APPENDIX A

Principles of Reserve Design, Species Conservation and Adaptive Management

For the Proposed Southern Orange County NCCP

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Introduction

The Orange County Southern NCCP Subregion Science Advisors (science advisors) were proposed as a means to assist the county in bringing scientific information and experience to bear on the conservation planning process for the southern subregion. The science advisors are independent from the county. The consulting team and county are not bound by the input of the advisors, but it is a generally held consensus among participating interests that sound scientific advice is an important part of creating a strong plan for the subregion.

The science advisors were tasked with developing three products: 1) principles for reserve design; 2) principles for conservation of species and habitats; and 3) principles and goals for an adaptive management program. This document presents the results of theses tasks.

The ultimate reserve design and likelihood of conserving certain species can be improved, and the probability of success over time increased, by the application of additional information from a research agenda targeted to provide key data to planning. These data include species/habitat relationships, autecological studies, presence/absence of rare species and narrow endemic species, natural disturbance patterns, life history characteristics, and other information. Much of this need is detailed in the original NCCP research agenda proposed by the Statewide Scientific Review Panel in 1993.

The Southern Orange County science advisors believe that existing data can lead to a supportable reserve design in the subregion for the species considered. This initial design could be further refined and improved through application of additional data, but the science advisors believe that the time and expense of such surveys relative to their likely effect or improvement on ultimate reserve design makes this exercise impractical. Some research needs to further increase the effectiveness of the conservation plan during the implementation phase, however, are identified in the Adaptive Management section of this report.

The language and terms used by the science advisors to describe the principles for species conservation, reserve design and adaptive management are not intended to correspond to legal definitions (e.g. “conserve,” or “critical”). The use of such words or phrases, unless specifically stated otherwise, is descriptive in nature and not intended to be legally explicit.

The Science Advisors

The goal of assembling a group of science advisors specific to the Southern Orange NCCP subregion was to bring individuals with relevant expertise and local experience to address issues unique to the subregion and provide advice useful to the consulting team and the county in developing alternative conservation plans. Some overlap exists with the state-authorized Science Advisors, but subregional advisors have a broader range of skills, including land management and ecological restoration. The science advisor process for the subregion was facilitated by The Nature Conservancy. The Conservancy recommended the individual advisors after broad and extensive consultation with the NCCP working group. Several of the advisors were compensated for their consultation by the State of California Department of Fish and Game using funds previously identified and intended for procuring scientific advice for the NCCP program.

There are other scientists, both locally-based and elsewhere, who are qualified to provide the advice and input needed to the subregional planning process. These individuals were not overlooked in creating the science advisors, rather the intent was to assemble a group with broad expertise and local experience that could perform needed tasks within the schedule necessary for the overall plan. The makeup of the science advisors did not preclude other individuals being called upon as necessary to address the tasks or provide review. This was done on several occasions, particularly with regard to expertise on plant and invertebrate species.

Assumptions

Descriptions of the specific tasks of the science advisors are summarized below at the beginning of the presentation of results for each task. It is important, however, to briefly discuss the general assumptions that the science advisors have operated under while addressing their work. These assumptions arose out of the direction the advisors received from the working group and are reviewed here.

1. *Role of advisors in reserve design decisions*: The final reserve design and boundaries will be recommended to the county by the consulting team based on an analysis of alternatives. The role of the science advisors and the principles they develop is to provide the best available information to the consulting team and the county. The science advisors will not be called upon to approve the final reserve design.

2. *Information used in science advisors work*: The principles for reserve design and conservation of species detailed in this report were derived by applying available information from local research, peer reviewed literature, and the experience of the science advisors and other available experts. This product represents a synthesis of scientific information about the targeted landscape, habitats and species in the Southern subregion. Except where noted, the advisors applied all the information they were provided. The advisors believe that the resulting principles will result in a reserve design and covered species list that is supported by current knowledge.

3. *Planning constraints*: Existing development, past disturbance, and current development agreements place limits on overall reserve design options within the subregion. These constraints may not be adjustable to any significant degree.

4. *Species and habitat assumptions*: The overall goal of the NCCP planning process is to protect the maximum number of species and range of habitats on the lists provided, modified by a roughly hierarchical analysis of importance. Legally protected species and rare habitats are highest priority, followed by subregional endemic species and eco-regional endemic species. Species with broader distributions follow these in importance.

5. *Ecosystem and process assumptions*: Preserves will be managed for long-term persistence of sensitive biological resources and habitat integrity, however they may be open to the public for certain types of recreation and selectively grazed. Fire and flood management practices will be necessary within the preserves along the urban interface. Also, the advisors note their strong preference for conservation through maintenance of extant habitats and linkages where possible, instead of using restoration and re-

vegetation. While in some cases this may be necessary to achieve overall habitat value goals, these are not considered biologically functional equivalents.

Results of Assigned Tasks

The working group and the County of Orange assigned the science advisors three tasks: 1) principles for reserve design; 2) principles for conservation of species and habitats; and 3) principles and goals for an adaptive management program. The following sections detail the result of those tasks, and together they form the advice of the science advisors for developing the NCCP for the subregion with respect to these issues.

Task I. Translation of NCCP Conservation Guidelines to Subregional Reserve Design Principles

Conservation guidelines developed by the state Scientific Review Panel (SRP) for NCCP in November, 1993, identified the biological foundation for planning for the entire 6,000 square mile NCCP region in Southern California. These guidelines established the scientific foundation for planning and articulated an interim conservation strategy, a research agenda, and premises on management and restoration of reserves.

The part of the SRP guidelines most relevant to the task of designing reserves was identification of seven basic tenets of reserve design applicable to NCCP. These general rules (listed below) are truisms of reserve design that form the basic scientific understanding of creating protected areas. It was determined, however, that additional specificity was useful regarding principles of reserve design for the southern subregion beyond that provided in the guidelines. The intent of the original SRP was that the tenets would be interpreted during subregional planning into geographically specific principles appropriate for that subregion, and this task is a fulfillment of that objective.

This report constitutes partial fulfillment of the SRP objective of translating the general NCCP reserve design tenets into explicit reserve design principles for the southern Orange County subregion. The intent of the science advisors is that the following subregional principles be general enough to allow flexibility in creating plan alternatives (in other words not parcel-specific), but precise enough that they capture the unique needs of the subregion. The principles constitute a set of "parameters of engagement" against which reserve design alternatives can be evaluated. The original seven tenets serve as categories under which the subregional principles can be grouped. It is important to note that the subregional science advisors modified the original seven tenets for the purposes of planning for the southern subregion. The subregional advisors combined *"keep reserve areas close"* and *"link reserves with corridors"* into one category, and added a new tenet: *"maintain ecosystem processes."*

In addition, to the above considerations, the science advisors recognize that it may be impractical or unrealistic to expect that every design principle will be completely fulfilled throughout the subregion. They also recognize that fulfillment of some principles may conflict with others. It is for this reason that the principles have been stated as "should" in most cases, rather than as absolutes. The principles of reserve design are specifically intended to form the scientific foundation for planning, but it is clear that the final reserve design will reflect a balance of a number of important interests of which biological conservation is but one. By the same token, the advisors do not believe that science should be treated as a competitive interest in planning negotiations, but instead should be a source of objectivity to inform the reserve design process.

Tenet 1. Conserve target species throughout the planning area

Species that are well distributed across their native ranges are less susceptible to extinction than are species confined to small portions of their ranges.

Reserve Design Principles:

- The three "official" target species (*Polioptila californica californica, Campylorhynchus brunneicapillus and Cnemidophorus hyperthyrus beldingi*) have not proven broad enough in their habitat requirements to serve as surrogate species for a multiple-habitat reserve of the type desired by planners in southern Orange County. Additional species may be necessary as indicators of other habitats (see #5 below).

- Reserve design alternatives should conserve species throughout the planning area.

- Reserves should carefully consider life history characteristics of species (breeding habitat, dispersal, foraging habitat, genetics, source/sink dynamics, the role of unoccupied habitat), particularly for those that are legally protected, endemic, or known to be declining.

- Reserves should maintain the potential for re-establishment and/or enhancement of sensitive species (such as tricolored blackbird, least Bell's vireo, willow flycatcher, red-legged frog, yellow-billed cuckoo, southern steelhead, quino checkerspot, common garter snake, black rail, etc.)

- Potential reserve sites should be prioritized based on the presence or potential presence of species or other ecological phenomena in the following five categories:

    1. *Legally protected species*: California gnatcatcher, least Bell's vireo, southwestern willow flycatcher, red-legged frog, arroyo southwestern toad, pacific pocket mouse, southern steelhead

    2. *Rare plant or habitat associations*: native grasslands, vernal pools, cliffs

    3. *Upper trophic level or generalist species*: golden eagle, red-tailed hawk, great horned owl, barn owl, mountain lion, bobcat, coyote, badger

    4. *Locally rare species*: long-eared owl, glossy snake, patch-nosed snake, long-nosed snake, lyre snake, blind snake, legless lizard, banded gecko, Gilbert's skink,
    5. *Species indicative of the quality of select habitat-types (NOTE: These are not "umbrella" species, nor necessarily sensitive species, but rather a collection of species with an affinity for each habitat-type. These species are highly indicative*

of the habitats which they occupy, and can be good indicators of both the quality of habitat and the presence of other species dependent upon that habitat-type):

a) Riparian - red-shouldered hawk, Cooper's hawk, sora, common yellowthroat, two-striped garter snake, red racer, arroyo toad, California tree frog, pacific pond turtle, arroyo chub, threespine stickleback, several bats

b) Coastal sage scrub - California gnatcatcher, cactus wren, wrentit, greater roadrunner, pacific kangaroo rat, California pocket mouse, red diamond rattlesnake, orange throated whiptail, spotted night snake, San Diego horned lizard

c) Oak woodland - Cooper's hawk, long-eared owl, western screech owl, acorn woodpecker, Nuttall's woodpecker, ash-throated flycatcher, bobcat, brush mouse, California slender salamander, bats

d) Grassland - white-tailed kite, northern harrier, burrowing owl, grasshopper sparrow, horned lark, savannah sparrow, lark sparrow, western meadowlark, loggerhead shrike, badger, western skink, ring-necked snake, western spadefoot toad, bats

e) Chaparral - wrentit, bushtit, spotted towhee, California thrasher, black-chinned sparrow, pacific kangaroo rat, California pocket mouse, rosy boa, western whiptail, red diamond rattlesnake, lyre snake

f) Pond **-** great blue heron, black crowned night heron, snowy egret, pied-billed grebe, tricolored blackbird, red-winged blackbird, sora, common yellowthroat, pacific pond turtle, pacific chorus frog, western toad, bats

Tenet 2. Larger Reserves are Better

Large blocks of habitat containing large populations of species indicative of habitat quality are superior to small blocks of habitat containing small populations.

