
Paul	Caron	CalTrans	213-897-0610	Paul_Caron@dot.ca.gov
Mike	Casterline	University of California-Santa Barbara	(805) 455-2464	mcasterline@bren.ucsb.edu
Liz	Chattin	South Coast Wildlands Project	626/599-9585	liz@scwildlands.org
Brendan	Clarke	National Park Service		brendan_clarke@nps.gov
Michelle	Cullens	Mountain Lion Foundation	916-442-2666 x107	cullens@mountainlion.org
Kristi	Daniel	CalTrans	213-897-3821	Kristi_Daniel@dot.ca.gov
Gary	Davis	National Park Service	(805) 658-5707	gary_davis@nps.gov
Russ	Dingman	California State Parks	(818) 880-0350	rdingman@parks.ca.gov
Michelle	Dohrn	Independent Biologist	818-957-6044	quinospt@earthlink.net
Sabrina	Drill	UC Cooperative Extension	323-838-8335	sldrill@ucdavis.edu
Paul	Edelman	Santa Monica Mountains Conservancy	310/589-3200 ext128	edelman@smmc.ca.gov
Jim	Edmondson	CalTrout	818-865-2888	troutmd@earthlink.net
Scott	Ellison	County of Ventura Planning Division	805-654-2495	scott6477@msn.com
Rick	Farris	United States Fish and Wildlife Service	805-644-1766	rick_farris@r1.fws.gov
Eric	Fegraus	University of California-Santa Barbara	805-570-6794	efegraus@bren.ucsb.edu
Robert	Fisher	United States Geological Survey	858/637-6882	rfisher@usgs.gov
Ei	Fujioka	University of California-Santa Barbara	805-968-3732	efujioka@bren.ucsb.edu
Nancy	Fuller	California State Parks	916-657-1151	nfull@parks.ca.gov
Kimball	Garrett	Natural History Museum of Los Angeles County	213-763-3368	kgarrett@nhm.org
Sandra	Gilboa	University of California-Los Angeles		
Russel	Guiney	California State Parks	(818) 880-0360	rguin@parks.ca.gov
Leigh	Hagan	University of California-Santa Barbara	805-886-3257	lhagan@bren.ucsb.edu
Steve	Harris	Mountain Restoration Trust	(818) 591-1701	sharris@mountainstrust.org
Denise	Kamradt	National Park Service	805/370-2337	denise_kamradt@nps.gov

Lee	Kats	Pepperdine Univeristy	310-506-4310	lee.kats@pepperdine.edu
Elise	Kelley	Santa Clara River Restoration Coordinator	805-643-1130	kelley@venturalink.net
Jo	Kitz	Mountains Restoration Trust	818-346-9675	jkitz@mountainstrust.org
Lena	Lee	National Park Service		lena_lee@nps.gov
Jonathan	Levine	University of California-Los Angeles	310-825-9259	jmlevine@obee.ucla.edu
Travis	Longcore	The Urban Wildlands Group, Inc.	310-247-9719	longcore@rcf.usc.edu
Claudia	Luke	San Diego State University-Field Programs	760/728-9446	cluke@sciences.sdsu.edu
Catrina	Mangiardi	University of California-Santa Barbara	805/560-0806	cmangiardi@bren.ucsb.edu
Barbara	Marquez	CalTrans	213-897-0791	Barbara_Marquez@dot.ca.gov
Peter	Nonacs	University of California-Los Angeles	310-206-7332	pnonacs@biology.lifesci.ucla.edu
Kristeen	Penrod	South Coast Wildlands Project	626/599-9585	kristeen@scwildlands.org
Rick	Rayburn	California State Parks	(916) 653-6725	RRAYB@parks.ca.gov
EJ	Remson	The Nature Conservancy	(626) 403-9755	eremson@tnc.org
Mark	Reynolds	The Nature Conservancy	(415) 281-0441	mreynolds@tnc.org
Seth	Riley	National Park Service	805/370-2358	seth_riley@nps.gov
Matt	Riley	University of California-Santa Barbara	805-968-4837	mriley@bren.ucsb.edu
Rick	Rodgers	National Marine Fisheries Service	(562) 980-4199	rick.rogers@noaa.gov
Walter	Sakai	Santa Monica Community College	310-434-4702	sakai_walter@smc.edu
Ray	Sauvajot	National Park Service	805/370-2339	ray_sauvajot@nps.gov
Susan	Shanks	Santa Monica Mountains Conservancy	310/589-3200	shanks@smmc.ca.gov
Rebecca	Shaw	The Nature Conservancy	415-281-0480	rshaw@tnc.org
Judi	Tamasi	Wildlife Corridor Conservation Authority	(310) 589-3200 x121	tamasi@smmc.ca.gov
John	Tiszler	National Park Service	805-370-2340	john_tiszler@nps.gov
Harshita	Tiwari	University of California-Santa Barbara	805-968-4837	htiwari@bren.ucsb.edu
Richard	Wales	United States Forest Service	626/574-5258	rwaltes@fs.fed.us
Hartmut	Walter	University of California-Los Angeles	310/825-3116	walter@geog.ucla.edu
Andrea	Warniment	South Coast Wildlands Project	626/599-9585	andrea@scwildlands.org
Morgan	Wehtje	California Department of Fish and Game	(805) 491-3571	mwehtje@dfg2.ca.gov
Steve	Williams	Resource Conservation District	310-455-1030	swilliams@rcdsmm.org
Carl	Wishner	Envicom	818-879-4700	cwishner@envicomcorporation.com

