On The Global and Regional
Ecological Significance of Southern Orange County:

Conservation Priorities for a Biodiversity Hotspot

CONSERVATION BIOLOGY INSTITUTE

October 2001

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Conservation Priorities for a Biodiversity Hotspot

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Cover Photo: Chris Pyle

October 2001

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Acknowledgements

The following conservation scientists (listed in random order) reviewed and commented on earlier drafts of this report: Dr. Jonathan Atwood, Dr. Ted Case, Dr. Paul Beier, Dr. Tom Scott, Dr. Michael Allen, Dr. Paul Zedler, Dr. Michael O'Connell, Dr. John Rotenberry, Dr. Hartmut Walter, Ms. Trish Smith, Dr. Jon Keeley, Dr. Michael Horn, Mr. Pete Bloom, Dr. James Strittholt, Dr. Robert Fisher, Mr. Fred Roberts, Dr. Jay Diffendorfer, Dr. Philip Behrends, and two anonymous reviewers. The comments of these individuals greatly strengthened the content of this report. We do not imply that peer review constitutes an endorsement of the report by these individuals or their institutions, although many of them voiced support for the findings and recommendations herein.

The Rancho Mission Viejo Corporation and Dudek & Associates provided maps and data for the Southern Orange County NCCP Subregion. Additional data were provided by Mr. Pete Bloom, Mr. David Bittner, and the U.S. Fish and Wildlife Service. Figure 1 was reprinted with permission of Conservation International, and Figure 2 with permission from The Nature Conservancy. Dr. James Strittholt of the Conservation Biology Institute prepared final report graphics and spatial analyses.

Executive Summary

This report summarizes available scientific information establishing the crucial role that Southern Orange County could play in efforts to conserve biodiversity at both global and regional scales. The report outlines a conservation framework for the area, using principles of conservation planning to delineate four core biological resource units. These four resource units must be conserved essentially intact, without further internal fragmentation by development, to continue supporting key species and ecosystem processes. We present this information in support of the Natural Community Conservation Planning (NCCP) program for the Southern Orange County NCCP subregion.

South-coastal California is a biodiversity "hotspot" of global importance. Hotspots are those areas harboring the greatest concentrations of living species, especially those species found nowhere else on Earth (endemics). Together, 25 global hotspots identified by leading conservation scientists support more than 60 percent of the Earth's total species diversity, on only 1.44 percent of its surface. Concentrating conservation efforts in these relatively small areas therefore gains the greatest biodiversity value from limited conservation funds.

Much of Southern California's unique biodiversity is concentrated in the foothills and terraces along the Pacific coast, from Orange County to the Mexican border. Having thus far escaped the urban sprawl that has reduced and fragmented natural habitats throughout southern California, southern Orange County supports a last best representation of this globally unique ecosystem. In concert with adjacent federal lands (Cleveland National Forest and Marine Corps Base Camp Pendleton), this large undeveloped block of natural habitat supports the broadest remaining array of natural environmental gradients and ecosystem processes in the south-coastal landscape. Southern Orange County and adjacent public lands support core populations of many imperiled wildlife species. The area's outstanding biological attributes include the following:

- Seven federally threatened or endangered species and critical habitat (areas designated by the U.S. Fish and Wildlife Service as essential to species survival and recovery) for three of these.
- Approximately 50 to 56 percent of the total remaining population of coastal cactus wrens—the single most important breeding area for this rare endemic bird.
- Approximately 15 to 25 percent of the California gnatcatchers in the U.S.—the country's largest contiguous population of this threatened species.
- Portions of the last remaining undammed and undiverted major drainage in all of southern California—San Mateo Creek is the most pristine coastal stream south of the Santa Monica Mountains and supports the southernmost population of the endangered steelhead trout.

- A tremendous diversity of nesting raptors (hawks, owls, eagles, and falcons)—with over 330 recorded nest sites and 15 species—including a critical foraging area for one of the last remaining golden eagle pairs in Orange County.
- Significant areas of native California grasslands, an imperiled vegetation community that exists here in natural mosaic with other diverse habitats—as much of south-coastal California once appeared.
- Healthy populations of mountain lions and mule deer, which require large and intact wildlands to survive.
- Some of the largest remaining populations of certain rare plant species within some of the last and best examples of such rare ecological communities as southern alkali marshes and alkali grasslands.

Based on these biological facts, principles of conservation biology and planning, and guidance provided by the Southern Orange County NCCP Science Advisors, we mapped those areas most critical to retaining these resource values in the region. *Four core biological resource areas (Arroyo Trabuco, Chiquita, San Juan, and San Mateo) must be conserved essentially intact, without further internal fragmentation, significant reduction in size, or degradation by development, to retain these resources and the ecosystem processes they depend upon.* Conserving private lands within these four areas would consolidate a large ecosystem reserve in conjunction with adjacent existing protected areas, such as the San Mateo Canyon Wilderness Area, Cleveland National Forest, Caspers Wilderness Park, Rancho Mission Viejo Conservancy, and Audubon Starr Ranch Sanctuary.

The findings and recommendations of this report should help guide NCCP planning for the Southern Orange County NCCP subregion, which is the last best hope to conserve a large, ecologically intact representation of the globally unique coastal foothills and terraces ecosystem. This hope can be achieved through the NCCP process as long as society agrees that these resource values are irreplaceable.

Introduction and Overview

> "It has long been my opinion that this area [southern Orange County] stands in a class by itself as our ONLY opportunity to conserve a large, unfragmented, ecologically intact portion of southern California's coastal ecosystems. The regional and global significance of this area cannot be overstated."
>
> Dr. Paul Beier
> Northern Arizona University

Most Southern Californians remain unaware that a globally significant ecological jewel lies near the heart of their region—a relatively intact and functioning ecosystem that rates as a global "hotspot" of biological diversity and conservation value. Having so far escaped the urban sprawl enveloping much of south-coastal California, the undeveloped lands of southern Orange County represent one last large and relatively undisturbed block of what was once a more extensive and unique ecosystem—the southern coastal foothills of the California Floristic Province.

Little remains of the natural habitats that once covered the coastal foothills and terraces that drain toward the Pacific Ocean between Los Angeles and Tijuana. Over 85 percent of the coastal sage scrub habitat has been converted to houses, roads, and golf courses; the native grasslands are all but lost to development and weedy invasions; and all but one major stream has been dammed and diverted. But what remains of this unique ecosystem still supports an assemblage of plants and animals dazzling in its variety and unlike any other in the world. The information summarized in this report suggests that a remarkably intact representation of this remnant ecosystem lies in southern Orange County, in an area large enough to support core populations of key wildlife species and to allow for the continued action of natural ecological processes and cycles. Unfortunately, many of these species and ecological functions are threatened with extinction unless large, interconnected habitat areas are conserved essentially intact, without further fragmentation by roads or other development.

Objectives of This Report

- Summarize available information to educate decision-makers and the public about the unique biological resources of Southern California and the Southern Orange County NCCP subregion.
- Use principles of conservation planning to delineate core resource areas that must be conserved intact to retain these unique resource values.

Southern Orange County is a "subregion" under the State of California's Natural Community Conservation Planning (NCCP) program. The 1991 NCCP Act seeks to sustain multiple species on a landscape level, while accommodating economic development outside of preserve areas. The Southern California NCCP Conservation General Process Guidelines (California Department of Fish and Game 1998) require "conservation of habitat on an ecosystem level…based on recognized principles of conservation biology."

NCCP planning was recently reinitiated in the Southern Orange County Subregion after several years of hiatus. Unfortunately, development plans have proceeded piecemeal in the interim, precluding some opportunities for comprehensive ecosystem planning. In 1996 a panel of scientific experts was convened to ensure that NCCP planning efforts for the

subregion were informed by the best available science, as required by law. This report supplements the Science Advisors' guidance by translating pertinent biological data, guidelines, and principles into a conservation framework for the region that would provide for the continued viability of this unique, remnant ecosystem and its imperiled species.

We delineated four core biological resource units in southern Orange County using widely accepted principles of conservation planning and specific guidance provided by the Science Advisors. These areas support a diverse mosaic of native habitats over broad environmental gradients, including coastal sage scrub, vernal pools, alkali marshes, native grasslands, oak woodlands, and pristine riparian and aquatic communities. Together with adjacent wilderness reserves and federal lands, these four areas allow such wide-ranging species as the golden eagle, mule deer, and mountain lion to persist in south-coastal California. These four areas are also crucial to the continued viability and recovery of such rare species as the southern steelhead, California gnatcatcher, coastal cactus wren, arroyo toad and numerous other rare and endemic species. To maintain these species and the natural ecological processes that define this unique coastal ecosystem, these four areas must be conserved without further internal fragmentation or substantial reduction in size.

Data Sources

Digital Map Information

Multi-resolution Land Characterization Consortium, US EPA/USGS, 1999, National Land Cover

California Gap Analysis Project, UC Santa Barbara Biogeography Lab, 1998, Land Status and Ownership

Bureau of Land Management, 1999, Land Ownership

GreenInfo Network, 2001, California Protected Areas

USGS digital elevation model (30 and 90 meter)

Teale Data Center, 1997, Transportation Digital Line Graph, 1:100,000

US Forest Service, 2000, Ecological Subsections

Conservation International, 2000, Global Biodiversity Hotspots

California Department of Conservation, Farmland and Mapping Monitoring Program (FMMP), 1996, Urban Areas

Paper Maps

Dudek & Associates, 1998b, Vegetation, 1:48,000 and 1:24,000

Dudek & Associates, 1998c, Species Locations, Selected Plants and Animals, 1:24,000

U.S. Army Corps of Engineers, 2000, Wetland Resources, Regulated Aquatic Resources, Riparian Vegetation, and Hydrogeomorphic Surfaces, ≈1:36,432

Information Sources and Limitations

We collected no new data for this report. Rather, we compiled and analyzed available scientific information from published and unpublished works, existing geographic data, data collected by field biologists, and expert opinion recorded by the Science Advisors and others.

This report does not analyze all species or issues that an NCCP plan document or environmental assessment must cover. Instead, we present information on selected resources and issues that we believe deserve high priority in designing a viable preserve for the subregion.

Biodiversity Hotspots

Since the British ecologist Norman Myers conceived the hotspot concept in the late 1980s, it has become an essential tool for setting conservation priorities throughout the world. Hotspots are those areas harboring the greatest concentrations of living species, especially those species found nowhere else on Earth (endemics). By concentrating conservation efforts in these relatively small samples of the Earth's surface, we theoretically gain the greatest "bang for the buck" from limited conservation funds.

Key Terms and Concepts

Biodiversity: The array of life on Earth, including all its different organisms, their genetic codes, and their interconnections within ecosystems and communities.

Biodiversity Hotspots: Those spatially limited areas of Earth supporting the greatest concentrations of living species, especially those endemic to a region.

Ecosystem: A dynamic complex of plants, animals, and other organisms that interact with one another and their non-living environment as a unit.

Endemic Species (Endemism): Species restricted in distribution, occurring nowhere outside a defined geographic area, such as a particular ecoregion.

Leading conservation scientists have identified 25 global biodiversity hotspots (Figure 1). The naturally vegetated portions of these 25 hotspots comprise only 1.44 percent of the Earth's land surface, but support about 70 percent or more of all vascular plant species. Moreover, as measured by species endemic to only a single hotspot, these 25 hotspots account for 44 percent of all plant diversity, 35 percent of all terrestrial vertebrate species, and 75 percent of all terrestrial animal species listed as threatened by the IUCN-World Conservation Union.

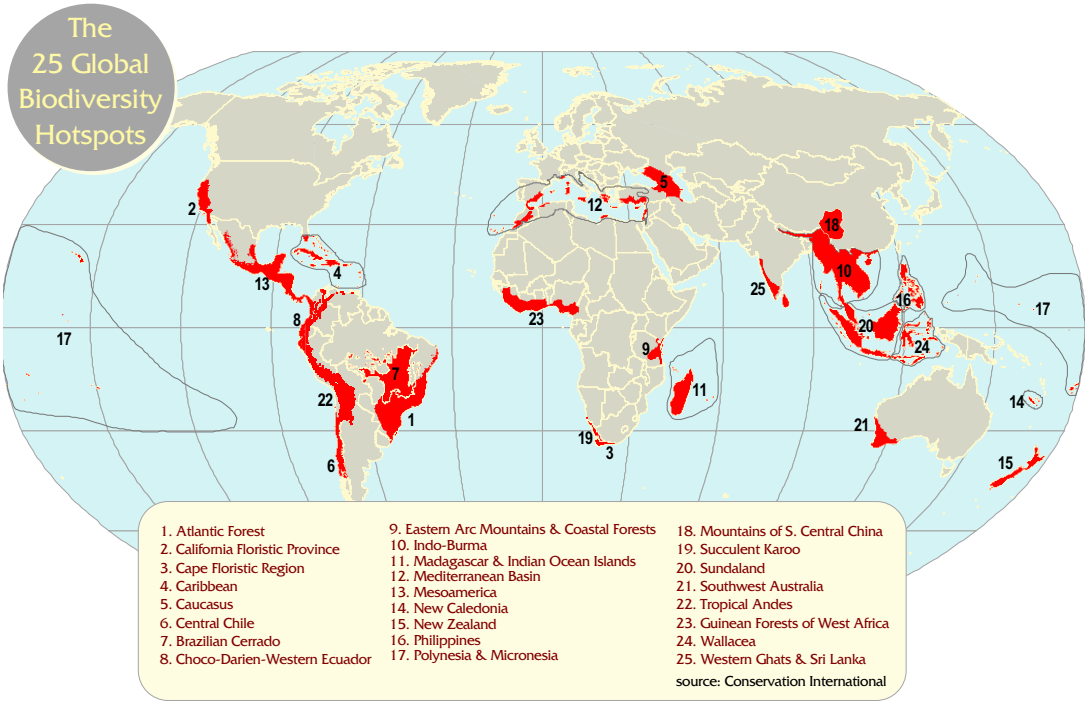

Figure 1 – The 25 global biodiversity hotspots (Mittermeier et al. 1999).