Reserve Design Principles:

The science advisors believe this design principle needs no elaboration for the southern Orange County subregional planning area beyond that provided in the original SRP conservation guidelines. The tenet mandates that, **all else being equal,** reserve design options that include greater areal extent are superior. When comparative circumstances are not otherwise equal, habitat diversity, the presence of special landscape features, and concentrations of species of concern will often offset a solely area-driven reserve design selection process. It is in the alternative analysis where these variables are weighed, with appropriate weight given to habitat block size.

Tenet 3. Reserves Should be Diverse

Blocks of habitat for reserves should contain a diverse representation of physical and environmental conditions.

Reserve Design Principles:

- Reserves should capture the environmental gradient, both within and among habitat-types. This includes the elevation gradient, the coast/inland gradient, and variability among soils, vegetation and habitat-types. This should, among other things, increase the probability of including unsurveyed or unknown species in the reserves.

- Several important grassland areas occur within the subregion. They are valuable for a variety of vertebrate species of concern, including the badger, burrowing owl, spadefoot toad, and horned lark. Also, the ecotone between coastal sage scrub and grassland is important for California gnatcatchers. Important grassland areas are: Gobernadora, Chiquita, Upper Gabino, Cristianitos, and areas Northeast of San Clemente and San Juan Capistrano.

- Several key riparian systems occur within the subregion, including along San Juan Creek, Trabuco Creek, and the San Mateo Creek drainage (Gabino and Cristianitos Creeks). Maintaining the integrity of these systems is important for a wide variety of species, including least Bell's vireo, yellow warbler, yellow breasted chat, willow flycatcher, arroyo toad, California glossy snake, silvery legless lizard, southwestern pond turtle, arroyo chub, and threespine stickleback.

- Habitat mosaics on the side of the subregion nearest the coast are important for a number of reptile and amphibian species of concern in the subregion and have historically incurred more losses to conversion than inland portions. They can contain rarer natural subcommunities and higher densities of some species (red diamond rattlesnake, spadefoot toad, San Diego ringneck snake, orange-throated whiptail, coronado skink).

- The reservoir on the north side of Ortega highway along San Juan Creek is an important foraging, nesting and habitat area for several bird species (such as black skimmer, California gull, great blue heron, double-crested cormorant, elegant tern, white pelican, arroyo toad and pond turtle). Maintenance of this reservoir--including periodic silt, sand and gravel removal--is an important part of maintaining these species in the subregion.

- Several canyons are important for nesting raptors, including Gabino, La Paz, Cristianitos and Talega Canyons.

Tenet 4. Keep Reserves Contiguous

Habitat that occurs in less fragmented, contiguous blocks is preferable to habitat that is fragmented or isolated by urban lands.

Reserve Design Principles:

- Reserve design alternatives should seek, in order of priority:

  1. Continuity within habitat (minimize additional fragmentation).
  2. Connectedness (increase existing habitat blocks).
  3. Proximity (minimize distance between habitat blocks).

- The reserve design should strive to maintain the contiguity of large intact habitat blocks and not fragment them internally (e.g. the southeast section of the planning area).

- Reserve design should attempt to minimize physical barriers and visual barriers between reserves, particularly those reserves that are close together. Different groups of species (rodents, birds, large mammals, reptiles) are affected by different barriers and distances. For example, gnatcatcher populations in fragmented habitat blocks rely on visual observation to identify other potential habitat blocks for dispersal. If nearby habitat (less than 0.5 mile) is barred from sight by obstructions, those blocks are effectively separated permanently from one another. Similarly, roads, even two lane asphalt, represent permanent barriers to small mammals and many herpetofauna. These issues should be considered when assessing potential connectivity of reserve alternatives.

- Development around reserves should be directed to existing disturbed areas everywhere possible and away from native communities.

- Reserve selection should favor increasing permanent open space and de facto permanent natural areas, or reserves should be in close proximity to those areas. They include:

  - Rancho Mission Viejo Conservancy
  - Caspers Park
  - O'Neill Park
  - Open Space in Upper Trabuco Creek
  - Wagon Wheel Park
  - Camp Pendleton
  - Cleveland National Forest

Tenet 5. Maintain and Create Landscape Linkages Between Reserves

Blocks of habitat that are close to one another serve species of concern better than blocks of habitat that are situated far apart. Interconnected blocks are better than isolated blocks. Landscape linkages function better when habitat blocks and vegetation within them are natural and resemble habitat and vegetation preferred by key species of concern.

Reserve Design Principles:

- Maintaining the integrity of riparian systems (including major stream courses and their tributaries) is very important for both vertebrates and invertebrates, in:

- San Mateo Drainage (Cristianitos and Gabino creeks)
- San Juan Creek
- Trabuco Creek (downstream of existing open space)
- Gobernadora Creek

- Linkages should follow landscape features and respond to patterns of dispersal exhibited by species considered in reserve design.

- Only open space corridors that are native vegetation serve as truly effective landscape linkages.

- Reserve design should not impose artificial linkages on the landscape at the expense of natural linkages.

- Ridgetop connectivity between Gobernadora and Bell Canyons is an important landscape linkage.

- Landscape linkages should be designed to serve the widest array of species by providing characteristics required for dispersal by the most wide-ranging organisms (mountain lion, bobcat, coyote, red diamond rattlesnake).

Tenet 6. Protect Reserves from Encroachment and Invasion of Non-native Species

Blocks of habitat that are roadless or otherwise serve to minimize human disturbance conserve species better than do accessible habitat blocks

Reserve Design Principles:

- Reserve design should designate a fuel management zone outside the reserve.

- Where possible, areas of reduced human activity and development (recreational parks, parking lots, etc.) are preferable adjacent to reserves.

- Landscape linkages are also vulnerable to edge effects and disturbances. Wide linkages are preferable, so they may contain “interior” habitat.

- Both reserve design configuration and the engineering of impacts in the adjacent areas should minimize the effect of detrimental habitat interfaces (high-speed roads, high density housing) on species most sensitive, particularly species with large home ranges (such as mountain lion or bobcat), or lesser vagility (such as red diamond rattlesnake or rosy boa).

- Reserve design, as well as activities authorized immediately adjacent to reserves, should strive to minimize artificial drainage and downslope movement of materials into conservation areas.

- Reserve design should control and manage human entry into conservation areas.

- Activities within the reserves should be limited to those with least impact on ecological communities and species as well as be restrictive initially and relaxed as appropriate based on impacts. Controls may include limiting visitor numbers, allowing only certain types of activities, and other seasonal constraints. They also may include control of illegal dumping and high-impact recreation, and limiting unauthorized collection of specimens and vermin control.

Tenet 7. Maintain Ecosystem Processes and Structures

Reserves that are designed to maintain ecosystem processes and structures are easier to manage and have a much higher likelihood of sustaining biotic diversity over time than reserves that fragment and disrupt ecosystem processes.

Reserve Design Principles:

- The size, boundaries and shape of reserves should be selected to allow maximum scope for fire management, whether passive ("let it burn") or active in the form of controlled management or experimental fires.

- The reserve system should protect intact hydrologic and erosional processes, including both normal function and extreme events (flooding, earthflow). Reserve design should protect to the maximum extent possible the hydrology and erosion regimes of riparian systems, especially in Cristianitos, San Juan and Trabuco drainages.

- Reserves should minimize the possibility of arson or accidental fires starting or entering the reserves, by including among other things, consideration of potential ignition sources.

Task II. Principles for Conservation of Species and Habitats

The second task of the science advisors in the Southern NCCP subregion is to identify principles for conserving species and habitats under the plan. One end result of the NCCP planning process is generally a permit approving incidental take for an explicit list of species. The process of assembling this species list involves, in part, an evaluation of the extent to which an individual species is effectively conserved by the plan. The wildlife agencies are exclusively responsible for this coverage determination. The science advisors will not be involved in the legal and regulatory process of determining which species receive permit coverage and which do not. The product of this task, instead, is to provide information and objective criteria that may assist the working group and agencies in their analysis. It takes the form of an objective, scientifically-sound set of principles that may serve as a planning hierarchy for conservation decisions (see below).

The consulting team, the Department of Fish and Game and the U.S. Fish and Wildlife Service provided the science advisors with a list of species to be considered for conservation in the Southern subregion. The advisors worked from the list of species that was provided, recognizing that there are other species, such as wide-ranging animals and some rare plants, that are not included on the list. To develop the planning hierarchy and conservation analysis, three groups of species have been identified from that list. The groups were created based on criteria for each species that should be satisfied to assure their conservation. Species have been grouped based on their life history characteristics, degree of rarity or endemism, regional and global context, response to management, extant population size and trend, genetics, and other variables as necessary. The science advisors have used the criteria within each grouping to substantiate inclusion of a specific species in that group. For the species in the third planning group, the advisors have included a list of the known actions beyond reserve design necessary to achieve conservation of those species in the subregion. The planning groups, their associated criteria for conservation, and the species that fit them (from the species lists provided) are listed below.