South Coast Missing Linkages Workshop Minutes
July 29, 2002 at Franklin Canyon Park

Ray Sauvajot, National Park Service – *Welcome*

- Project goal is to identify, understand and protect habitat linkages across California
- Missing Linkages statewide conference (November 2000) allowed participants to map habitat linkages between remaining wildland areas using consensus-based approach
- Threats and scientific needs identified for each linkage area and compiled into conference proceedings, which has received attention from land planners and the media
- 69 linkages identified for landscape connectivity in the South Coast Ecoregion; 15 highest priority (most irreplaceable and vulnerable) linkage areas selected for immediate conservation action; this pilot planning project can be replicated across California
- Two workshops: biological perspectives (focal species information) and conservation design/delivery (land protection); thorough planning will attract conservation dollars
- Presentations will discuss connectivity needs for various groups of species and provide scientific framework for afternoon taxonomic working group sessions; datasheets will be used to collect linkage information and identify importance of corridor for focal species

Jonathan Levine, University of California Los Angeles – *How Does Habitat Connectivity Affect Rare Plant Persistence?*

Summary: It is commonly believed that dispersal is essential to the persistence of plant populations. Here, I present evidence from general ecological models identifying important caveats about the systems and species for which this notion is valid. By examining other mechanisms of persistence including dormancy and tolerance, I point out that the importance of dispersal, and ultimately habitat connectivity for the persistence of rare plant populations should not be assumed *a priori*.

Biography: Jonathan Levine in an assistant professor of conservation biology in the Department of Organismic Biology, Ecology, and Evolution, and the Institute of the Environment at UCLA. He received his doctoral degree at the University of California, Berkeley for his work on the relationship between native plant species diversity and biological invasions along the South Fork Eel River in northern California. Jonathan has written extensively on the controls over the success and impacts of biological invasions. Current interests include the importance of dormancy and environmental variation for the persistence of the rare annual plants on the southern California Channel Islands.

- Framework for choosing focal plant species: plant persistence dependent upon pollination and dispersal, often by animal vectors that require habitat connectivity
- Rare plant populations are threatened by demographic stochasticity (chance variation in birth rate, death rate, etc.) and environmental variation (such as drought); potential buffers against environmental variation: high tolerance (e.g. - special physiology allows Dudleya species to survive drought), dormancy (seeds can live for several years), and

dispersal (movement through shifting mosaic of favorable and unfavorable habitat locations); habitat connectivity is important for the dispersal of many plant species
- Dispersal is difficult way for rare plants to persist; dormancy is more flexible approach
- Theoretical model for rare annual plant populations on Channel Islands with variable climate, exotic annual grass competitors, and variable germination and dormancy - simulation shows population increase during periods of environmental fluctuation (which limits competition with exotic grasses allowing dormant seeds to flourish)
- Habitat linkages needed for movement of pollinators and dispersers; dispersal favorable for persistence of certain species according to three ecological models: evolution/natural selection, metapopulations in shifting environments, and neutral landscape/percolation in patchy environments; dispersal favors persistence if patch quality varies asynchronously (e.g. – Dudleya on rock outcrop might disperse seed to inappropriate chaparral habitat)
- Dispersal allows patches to be re-colonized by plants following disturbance, although after wildfire some species sprout from dormant seeds; habitat fragmentation and alteration may make plant dispersal more important than under natural conditions
- Plant dispersal takes place on a large scale; connectivity can potentially hurt plant populations by allowing invasion by non-native species
- Future regional climate is predicted to involve more extreme variations (severe floods and droughts); for non-rare plant species, connectivity may be important for dispersal into more favorable habitats, post-fire colonization, and seed dispersal by animals