Overall, this 1.44 percent of the Earth's surface appears to account for roughly 60 percent or more of the remaining diversity of life on Earth, considering all groups of species (Mittermeier et al. 1999, Mittermeier et al. 1998). Although we cannot discount the species and habitats outside of these hotspots as unworthy of conservation, the hotspots clearly represent areas of concentrated biodiversity and high conservation priority.

California's South Coastal Hotspot

> "We always tend to equate biodiversity only with places like Brazil or Indonesia. But as you look more deeply, you begin to realize that it's as if North Americans have won the biological lottery, but forgot to look at the ticket."
>
> Dr. Eric Dinerstein
> Chief Scientist, World Wildlife Fund

The hotspot concept has been studied and applied by numerous biologists to identify conservation priority areas using different groups of species, different spatial and temporal scales, and different analytical techniques (for example, by mapping plant diversity, the number of endemic species, or the number of threatened and endangered species across the globe, or across the United States). Regardless of the techniques, scales, or species used, these analyses invariably identify south-coastal California as a hotspot for species diversity, endemism, endangerment, and conservation priority (Myers 1988, Myers 1990, Kiester et al. 1996, Dobson et al. 1997, Flather et al. 1998, Mittermeier et al. 1998, Wilcove et al. 1998, Mittermeier et al. 1999, Griffin 1999, Rickets 1999, Myers et al. 2000, Stein et al. 2000, Rutledge et al. 2001).

For example, Wilcove et al. (1998) identified hotspots within the United States for all federally listed threatened and endangered species. They found south-coastal California to be a hotspot for nearly every group of species, including plants, invertebrates, birds, mammals, and reptiles. Most recently, Rutledge et al. (2001) tested how this endangered species hotspot pattern holds within the United States when examined across different time spans—beginning in 1967 when the government started listing species. Unlike other hotspots that were added or subtracted from the hotspot list over time (due, for example, to changing priorities in species listing), the southern California hotspot endured throughout the entire study period.

Figure 2 shows one recent hotspot map for the continental United States and Hawaii. The map indicates major concentrations of imperiled species (as listed by the country's state Natural Heritage Programs), weighted by the rarity of each species (those with the smallest geographic ranges count most). This weighting scheme assumes increased conservation significance for areas supporting large numbers of rare species that occur nowhere else. Hence, these hotspots represent "irreplaceable" places for preventing species extinctions (Stein et al. 2000). By this method, south-coastal California stands out as one of the six greatest hotspots for imperiled species in the U.S. Of these six hotspots, Southern California supports the second greatest number of federally threatened and endangered species after Hawaii (U.S. Fish and Wildlife Service 2001).

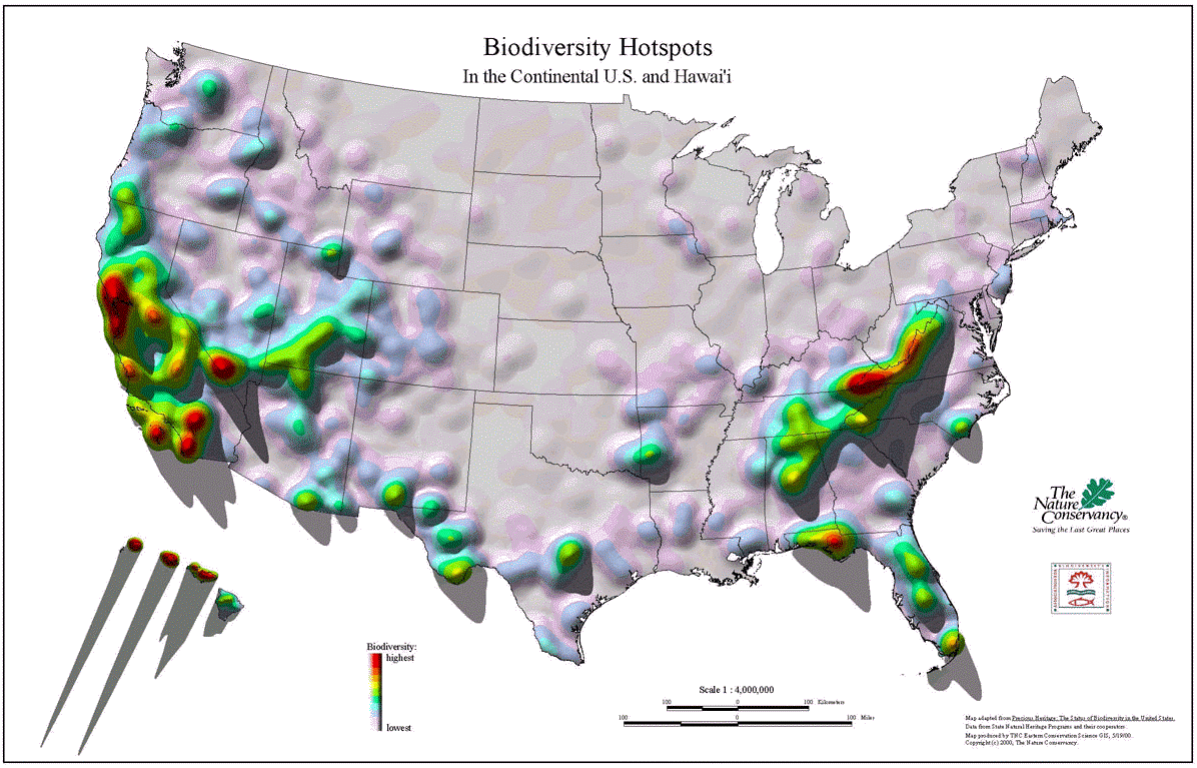

Figure 2 – Biodiversity hotspots in the continental U.S. and Hawaii (map courtesy of The Nature Conservancy, Stein et al. 2000).

Looking successively closer at biogeographic patterns shows south-coastal California to be a "hotspot within a hotspot," and southern Orange County to lie at its heart.

The Global Scale: The California Floristic Province—At a global scale, southern California lies within the California Floristic Province, which extends from southern Oregon to northern Baja and includes most of California west of the interior deserts and the Sierran Crest. It includes essentially all of the Pacific coast hotspots in Figure 2. This floristic province supports one of the richest plant assemblages in the world, supporting about 25 percent of all plant species occurring north of Mexico—and about half of these species are endemic to the province (Mittermeier et al. 1999, Raven and Axelrod 1978). Only five floristic provinces in the world are defined by Mediterranean climatic conditions (hot, dry summers and cool, moist winters, mediated by proximity to oceans). All five of these provinces are global hotspots, each with an exceptionally high proportion of endemic plants. Of the five, the California Floristic Province has the greatest diversity of soil types and moisture regimes (Stebbins and Major 1965), which further contributes to its wide array of plant communities and associated species—from Mediterranean shrublands (such as coastal sage scrub and maritime chaparral) to coniferous forests—and from perennial grasslands to alkali marshes, riparian forests, oak woodlands, and vernal pools.

The Continental Scale: The South Coast Ecoregion—Within the California Floristic Province, that portion lying generally south and west of the Transverse and Peninsular

mountain ranges along the Pacific coast comprises the South Coast Ecoregion (Figure 3). This ecoregion—bounded as it is by the Pacific Ocean and a dramatic series of mountain ranges—mixes a complex array of geological substrates, topographic features, climatic regimes, soil types, and other physical factors. The mountains also serve as barriers to plant and animal dispersal, thus isolating this area somewhat from other ecological communities and species. The result is a natural laboratory of speciation and ecological innovation that has made the South Coast Ecoregion a "hotspot within a hotspot." It supports more endemic plant and animal species (at least 138) and more imperiled species (158 and counting) than any other ecoregion in the U.S. (Stein et al. 2000). According to the California Department of Fish and Game (1996), this ecoregion supports more than one-third of California's native plant species on only 8 percent of the land area.

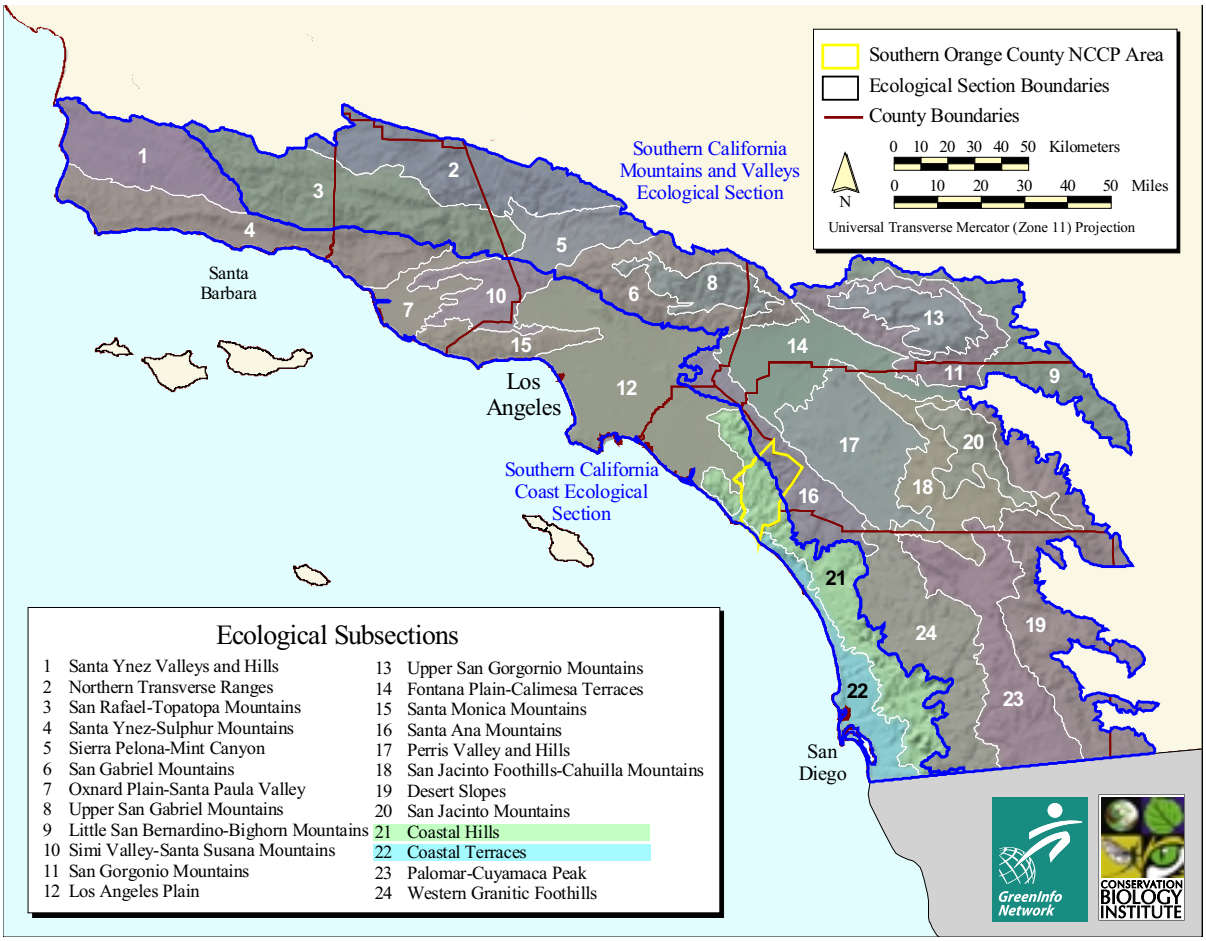

Figure 3 – California's South Coast Ecoregion showing ecological sections and subsections (Goudey and Smith 1994).

The Regional Scale: The Coastal Hills and Coastal Terraces Ecological Subsections—Much of the diversity and endangerment in the South Coast Ecoregion is concentrated in those areas closest to the coast, within two ecological subsections highlighted in Figure 3—the Coastal Hills and Coastal Terraces Ecological Subsections (as mapped by

the ECOMAP program: Bailey et al. 1994, Goudey and Smith 1994, McNab and Avers 1994). These gentle slopes draining to the Pacific are covered by coastal sage scrub and other associated vegetation communities whose distributions are limited by a unique combination of physical conditions, especially the Pacific Ocean's strong moderating effect on climate (Westman 1981, 1983; Miles and Goudey 1998). More than 100 threatened or endangered species are associated with coastal sage scrub vegetation (Atwood 1993, California Department of Fish and Game 1996), and the coastal foothills and terraces are widely considered to support among the greatest diversity of endemic plant species in North America (Stebbins and Major 1965, Stein et al. 2000).