Local survey data are incomplete for many taxa, and for plants in particular. Rare plants can present problems for conservation because they are often in patchy and highly localized distributions. Contributing botanists recommend surveying for nearly all the plant species during implementation, particularly in the southeast portion of the subregion, since it is the least studied. Current data and knowledge of rare plant distributions indicates that the Canada Chiquita-Canada Gobernadora-Christianitos axis is likely the most important rare plant area within the southern subregion.

It is fundamental to note that the species have been grouped for conservation based on the assumption that the overall reserve design will adhere as closely as possible to the principles recommended in Task I. The criteria for conservation and the assignment of species to groups will change if the reserve design principles in Task I are not observed. Similarly, some species can be best conserved by a combination of the reserve design principles and by management activities to be developed in Task III. The three sets of principles work together to enable a strong conservation program for the subregion.

Group 1: Minimal Conservation Action Needed

Species whose conservation is affected minimally by the outcome of the planning process.

***Criteria*:** Very limited impact of any alternative plan on species; or
Not found or insignificant in planning area; or
Very high population numbers in subregion

***Species*:**

<u>Birds</u>

Allen's hummingbird	*Selasphorus sasin*
American bittern	*Botaurus lentiginosus*
bald eagle	*Haliaeetus leucocephalus*
bank swallow	*Riparia riparia*
Belding's savannah sparrow	*Passerculus s. beldingi*
black rail	*Laterallus jamaicensis*
black swift	*Cypseloides niger*
black tern	*Chlidonias niger*
Brewer's sparrow	*Spizella breweri*
brown pelican	*Pelecanus occidentalis*

canvasback	*Aythya valisineria*
clapper rail	*Rallus longirostris*
common loon	*Gavia immer*
Costa's hummingbird	*Calypte costae*
gull-billed tern	*Sterna nilotica*
hairy woodpecker	*Picoides villosus*
harlequin duck	*Histrionicus histrionicus*
hepatic tanager	*Piranga flava*
hermit warbler	*Dendroica occidentalis*
horned grebe	*Podiceps auritus*
least bittern	*Ixobrychus exilis*
least tern	*Sterna antillarum*
Lewis' woodpecker	*Melanerpes lewis*
long-billed curlew	*Numenius americanus*
mountain plover	*Charadrius montanus*
olive-sided flycatcher	*Contopus borealis*
osprey	*Pandion haliaetus*
peregrine falcon	*Falco peregrinus*
prairie falcon	*Falco mexicanus*
purple martin	*Progne subis*
reddish egret	*Egretta rufescens*
rufous hummingbird	*Selasphorus rufus*
savannah sparrow	*Passerculus s. rostratus*
snowy plover	*Charadrius alexandrinus*
spotted owl	*Strix occidentalis*
summer tanager	*Piranga rubra*
Vaux's swift	*Chaetura vauxi*
Virginia's warbler	*Vermivora virginiae*
western grebe	*Aechmophorus occidentalis*
white-faced ibis	*Plegadis chihi*
yellow rail	*Coturnicops noveboracensis*

Reptiles

southern sagebrush lizard	*Sceloporus graciosus vandenburgianus*

Mammals

San Diego desert woodrat	*Neotoma lepida intermedia*
Stephens' kangaroo rat	*Dipodomys stephensi*

Group 2: Best Conserved at Habitat/Landscape Level

Species conserved most effectively by protection activities at the habitat or landscape scale. These species are best conserved by following the reserve design principles identified in Task I and the management goals and principles to be identified in Task 3. Their conservation can be relatively accurately inferred from a well-planned and managed network of reserves in a functioning landscape.

***Criteria*:** Widespread within subregion; or
Relatively robust overall species population; or
May or may not be common outside subregion; or
Life history characteristics respond to habitat scale conservation; or
Detailed surveys or inventories not crucial in order to conserve; or
Known or suspected to respond well to habitat management; or
Locally genetically indistinct; or
No individual action needed other than habitat protection and mgmt

***Species*:**

Birds

Bell’s sage sparrow	*Amphispiza belli belli*
barn owl	*Tyto alba*
Bewick's wren	*Thryomanes bewickii*
black skimmer	*Rynchops niger*
cactus wren	*Campylorhynchus brunneicapillus*
California gnatcatcher	*Polioptila californica*
California gull	*Larus californicus*
California thrasher	*Toxostoma redivivum*
Cooper's hawk	*Accipiter cooperii*
double-crested cormorant	*Phalacrocorax auritus*
elegant tern	*Sterna elegans*
golden eagle	*Aquila chrysaetos*
grasshopper sparrow	*Ammodramus savannarum*
horned lark	*Eremophila alpestris actia*
lark sparrow	*Chondestes grammacus*
Lawrence's goldfinch	*Carduelis lawrencei*
loggerhead shrike	*Lanius ludovicianus*
merlin	*Falco columbarius*
northern harrier	*Circus cyaneus*
Pacific-slope flycatcher	*Empidonax difficilis*
red-breasted sapsucker	*Sphyrapicus ruber*
red-shouldered hawk	*Buteo lineatus*
rufous-crowned sparrow	*Aimophila ruficeps canescens*
sharp-shinned hawk	*Accipiter striatus*
short-eared owl	*Asio flammeus*
Swainson’s hawk	*Buteo swainsoni*
white pelican	*Pelicanus erythrorhynchos*

Amphibians

coast range newt	*Taricha torosa*

Reptiles

coast patch-nosed snake	*Salvadora hexalepis virgultea*
coastal rosy boa	*Lichanura trivirgata roseofusca*
coastal western whiptail	*Cnemidophorus tigris multisc*.
Coronado skink	*Eumeces skiltonianus interpar*.
orange-throated whiptail	*Cnemidophorus hyperthyrus*
San Diego horned lizard	*Phrynosoma coronatum blain*.
San Diego mountain kingsnake	*Lampropeltis zonata pulchra*
San Diego ringneck snake	*Diadophis punctatus similis*

Mammals

California leaf-nosed bat	*Macrotus californicus*
dulzura California pocket mouse	*Chaetodipus californicus femoralis.*
long-legged myotis	*Myotis volans*
mule deer	*Odocoileus hemionus*
pallid bat	*Antrozous pallidus*
San Diego pocket mouse	*Chaetodipus fallax fallax*
spotted bat	*Euderma maculatum*
Townsend’s big eared bat	*Plecotus townsendii*
western mastiff bat	*Eumops perotis*

Fish

tidewater goby[1]	*Eucyclogobius newberryi*

Plants

Catalina mariposa lily	*Calochortus catalinae*
Coulter's matilija poppy	*Romneya coulteri*
intermediate mariposa lily	*Calochortus weedii var. Intermedius*
Palmer's grapplinghook	*Harpagonella palmeri*
summer holly	*Comarostaphylos diversifolia diversifolia*
western dichondra	*Dichondra occidentalis*
curving tarweed	*Holocarpha virgata ssp. Elongata*
rayless ragweed	*Senecio aphanactis*

Group 3: Best conserved at species-specific level

Organisms requiring species-level conservation action (including protection of individuals) in order to ensure their conservation, either within the subregion or as a species, are included in Group 3. The species in this group require one or more of three types of conservation action: 1) fine-tuning of reserve design or specific management activities; 2) reintroduction and/or

[1] This species is not known to occur in the planning area, but it is found in the lower San Mateo drainage immediately adjacent to the Southern subregion. The reserve design and activities conducted in the planning area may affect the species downstream.

significant enhancement; or 3) additional data and research are necessary to determine basic needs. Species are identified below with a superscript [1,2 or 3] corresponding to the appropriate type of action needed above. Where possible, species-specific conservation principles have been developed and are provided. In addition, surveys are recommended for all the species in this group during implementation to monitor and fine tune conservation requirements.

***Criteria*:** Known or predicted extremely low population; or
Narrowly endemic within subregion; or
Highly specialized life history requirements; or
Subregion crucial to survival of entire species; or
Known or suspected poor response to management; or
Highly sensitive to small changes in landscape or habitat; or
Dependent on intensive conservation activities; or
Widespread but extremely uncommon

***Species*:**

<u>Birds</u>

least Bell's vireo[1]	*Vireo bellii*
yellow warbler[1]	*Dendroica petechia*
yellow-billed cuckoo[1,2]	*Coccyzus americanus*
yellow-breasted chat[1]	*Icteria virens*
willow flycatcher[1]	*Empidonax traillii*

- Reserve design should conserve riparian habitat along key drainages and tributaries
- Management and enhancement of riparian systems will improve opportunities for these species during implementation

burrowing owl[1]	*Speotyto cunicularia*
ferruginous hawk[1]	*Buteo regalis*

- Reserve design should conserve key grasslands to the extent possible
- Documenting winter distribution and habitat needs is important

long-eared owl[1]	*Asio otus*
white-tailed kite[1]	*Elanus leucurus*

- For conserved nesting sites, undisturbed habitat within 0.5 miles is important (this may be fine-tuned based on local habitat context and topography)
- Basic life history research and monitoring should be included in plan implementation protocol

tricolored Blackbird[1]	*Agelatus tricolor*

- Reserve design should establish a minimum of 100yd buffer around colonies to be conserved

- Permanent ponds with cattails are key breeding and foraging areas

Amphibians

arroyo southwestern toad[1] *Bufo microscaphus calif.*

- Reserve should protect the integrity of important riparian systems and watercourses

- Exotic fish, frogs and Argentine ants should be strongly controlled

- For conserved breeding sites, uplands up to 0.5 miles from associated streams are important