Travis Longcore, The Urban Wildlands Group - *Invertebrates and Landscape-level Conservation Planning*

Summary: Invertebrates respond to landscape features across many scales, including much finer scales than vertebrates. While they can maintain viable populations in much smaller areas than charismatic megafauna, they are also perhaps even more sensitive to habitat degradation -- a simple footpath may constitute habitat fragmentation for some invertebrates. Corridors may funnel some mobile species between appropriate habitats, but inter-patch distance is equally if not more important. For flying insects such as butterflies, stepping stones of habitat may be more efficient than corridors in ensuring metapopulation viability. Landscape conservation planning for invertebrates must recognize their different scales of response, the value of relatively small and "isolated" habitat areas, and relative threats to population viability.

Biography: Travis Longcore completed his PhD in Geography at UCLA, and is an expert in urban conservation biology and restoration. His research has focused on the use of terrestrial arthropods to evaluate the success of ecological restoration in coastal sage scrub communities. Dr. Longcore has professional experience with urban habitat conservation and environmental education, having worked on efforts to conserve the Palos Verdes blue butterfly, and to develop butterfly garden programs for inner city schools. He is active in conservation planning for endangered species, serving on U.S. Fish and Wildlife Service Recovery Teams for the El Segundo blue butterfly and Quino checkerspot butterfly. He is currently Research Assistant Professor of Geography in the USC Sustainable Cities Program and Science Director of The Urban Wildlands Group, a Los Angeles-based conservation think tank.

- Incredible invertebrate diversity to consider for landscape-level planning
- Smaller scale for invertebrates when considering fragmentation: even dirt pathway may be movement barrier for certain species (e.g. – wolf spider); certain beetle species

remain in leaf litter under trees and will not leave favorable habitat patch; width of road/path and construction material (grass, gravel, pavement) influence beetle movement

- Flying insects: roads can still present dispersal barrier; butterfly species have different landscape mobility (only certain species will cross water/trees/path/road); some mobile butterflies use habitat corridors, while more sedentary species remain within habitat patches and may move less than ten meters (e.g. – remain at location of rare host plant); older female butterflies more likely to disperse long distances
- Patch size/distance matters; fragmentation can prevent habitat re-colonization by inverts
- Flightless habitat specialists (scorpions, land snails, trap door spiders): lifetime mobility only a few meters; require specific plants/soils; landscape-level connectivity already largely lost; poor linkage focal species - more important to preserve high quality habitat
- Mobile flightless inverts (certain beetles): move tens to hundreds of meters; connectivity compromised; poor linkage focal species – more important to preserve habitat mosaic
- Flying habitat specialists (butterflies, bees, moths, possibly grasshoppers): may move hundreds of meters up to few kilometers; require specific host plant, habitat type, or disturbance cycle; inter-patch distance influences colonization; good focal species - corridors must contain specific habitat qualities required by focal species
- Flying habitat generalists (mosquito, cabbage butterfly): no connectivity concern; can move between habitats as needed; poor focal species
- Recommended focal species are flying habitat specialists mobile enough to utilize linkages; for invertebrates, management of internal habitat quality in linkage areas is extremely important; must prevent irrigation (which leads to abundance of exotic invertebrates), artificial night lighting (some invertebrates use lights to navigate), chemical pollution (pesticides and fertilizers), and statutory habitat destruction for fire clearance/fuel modification (200 feet = approx. three acres habitat lost per structure)

Robert Fisher, United States Geological Survey, Biological Resources Division – *Landscape Linkage Planning for Herpetofauna & Fish in the South Coast Ecoregion*

Summary: This presentation explores the contrasting habitat requirements of amphibian, reptile, and fish species found within the South Coast Ecoregion, and discusses the various types of barriers that preclude movement for each. The results of movement studies conducted in other parts of the Ecoregion will provide information on how to address these needs and issues with respect to linkage planning and design.