The coastal foothills and terraces landscape is also favored by humans, which have developed most of it for their own uses. The resultant removal and fragmentation of the region's natural communities threatens many endemic species with extinction.

***The Subregional Scale: Southern Orange County*—**Nearly all of the Southern Orange County NCCP Subregion falls within the Coastal Hills Ecological Subsection (excluding Cleveland National Forest lands, which lie in the higher elevation Santa Ana Mountains Ecological Subsection). Together with large adjacent habitat blocks in the Santa Ana Mountains and Camp Pendleton, this NCCP subregion supports a tremendous diversity of imperiled species within a globally unique ecosystem. As discussed in more detail below, southern Orange County and adjacent natural areas represent a last best example of the coastal foothills ecosystem. Thus, southern Orange County lies at the heart of a global biodiversity hotspot.

Effects of Human Development and Gaps in Ecosystem Protection

Key Terms and Concepts

Edge Effects: Habitat degradation concentrated near the interface between natural and disturbed areas, such as increases in weedy species, pollutants, soil erosion and compaction, and predation by house pets.

Habitat Degradation: Human-induced changes in the physical, chemical, or biological properties of natural habitats that reduce their ability to support native species and ecological processes.

Habitat Fragmentation: The reduction of remnant habitats into smaller and more isolated blocks, each of which may be too small to continue supporting viable populations of species or ecosystem processes that operate over large landscapes, such as fire and hydrological cycles.

Internal Fragmentation: Fragmentation within otherwise contiguous habitat areas, thus creating "donut holes" in the habitat matrix.

The principal causes of species endangerment are the direct removal or degradation of habitat and fragmentation of remaining habitat areas into smaller and more isolated blocks (Ehrlich and Ehrlich 1981, Diamond 1984, Wilcox and Murphy 1985, Noss and Cooperrider 1994, Noss et al. 1997, Flather et al. 1998, Stein et al. 2000, Czech et al. 2000). A review by Stein et al. (2000) found that about 85 percent of imperiled species in the U.S. are affected by habitat loss and fragmentation, 49 percent by alien species, 24 percent by pollution, 17 percent by overexploitation, and 3 percent by disease. In Southern California, the principal

causes of species endangerment are residential and industrial development (56 percent of endangered species), exotic species (52 percent), agricultural development (45 percent), heavy equipment, including military training (44 percent), and livestock grazing (36 percent) (Flather et al. 1998).

Considered in a slightly different way, the leading cause of species endangerment in California is urban sprawl—low-density, automobile-dependent development that sprawls into natural areas outside existing cities and towns. Sprawl is estimated to imperil 66 percent of the listed species in California (Czech et al. 2001). In addition to directly removing habitats required by native species, sprawl also fragments remaining habitat areas into small or isolated blocks, each of which may be too small to sustain natural ecological functions or populations of certain species. Fragmentation also increases adverse edge effects, such as incursions by exotic, weedy species, trampling by humans, predation by house pets, and changes in fire frequency or intensity. The following major factors of habitat degradation are of particular importance in southern Orange County.

***Internal Fragmentation*—**All else being equal, habitat removal from the interior of a habitat area is more deleterious than habitat removal around the edges. Simple geometry dictates that internal fragmentation by development "bubbles" or "donut holes" within natural landscapes causes greater edge effects than an equal area of development at the habitat edge. Moreover, the adverse effects of these internal edges occur where they generally do the most harm to native species and ecological processes. "Leap-frog" development patterns that create internal fragmentation also require new roads, utility lines, and other infrastructure across the intervening habitat, thus further compounding adverse effects on native species and ecological processes. For example, the Wildlife Research Institute reports that 67 percent of all golden eagle deaths in Southern California since 1987 have been caused by collisions with electrical distribution and transmission lines, which is considered a leading cause in the species' decline here (D. Bittner and P. Bloom personal communication).

***Roads*—**Roads, in particular, cause increased edge effects, direct mortality via road kill, disruption of natural migration or movement patterns, interference with species communication, changes in water runoff and flow patterns, and air, water, and soil pollution (Trombulak and Frissell 2000, Forman and Deblinger 2000, Jones et al. 2000, Reijnen et al. 1997). During Beier's (1993, 1995) study of mountain lions in the Santa Ana Mountains, vehicles killed 33 percent of the population, including four lions killed at one road crossing during a 2-year period. Horn et al. (1993) predicted that planned roads in Orange County would help to complete the already partial isolation of existing reserves, leading to further species extinctions in the region.

***Changes in Fire Regimes*—**Southern California vegetation communities have evolved with fire, which typically burned Mediterranean shrub communities at intervals of 20 to 50 years (Keeley 1986). Overly frequent fires may "type-convert" shrublands to grasslands. The establishment of exotic annual grasses provides a fuel load that decreases the return interval between fires, creating a positive feedback loop that favors non-native grasses over native species even more (Minnich and Dezzani 1998). On the other hand, fire suppression by man

leads to ecological stagnation and increased fuel loads—with larger, hotter, catastrophic fires as the eventual result. Maintaining natural fire cycles is therefore essential to retaining natural ecosystems and native species in Southern California. Achieving this goal requires large native landscapes of many thousands of acres to allow for natural fire and successional patterns to persist away from areas of human habitation.

***Changes in Hydrology*—**Many southern California habitats and species also depend on the natural flood-scour-deposition cycles in watersheds unaltered by dams, diversions, irrigation, or vegetation removal. These natural hydrological cycles are necessary to replenish nutrients, create openings, refresh riparian vegetation communities, replenish sands in coastal estuaries and on beaches, and open coastal lagoon mouths. Exotic plants, fishes, and amphibians are also far more common in drainages with altered hydrology, and are primary causes of endangerment for numerous aquatic and riparian species (Swift et al. 1993, Jennings and Hayes 1994, Stephenson and Calcarone 1999). Thus, maintaining natural watershed areas and their hydrological processes is essential for retaining many imperiled species.

***Pollution*—**Air and water pollution, especially coupled with changes in natural fire regimes and hydrological processes, have significantly degraded habitats throughout much of Southern California (Zedler et al. 1983, Zedler 1995, Minnich and Dezzani 1998, Allen et al. 1996, Stephenson and Calcarone 1999). Increased nitrogen input into soils from automobile exhaust greatly favors weedy annual species over native perennial species (Allen et al. 1996). When this effect is combined with invasion of exotic grasses and unnaturally frequent fires, coastal sage scrub and other native communities are rapidly converted to non-native grasslands or weedy fields (Minnich and Dezzani 1998). This process is likely to accelerate under global climate change, as discussed below (Field et al. 1999, M. Allen personal communication).

***Climate Change*—**Climate models suggest that Southern California will experience increased winter precipitation, hotter and drier summers, and more severe El Niño events (Field et al. 1999). One effect of these changes will likely be a general shift in the distribution of vegetation communities and individual species to higher elevations and latitudes (Field et al. 1999). Simulation models suggest that this ecological migration will occur at an average rate of about 0.1 to 1 kilometer per year (Malcolm et al. 2001). The availability of broad elevational and other ecological gradients within contiguous habitat areas is critical to accommodate such changes in ecological conditions and species distributions. The primary effect of climate change on Southern California's vegetation will likely be further expansion of non-native grasslands into areas currently dominated by coastal scrub and chaparral, especially in areas suffering from altered fire regimes and air pollution (Field et al. 1999). Southern Orange County may be less susceptible to this exotic encroachment than other areas in Southern California due to its relatively clean air and natural fire regimes (M. Allen personal communication).

***Conclusion*—**Maintaining functional ecosystems requires large, unfragmented natural areas over which natural environmental and ecological processes operate. The loss and

fragmentation of natural areas result in a variety of anthropogenic effects that degrade ecological integrity and lead to extirpation of species. Southern Orange County possesses several attributes favoring its ability to maintain natural processes and the species that depend on them: clean air, large area, broad ecological gradients, intact watersheds and hydrological cycles, and good connections to existing reserves and other public lands.

Analyzing Conservation Priorities

Key Terms and Concepts

Ecological Integrity: The degree to which an ecosystem retains its naturally functioning parts and processes, without adverse modifications by man.

Focal Species: Species selected for conservation analyses because they serve as surrogates for larger groups of species or ecosystem functions, such as species requiring large areas or that are especially sensitive to habitat degradation.

Gap Analysis: An assessment of existing protection levels for aspects of biodiversity (species, ecosystems) to identify "gaps" in protection offered by existing reserve networks.

Representation Analysis: An assessment of the range of environmental attributes present in an ecosystem or region of interest, and the proportion of this range that is captured within existing or proposed reserves.

Special Elements Analysis: An assessment of how well a reserve system conserves particular species, places, or biological occurrences of high conservation value, such as biodiversity hotspots or rare community types.

Conservation scientists use variants of three general methods to establish conservation priorities: (1) *special element analysis*, (2) *representation* (or *gap*) *analysis,* and (3) *focal species analysis*. Special elements are species, places, or biological occurrences of high conservation value (Noss et al. 1999), such as biodiversity hotspots or unique habitat types like vernal pools or alkali marshes. Representation approaches select samples of habitat types or environmental gradients that "capture" the full range of environmental attributes necessary to maintain biodiversity and ecosystem processes (Hummel 1989, Scott et al. 1993, Soulé and Sanjayan 1998). A variant of representation analysis, *gap analysis* uses geographic information systems (GIS) and geographic data to identify aspects of biodiversity that are under-represented within existing reserves and therefore are "gaps" in protection of particular ecological communities, habitats, or species. Focal species approaches select key species that, if adequately conserved, help ensure adequate reserve size, configuration, and connectivity to maintain most or all of the other species and processes comprising a functional ecosystem (Miller et al. 1998/99). Focal species are often those requiring large areas for survival, such as mountain lions or eagles, or that are most sensitive to human activities, such as amphibians or fishes that cannot tolerate pollution (Lambeck 1997).

Combining these three approaches results in the most complete evaluation of natural variability and therefore the most robust and defensible reserve designs (Kirkpatrick and Brown 1994, Noss et al. 1999). Given the global conservation importance of the Coastal Hills and Coastal Terraces Ecological Subsections, we recommend a combined approach for analyzing conservation priorities. A reserve system for the region should capture the full range of environmental conditions, ecological communities, and species within these subsections; and a reserve design for southern Orange County should capture all its special elements (including vernal pools, alkali marshes, seeps, cliffs, and core breeding habitats)

and the full representation of environmental variability in the subregion (including all vegetation communities, elevations, slopes, aspects, and distances from the coast). Moreover, the reserve should ensure continued persistence of wide-ranging and highly sensitive focal species by maintaining large core habitat areas that are sufficiently linked to maintain natural movement patterns and ecosystem functions that operate at the landscape scale. This report only touches on certain aspects of this approach. More complete analyses that address all sensitive species occurring in the subregion should be conducted as part of the NCCP process.

Gaps in Protection for the Coastal Foothills and Terraces

Figure 4 maps current land protection status within the Coastal Hills and Coastal Terraces Ecological Subsections. It portrays the pattern of urban and agricultural development in the area, as well as existing and proposed conserved lands. Unprotected lands that still support native habitats represent potential gaps in protection. Thus, this map helps illustrate those areas most worthy of conservation attention, especially the larger, more intact private lands that are adjacent to existing reserve areas.

Figure 4 shows military lands distinct from other public and private lands, due to their unique land use and legal issues. The military does not set aside or "conserve" land. Rather, it attempts to manage land areas consistent with federal resource protection laws, while pursuing its primary mission of national security. The military is exempt from state and local regulations (Boice 1996).

Marine Corps Base Camp Pendleton supports many threatened and endangered species and outstanding examples of southern California vegetation communities (M. Allen personal communication) and is a significant component of regional biodiversity and ecosystem function. In combination with southern Orange County and habitats in the Santa Ana Mountains, the open spaces of Camp Pendleton contribute greatly to maintaining ecological functions and values in the region.

Outside of military lands, five large areas of unprotected private lands remain within the Coastal Hills and Coastal Terraces Ecological Subsections (Figure 4, Table 1). These areas are described below, from north to south, in terms of their current conservation status, support of important biological resources, and connections to conserved habitats. Because each area comprises a unique set of ecological conditions and species—and together represent the full north to south and coastal to inland gradients of the coastal foothills and terraces landscape—they represent a complementary set of natural areas, and each is worthy of substantial protection.