- Light pollution from highways and developments should be minimized

- Surveys should be conducted during implementation to fine tune management

California red-legged frog[2] *Rana aurora draytoni*

- Surveys should be conducted to establish presence/absence in subregion before attempting reintroduction

- Potential habitat should be restored or enhanced

- Exotic predators (bullfrog, sunfish) should be controlled or eliminated

- Water quality and riparian zones should be protected in key drainages

western spadefoot toad[1] *Scaphiopus hammondii*

- Important grassland areas should be conserved or alternatives identified
- Possibly limited by lack of breeding pools in uplands

Reptiles

California glossy snake[1] *Arizona elegans occidentalis*

- Riparian sandy deposits along key drainages should be conserved and sand mining minimized; this is one of 3 places in Southern California where this subspecies has been recorded

- Argentine ants and light pollution from highways should be controlled and minimized northern red diamond rattlesnake[1] *Crotalus ruber ruber*

- Road kill is suspected to be highest mortality factor; all sources of road kill should be minimized
- Western sections of planning area have highest population density and should be conserved if possible
- Fragmentation of intact habitat blocks should be limited

San Diego banded gecko[3] *Coleonyx variegatus abbotti*

- Expected to occur in very low densities; surveys and monitoring (especially across elevational gradient) needed to establish preferred habitats and conservation needs

silvery legless lizard[1] *Anniella pulchra pulchra*

- One of only two species in Southern California representing an endemic family
- Sandy deposits in San Juan Creek, including downstream reaches, may be important
- Argentine ants should be controlled

southwestern pond turtle[1] *Clemmys marmorata pallida*

- San Juan Creek is an important drainage for this species
- Migrate overland to nest; uplands associated with ponds important
- Road kill and collection by humans should be minimized

two-striped garter snake[1] *Thamnophis hammondii*

- Riparian areas and adjacent uplands to distance of 0.5 miles should be conserved where possible
- Collection of specimens should be minimized

<u>Mammals</u>

Pacific pocket mouse[1,3] *Perognathus longimembris pacificus*

- Encroachment from adjacent development should be minimized, especially housecats
- Suggest additional surveys in suitable habitat
- Closest known population near San Mateo estuary (outside subregion)

San Diego black-tailed jackrabbit[2] *Lepus californicus bennettii*

- Suitable habitat remains in subregion and should be restored/enhanced
- Surveys should be conducted to establish presence/absence before attempting reintroduction
- Human encroachment on reserves should be minimized

southern grasshopper mouse[3] *Onychomys torridus ramona*

- No confirmed presence in subregion, although within historic range
- Surveys necessary to establish presence/absence and management needs

<u>Fish</u>

arroyo chub[1] *Gila orcutti*

- Trabuco and San Juan creek drainages are important to the species
- Exotic fish (e.g. *Gambusia*) should be controlled
- Hydrologic processes and water quality in key areas should be protected and restored

southern steelhead[2] *Oncorhynchus mykiss*

- Conservation plan should coordinate with recovery plan for the species
- Natural hydrology and erosional processes in San Mateo watershed should be maintained to provide restoration opportunities
- San Juan Creek drainage and tributaries are important for restoration

threespine stickleback[1] *Gasterosteus aculeatus ssp.*

- This subspecies is endemic to the San Juan/Trabuco drainage; water quality and quantity in the drainage should be maintained
- Exotic and invasive fishes and frogs should be controlled

<u>Plants</u>

Blochmann's dudleya[1] *Dudleya blochmaniae*

- Coastal bluffs are primary habitat

- Management to prevent human encroachment from nearby urbanized areas

- Highly limited distribution; 2 small populations known in subregion, additional surveys needed
- Annual/biennial monitoring of population numbers recommended

- Identification of potential restoration sites with suitable habitat within subregion and implementation of efforts to restore additional populations within subregion

chaparral beargrass[1] *Nolina cismontana*

- Relies on specific soil types (typically supporting chamise chaparral or coastal sage scrub)

- Over 90 % of known species distribution located in Central Coastal and Southern subregion

- Reserve design should protect specific soils where possible (mostly associated with Cieneba sandy loam, and Cieneba-Rock outcrop complex)

- Reserve design should attempt to protect major populations (i.e, Foothill Trabuco, Hot Springs Canyon, the latter is on already on land managed by the U.S. Forest Service)

- Soil specific surveys for additional populations

- Fire management likely necessary to promote reproduction

cliff spurge[1,3] *Euphorbia misera*

- Not confirmed from subregion, but populations known to be low in U.S.

- Reserve design should protect coastal bluff scrub, coastal bluffs, and steep coastal cliffs.

- Surveys necessary to establish presence/absence in subregion

- For confirmed populations, management consists of monitoring and control of invasive exotic plants

coastal golden bush[1,3] *Isocoma menzesii var. sedoides*

- Not confirmed from subregion; only one Orange County record, from Crystal Cove State Park

- Found on coastal bluffs and coastal bluff scrub; need surveys to establish presence/absence; easily detected in surveys

- Management consists of monitoring and control of invasive exotic plants

Coulter's saltbush[1,3] *Atriplex coulteri*

- One definitive record in Cristianitos Canyon along proposed transportation corridor alignment

- Additional surveys needed to establish presence/absence and habitat preference

heart-leaved pitcher sage[1] *Lepichinia cardiophylla*

- Known distribution in subregion: 2 populations reported near Trabuco Peak, others populations in Central/Coastal

- Associated with chaparral above 1,000 feet-- all appropriate habitat probably in the National Forest

many-stemmed dudelya[1] *Dudleya multicaulis*

- Requires xeric barrens, cobbly clay soils

- Species currently occupies half of historic range; concentrated in 5 core populations; western and southern areas important
- Reserve design should attempt to protect 80 percent of populations with minimum of 200-foot buffer from developed areas

- Transportation corridor may impact over 7,000 known individuals

- Management consists of species monitoring, exotics control in areas adjacent to development.

- Rare in Casper's Regional Park and Starr Ranch

ocellated Humboldt lily[1] *Lilium humboldtii ssp. Ocellatus*

- Key habitat for protection is oak woodland and stream courses in the foothill-mountain transition zone

- Most habitat is in Starr Ranch, Casper's Park and the National Forest; Foothill Trabuco unprotected

- Population monitoring needed to inform adaptive management

Parish's saltbush[1,3] *Atriplex parishii*

- Known from only two localities (both in Riverside County), however southern subregion has moderate chance of supporting the species

- Reserve design should attempt to include alkali habitats, swales, sinks, depressions, and grasslands with heavy alkali-clay such as in Canada Chiquita

- Habitat specific surveys needed during implementation

- Manage through population monitoring and invasive exotic plant control

Pacific saltbush[1,3] *Atriplex pacifica*

- Found rarely on coastal bluffs; may also be dependent on alkali habitats, swales, sinks, depressions and grasslands with heavy alkali-clay componants like *A. parishii*

- Suitable habitat known from coastal bluffs in subregion and in western lowland areas

Parry's tetracoccus[1] *Tetracoccus parryi*

- Specific to heavy gabbro-clay soils in chaparral
- Only known locality and most habitat within National Forest

prostrate spineflower[3] *Chorizanthe procumbens*

- Distribution very poorly understood in subregion

- Narrowly endemic to sandy areas

- Management needs include population monitoring and fire management

San Miguel Savory[1] *Satureja chandleri*

- Most of known habitat within National Forest

- Key habitats for potection are oak woodland, oak gallery forest, and shaded stream courses above 500 feet elevation

- Largest known populations of this species are within subregion in the vicinity of Upper Hot Springs Canyon and Chiquito Basin

- Management needs include monitoring and prevention of invasive exotic plants

southern tarplant[1] *Hemizonia parryi ssp. Australis*

- Populations known to be very reduced and restricted species-wide

- Found in moist alkali soils, alkali swales, sinks, depressions and grasslands with heavy alkali-clay componants such as in Canada Chiquita. Populations in Canada Chiquita some of the largest known and should be protected

- Management includes population monitoring and control of invasive exotic plants

sticky dudleya[1] *Dudleya viscida*

- Key habitats needing protection are shaded, steep rocky cliffs and canyon walls

- Most habitat appears to be within National Forest, Casper's Park and Starr Ranch, although appropriate habitat exists in Rancho Mission Viejo in southeast portion of subregion

- Unlikely to occur in western lowlands and foothillls of subregion

thread-leaved brodiaea[1] *Brodiaea filifolia*

- Declining rapidly over entire range
- Reserve should protect southern needlegrass grasslands and mixed native-non-native grasslands in clay soils

- Most populations known from western portion of southern subregion and should be protected if possible

Invertebrates

quino checkerspot[1,2] *Euphydryas editha quino*

- Locally extinct in Orange County

- Reintroduction should be enabled through reserve design and management by protecting open coastal sage scrub and host plants at a minimum of five locations

- Populations in northern Baja are likely source for translocations

Harbison's dun skipper[3] *Euphyes vestris harbisoni*

- Distribution very poorly known; surveys needed to establish presence/absence in subregion

- Key habitats are oak riparian drainages and adjacent seeps supporting *Carex spissa*, the larval host plant

Riverside fairy shrimp[1] *Streptocephalus woottoni*

- Only known subregional record from vernal pools in Saddleback Meadows

- Surveys desirable to determine presence absence of habitat

- Management requires maintenance of vernal pools and associated watersheds

San Diego fairy shrimp[1]	*Branchinecta sandiegoensis*

- No confirmed records from subregion
- Requires vernal pool habitat; surveys suggested along with Riverside fairy shrimp
- Management includes maintenance of vernal pools and associated watersheds

A Further Note on "Umbrella Species":