Biography: Robert Fisher completed his B.S. in Biology at University of California, Irvine, and both his M.S. in Zoology, and Ph.D. in Population Biology at University of California, Davis. His research interests include herpetology, including declining species, conservation biology, monitoring programs for vertebrates, and reserve design.

- Watershed boundaries are an important consideration for focal species; within linkage area, there are 6 fish species (arroyo chub, unarmored stickleback, partially armored stickleback, striped mullet, lamprey, and southern steelhead), 1 turtle, and many amphibians, lizards and snakes
- Focal species selection should be based on biological attributes: terrestrial breeding salamanders (riparian and upland chaparral); aquatic breeding newts (good indicator species, but difficult species to connect appropriate habitats across these linkages); frogs and toads (red-legged frog makes good focal species - once widespread and now

restricted to few locations; also arroyo toad and California treefrog); western pond turtle should be considered because it is capable of terrestrial movement

- Habitat specialist lizards – legless lizard (little movement), alligator lizard (resilient to fragmentation impacts), horned lizard (patchy distribution); recommended focal species is coastal whiptail, which is sensitive to fragmentation and utilizes various habitats
- Snakes: red racer uses scrub and grassland habitats; coast patch-nosed snake inhabits riparian areas; south coast garter uses various habitats and its range has been reduced
- Regional aquatic systems contain dams and other barriers; wild habitats must be reconnected; movement through urbanized landscape of linkage areas may involve use of low quality habitat, allowing exposure to artificial lighting, fish parasites, and exotic species; current herpetological studies focus on stickleback and frog exposure to fungus and disease; USGS is conducting amphibian distribution surveys with pitfall traps across southern California, investigating species-specific connectivity needs, and observing habitat recovery after wildfire

Kimball Garrett, Los Angeles County Natural History Museum – *An Ornithological Primer for Ecologists*

Summary: Birds are often not the focus of wildlife habitat connectivity planning because of their perceived ease of movement across barriers and unsuitable habitats. Nevertheless, birds vary greatly in their dispersal ecology, ability to cross unsuitable habitats, and tolerance of fragmented or modified habitats. My presentation is largely intended to be an ornithological primer for ecologists. In it I will review some of the important bird species in riparian, scrub, woodland, and grassland habitats in Ventura County and western Los Angeles County, with a focus on sensitive and declining species and their dispersal ecology. As with most groups, birds are poorly studied with respect to habitat connectivity needs and even basic life history traits that impact dispersal ability.

Biography: Kimball L. Garrett has been the Ornithology collections manager at the Natural History Museum of Los Angeles County since 1982; he obtained his undergraduate degree in Zoology at University of California Berkeley and did graduate work in ornithology at UCLA. He is co-author of "Birds of Southern California: Status and Distribution," published in 1981 by the Los Angeles Audubon Society, and served on the steering committee for the Breeding Bird Atlas of Los Angeles County, the results of which he is now co-authoring.

- Most birds are able to move across barriers and unsuitable habitat; biota of Baldwin Hills (isolated coastal scrub habitat in Los Angeles Basin) lost regional connectivity; Bewick's wren and spotted towhee remain (no historical density data or dispersal information available); cactus wren, a sedentary habitat specialist, disappeared from site
- Abundant/widespread birds (such as the house finch): no need to consider for avian connectivity planning; many already adapted to human landscape modification
- Artificially over-abundant/nuisance birds: plan to reduce or exclude; show accelerated population growth and range expansion; common raven and brown-headed cowbird, although native, can inflict negative impacts upon native species; also, do not plan for non-native species (European starling, parrots, parakeets)
- Water birds have evolved to travel great distances; excellent fliers adapted to interrupted habitats; migrate to breeding habitat; not important for linkage planning
- Focal bird species for linkage planning should be sedentary, habitat specific land birds; concentrate on sensitive, range-restricted or otherwise important species, including endemics (yellow-billed magpie and Clark's marsh wren found in region but not linkages)