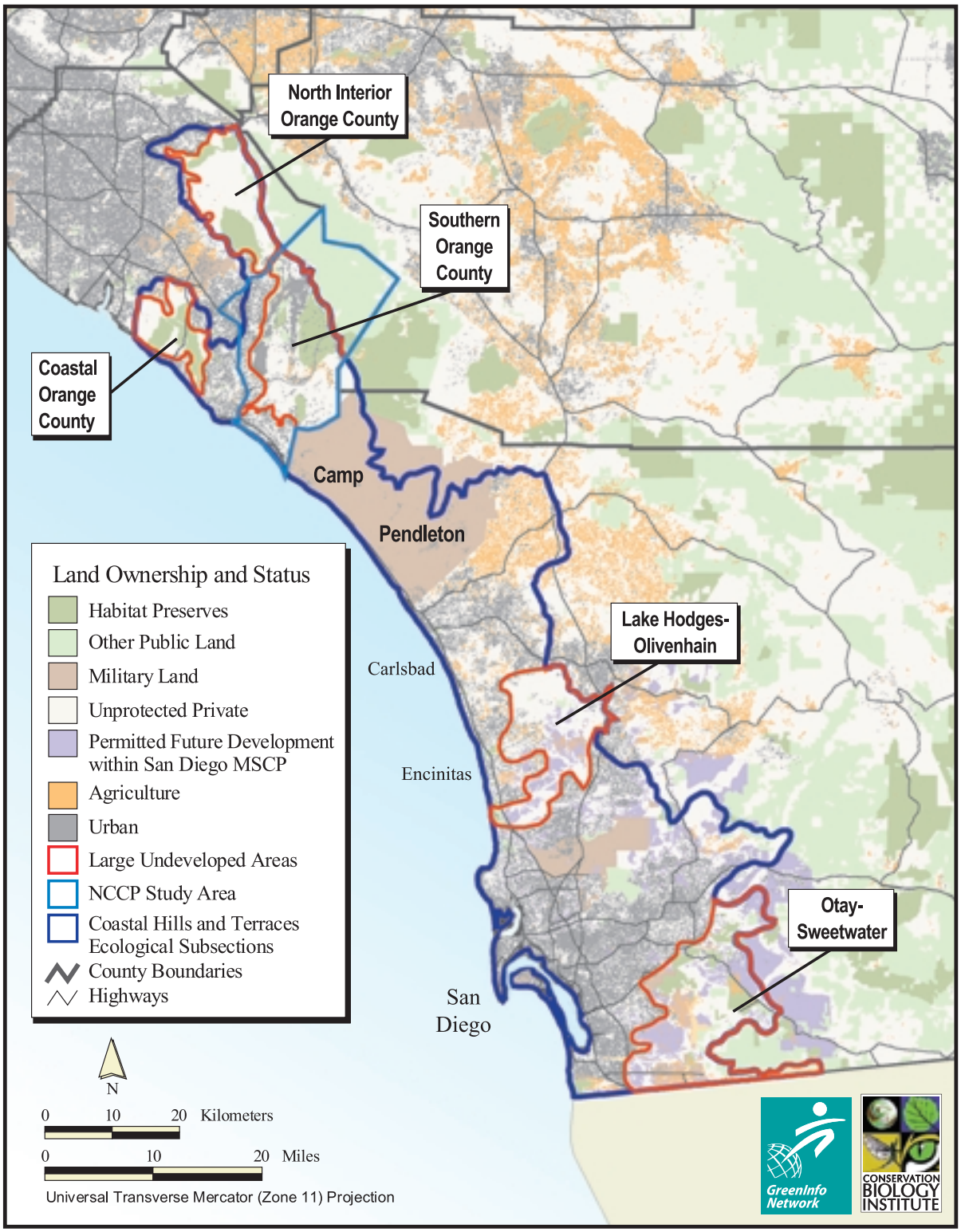

Figure 4 — Land protection status in the Coastal Hills and Coastal Terraces Ecological Subsections.

Table 1. Characteristics of the largest remaining unprotected land areas in the Coastal Hills and Coastal Terraces Ecological Subsections (excluding military lands).

Area	Gross Acreage	Acres of Natural Habitat	Dominant Vegetation Communities[1]	Physiography	Status/Comments
North Interior Orange County	43,651	43,085	Chaparral, coastal sage scrub, grasslands (non-native and native), riparian woodland	15 to 25 miles from coast; 900 to 2,000 feet elevation	Adjacent to Cleveland National Forest, but otherwise somewhat isolated from other habitat areas by urban development. NCCP plan protects about 20,000 acres.
Coastal Orange County	23,252	22,398	Coastal sage scrub, grasslands (non-native and native), chaparral	0 to 5 miles from coast; 0 to 1,200 feet elevation	Isolated from other large habitat areas by urban development. Approved NCCP plan protects about 18,000 acres.
Southern Orange County	64,092	46,835	Coastal sage scrub, grassland (native and non-native), chaparral, riparian woodlands and forests	0 to 15 miles from coast; 0 to 1,625 feet elevation	Not yet planned under NCCP; relatively little fragmentation. Well connected to existing large wilderness areas and other habitat reserves.
Lake Hodges-Olivenhain Area, San Diego County	60,137	[2]52,480 (40,861)	Chaparral, coastal sage scrub	0 to 15 miles from coast; 0 to 1,700 feet elevation	Existing NCCP agreement for south half allows substantial development and fragmentation; largely isolated from other large habitat areas. North half currently being planned under NCCP (North San Diego County MSCP Subarea Plan).
Otay-Sweetwater Area, San Diego County	98,498	[3]87,032 (59,645)	Coastal sage scrub, chaparral, non-native grasslands, riparian scrub	5 to 25 miles from coast; 250 to 2,000 feet elevation	Existing NCCP agreement and independent state and federal acquisitions are conserving significant habitats, but in a more fragmented configuration than current conditions.

[1]Aggregated vegetation communities listed in order from greatest to least acreage (source: California Gap Program)
[2]Approved MSCP plan permits about 11,619 acres of habitat removal, which will reduce natural habitat acres to about 40,861, not accounting for potential permitted development under the North County Subarea MSCP Plan.
[3]Approved MSCP plan permits about 27,387 acres of habitat removal here, which will reduce natural habitat acres to about 59,645.

North Interior Orange County

This area is adjacent to Cleveland National Forest on the steep hills rising above urbanized Orange County. It represents the northernmost inland extension of the Coastal Hills Ecological Subsection. The NCCP preserve for this area includes a large block of habitat in Limestone Canyon (chaparral, native grasslands, and riparian woodlands), with remnant lower-elevation coastal sage scrub on southern slopes. Other portions of the preserve are relatively small and fragmented by highways and housing developments. This area also includes the Irvine Company's North Ranch, which is intact but unprotected habitat adjacent

to Cleveland National Forest that is considered essential to persistence of wide-ranging species like mountain lions and golden eagles in the Santa Ana Mountains (T. Smith personal communication). It is well connected to other portions of the Coastal Hills and Coastal Terraces Ecological Subsections as well as the Santa Ana Mountain subsection via Cleveland National Forest, but lower elevation connections are threatened with development.

Coastal Orange County

This habitat block in the San Joaquin Hills represents the northernmost portion of the Coastal Hills and Coastal Terraces Ecological Subsections along the immediate coast. Although it is valuable habitat for numerous species, it is smaller and more isolated than other habitat blocks in the Coastal Hills and Coastal Terraces Ecological Subsections, and thus is no longer capable of supporting such wide–ranging species as mountain lions or nesting eagles.

Southern Orange County

This is the least fragmented portion of the Coastal Hills Ecological Subsection (after accounting for permitted habitat removal in San Diego's NCCP, the Multiple Species Conservation Program or MSCP; Table 1 and Figure 4). Together with large protected areas in the adjacent Santa Ana Mountains Subsection, this area still supports mountain lions and golden eagles. Southern Orange County supports a great diversity of vegetation communities in a natural mosaic. The native grasslands here are more extensive and in better condition than in any other portion of the county (F. Roberts personal communication).

Coastal sage scrub in this area is notable in that it includes large areas on gently sloping, lower elevation hills and valleys that are strongly influenced by a maritime climate. This rich form of coastal sage scrub has become exceedingly rare in the South Coast Ecoregion, because it typifies those areas that were most rapidly converted to urban and suburban development since the 1930s. Most other large, extant blocks of coastal sage scrub are on steeper slopes and in more interior climate zones that were not readily removed by development. Prevailing oceanic wind patterns bring cleaner air to southern Orange County than found in most of Southern California, making it more resistant to conversions to non-native grasslands and the effects of global warming (Field et al. 1999, Allen et al. 1996, M. Allen personal communication).

As the focus of this report, the resources of south coastal Orange County are more fully described in the next section.

Lake Hodges-Olivenhain

This island of natural open space is almost entirely surrounded by urban development in San Diego County, although it remains somewhat connected to more inland areas via the San Pasqual Valley. The southern half of the area is within the permitted San Diego MSCP plan area (about 11,619 acres is permitted for removal, leaving about 40,861 acres of natural

habitat potential for conservation). The County of San Diego is currently planning the northern portion through the North San Diego County MSCP.

The Lake Hodges-Olivenhain area is an important core habitat for coastal sage scrub and chaparral species—as part of a series of landscape "stepping stones" (Amec and Conservation Biology Institute 2001). It extends from near the coast, at sea level, to about 15 miles inland; however, the more coastal areas are highly fragmented, such that the bulk of conserved habitats will be 5 to 10 miles from the coast.

Otay-Sweetwater

This is the largest of the five areas in gross acreage and supports large and well-connected blocks of native habitat. The Otay-Sweetwater area lies about 5 to 25 miles from the coast, but the bulk of habitat conservation is and will occur more than 10 miles from the coast, where habitats reflect more inland climatic conditions. San Diego's MSCP plan, in conjunction with acquisitions for the San Diego National Wildlife Refuge and the Rancho Jamul State Ecological Reserve, have made important progress in securing large and valuable habitat areas, including some topographically gentle locations. It is well connected to more interior ecological subsections. Currently, the area supports roughly 87,052 acres of natural vegetation, but about 27,387 of these are outside of approved MSCP preserve planning boundaries and therefore subject to development.

Summary: Status of Remaining Habitat Areas in the Coastal Foothills and Terraces

The five unprotected, large habitat blocks remaining within the coastal foothills and terraces landscape are all important to maintaining regional biodiversity and precluding further species extinctions. Each area exhibits unique aspects of biodiversity not represented in other areas (for example, some narrow endemic plant species are restricted to only one or two of these five areas).

Of the five areas, the Otay-Sweetwater area and Southern Orange County are the two largest, most intact, and best connected to adjoining ecological subsections, and have the greatest potential to sustain viable populations of key species and relatively natural ecosystem processes. Of these two areas, Southern Orange County has less overall fragmentation, assuming that development proceeds as currently permitted in the Otay-Sweetwater area of San Diego County. It may also be more resistant than other areas to exotic invasions and ecological shifts influenced by air pollution and global climate change. Southern Orange County therefore seems the last best opportunity to conserve an intact portion of the coastal foothills ecosystem.

Southern Orange County — The Heart of a Hotspot

This section describes those attributes of the Southern Orange County NCCP Subregion that make it the last best opportunity to conserve the unique coastal foothills ecosystem—the heart of a biodiversity hotspot.

- It supports viable populations of at least seven federally listed threatened or endangered species and contains critical habitat (areas officially designated by the U.S. Fish and Wildlife Service as essential to the survival and recovery of the species) for at least three species—the California gnatcatcher, Riverside fairy shrimp, and arroyo toad.

- It supports approximately 50 to 56 percent of the total remaining population of coastal cactus wrens, representing the largest remaining core area for this endemic form and its rare cactus-dominated sage scrub habitat (Harper and Salata 1991, Ogden 1992, Garrett 1992, Rea and Weaver 1990, Dudek & Associates 1998a).

- It supports approximately 15 to 25 percent of the remaining U.S. population of the endemic California gnatcatcher, representing the largest contiguous population of this threatened songbird in the country (Dudek & Associates 1998a, Atwood 1990, 1992; U.S. Fish and Wildlife Service 1993).

- It supports a great diversity of nesting raptors (hawks, owls, eagles, and falcons)—with 15 nesting species and over 330 recorded nest sites for 11 of these (Dudek & Associates 1998a, P. Bloom unpublished data).

- It is a critical foraging area for one of the few remaining golden eagle pairs in Orange County and has potential to support other nesting pairs of eagles as well as peregrine falcons (Bittner 2001, P. Bloom personal communication).

- It supports a significant (though yet unquantified) acreage of native grasslands, which have been extirpated from the vast majority of Southern California. These occur in a natural mosaic with coastal sage scrub, chaparral, and oak woodlands, a semblance of how most of the south coastal foothills and terraces once appeared (P. Behrends, P. Bloom, and F. Roberts personal communication).

- It supports portions of relatively intact and high-quality watersheds for two major drainages: San Juan Creek and San Mateo Creek—the last remaining undammed and undiverted major drainage in coastal Southern California south of Ventura. San Mateo Creek is "…probably the most pristine coastal stream south of the Santa Monica Mountains" (Stephenson and Calcarone 1999).

- San Mateo Creek supports the southernmost population of the endangered southern steelhead, the only population recorded south of Malibu Creek. Protecting this watershed is therefore essential to recovering this species with the fullest range of genetic diversity (National Marine Fisheries Service 2000, Hunter unpublished 2000).

- Both San Mateo Creek and San Juan Creek support a variety of sensitive aquatic and amphibian species (including substantial populations of the arroyo chub, threespine stickleback, and endangered arroyo toad), which depend on the clean waters and natural flood-scour-deposition cycles that are possible only in such natural watersheds (Swift et al. 1993, Griffin et al. 1999, Stephenson and Calcarone 1999).

- In combination with adjacent Cleveland National Forest and Marine Corps Base Camp Pendleton, it supports populations of mountain lions and mule deer. This reflects the ecological integrity of the area, because these species require large and intact wildlands to survive (Beier 1993, 1995). Habitat fragmentation has all but extirpated them from coastal California south of Camp Pendleton.