Several vertebrate species in the subarea from this lists provided have broad requirements in both habitat and home range. They might serve as effective umbrella species for planning purposes; by providing for their requirements many other species will benefit. For example, landscape linkages designed for bobcats and mountain lions would work well for a number of other species. Or, conserving the nesting and foraging territories of some of the raptors will provide habitat for many other organisms. The species below have been identified in the reserve design principles under Tenet 1, but are worth describing here as well. In particular, the bobcat and the mountain lion are known empirically to serve well as umbrellas and there is extensive information on the breeding and foraging distribution of the three raptor species in the subregion. The following species can be important in identifying the potential reserve network:

American badger	*Taxidea taxus*
bobcat	*Lynx rufus*
coyote	*Canis latrans*
mountain lion	*Felis concolor*
red-tailed hawk	*Buteo jamaicensis*
great horned owl	*Bubo virginianus*
golden eagle	*Aquila chrysaetos*
barn owl	*Tyto alba*

Task III: Principles for Adaptive Management

This section develops an outline and principles for an adaptive management program for the subregional NCCP. It begins with a discussion of general land management principles and relates them to the key conservation goals of the NCCP. It discusses adaptive management and its fundamental elements to provide context for the specific suggested management program goals for the southern subregion. The report then outlines potential steps to implement an adaptive management approach for the subregion, based on the target landscape, species and natural communities of particular concern. Through a case example, the report shows how a community-specific model can be used to develop a set of testable management hypotheses. A discussion contrasting research, monitoring and management follows, leading to a suggested structure for the subregional program, tasks, responsibilities, products, and potential schedules. The section concludes with a discussion of funding strategies for management and research in the subregion. While the science advisors did not consider the allocation of responsibilities of funding adaptive management, the importance of funding was recognized and the program is believed to be financially feasible.

Overall Land Management Goals

There is a recent growing trend toward managing natural lands at the ecosystem level. The science advisors acknowledge and support this focus for adaptive management as the scale most likely to produce success for the conservation program. To do this, it is important to set some broad overall goals for land management. The advisors recommend that the management program of the subregional NCCP seek to achieve the following overall goals. The management activities outlined in this framework are intended to assist in meeting these goals:

1. Ensure the persistence of a native-dominated vegetation mosaic in the planning area.

2. Restore or enhance the quality of degraded vegetation communities and other habitat-types consistent with overall conservation goals for species and natural communities.

3. Maintain and restore biotic and abiotic natural processes, at all identified scales, for the planning area.

Although overall goals are extremely important to point the program in the right direction, they provide little guidance in defining target conditions for specific habitats and management activities on individual parcels. The following sections discuss development of a program aimed at the above goals while addressing species and community specific objectives and conditions.

Keys to Adaptive Management

This section briefly describes the emerging science of adaptive, ecosystem-level management as it relates to the reserve design and species conservation principles in the previous two sections. The science advisors identify the key elements of an adaptive management program and discuss in detail the process of setting objectives for management and development of natural community models that help initiate the adaptive process. This section also points out the crucial nature of biological monitoring as part of an overall management program.

Ecosystem management presumes a working knowledge of system function and structure. Yet we know comparatively little about how coastal scrub and associated habitats function and the roles of many species in this process. Coastal sage scrub received very little attention from researchers until the late 1970's (see O'Leary et al 1994). As a result, it is difficult to initiate a precise long-term management program from the beginning of a conservation plan. The management program by necessity should be iterative -- continually refining initial management strategies according to information learned during the process of management and monitoring. This is particularly true for the effects of habitat fragmentation on the persistence of coastal sage scrub and associated species -- an important, but relatively unstudied issue.

A formally structured protocol for this learning process, termed "Adaptive Management," directs management and monitoring actions to optimize information acquisition and improve management in feedback steps (Lee 1993:9). Adaptive management assumes that managers will take actions (including leaving habiats undisturbed) that modify present ecosystem structure and function with the aim of moving the system towards a more desirable state or keeping it within some acceptable limits. This process takes advantage of the information generating opportunities that management activities create (Fig 1). The process is based on a feedback loop in which individual management objectives are flexible and can be changed as new information becomes available or as conditions or priorities change (Schroeder and Keller 1990, Walter and Holling 1990). Adaptive management is iterative, meaning that managers constantly monitor and evaluating the consequences of their activities and refine them. This approach to conservation allows land management to proceed in the absence of complete initial information.

The fundamental elements of an adaptive management program are:

1. Setting Management Objectives

Before specific management activities can be identified for a parcel, habitat or landscape, planners and managers should identify desired future conditions. These are the initial objectives on which management activities are undertaken. Objectives should be measurable. They should incorporate the diverse views of stakeholders and specific legal requirements for conservation as well as recognize the limits of such factors as available funds and land ownership. It is important that objectives are set with full recognition of the economic, social and political context in which the conservation program takes place. Stakeholders and land managers should define site specific objectives with review and input from scientists with expertise.

The advisors propose the following issues as a good starting point in objective setting (after Schroeder and Keller 1990):

- The rarity of a species or community
- Importance of endemic species/communities
- The variability in abundance of species/communities
- Keystone species
- Species or communities that are good indicators of change in the ecosystem of concern
- Defining and managing for “natural conditions”
- Cumulative effects of isolated impacts
- Major landscape-level changes

It is also important that objective setting consider the multiple scales affected by the conservation program (global, regional and local). For example, an objective to manage for the maximum absolute number of species (species richness) might not be desirable if it results in loss of a rare species not found elsewhere (Samson and Knopf, 1982; Noss and Harris, 1986). Setting objectives with an eye to regional context allows greater contribution of local projects to overall biodiversity conservation. This point emphasizes the need to have an overall assessment of the NCCP Region and various tradeoffs at the subregional level such as provided by the NCCP Regional Science Advisors.

2. Preparing Management Plans and Conceptual Models

Using the objectives identified in Step 1 and based on the best initial information available, management plans for reserve parcels and habitats should be prepared. A concept of how the natural system functions and responds to various management treatments is also important to creating management plans. Managers should develop these conceptual models of each focal habitat-type before developing management plans. In Figure 2, we illustrate a conceptual model of upland habitats under three management scenarios. This simple conceptual model describes the changes in the system (based on current knowledge) resulting from different management treatments, and it aids in identifying which treatments to use to bring about the objectives described in Step 1. This qualitative, relational model represents mostly assumptions or hypotheses that can then be tested through management. Monitoring the effects of that management can provide information allowing both the conceptual model and management activities to be refined over time to better meet the overall goals of the conservation program.

3. Identifying Uncertainties and Knowledge Gaps in Management Plans

To continue creating an adaptive management program, it is important to identify early gaps in knowledge about the natural system that lead to uncertainties about the effectiveness of the management plan in achieving desired objectives. These gaps point out specific areas for scrutiny during monitoring or weaknesses in the model. For example, we may not know how what happens to a natural community if fire is applied too frequently (a weakness in the model) or we may simply not know what role fire plays in the community at all (a weakness in basic research).

The purpose of identifying gaps in models and knowledge is to translate them into a set of questions that can be addressed through monitoring and/or research. This experimental approach to management recognizes the limitations of current knowledge about natural communities and informs constant improvement of management efforts. As knowledge gaps are identified and hypotheses are tested, conceptual models and management plans get better at achieving the objectives of the conservation program.

4. Monitoring the Management Program

Assumptions about the effect of management actions in initial management plans and their ability to achieve desired objectives should be evaluated through ongoing monitoring. The results of monitoring, when compared to the hypotheses in the conceptual natural community models, are what allow refinement of management activities. The key to monitoring, then, is what is monitored and why. *The biological monitoring program should be developed specifically to measure and evaluate the effects of management activities. It should identify and measure variables that permit iterative refinement of the management program.*

The monitoring program should be structured so that the information collected allows both the determination of factors crucial to permit compliance and identification of trends that allow the management program and plans to be adapted. For example, one could monitor California gnatcatchers (*Polioptila californica*) by either counting absolute numbers of birds or by measuring key habitat variables. After a decade of monitoring, the first method would result in simply 10 years of population numbers with no sense of the cause of trends. The second method would give as accurate a picture of population health, but would also pick out trends that could be addressed through adapting management. Either method might suffice for permit compliance regarding coverage of gnatcatchers.

The biological and management monitoring program should include both routine long-term observations and management experiments since some crucial assumptions about cause and effect of management may not be easily tested by simple observation. These are important activities, and should be integrated into the management program in the context of ongoing management. Done creatively, this can occur without increasing or complicating management activities. Furthermore, some questions are better explored in more traditional scientific studies and the answers to these questions may be critical for success of the conservation management program. A successful adaptive management program should therefore include both routine observational monitoring and experimental management actions and monitoring designed to test assumptions beyond simply passive observation, supplemented by research to answer fundamental questions of ecosystem function or processes. The fundamental questions for biological monitoring to inform adaptive management should be: which attributes of the system should be measured, and when should the alarm bells go off that unacceptable change is occurring?

5. Incorporating Monitoring and Research Results Into Revised Management Plans

As discussed above, designing management plans as assumptions or hypotheses to be tested allows immediate biological and permit compliance needs to be met while utilizing management as an experimental treatment. Analysis of the ecological information gathered in the monitoring process should be fed back into revised management plans, and new hypotheses posed as new information becomes available. Over time, both knowledge (as reflected in conceptual natural community models) and management activities are refined and are better able to achieve the overall goals of the conservation program.

Adaptive Management for the Southern Orange County Subregion

The previous section described the fundamental steps in creating any adaptive management program. Program success depends on development of objectives and initial natural community conceptual models based on current information, and feeding these into management plans that can be tested and refined over time as knowledge gaps are filled through monitoring. The science advisors recommend that the management program for the Southern Orange NCCP follow this approach. This section identifies suggested target communities for management planning in the subregion as well as the natural processes that should be part of the conceptual models. The following sections identify additional pieces of the adaptive management program.