- Riparian restoration and cowbird control have benefited migratory least bell's vireo, but poor focal species as re-colonization is not defined by habitat linkages; migratory willow flycatcher is also poor focal species, and not responding as well to recovery efforts
- Recommended focal species is rapidly declining loggerhead shrike, sensitive to landscape modification because young disperse (neither migratory nor sedentary)
- Some endangered species not appropriate focal species for habitat connectivity – more threatened by loss of prey base, declining habitat quality, pesticides, and exploitation
- Focal species should be non-migratory; consider keystone species (large predators, cavity nesters) and habitat specialists (acorn woodpecker and spotted owl in woodlands, Say's phoebe in arid open country, wrentit in low scrub/chaparral, non-migratory sparrows in low scrub, common ground dove in riparian/agricultural habitat, California gnatcatcher in dry desert washes, coastal horned lark and burrowing owl in grassland)

Seth Riley, National Park Service - *Fragmentation, Urbanization, Connectivity, and Mammalian Carnivores in the Santa Monica Mountains to Sierra Madre Mountains Region*

Summary: Maintaining habitat and landscape connectivity is particularly important for wide-ranging and low-density species such as mammalian carnivores. In the area of the Santa Monica to Sierra Madre linkage, we are fortunate to have detailed existing information on the movements and ecology of carnivores, specifically bobcats, coyotes, and, very preliminarily, mountain lions. While both coyotes and bobcats occur in the fragmented, urban landscape of the Simi Hills and northern Santa Monica Mountains, even at high densities, they are affected in various ways by urbanization and fragmentation. Most adult female bobcats, the group responsible for successful reproduction, rarely utilize developed areas or cross major urban roads. Male bobcats and coyotes do so more, particularly at night, but even the home ranges of coyotes and male bobcats in this landscape are made up of mostly (75%) natural habitat. In addition, a specific study of freeway undercrossings showed that while different mammals used them to varying extents, bobcats and coyotes were more likely to do so when natural habitat was present on both sides of the crossing point. Natural habitat is critical both for the maintenance of reproducing carnivore populations in this landscape, and for the maintenance of movement between regional habitat blocks. Genetic analyses are also underway to determine whether freeways have already resulted in detectable barriers to gene flow. Certainly the most difficult species to maintain in the Santa Monica to Sierra Madre area over the long-term is the mountain lion. A recently initiated study of lion movements and home range use in the region will help us learn more about what may be required to conserve even the largest carnivores.

Biography: Seth Riley graduated in 1988 from Stanford University with a B.A. in Human Biology, concentrating in Animal Behavior and Ecology. From 1988-1990 Seth worked as a wildlife biologist for the National Park Service at the Center for Urban Ecology in Washington. Seth attended the University of California, Davis graduate school, where he graduated with a Ph.D. in Ecology in 1999. After graduating, Seth worked as a post-doctoral fellow at Davis, and began his current position as Wildlife Ecologist with the National Park Service at Santa Monica Mountains National Recreation Area in 2000, where current projects include a bobcat and coyote study that addresses home range and habitat use, reproduction, food habits, and genetics, a mountain lion GPS telemetry study, stream surveys for amphibians, pitfall/drift fence trapping to determine terrestrial reptile and amphibian distribution and abundance, and bat inventory and monitoring.

- Connectivity extremely important for wide-ranging, terrestrial, territorial, low-density mammalian carnivores; best to choose focal species for which dispersal needs have been studied to provide biological foundation for linkage design
- NPS has studied bobcats and coyotes in the Santa Monica Mountains and Simi Hills using radio collars, focusing on movement across the 101 freeway to measure impacts of urbanization and study habitat use; bobcats are dimorphic (average home range in this region is 3 square km male / 1.5 square km female – extremely small for this species); coyotes also dimorphic (average home range in this region 6 square km male / 3 square km female); adult female bobcats rarely enter developed areas; male bobcats and coyotes will utilize developed areas, but prefer natural areas
- One female coyote dispersed into San Fernando Valley, and often traveled between semi-natural habitat at Pierce College and Sepulveda Basin using the L.A. River channel; even in urban areas, animals are moving and finding the most suitable habitat
- Small roads can be crossed by wildlife, but are still sources of mortality; freeways are significant barriers, but can be crossed at certain sites (bridges and under-crossings)
- 101 crossed at Liberty Canyon by raccoons, spotted skunks, rodents, coyotes, bobcats, and a mountain lion; monitored with remote camera and tracks in gypsum; carnivores preferred to cross at sites with natural habitat on both sides of freeway; tracking data for bobcats and coyotes used to compare mortality (roadkill, mange, etc.) and fragment size
- Mountain lion is difficult to maintain in fragmented landscape; NPS recently captured 140 lb. male lion; GPS collar is now collecting movement data; long-term estimate for this area is less than ten lions; connectivity important; 600 square km available in Santa Monica Mountains (Beier 1993: 2200 square km needed to maintain lion population); NPS would like to also track lions in Santa Susana Mountains and Simi Hills
- Little known about habitat and connectivity requirements for rare carnivores - badger, ringtail, weasel, fox; studies needed to understand distribution