- It supports one of the largest known complexes of several rare or endangered plant species, including southern tarplant, many-stemmed dudleya, and intermediate mariposa lily (F. Roberts personal communication).

- It supports some the largest concentrations of alkali grassland and alkali wetlands in southern California, which are of considerable importance because they support rare plants that are in serious decline in Southern California (F. Roberts personal communication).

The following sections describe these attributes in more detail, highlighting those considered most critical to defining conservation priorities for the southern Orange County NCCP Subregion.

Vegetation Communities and Environmental Gradients

Table 2. Vegetation Communities and Land Cover for the Southern Orange County NCCP Planning Area (Dudek & Associates 1998a).

Coastal sage scrub	21,352
Grassland[1]	16,742
Chaparral	8,490
Riparian	5,645
Oak woodland	1,582
Forest	444
Lakes and reservoirs	423
Stream courses	81
Freshwater marsh	28
Cliff and rock	10
Vernal pools	8
Subtotal Natural Habitats	**54,805**
Developed	30,211
Agriculture	4,287
Disturbed land	2,330
Subtotal Non-habitat	**36,828**
Grand Total	**91,633**

[1]Approximately 20-30% of this is estimated to be California native grasslands (Behrends personal communication).

The Southern Orange County NCCP planning area is about 91,800 total acres (excluding Cleveland National Forest). Of this, about 54,800 acres (60 percent) remain in natural habitat (Figure 5, Table 2). The planning area ranges from sea level to 2,700 feet. Of particular note are over 21,300 acres of coastal sage scrub vegetation—habitat for a large number of endemic and listed species of plants and wildlife (California Department of Fish and Game 1996, Stephenson and Calcarone 1999). Coastal sage scrub in this area is distinctive for the diversity of environmental gradients it covers, from gentle slopes and valleys to steep ridges, from near the coast to more inland areas, and from sea level to the highest elevations that support sage scrub species (over 2,400 feet). This is unlike most conserved areas of coastal sage scrub communities, which cover a more limited range of environmental gradients and especially steeper canyon slopes and more inland areas. Nowhere else in the U.S. is this full range of coastal sage scrub environmental gradients so fully expressed within a single, contiguous area as in the Southern Orange County NCCP Subregion. Not only does this help support a diverse array of species—each requiring slightly different combinations of ecological conditions—these gradients also provide an environmental hedge against global climate changes.

Diverse arrays of other habitat types occur in mosaic with the dominant sage scrub vegetation, including native, perennial California grasslands, annual grasslands, chaparral, riparian woodlands and scrub, oak woodlands, and a variety of wetland vegetation types. Together, this natural mosaic of communities supports a tremendous diversity and density of wildlife and allows for nearly the full range of ecological processes and cycles to continue with minimal human intervention. This is quite different from more fragmented reserve areas being established elsewhere in the ecoregion, where intensive, active habitat management (such as controlled burning, exotic species control, and artificial sediment transport) are considered essential to maintaining the species these reserves are intended to protect (Amec and Conservation Biology Institute 2001, Scott and Sullivan 2000, Sullivan and Scott 2000).

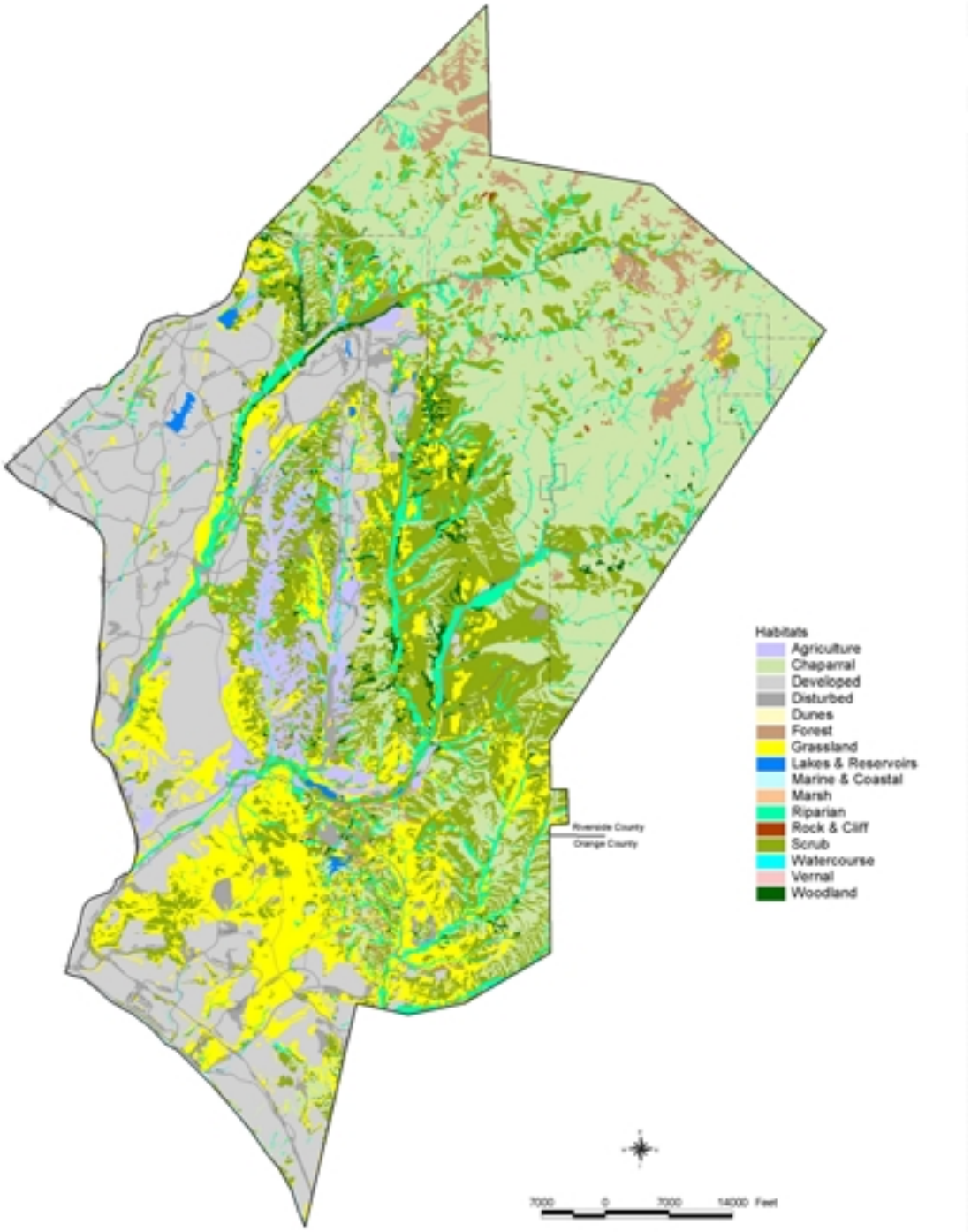

Figure 5 — Vegetation communities in the Southern Orange County NCCP subregion (Dudek & Associates 1998b).

Profiles of Key Resources

This section describes some key species and other resources we believe should help define conservation priorities for southern Orange County. It is not intended to cover all aspects of biodiversity in the study area, but to highlight a few that deserve high priority in preserve design and for which we have good distribution data.

Survey Data

Dudek & Associates (1998a, 1998b, 1998c) provided the vegetation map for the NCCP subregion and maps and tables summarizing results of species surveys in the planning area. These species surveys covered the largest private property and some public lands in the NCCP subregion, but excluded Cleveland National Forest. This should be considered when inspecting the range maps in this report (Figure 6).

For the California gnatcatcher, coastal cactus wren, and arroyo toad, the surveys covered essentially all potential habitat in the planning area and provide a reasonable estimate of adult population size during the survey year(s) (P. Behrends and P. Bloom personal communication). For many other species (especially plants and invertebrates) surveys covered more limited samples of available habitat, and additional populations are likely to be found in the future (P. Behrends and F. Roberts personal communication).

Figures 6a through 6d show the distributions of selected species in the study area based on surveys covering most portions of the NCCP subregion except the Cleveland National Forest (see text box). We defined core and secondary concentrations of each species from mapped observation points using species-specific criteria. Core concentrations include at least 10 independent location points (3 points for raptor nests) at close spacing (less than 2,000 feet between points for California gnatcatcher and coastal cactus wren; less than 1 mile for raptor nests). For the arroyo toad, core areas include stream segments having over 100 adults during spring surveys. Secondary or buffer areas include lesser concentrations of points or less contiguous habitat areas that nevertheless have high habitat value and support significant populations of these key species.

Coastal Cactus Wren—The cactus wren is a large, non-migratory species of wren found primarily in desert areas of southwestern North America. Although the species is fairly widespread, a unique form of cactus wren is restricted to coastal sage scrub habitats on the coastal foothills and terraces of south-coastal California and extreme northwestern Baja California (Rea and Weaver 1990, Harper and Salata 1991, Solek and Szijj 1999). This coastal population has been proposed as a unique subspecies (Rea 1986), and although this taxonomic distinction remains in dispute (U.S. Fish and Wildlife Service 1994), there is no question that the coastal form occupies a unique ecological niche and represents an important component of the south-coastal ecosystem.

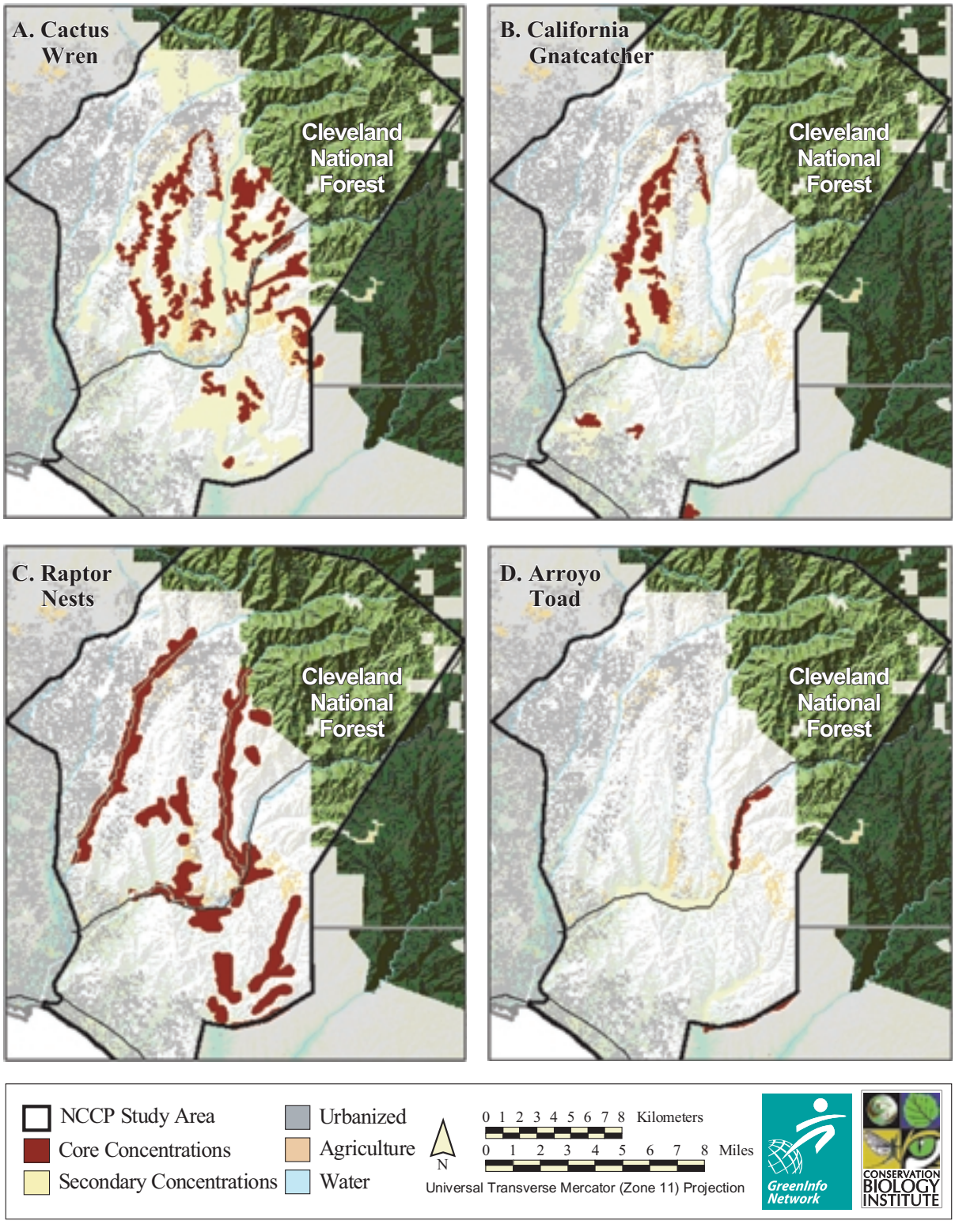

Figure 6 — Distributions of key species in the NCCP Subregion outside of Cleveland National Forest.