Two levels of planning should be conducted for the subregion. Conceptual models and initial management plans should be completed for each target natural community-type, and an overall qualitative model developed for the entire subregion to identify and coordinate interactions and management activities among natural community-types. These planning exercises will define current knowledge, identify gaps and direct initial management and monitoring activities.

Because of the biological complexity of the subregion, the science advisors believe that the number and scope of the conceptual models should be limited for practical purposes. In addition to the overall subregional model, conceptual models should be developed for the following generalized vegetation categories. These models should also include where appropriate the habitat relationships and management conditions identified for species from Group 3 of the Species Conservation Principles:

- Riparian
- Shrublands

- Woodlands
- Grasslands
- Wetlands
- Selected transitional habitats

The conceptual models developed for the subregion and generalized vegetation categories should also carefully consider the effects on preserved areas created by the wildland/urban interface that currently exists and that will be created by the development permitted under the NCCP. In particular, the following two factors should be considered:

1. Edge Effects

Encroachment from inhospitable adjacent land uses and other disturbances (e.g. feral cats, species collectors, etc.) may cause otherwise suitable habitat to be unoccupied by species of concern. Wildlife species often are extirpated from a proportion of high quality habitats near urban areas. The extent of this extirpation is highly variable and usually cannot be detected by vegetation or habitat element measurements (see Bolger et al 1997, Scott 1993).

2. Habitat Fragmentation

Converting parts of a natural landscape to developed areas disrupts patterns of dispersal or movement (e.g. many small mammals will not cross roads). Regional habitat patterns may be changed to the point that dispersal to some parcels of suitable habitat is insufficient to keep it occupied by a species of concern, even if those parcels are protected and remain relatively free from disturbance. For example, bird occurrence at Foothill Ranch (Scott unpublished data 1989 through 1996) adjacent to the Southern Orange County NCCP area indicates a high rate of species turnover in some patches of coastal oak woodland and sage scrub habitats. Dispersal between patches compensates for high mortality (perhaps due to Factor 1 above) and/or random extirpation. Habitat loss to land development further reduces availability and pattern of habitat patches in the landscape, reducing the likelihood that individual patches will be recolonized. The concept that there may be a critical threshold for the density and distribution of source populations is poorly understood.

Because of the importance of natural processes in maintaining species and habitats, and also due to the introduced factors illustrated above, it is critical that the adaptive management program address landscape issues and processes. When creating conceptual models for vegetation categories or habitat types it is recommended that the following processes be considered:

- Fire
- Hydrology/flooding
- Invasion of exotic species
- Erosion/sediment transport
- Recreation/Visitor use
- Encroachment/edge effect

Example Conceptual Natural Community Model - Coastal Sage Scrub

To assist subregional planners with modeling the vegetation categories identified above, the science advisors have developed and provided this preliminary model of the coastal sage scrub community based on current knowledge. The model depicts changes in species richness, successional stage and habitat-type over time in response to the varying effects of fire, invasions of exotic species, and other impacts such as grazing. This community-level information can be combined with other upland communities to define interactions and management activities across a broader portion of the landscape. The coastal sage scrub model is depicted in Figure 3.

The vegetative composition of coastal sage scrub has been shown to consist of relatively few dominant shrub species, with the majority of species occurring in the herbaceous understory (Westman 1981). Species richness in coastal sage scrub is typically highest in the first few years following a fire. This is attributed to the establishment of specialized fire-following annual grasses and plants. After a peak in local species diversity during a 5-10 year period, there is a general decline in understory herb species (and overall species diversity) over time. This may be attributed to dominant shrub species increasing in cover, thereby shading out the understory herbs (Keeley and Keeley 1984). Once the dominant shrub species are established, they will continue to re-seed and re-sprout in the absence of fire. The ability of coastal sage scrub to continually re-seed or re-sprout in the absence of fire suggests that a stand of sage scrub is typically of mixed age and leads to the hypothesis that the natural fire interval for sage scrub may be longer than is commonly assumed.

Post-fire shrub and herb diversity can vary depending on natural and anthropogenic or non-natural disturbance regimes. Westman and O'Leary (1988) found that sites adjacent to grazing tend to become dominated by annual grasses with poor recovery of dominant shrubs. In addition, short fire intervals (i.e. less than 20 years) may greatly reduce or eliminate some important or rare species, while longer fire intervals allow for the maintenance of species diversity (Malanson 1985). The example model demonstrates these effects by showing that species diversity declines over time in early and mid-successional sage scrub subject to either a repeat fire event or grazing. Increased dominance by non-native grasses as a result of grazing or a repeat fire event may in turn increase the fire frequency in that stand of sage scrub. As shown in the model, increased fire frequency may result in loss of species diversity and eventual type conversion of that stand to non-native grassland.

The example model shows that a late successional stand of sage scrub that has not been altered by grazing has the best chances for maintaining species diversity after a fire. The condition in a good portion of the subregion is the opposite, however, since much of the area is subject to grazing, and suggesting that fire management programs for sage scrub in the southern subregion should consider and plan for the potential effects of exotic species invasions.

Management Hypotheses for Coastal Sage Scrub

Based on the model developed above and illustrated in Figure 3, the following are examples of initial hypotheses that might be included in an initial management plan and then tested through the management and monitoring process. Some of these assumptions might be better addressed through research outside the scope of the NCCP, but the management and monitoring program should creatively maximize the number that can be tested through the adaptive management and monitoring program.

Hypotheses:

1. Fire intervals of less than 10 years will result in a decrease in diversity of native species and an increase in the frequency of non-native grasses and forbs.

2. Winter and spring fire events will result in a decrease in the density and diversity of native shrub species.

3. Grazing in post-fire, early and mid-successional coastal sage scrub will result in decreased species diversity over time.

4. An established (late successional) stand of coastal sage scrub that has not been subject to grazing will have a higher overall post-burn native species diversity than a same-aged stand that has been grazed.

5. Structural and compositional components of required habitat, for selected species, will decline in quality with fires occurring at least every 10 years.

6. Habitat quality, for certain associated species, will declined with grazing or grazing/fire events during early seral stages of succession.

The Role of Research in Adaptive Management

To date, ecologists and land managers have rarely attempted to synthesize the effects of management actions on landscape level projects. There is also relatively little basic information about how the system reacts to both natural and anthropogenic events or management techniques. This does not mean that sound biological management is impossible, only that it must be iterative. By the same token, research efforts have not been coordinated well to inform management, and the quality of conceptual ecological models and management activities have not progressed linearly. A recent conference on management and research in NCCP attempted to address this issue, and the science advisors recommend consideration of the report produced by the "Core Group" of the conference as a means to integrate these two issues.

In addition to the management/monitoring feedback described earlier, ecological research can be an effective way to fill the gaps in knowledge needed to refine management activities. For example, a management objective might be to preserve a particular natural community without significant change in its function. Because of variable climate and normal patterns of successional change, it is reasonable to state the objective as "no more change than would be expected given natural succession and the effect of variables like rainfall and temperature. But if we don't know how rainfall and temperature effect the system at a basic level, it is hard to identify changes in the system and how to compensate for them by adapting management. For example, complete loss of plant cover from a fire may be of no long term importance or it may be disastrous, depending on the system and the circumstances. This basic knowledge is gained through research. The advisors believe that the principles for adaptive management outlined here will make the most effective use of the benefits of both biological monitoring and research.

The following list focuses research on unanswered questions most affecting long-term conservation outcomes in Southern Orange County. *The NCCP management and biological monitoring program should be creatively designed to answer as many of these questions as possible*. The rest should be the subject of research early in implementation. The science advisors do not suggest a responsible entity for this research, only that the information is fundamental to development of a robust adaptive management program.

- Inventory and landscape pattern of CSS, grasslands, oak woodlands, riparian, chaparral.
- Trends in species composition and distribution in the above 5 communities
- Dispersal characteristics and landscape corridor use by focal species
- Demography, population viability and genetic or taxonomic analysis for selected target species
- Surveys and autecological studies of sensitive species (Category 3 list from Task 2)

Steps and Products for the Southern Orange County NCCP Adaptive Management Program

This section identifies a series of products and steps to creating an adaptive management program for the subregion. It also provides suggestions on priority and hierarchy. All these elements should be completed for the adaptive management program to operate effectively.

Elements of the Adaptive Management Program

As we have illustrated in this document, an adaptive management plan for the Southern Orange County subregional NCCP should contain the following elements (in hierarchichal order):

- Overall Land Management Goals
- Community or Species-Specific Management Objectives
- A Subregional Conceptual Model[1]
- Conceptual Ecological Models For Identified Natural Communities[1]
- Clearly Articulated Management Hypotheses
- Identification Of Knowledge Gaps in Models and Techniques
- Management Plans for Specific Natural Communities[2]
- A Landscape Plan Coordinating Overall Reserve System Management [2]
- Biological Monitoring Plan With Suggested Priorities To Address Management Hypotheses (what to measure, what to test)

The biological monitoring section of the NCCP plan should coordinate monitoring of management effects on sensitive species identified in Task 2 (the Species Conservation Principles). The vegetation specific plans and the landscape-level plan should address the following management issues:

- Fire
- Grazing
- Exotics Control

- Restoration
- Recreation

Ongoing or Continuing Management Activities

Even in the current absence of a well defined adaptive management plan some management activities should be initiated or continued. These activities should focus on maintaining the quality of existing habitats and restoring areas that have been highly degraded. All these activities should occur in an adaptive context upon completion of the adaptive management program.

For some management issues there is sufficient information to identify extreme threats and effective actions. For example, aggressive weed species are an existing extreme threat. Uncontrolled spread of invasive weeds such as artichoke thistle have the potential to quickly degrade (and have degraded) protected habitats and may reduce future conservation options. With proven control technologies in place for these threats, the science advisors recommend that active weed eradication commence or continue for some species immediately and not wait for the development of an adaptive management plan. Particular emphasis should be placed on both artichoke thistle (*Cynara cardunculus)* and arundo (*Arundo donax*) with the option for control of other species as appropriate. Technologies for control of these species may include, but should not be limited to herbicide treatments, prescribed fire and prescribed grazing. Weed control efforts should be subject to approval by existing management committees, or by a technical advisory committee if one is formed when the NCCP is approved.