Claudia Luke, San Diego State University, Field Stations Program – *Considerations for Connectivity & Overview of Working Group Session*

Summary: This presentation describes the Santa Ana – Palomar Mountains linkage to allow workshop participants to understand purposes of the focal species groups, identification of critical biological issues regarding connectivity, and qualities of species that may be particularly vulnerable to losses in connectivity.

Biography: Claudia Luke received her Ph.D. in Zoology from U.C. Berkeley in 1989. She is Reserve Director of the Santa Margarita Ecological Reserve, an SDSU Field Station, and Adjunct Professor at San Diego State University. She is on the Board of Directors for the South Coast Wildlands Project and has been the lead over the last two years in conservation planning for the Santa Ana – Palomar Mountain linkage.

- At the November 2000 Missing Linkages conference, participants determined which areas within California needed to be connected to allow species movement
- South Coast Ecoregion workgroup selected criteria to prioritize linkages and connect largest protected lands; planning efforts have progressed for the Santa Ana – Palomar Mountains linkage area - workshops have been held to select focal species
- Global linkage role: preservation of biodiversity hotspot with concentration of endemic species (formed by gradients in elevation, lack of past glaciers, soil diversity)

- Regional linkage role: maintenance of habitat connectivity to prevent extirpations, and considerations for climate change (warmer wetter winters and drier summers may cause extreme floods and wildfires, drier vegetation types may expand to higher elevations)
- Local linkage role: connect protected parcels, considering dispersal methods of focal species, and impacts to habitat specialists, endemics, edge effects, and gene flow
- Focal species approach to functional linkage planning based on Beier and Loe 1992 corridor design (choose appropriate species, evaluate movement needs, draw corridor on map, monitor); focal species are units of movement used to evaluate effectiveness of linkages; wide diversity of species necessary to maintain ecological fabric; collaborative planning effort based on biological foundation and conservation design/delivery
- Choose species sensitive to fragmentation to represent linkage areas; Crooks and Soule 1999 showed that in San Diego as fragment size decreases, multiple bird species are lost; must consider associated species in planning, including keystone species important to survival of other species (e.g. - *Yucca whipplei* pollinated by specific invertebrates)
- Each taxonomic working group will choose a few species, delineate movement needs, record information on natural history, distribution, habitat suitability, current land conditions, key areas for preservation and restoration; consider metapopulation dynamics so that if a species disappears due to disturbance, habitat can be re-colonized
- Focal species data will be displayed on conservation design map and used to guide planning efforts; regional approach to linkages will help the South Coast Missing Linkages Project gain visibility and leverage to work with multiple agencies and organizations

Appendix C: 3D Visualization

South Coast Wildlands has produced several flyovers or 3D visualizations of the Santa Monica-Sierra Madre Connection and other linkages throughout the South Coast Ecoregion as part of the South Coast Missing Linkages Project.

The 3D Visualization provides a virtual landscape perspective of the local geography and land use in the planning area.

INSTRUCTIONS ON VIEWING FLYOVER

The flyover provided on this CD is an .mpg file (media file) which can be viewed using most popular/default movie viewing applications on your computer (e.g. Windows Media Player, Quick Time, Real One Player, etc).

Simply download the .avi file "3D_Visualization.mpg" from the CD onto your computer's hardrive. Putting the file on your computer before viewing, rather than playing it directly from the CD, will provide you with a better viewing experience since it is a large file.

Double click on the file and your default movie viewing software will automatically play the flyover.

If you cannot view the file, your computer may not have any movie viewing software installed. You can easily visit a number of vendors (e.g. Real One Player, Window Media Player, etc.) that provide quick and easy downloads from their websites.

Please direct any comments or problems to:

Clint Cabañero
GIS Analyst/Programmer
South Coast Wildlands
clint@scwildlands.org