The coastal cactus wren requires coastal sage scrub with patches of tall cactus, and its distribution reflects the patchy distribution of this habitat. Degradation of cactus wren habitat by unnaturally high fire frequencies has greatly reduced wren populations on Marine Corps Base Camp Pendleton and other areas (Rea and Weaver 1990, Harper and Salata 1991, Bontrager et al. 1995). Orange County supports the majority of the remaining population, probably in the range of 65 to 85 percent of the remaining nesting pairs (estimated at 2,450 to 2,732 pairs based on data in Harper and Salata 1991, Ogden 1992, Garrett 1992, Rea and Weaver 1990, Dudek 1998a, and P. Behrends personal communication). The Southern Orange County NCCP Subregion has 1,378 recorded locations (Table 3). This represents about 50 to 56 percent of the total estimated nesting pairs and is the largest and most contiguous remaining population. Central coastal Orange County supports the second largest population, with 777 recorded locations (P. Behrends, personal communication). Most other populations have been isolated by urban development and support much smaller numbers. Figure 6a maps concentrations of nesting coastal cactus wrens in the southern Orange County planning area.

California Gnatcatcher—The coastal California gnatcatcher is a small songbird endemic to coastal sage scrub vegetation communities in the South Coast Ecoregion, especially within the Coastal Hills and Coastal Terraces Ecological Subsections. The greatest population densities occur near the coast (Amec and Conservation Biology Institute 2001), perhaps due to higher winter survivorship and richer food sources (Mock 1998). A victim of widespread habitat loss and fragmentation, the gnatcatcher was listed as threatened in 1993.

Total population size is difficult to measure, but has been estimated at 1,811 to 2,562 pairs in the U.S., with the single largest concentration in southern Orange County (Atwood 1990, 1992; U.S. Fish and Wildlife Service 1993). The total number of recorded locations in the U.S. is about 5,200—which includes pairs, single individuals, some redundant locations, and some locations recently lost to development. The Southern Orange County NCCP Subregion database includes 627 non-redundant locations (Table 3), probably representing roughly 500 to 600 breeding pairs in most years. Thus, the subregion supports *at least* 12 percent

Table 3. Recorded locations of selected songbirds in the Southern Orange County NCCP Subregion (Dudek & Associates 1998a, 1998c).

Common Name	Scientific Name	Federal/State Status*	Locations
coastal cactus wren	*Campylorhynchus brunneicapillus*	FSC/CSC	1,378
California gnatcatcher	*Polioptila californica californica*	FT/CSC	627
grasshopper sparrow	*Ammodramus savannarum*		619
least Bell's vireo	*Vireo bellii pusillus*	FE/CE	29
southwestern willow flycatcher	*Empidonax traillii extimus*	FE/CE	1
tricolored blackbird	*Agelaius tricolor*	FSC/CSC	104

*FT = Federally Threatened; FE = Federally Endangered; FSC = Federal Species of Concern.
CE = California Endangered; CSC = California Species of Concern

(627/5,200), and probably more than 20 percent (500/2,562) but fewer than 33 percent (600/1,811) of the U.S. population. Factoring in various uncertainties in these estimates, including the fact that the Atwood (1990, 1992) and U.S. Fish and Wildlife Service (1993) estimates were based on data collected during drought years, we conclude that the southern Orange County subregion supports roughly 15 to 25 percent of the U.S. population of gnatcatchers.

This core breeding area—concentrated on the gentle hills around Chiquita Canyon and Cañada Gobernadora (Figure 6b)—is unique not only in size (about 4,000 acres of occupied habitat scattered over about 8,500 total acres) and gnatcatcher density, but also in its physical and ecological setting. It lies relatively close to the coast (6 to 12 miles) on gently rolling hills having a relatively low incidence of exotic plant species. Other large gnatcatcher habitat areas are generally farther inland (11 to 25 miles) and mostly on steeper, higher elevation scrub communities that support lower densities of gnatcatchers. Moreover, the southern Orange County population could likely be increased by restoring coastal sage scrub to portions of Chiquita Canyon, where sage scrub was historically removed by discing for dry farming and pasture.

Nesting Raptors—Pete Bloom, a field biologist who grew up studying wildlife in southern Orange County, has for over 20 years recorded nest locations of raptors (eagles, hawks, falcons and owls) using the area. Bloom's data, supplemented by data from Dudek & Associates (1998a, 1998c), show this area to support a rich and stable raptor community (Table 4; Figure 6c). Fifteen species of raptors are known to nest in the subregion, and another five species use the area seasonally (P. Bloom personal communication). Two important raptor species—the golden eagle and peregrine falcon—may no longer nest in the subregion, but do forage here and have a high likelihood of returning to nest in the near future. Peregrine falcon once nested on at least two of the many sandstone cliffs that jut from canyon walls throughout the study area; but these aeries along San Juan Creek and Gabino Canyon were abandoned sometime during the mid-twentieth century when the species was in steep decline. The North American population of the state-endangered peregrine responded positively to conservation and management efforts throughout its range (enough, in fact, to permit its delisting by the U.S. Fish and Wildlife Service in 1999). Bloom believes that the increasing population of peregrines in California

Table 4. Number of nesting locations recorded in the Southern Orange County NCCP Subregion for selected raptor species (Bloom unpublished data; Dudek & Associates 1998a, 1998c).

Common Name	Scientific Name	Nest Locations
peregrine falcon	*Falco peregrinus*	2*
golden eagle	*Aquila chrysaetos*	2*
barn owl	*Tyto alba*	51
great horned owl	*Bubo virginianus*	29
long-eared owl	*Asio otus*	10
northern harrier	*Circus cyaneus*	1
Cooper's hawk	*Accipiter cooperii*	38
red-tailed hawk	*Buteo jamaicensis*	110
red-shouldered hawk	*Buteo lineatus*	68
turkey vulture	*Cathartes aura*	3
white-tailed kite	*Elanus caeruleus*	30

*Historic aeries not currently occupied.

will eventually result in this magnificent species returning to nest on cliffs in southern Orange County.

The golden eagle also once nested in the area and could again in the future. Orange County supported about seven eagle territories during the twentieth century, but at least four of these were extirpated by encroaching development from 1925 to 1985 (P. Bloom unpublished data). One aerie along the Arroyo Trabuco was abandoned in 1985 due to human disturbance near the nest and conversion of foraging habitat to housing (P. Bloom personal communication).

This story echoes many similar tales throughout Southern California. David Bittner and colleagues at the Wildlife Research Institute have been monitoring golden eagle pairs throughout Southern California since 1987 (over 200 pairs to date), building on research and records collected by many other biologists as far back as 1895 (records kept by Western Foundation of Vertebrate Zoology). These studies show that over 50 percent of Southern California's breeding golden eagles have been extirpated since the 1970s, due most significantly to destruction of habitat. In the words of Bittner: "Preservation of foraging habitat is as critical as protecting the nest sites of golden eagles. Without both nesting and foraging habitat golden eagles will continue to decline in Orange County and the rest of Southern California" (Bittner 2001).

Nevertheless, golden eagles still nest in the ecoregion, with several territories in or near southern Orange County, although the nest sites themselves are mostly in the Cleveland National Forest. One pair nesting along San Mateo Canyon depends on the Southern Orange County NCCP Subregion for survival. Bittner and colleagues estimate that about 7 of every 10 foraging trips are to the extensive mosaic of grasslands and scrub habitats of Talega, Gabino, La Paz, Blind, and Cristianitos canyons in southern Orange County. In the opinion of Bittner and the eagle research staff at Wildlife Research Institute, further loss of this hunting area in southern Orange County "would affect [this pair's] ability to successfully fledge young and will eventually lead to the loss of this golden eagle breeding pair altogether" (Bittner 2001).

Bloom and Bittner believe that golden eagles could nest again in the Southern Orange County NCCP Subregion outside of Cleveland National Forest, unless new housing developments further fragment the remaining habitat. Offspring from the current pair on San Mateo Creek may help fulfill this prediction.

Arroyo toad—The arroyo toad is a federally endangered, endemic amphibian of south-coastal California. It occupies streams and adjacent uplands within the Coastal Hills and Coastal Terraces Ecological Subsections, and to a lesser degree higher mountain sections below the headwaters (Jennings and Hayes 1994, U.S. Fish and Wildlife Service 1999b). Most populations have been extirpated, and many remaining populations are adversely affected by combined effects of wetland and upland habitat loss, reservoirs, water diversions, introduced predators (such as bullfrogs, mosquito fish, and largemouth bass), mining activities, road kill, and changes in river flows and sedimentation patterns (Griffin et al. 1999). South of Los

Angeles, only three watersheds still support the species through the full range of stream gradients, from the headwaters to the coast: San Mateo, San Onofre, and Santa Margarita (Griffin et al. 1999). Of these, only the San Mateo watershed remains undammed and hence lacks many of the associated threats to the species (Stephenson and Calcarone 1999). In addition, preliminary genetics work (Shanahan 1998) has shown the San Mateo population to have the highest known genetic diversity in the species and suggests that this population may be genetically distinct from others in the range. Hence, maintaining the San Mateo watershed in its current pristine condition is essential to the persistence and recovery of the species and may be critical to retaining its full genetic diversity.

Table 5. Recorded locations of selected amphibians, reptiles, and invertebrates in the Southern Orange County NCCP subregion (Dudek & Associates 1998a, 1998c).

Common Name	Scientific Name	Federal/State Status*	Locations
arroyo toad	*Bufo californicus* [*Bufo microscaphus californicus*]	FE/CSC	2,626 acres >550 adults
arboreal salamander	*Aneides lugubris*		12
coast range newt	*Taricha torosa torosa*	/CSC	
western spadefoot toad	*Scaphiopus hammondii*	FSC/CSC	16
orange-throated whiptail	*Cnemidophorus hyperythrus beldingi*	FSC/CSC	179
red-diamond rattlesnake	*Crotalus ruber ruber*	FSC/CSC	15
rosy boa	*Charina trivirgata*	FSC/	4
San Diego ringneck snake	*Diadophis punctatus similis*		10
San Diego horned lizard	*Phrynosoma coronatum blainvillei*	FSC/CSC	47
southwestern pond turtle	*Clemmys marmorata pallida*	FSC/CSC	23
Riverside fairy shrimp	*Streptocephalus woottoni*	FE/	6
San Diego fairy shrimp	*Branchinecta sandiegonensis*	FE/	2

*FT = Federally Threatened; FE = Federally Endangered; FSC = Federal Species of Concern.
CE = California Endangered; CSC = California Species of Concern

Within southern Orange County, Bloom surveyed populations of adult arroyo toads during the 1998 breeding season to identify major breeding concentrations downstream from Cleveland National Forest, as shown on Figure 6d and quantified in Table 5. He found abundant populations along upper San Juan Creek and Bell Creek (a tributary of San Juan Creek) and along Talega Creek (a tributary of San Mateo Creek). He also found lesser concentrations on Gabino Creek (another tributary of San Mateo Creek) and along lower San Juan Creek. Construction of new roads may have contributed to population declines and recent extirpation of arroyo toads in these lower reaches of San Juan Creek (P. Bloom personal communication). Note that Figure 6d does not show other known populations on Cleveland National Forest and Camp Pendleton.

Southern Steelhead and Other Native Fishes—Steelhead are the anadromous (sea-running) form of rainbow trout, and southern steelhead are winter-run populations that occur south of the Santa Maria River in Santa Barbara County. The southern steelhead is federally listed as

endangered, but the listing and subsequent designation of critical habitat initially failed to recognize that a population existed farther south than Malibu Creek (Los Angeles County). In fact, the southernmost population exists in San Mateo Creek and its tributaries.

Historically, southern steelhead ranged south to Baja California (Swift et al. 1993) and occurred in both San Juan and San Mateo creeks. Research on historic population sizes in various southern California coastal streams suggests that San Mateo Creek may have been one of the most important steelhead streams in the region (U.S. Fish and Wildlife Service 1998b). Individuals in San Mateo Creek regularly ranged up to 30 inches in length and 20 pounds in weight—substantially larger than fish recorded from Malibu Creek during the same time period.

Southern steelhead were considered to be extirpated from streams south of Malibu Creek until 1999, when an individual was caught in San Mateo Creek (A. Vejar, California Department of Fish and Game, personal communication). Since then, surveys have documented juvenile and adult steelhead in San Mateo Creek and tributaries on federal lands. Genetic analyses have confirmed that these are wild, reproducing, anadromous southern steelhead, and not the result of trout planting (California Department of Fish and Game 2000, National Marine Fisheries Service 2000). As a result of this new information, the National Marine Fisheries Service (2000) has proposed extending the southern steelhead's designated Evolutionarily Significant Unit and critical habitat to include the San Mateo Creek watershed. Recent surveys of habitat suitability have not been conducted in San Juan Creek, but headwater streams are also likely to support suitable habitat. According to Hunter (unpublished 2000), the San Mateo watershed is a "Core Watershed" (critical to persistence and recovery of the species), and the San Juan watershed is a "Recovery Watershed" (critical to recovery with some restoration to allow recolonization).

San Juan and San Mateo creeks support two other native fish species that have been extirpated from most streams in their original range: arroyo chub and threespine stickleback. The native fish fauna in coastal Southern California is a unique assemblage of six extant (and one extinct) species that are adapted to streams having highly variable conditions (Swift et al. 1993). Unlike most streams in Southern California, San Mateo and San Juan creeks appear to still support all of their historically occurring species. The threespine stickleback, in particular, is widespread in the subregion, including the Arroyo Trabuco, upper San Juan Creek, Hot Spring and Cold Spring canyons, and Bell Canyon. Control of exotic fishes, crayfish, and frogs and maintenance of natural hydrological processes and water quality are key to conserving this rare species within the NCCP subregion (Atwood et al. 1996).