The use of managed fire should be continued for grasslands and chaparral communities in the subregion. The science advisors believe that sufficient documentation of fire effects in these communities currently exists to plan ecologically sound management actions. Management burns should be coordinated with technical expertise and advice. Additional burning may be considered for scenarios where it may provided significant fire protection for sensitive resources, aid in the control of invasive weeds or provide an effective pre-treatment for restoration.

It is assumed that current levels of cattle grazing will continue on the site during the development stages of the adaptive management plan (and potentially beyond, depending on desired future habitat conditions) and grazing will be an important process managed through both the landscape-level plan and the specific natural community plans (see above). In the interim, the conservation outcomes of the NCCP would best be served by managing grazing allotments with strategies similar to those outlined in the grazing plan developed for the Irvine Open Space Reserve. Additional grazing of cattle, sheep or goats could be considered for weed control or fire protection objectives.

Restoration of highly degraded sites should also continue prior to completion of an adaptive management plan. Experimental or management treatments aimed at restoring non-native annual grasslands to coastal sage scrub should be highlighted in this process.

Implementing Adaptive Management in the Southern Subregion

This section offers recommendations about the issues and principles encountered in operating an adaptive management program and advice on the progression of tasks from immediate to long-term. For such an ambitious program to work effectively, there must be a blend of cooperation, objectivity, expertise, and critical evaluation. The science advisors note that the program administrative structure within which adaptive management takes place is fundamental to long-term success.

Without making conclusions about the administrative structure for implementing the Southern Orange County NCCP, the science advisors strongly recommend that a number of important issues for the adaptive management program be considered when the structure is created. The advisors also recommend that the advice and input of experienced, objective experts be sought frequently in the continuing administration of the adaptive management program.

Program Issues:

There are several issues at the program level that should be addressed through administration of the adaptive management program. These are:

- Coordination of resource agencies and technicians/scientists in conducting reviews and updates of adaptive management program goals and objectives
- Preparation of periodic reports on the management program
- Review of management plans
- Allocations of funds for management

Technical Issues:

These technical issues are essential to ensure ongoing effectiveness of the adaptive management program:

- Reviewing and updating program goals, objectives and techniques based on monitoring results
- Identification of long-term (10 year or more) and short term management priorities
- Development of long-term management and monitoring plans
- Review and establishment of research needs/coordination with researchers
- Development of plans and budget requests for management activities and biological monitoring programs
- Solicitation and evaluation of proposals received for management work
- Review of reports prepared by contractors/researchers
- Evaluation of effect of proposed modifications to reserve design

The NCCP Regional Science Advisors

The NCCP Regional Science Advisors were established by the state of California to provide objective expert input and examine programmatic science issues to provide advice and a regional perspective for the entire NCCP regional program. For this reason, the Southern Orange County science advisors believe that this group (or a similar one) should be integrated as closely as possible with the ongoing management program for the subregion to provide a regional biological context and perspective for management activities and progress under the plan and to use the information gained from the Southern Orange NCCP management program to identify regional research and management issues and priorities. The regional science advisors would also be effective in bringing the experiences and knowledge developed in implementation of other subregional plans to bear on the Southern Orange adaptive management process. The significant bioregional questions addressed by this group are crucial to success both at a subregional level and for the NCCP Region as a whole.

Funding Adaptive Management for the Southern Orange Subregion

The science advisors have avoided constraining their recommendations based on assumptions about funding. However, they acknowledge that funding the adaptive management program will be an important consideration. Most important, funding needs are not consistent through time. As knowledge is gained about the function and condition of a particular natural community, the cost to manage it becomes more efficient. One factor that may reduce the overall cost of the program is how closely the principles in Tasks 1 and 2 are followed (see below). The advisors offer the following suggestions on funding needs for an adaptive management program.

The advisors recommend that the adaptive management program be acted on and funded in a two phase process; 1) a relatively intense, shorter term program to create and refine models, identify gaps in knowledge about the systems, change management techniques as necessary and address specific immediate threats such as exotic and invasive plants; and 2) a longer term, less intense program with a lower level of permanent funding to monitor management activities, processes and trends once the techniques and models have been refined. Most of the experience gained and refinement necessary for the management program and much of will be gained in the early years of implementation. Underfunding the initial years of implementation will ensure that the management program will be continually "behind the curve" on many crucial issues such as restoration and exotic species control, with potentially negative consequences for the long term success of the program. On the other hand, intensive management and restoration early on is likely to be rewarded with a less costly "maintenance" level of management over the long term.

It is assumed that the funding for adaptive management in the subregion will be derived from an endowment or similar source. The science advisors recommend that planners consider structuring the endowment to provide whatever funds are necessary to carry out the crucial short term needs identified above and then stabilize the endowment at a level sufficient to fund ongoing, long-term monitoring of processes and trends, rather than making the entire endowment a non-wasting, perpetual source that may prove to be inadequate to establish the adaptive management program in the short term.

Conclusion

The science advisors intend that the principles for reserve design, species conservation and adaptive management described here be part of the foundation of a comprehensive program of conservation for the southern Orange County NCCP subregion. The first layer of this overall program is a reserve system based on strong design principles. For species not adequately protected by well-designed reserves, a layer of species conservation principles provide additional security. Adaptive management and targeted monitoring designed to examine and respond to changing conditions or unexpected consequences and develop crucial conservation information over time is the third layer in the hierarchy.

The principles described in this report are intended to coincide closely and be taken collectively, not in part. Many of the reptiles and amphibians, for example, do not need individual species-level action to conserve them, but they depend on a good reserve design, management, and careful monitoring over time to ensure that management activities are successful. The three sets of principles thus work together to enable a strong conservation program for the subregion.

By the same token, a reasonable final reserve design may not address each principle in its entirety. The science advisors have described all the important objectives for creating reserves in the subregion, but recognize implicitly that there will be tradeoffs in arriving at a final overall design. It is the expectation of the advisors that the principles for reserves and species outlined here will be followed as closely as possible given planning constraints and will be the foundation for discussions and tradeoffs among the program stakeholders and the county prior to any action by the county.

In some cases, the reserve design alternative analysis may encounter conflicts between principles, such as between a riparian connector versus a ridgetop connector, or a large, fragmented habitat block versus a smaller, intact habitat block. The science advisors have tried to provide as much guidance as possible in anticipation of these issues. The advisors hope remaining inconsistencies can be illustrated in various reserve design configurations so that the consulting team can recommend which alternative is preferred. Within the scope of work conducted by the science advisors, it is not possible to unequivocally weigh each of the principles against the others.

The science advisors have attempted to describe all the important objectives for an adaptive management program for the subregion, but also acknowledge that other factors will influence the scope and objectives of the program, especially the specific management actions taken on individual habitat parcels. Given these realities, the advisors have attempted to identify rough priorities for management that will guide these activities. Since adaptive management is so vital to the biological success of the NCCP, however, it is the hope of the science advisors that the outline and framework presented here will be followed as closely as possible.

The advisors note strongly that the need for and cost of management is closely tied to the reserve design and species conservation actions taken in the NCCP plan. For example, the more systematic disturbance created by the reserve design (e.g. fragmentation that will lead to encroachment) the more difficult and costly the adaptive management program must be in order to compensate for it. By the same token, a reserve design that adheres closely to the principles developed in Task 1 can be more cheaply and efficiently managed.