Mule Deer and Mountain Lion—Mule deer and mountain lion are linked in a primary predator-prey system that serves as an indicator of ecological integrity. Both species are adversely affected by habitat fragmentation and have been largely extirpated from coastal habitats south of Marine Corps Base Camp Pendleton. As part of the larger Santa Ana Mountains landscape, the undeveloped habitat areas of southern Orange County support both lions and deer in healthy populations. Intensive studies using radio-telemetry have documented the natural movements of lions throughout the area (Padley 1991; Beier 1993,

1995). Beier (1993) studied the population viability of mountain lions in the Santa Ana Mountains and Palomar Range and concluded that further loss of habitat or of critical habitat linkages would likely extirpate lions from the region. Based on this research and a mountain lion habitat suitability model that was peer reviewed by experts (including Drs. Paul Beier, Kevin Crooks, and Michael Soulé), Hunter (unpublished 2000) identified the San Mateo and San Juan watersheds of this subregion as a "Key Conservation Area" for maintaining a viable population of mountain lions in the region.

Fairy Shrimp—The NCCP subregion supports two federally endangered invertebrates: Riverside and San Diego fairy shrimp. These small crustaceans inhabit temporary ponds called vernal pools and are adapted to the variable conditions of these ecosystems—forming encysted embryos that lie dormant in dry soils and emerge once the pools fill with winter rains. Different species have adapted to pools with different physical and chemical conditions. Riverside fairy shrimp occupy deep, cool vernal pools, whereas San Diego fairy shrimp occupy smaller, shallower pools.

Surveys by Dudek and Associates and PCR during 2001 documented Riverside fairy shrimp in pools on Chiquita Ridge, an area south of Ortega Highway known as Radio Tower Road, and at Saddleback Meadows in the northwest portion of the planning area (P. Behrends personal communication). The Saddleback Meadows population represents a geographically distinct complex within the species' range (U.S. Fish and Wildlife Service 1998a). Some of these pools are already protected. According to Fred Roberts (personal communication), additional locations may exist in the planning area.

San Diego fairy shrimp have been recorded in vernal pools on Chiquita Ridge and along Radio Tower Road (U.S. Fish and Wildlife Service 1998a, P. Behrends personal communication). These locations represent a distinct complex within the species' range (U.S. Fish and Wildlife Service 1998a). Preserving these pools and surrounding watersheds is essential to recovering San Diego fairy shrimp due to the potential genetic uniqueness of these populations. The U.S. Fish and Wildlife Service considers the San Diego fairy shrimp to have a high degree of threat but a high potential for recovery.

Rare Vegetation Communities and Plants—The Southern Orange County NCCP Subregion supports a diverse assemblage of rare plant species that are associated with unique habitat types (Table 6). It supports the largest known populations of southern tarplant, many-stemmed dudleya, and intermediate mariposa lily (F. Roberts personal communication), which are listed as rare or endangered in California and elsewhere by the California Native Plant Society (CNPS List 1B). Major populations of other CNPS List 1B plants in the subregion include Coulter's saltbush, sticky-leaved dudleya, and thread-leaved brodiaea. Thread-leaved brodiaea is also federally listed as Threatened and state listed as Endangered. Over 2,750 individuals of this species have been observed in the south-central portion of the subregion, in association with native, purple needlegrass grassland, and new populations are continuing to be discovered in other portions of the subregion (F. Roberts personal communication).

Table 6. Rare plant species in the Southern Orange County NCCP subregion (Roberts personal communication).

Common Name	Scientific Name	CNPS List[1]	Population Status[2]
Alkali wetlands and grasslands			
Southern tarplant	*Centromadia parryi* ssp. *australis*	1B	C
Coulter's saltbush	*Atriplex coulteri*	1B	M
Salt spring checkerbloom	*Sidalcea neomexicana*	2	P
Coastal sage scrub and chaparral			
Intermediate mariposa lily	*Calochortus weedii* var. *intermedius*	1B	C
Western dichondra	*Dichondra occidentalis*	4	M
California juniper	*Juniperus californica*	LR	M
Many-stemmed dudleya	*Dudleya multicaulis*	1B	C
Ashy spikemoss	*Selaginella cinerascens*	LR	P
Native and clay soil grasslands			
Small-flowered morning-glory	*Convolvulus simulans*	4	P
Paniculate tarplant	*Deinandra paniculata*	4	M
Prostrate spineflower	*Chorizanthe procumbens*		P
Thread-leaved brodiaea	*Brodiaea filifolia*	FT, CE, 1B	M
Chocolate lily	*Fritillaria biflora*	LR	M
Palmer's grappling hook	*Harpagonella palmeri*	4	M
Catalina mariposa lily	*Calochortus catalinae*		M
Oak woodlands			
Engelmann's oak	*Quercus engelmannii*	4	P
Rock outcrops			
Sticky-leaved dudleya	*Dudleya viscida*	1B	M
Vernal pools			
Water pygmy stonecrop	*Crassula aquatica*	LR	M
Hairy pepperwort	*Marselia vestita*	LR	M
Mesa brodiaea	*Brodiaea joloensis*	LR	P
Mud nama	*Nama stenocarpum*	2	M
Virginia rockcress	*Sibara virginica*	LR	P
Washes			
Coulter's matilija poppy	*Romneya coulteri*	4	M

[1]California Native Plant Society Status
1B = Rare or endangered in California and elsewhere
2 = Rare or endangered in California, more common elsewhere
3 = Plants about which more information is needed
4 = Plants of limited distribution

FT = Federally threatened
CE = California endangered
LR = Locally rare (Roberts, personal communication)

[2] Population status in the study area
C = Critical populations
M = Populations important but not critical
P = Species present but in low numbers

Many of these rare plant species depend on unique vegetation communities or habitat types that are especially noteworthy in southern Orange County. Large expanses of alkali grasslands and wetlands are located in Cañada Chiquita and Cañada Gobernadora, which Roberts (personal communication) believes are the largest remaining alkali wetlands in Southern California. Significant areas of clay soils, native grasslands, vernal pools, oak woodlands, and riparian habitats also occur in the planning area, in addition to the large, intact patches of coastal sage scrub discussed previously. The native grasslands, in particular, are considered to be amongst the largest and best remaining examples of this community in Southern California (F. Roberts personal communication). California's native, perennial grasslands have been reduced to about 0.1 percent of their original range (Barry 1972, as cited in Keeley 1990).

Special Microhabitat Features—Habitat consists of more than just the vegetation associations that biologists often use to describe species-habitat relationships. Habitat includes all of the physical and biological features required by a species to survive and reproduce, such as cliffs for nesting eagles and falcons or large hollow trees for roosting bats. In addition, certain very rare habitats or microhabitat features, such as vernal pools, springs, and seeps, need special consideration in conservation planning to ensure that they are adequately protected and buffered from adverse effects to the species they support.

The Southern Orange County NCCP Subregion includes a variety of such features, some of which are mapped and others that are not. Sandstone cliffs are scattered throughout the canyons, where they are used as traditional nesting aeries by several of the resident raptor species. Vernal pools in the area support the endangered Riverside fairy shrimp and San Diego fairy shrimp and other rare species. Groves of large sycamore trees along streams support populations of the uncommonly observed arboreal salamander, and large oaks and sycamores are used for roosting by insectivorous bats, as nesting sites by raptors, bluebirds, and other species, and as granary trees by acorn woodpeckers (where the woodpeckers store acorns in thousands of small holes they drill in the trunks). Upland springs and seeps, which have yet to be fully mapped, create unique microhabitats for plants and animals along the ridges and canyon walls. Water bodies scattered throughout the area also providing drinking water for wildlife and are used as nesting, roosting, or foraging habitat by a diversity of water birds. Chiquita Canyon holds some of the last alkali marshes in the region, and hundreds of tri-colored blackbirds—a species of concern—nest in these and other marshes in the area.

Conservation Priorities In Southern Orange County

Southern Orange County supports significant remnants of a once extensive and still globally unique ecosystem. In this section, we present conservation measures to maintain this portion of the South Coast Ecoregion as a viable and functioning ecosystem. Due to limitations in data availability and the complex nature of conservation planning, this should be considered a framework for further refinement as part of the NCCP process. The NCCP process should also address the full range of species and expected impacts from proposed development, which are beyond the scope of this report.

The approach we take recognizes southern Orange County as the heart of a biodiversity hotspot and probably the last best example of a globally unique ecosystem. The resource values this subregion supports are therefore irreplaceable (*sensu* Stein et al. 2000). This dictates that any conservation plan for the area deserves liberal application of the "precautionary principle," which holds that, given uncertainty about ecological processes and the consequences of habitat alteration, conservation plans must err on the side of conservation to hedge against loss of species or ecological collapse (Noss et al. 1997).

Principles of Conservation Planning

To ensure that the Southern Orange County NCCP is informed by the best available science, stakeholders in the process convened a prestigious group of science advisors in 1996. The group included well-known scientists from universities, museums, and other research institutions, as well as local field biologists having comprehensive understanding of southern Orange County's ecology and species. The Science Advisors produced a document entitled *Principles of Reserve Design, Species Conservation, and Adaptive Management for the Proposed Southern Orange County NCCP* (Atwood et al. 1996). The document translated broad "tenets" of reserve design prepared by the NCCP Scientific Review Panel (California Department of Fish and Game and California Resources Agency 1993) into more explicit principles to be used in designing a preserve system specifically for southern Orange County. In this document, we attempt to translate the Science Advisors' principles and our own findings into a map showing which areas are most critical to conserve in southern Orange County.

We adopted the following principles (based on Atwood et al. 1996) to guide mapping of core biological resource areas:

- Conserve species throughout the planning area.
- Maintain potential for re-establishment or enhancement of sensitive species (such as southern steelhead or peregrine falcon) and habitats (such as coastal sage scrub that has been converted to agriculture).
- Keep reserves large to support larger populations of species and to maintain ecosystem processes that operate over large landscapes (like natural fire and hydrological cycles).

- Keep reserves diverse by capturing broad environmental gradients, such as the full range of elevations, slopes, soil types, distance from coast, and vegetation types.
- Maintain important grassland areas and grassland-scrubland mosaics, especially in Gobernadora, Chiquita, Upper Gabino, and Cristianitos canyons and in areas northeast of San Clemente and San Juan Capistrano.
- Maintain the integrity of key riparian systems, especially San Juan Creek, Arroyo Trabuco, and key tributaries to San Mateo Creek (Gabino, Talega, and Cristianitos creeks). This includes protecting the natural hydrology and erosion regimes over entire watersheds.
- Keep reserves contiguous and connected, and avoid internal fragmentation of large habitat blocks.
- Minimize physical or visual barriers to species movement, such as roads through reserve areas.
- Direct development to already disturbed areas and away from native communities wherever possible.
- Maintain landscape linkages, especially along riparian systems or other naturally vegetated landscape features used by dispersing animals (especially wide-ranging species like mountain lions). Maintain ridgetop connectivity between Gobernadora and Bell canyons, which is considered essential for mountain lion movements (Beier and Barrett 1993).

Core Biological Resource Units

We delineated four Core Biological Resource Units (Figure 7) within the subregion using a variety of geographic information and the guiding principles outlined above. Each of these units supports unique resource values and therefore has unique biological objectives and management considerations. To ensure continued ecological integrity, each unit must be conserved essentially intact as mapped, without further habitat degradation or internal habitat fragmentation. Some minor modifications of the external boundaries may be acceptable based on further study. However, any development proposal in or near these core units must use the best available science to demonstrate that the project would not reduce any unit's ecological integrity, including its ability to support key species and ecological and environmental processes.

These core units do not necessarily represent all areas necessary to support all species of concern in the subregion. For certain species, such as narrow endemic plants that persist in small habitat fragments, smaller reserves outside of these core areas may also be necessary. Delineation of such areas is beyond the scope of this report and should be based on more detailed biological analysis as part of the NCCP process.