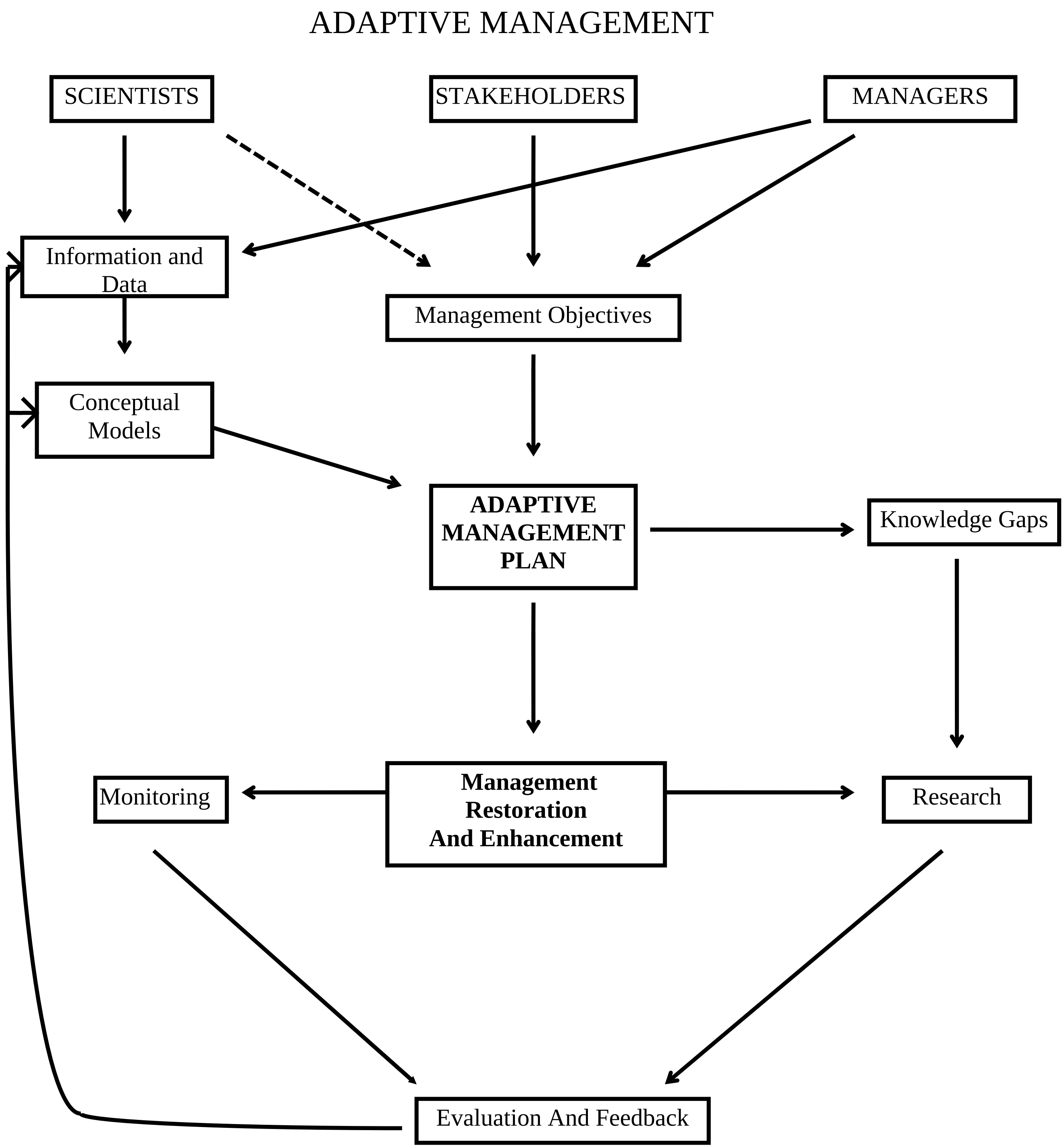


Figure 1. Adaptive management flow chart.

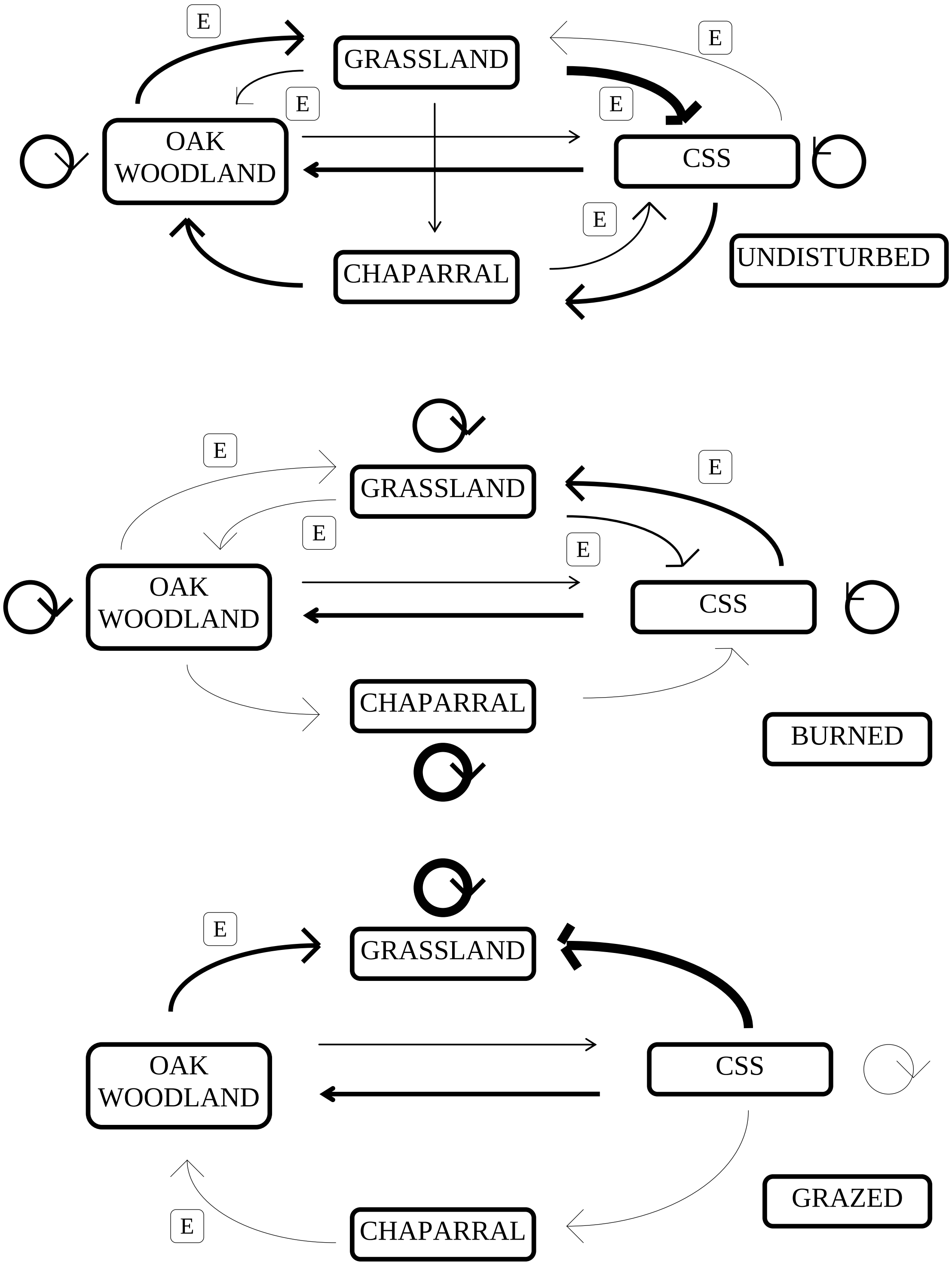
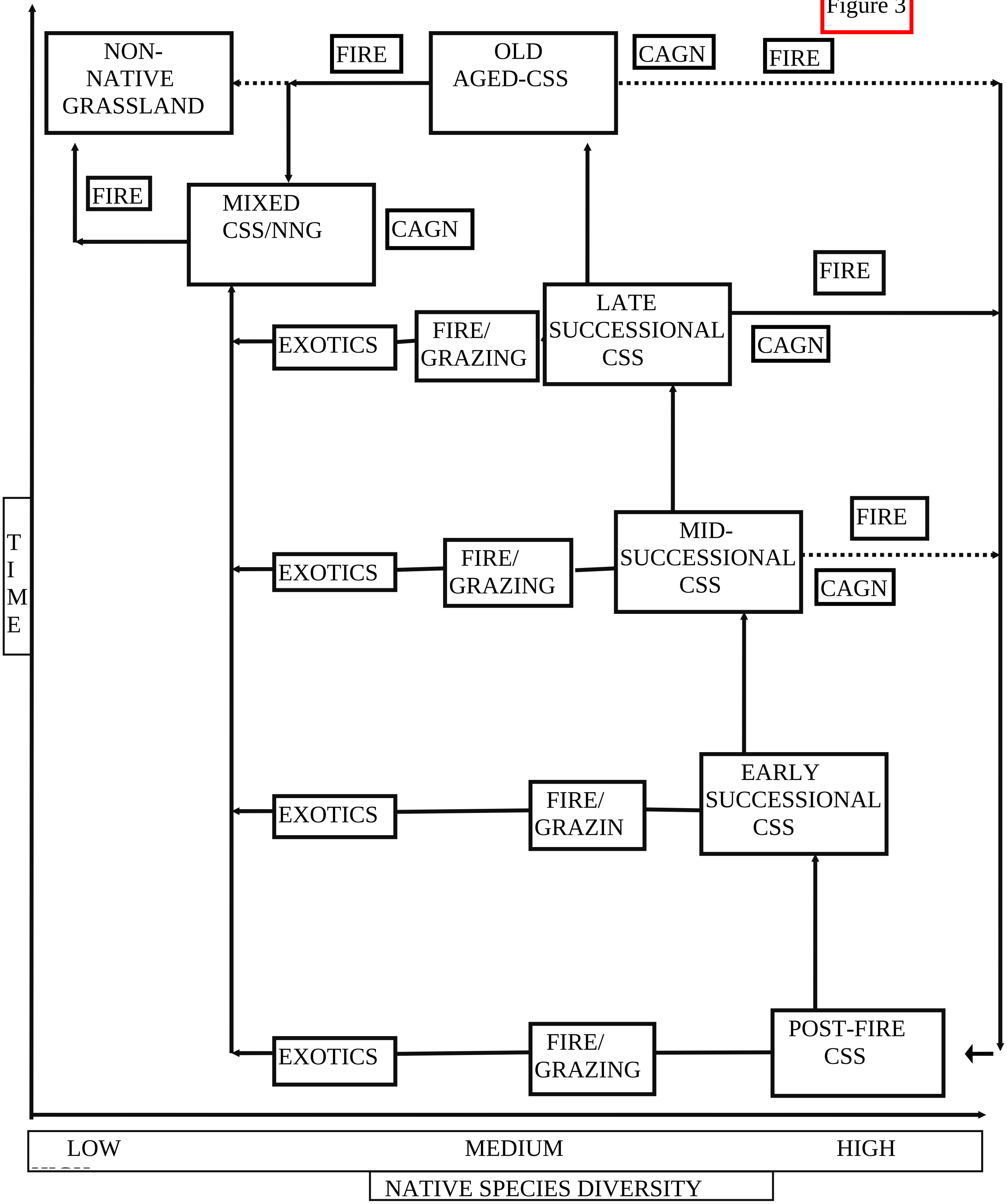


Figure 2. State-transition models for upland habitats under three management scenarios. Line thickness is proportional to the probability of that change. E refers to significant invasions of exotic species.

Figure 3



LEGEND
PRIMARY PATH
SECONDARY PATH

CONCEPTUAL COASTAL SAGE SCRUB HABITAT MODEL

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