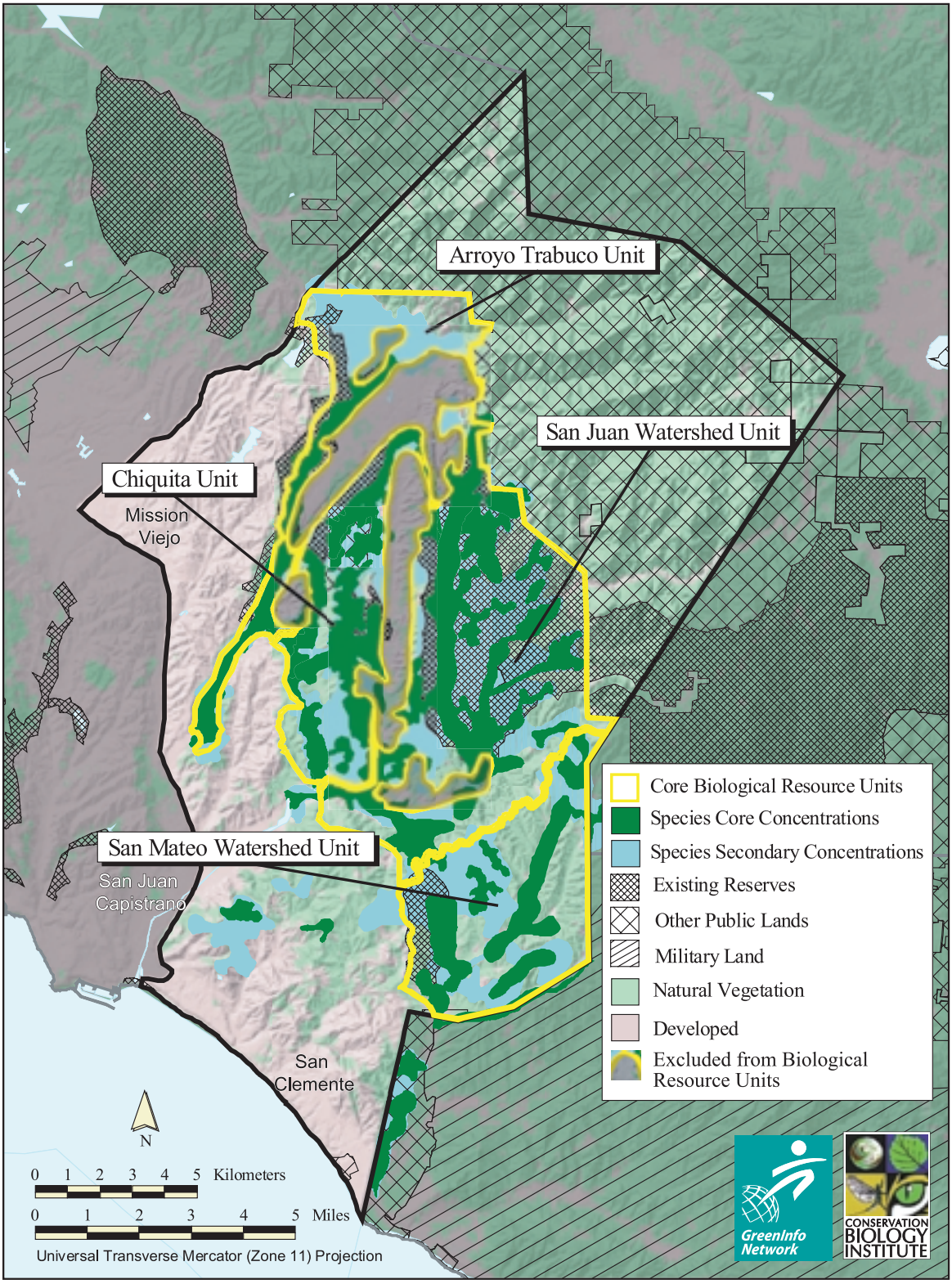

Figure 7 — Core biological resource units in the Southern Orange County NCCP Subregion.

Information sources used in mapping included a vegetation map for the area (1 inch = 4,000 feet; Dudek & Associates 1998b) and the combined core areas for key species (Figure 6). Where possible, entire watershed areas were delineated to meet the planning principles. Existing developed areas were excluded. In a few cases, recent developments are not depicted on existing maps, so development patterns may differ somewhat from those depicted on Figure 7.

Arroyo Trabuco Unit

Arroyo Trabuco Unit

Size: 6,988 acres, including 4,595 acres of natural habitat; 2,000 acres are already protected (28.6%).

Primary Communities: Wetland and aquatic communities, including vernal pools and riparian forest; coastal sage scrub and chaparral linking the riparian/aquatic system to headwaters on Cleveland National Forest.

Special Elements: Vernal pools, raptor nesting sites.

Focal Species: Rare fishes (arroyo chub and threespine stickleback), nesting raptors, fairy shrimp, mountain lion, mule deer.

Essential Processes: Hydrological cycles, wildlife movement; ecological migration response to climate change.

Conservation & Management Goals: Manage edge effects, water runoff, and non-point source pollutants; maintain natural hydrological cycles; control trespass in sensitive areas; maintain linkages to Cleveland National Forest. and Chiquita Unit.

The Arroyo Trabuco and associated riparian and watershed habitats support a rich biota despite some isolation by development in the lower reaches below the headwaters. In addition to supporting threespine stickleback, arroyo chub (P. Behrends personal communication), and a wide variety of nesting raptors (Dudek & Associates 1998a, 1998c), the Arroyo serves as a movement corridor for mountain lions (Beier 1993).

About 2,000 acres along Arroyo Trabuco are already conserved as biological open space. Due to the linear nature of the Arroyo, with dense housing developments on both sides, it is expected to suffer a variety of adverse edge effects. The headwaters in the northern portion of the study area are less constrained, having high ecological integrity where they arise in the Cleveland National Forest. Opportunities for further conservation in the area are limited, except in the northern areas south of Cleveland National Forest. Management plans should address adverse edge effects along the Arroyo, ensure continued function of natural hydrological cycles (flood-scour-deposition), and maintain water quality by controlling water runoff from development. Non-native aquatic species, such as bullfrogs, crayfish, sunfish, and mosquito fish, should be monitored and controlled. Public access and recreational uses should be managed consistent with resource protection goals in this area.

Chiquita Unit

Chiquita Unit

Size: 8,763 acres, including 7,017 acres of natural habitat; 1,745 acres are already protected (17.1%).
Primary Communities: Coastal sage scrub, grasslands (native and non-native), alkali marsh, riparian scrub, vernal pools.
Special Elements: Vernal pools, alkali marshes, native grasslands, and coastal sage scrub with wide ecological gradients.
Focal Species: Coastal cactus wren (core population), California gnatcatcher (core population), fairy shrimp, and numerous rare plants associated with vernal pools, alkali marsh, native grasslands, and clay soils.
Essential Processes: Fire/vegetation-succession cycle over a broad landscape; ecological migration response to climate change.
Conservation & Management Goals: Prevent internal fragmentation; restore agricultural areas to coastal sage scrub and native grasslands; maintain connections to other three units; manage for natural fire regime.

Cañada Chiquita represents the single most important core area remaining in southern California for the coastal cactus wren and the California gnatcatcher. This unit captures a broad range of variation of the coastal sage scrub ecosystem in one large contiguous block of habitat (over 7,000 acres), with pockets of native grasslands, alkali marsh, oak woodlands, and other native habitats. The lower and gentler slopes have been disced to support dry farming and some orchards have been planted in the lower canyon. These agricultural changes have somewhat fragmented the natural habitat and introduced exotic plants, but do not present barriers to dispersal or habitat use by key species, such as gnatcatchers, cactus wrens, and mountain lions. According to Fred Roberts (personal communication) the dry-farmed areas still support a number of sensitive plant species and areas of native grasslands. These disced areas could be restored to native sage scrub and grasslands.

About 1,745 acres are already protected under conservation easement, most notably the Chiquita Canyon Conservation Area in the uppermost part of the Cañada. Housing developments have encroached on both the west (Mission Viejo and Ladera) and east (Coto de Caza). However, Cañada Chiquita is well buffered from these developments by topographic relief. Of more concern is internal fragmentation within the upper Cañada, due to recent extension of the Foothill tollroad to Oso Parkway and construction of a high school adjacent to the roadway.

San Juan Watershed Unit

San Juan Watershed Unit

Size: 19,490 acres, including 16,885 acres of natural habitat; 11,429 acres are already protected (58.6%).

Primary Communities: Coastal sage scrub, chaparral, oak woodland, riparian/aquatic systems.

Special Elements: Cliffs and outcrops, seeps and other wetlands.

Focal Species: Coastal cactus wren (core population), rare fishes, arroyo toad (core population), raptors, mountain lion, mule deer.

Essential Processes: Fire/vegetation-succession cycle over a broad landscape; natural hydrological cycles; ecological migration response to climate change.

Conservation & Management Goals: Prevent internal fragmentation; buffer and connect existing reserve areas; maintain broad landscape connections to Chiquita and San Mateo Watershed units; maintain watershed integrity and water quality; manage for natural fire regime.

This large area (nearly 19,500 acres) of high ecological integrity supports a wide diversity of habitat types and species within the watershed of San Juan Creek, including pristine Bell Canyon. In addition to core concentrations of cactus wrens and nesting raptors, this area is critical for conserving several key aquatic species, including arroyo toad and arroyo chub. Conserving this area is essential for maintaining mountain lions in the subregion and perhaps the entire ecosystem surrounding the Santa Ana Mountains (Beier 1993). Primary biological goals include maintaining high ecological integrity by precluding internal fragmentation by roads, agricultural expansion, or development, and maintaining water quality and natural hydrological regimes within the watershed. Watershed protection, including protection of the underground aquifer, is essential to maintain conditions required by sensitive aquatic species in San Juan Creek and tributaries. New or deeper wells could lower the aquifer and the flow of water required by these species, and replacing native vegetation with development would increase runoff and add pollutants to the water.

Nearly 60% of this unit, including pristine Bell Canyon, is already protected as biological open space in Caspers Wilderness Park and Audubon Starr Ranch Sanctuary. The Ortega Highway (State Route 74) runs through the area, but other existing roads are relatively low impact ranch roads. This area is contiguous with the San Mateo Canyon Wilderness to the east. Additional conservation is required to connect these existing reserves via broad landscape linkages to the Chiquita Unit to the west and the San Mateo Watershed Unit to the south. Doing so would secure a large watershed reserve system of high ecological integrity.

San Mateo Watershed Unit

San Mateo Watershed Unit

Size: 10,908 acres, including 9,855 acres of natural habitat; 1,271 acres are already protected (11.7%).

Primary Communities: Coastal sage scrub, grasslands (native and non-native), chaparral, oak woodland, riparian/aquatic systems.

Special Elements: Native grasslands (high quality), western juniper (relict population), cliffs and outcrops (raptor aeries), seeps and other wetlands.

Focal Species: Golden eagle (essential foraging area), steelhead trout (recovery watershed) and other rare fishes, arroyo toad, raptors, mountain lion, mule deer, and numerous rare plants.

Essential Processes: Fire/vegetation-succession cycle over a broad landscape; natural hydrological cycles over entire watershed; ecological migration response to climate change.

Conservation & Management Goals: Prevent internal fragmentation; conserve all grassland areas; buffer cliffs (raptor aeries); buffer and connect existing reserve areas; maintain broad landscape connections to Chiquita and San Juan Watershed units; maintain watershed integrity and water quality; manage for natural fire regime; manage trespass in or near sensitive areas, including raptor aeries.

The San Mateo Watershed Unit is nearly 11,000 acres in total size, including nearly 10,000 acres of natural habitat. It supports some of the most pristine natural habitats left in southern California, including native grasslands, riparian woodlands, and broad canyons and ridges covered with coastal sage scrub, chaparral, and oak woodlands. San Mateo Creek is the last remaining undammed and undiverted major drainage in coastal California south of Ventura. This unit includes Cristianitos, La Paz, Talega, and Gabino creeks, which drain into San Mateo Creek near the boundary of Marine Corps Base Camp Pendleton.

As one tribute to the area's high ecological integrity, the San Mateo watershed is the only watershed south of Malibu Creek to support a breeding population of southern steelhead and is considered critical to recovery of this listed species. It also supports threespine stickleback, arroyo chub, and core populations of arroyo toads. Riparian areas downstream, on Marine Corps Base Camp Pendleton, also support core populations of endangered least Bell's vireos, southwestern willow flycatchers, and tidewater gobies. Grasslands in the area are considered critical foraging areas for the golden eagle pair nesting along nearby San Mateo Canyon (Bittner 2001). This area also supports the best remaining examples of native grasslands in the subregion, in part due to the moderate grazing pressure it has received relative to other areas (P. Bloom personal communication). Finally, this large, intact habitat area is considered essential to maintaining deer and mountain lion populations in the subregion.

The overall biological goal for this area must be to maintain the existing level of ecological integrity, water quality, and natural hydrological regime by precluding internal fragmentation by new roads or other development. The area is largely intact despite some fragmentation by Cristianitos Road and the existing TRW facility in the southern part of Cristianitos Canyon. The unit abuts Marine Corps Base Camp Pendleton on the south, the San Juan Watershed Unit on the north, and private inholdings between the subregion and the San Mateo Wilderness Area on the east. Only about 1,271 acres are already conserved, as the Rancho Mission Viejo Conservancy Area in the western portion of the watershed.

Conclusions

The Southern Orange County NCCP represents a unique opportunity to conserve what remains of a globally unique, diverse, and functioning ecosystem and its collection of endemic species. In many ways, this subregion—the heart of a global biodiversity hotspot—seems the last best hope to conserve a large, unfragmented, and ecologically intact representation of the natural ecosystem that once existed throughout the coastal foothills of Southern California. Without a doubt, this area represents the most important single tract of land in this ecoregion for conserving the coastal cactus wren and California gnatcatcher. Wise conservation decisions here would also help retain and recover populations of the southern steelhead, golden eagle, mountain lion, and mule deer, along with numerous other species unique to this ecoregion. The science of conservation planning dictates that large, intact, and unfragmented watershed units be conserved within this area, connected by landscape linkages, and where necessary, healed with ecological restoration. This can be achieved through the NCCP process, so long as society agrees that these resource values are irreplaceable.

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