DRAFT

APPROACH TO EVALUATION OF RESERVE ALTERNATIVES FOR SRP REVIEW WESTERN RIVERSIDE COUNTY MSHCP

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Table of Contents

ATTACHMENTS:

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1.0 Purpose

This document represents the first work product prepared for review by the Scientific Review Panel (SRP) to be appointed for the Western Riverside County MSHCP. The SRP is being appointed by the Center for Conservation Biology at UCR under the guidance of the Dean of the College of Agriculture and Natural Sciences, and in cooperation with the County of Riverside. The scope of work for the SRP developed by UCR and the County calls for review and comment on three documents related to MSHCP preparation and processing. According to the scope of work, the first document to be reviewed will outline the approach taken and available data used to develop the MSHCP plan, evaluation of the methods put to use, the data bases incorporated, and the criteria for distinguishing known and unknown information.

Based on that scope of work, this document has been prepared. This document presents the analytic approach proposed to be used to evaluate the relative merits of conservation alternatives developed as part of the MSHCP planning process. Following review and comment by the SRP, this approach will be incorporated in the analysis of MSHCP alternatives; that analysis represents the second work product to be prepared for review by the SRP. In accordance with the scope of work developed for the SRP, this document summarizes the data to be used in the analysis, the approach to be taken, and expected limitations based on known and unknown information.

It should be noted that this document is intended to outline the approach to the analysis of MSHCP alternatives and not to present the analysis itself. In order to present the proposed approach, draft analysis materials have been prepared for review and comment by the SRP and are presented in the Attachments to this document. Please note that the materials presented in the Attachments are in draft form. We welcome comments as we proceed to complete the analysis of MSHCP alternatives.

2.0 Overview of Approach

The approach described in this document was developed by the MSHCP consultant, Dudek & Associates (DUDEK). In developing the approach, meetings were held with U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG) and County staff on October 7 and October 15, 1999 to review elements of the approach. As part of these interactions, certain broad parameters of the approach were discussed as summarized below:

- The approach should consider the MSHCP biological goals and principles as

outlined in the Planning Agreement to be executed between the wildlife agencies and participating jurisdictions. As stated in the Planning Agreement, the biological goals and principles underlying the MSHCP are to "promote the biological viability and recovery of western Riverside County ecosystems and habitats, and species dependent thereupon, toward a goal of reducing the need to list additional species in the future."

- Consistent with the language in the Planning Agreement, the approach should consider overall ecosystem conservation. Items to be considered in the approach with respect to this overall goal include the following:

  – Maintain/establish a self-sustaining reserve system to the extent feasible;
  – Implement adaptive management when and where necessary.

- Consistent with the language in the Planning Agreement, the approach should consider species conservation. The approach should therefore address conservation of individual species and their habitats.

- It is appropriate to organize the approach around the biological tenets identified as part of the California Natural Communities Conservation Planning Program (NCCP) process. These tenets and elements appropriate for analysis under each tenet are presented below. It is recognized that the NCCP tenets are broad-based and must be considered specifically in the context of Western Riverside County for the MSHCP.

  a) ***Conserve focus species and their habitats throughout the planning area:*** The approach will focus on the 164 species identified for further analysis as part of the MSHCP in the August 9 "Draft Proposal" document.

  b) ***Conserve large habitat blocks:*** The approach will consider size, shape and naturalness of habitat blocks. Naturalness will be considered in the context of large blocks of a single habitat type and large blocks of natural lands that may contain several habitat types.

  c) ***Conserve habitat diversity:*** The approach will consider vegetation, topography and physiographic representativeness.

d) ***Keep reserves contiguous and connected:*** The approach will consider both ecosystem processes (e.g., riverine systems) and linkage requirements for focus species.

e) ***Protect reserves from encroachment and invasion by non-native species:*** The approach will consider edge effects, invasion by exotics, wildfire management, and the effects of roads and utilities.

- Although the U.S. Fish and Wildlife Service and California Department of Fish and Game ultimately will be responsible for determining whether the proposed conservation plan meets the legal standards of the federal and state Endangered Species Acts, the proposed approach will evaluate the extent to which the conservation plan is "practicable" in regard to minimizing and mitigating the taking of species covered by the plan. The approach also will assess whether the conservation plan has "appreciably reduced" the likelihood of the survival and recovery of listed species in the wild.

As discussed in Section 4.0, Methods, a variety of tools are proposed to be used to complete the analysis of MSHCP alternatives. The proposed approach emphasizes appropriate use of the available data and tools, with the overall objective of clearly presenting and documenting the thought process used to arrive at conclusions in the analysis. Key elements of the approach are: (1) using GIS as a tool to identify biologically important areas in the context of the NCCP reserve design tenets, and (2) using the scientific literature to support analysis assumptions and conclusions. In addressing these elements of the approach, two working papers have been prepared and are included as Attachments 1 and 2 to this document. Attachment 1 presents an overview of habitat assessment and reserve selection approaches using GIS. This background information was considered in the identification of specific GIS analytic methods described in Section 4.0 of this document. Attachment 2 presents a sample narrative analysis for a specific species, based on a specific reserve design tenet, using the scientific literature to support the analysis. This sample analysis is intended to give the SRP an example of the narrative approach that will be used as one of the components in the evaluation of species conservation for MSHCP alternatives.

3.0 Materials Available for Analysis

The materials to be used in the analysis are those assembled for the overall Riverside County

Integrated Plan (RCIP) program. Substantial portions of the MSHCP data base have been assembled by UCR, particularly with respect to species data. The RCIP GIS consultant and data archiver, RBF & Associates, maintains a library of materials with detailed notation of sources, scales, precision, and date in digital form available to all members of the RCIP team, including UCR. These data will form the basis of the analysis of MSHCP alternatives. A detailed narrative description of data sources and materials will be included in the environmental baseline narrative to be included in the MSHCP.

The primary GIS data layers and software anticipated to be used in the analysis of MSHCP alternatives are listed below:

1. Vegetation map of western Riverside County (PSBS &KTU&A)
2. Species location maps (UCR, USFWS, CNDDB, miscellaneous other)
3. Existing land use map (LSA - as part of RCIP team effort)
4. Ownership map (County/RCIP team)
5. Blueline streams map (USGS)
6. Soils map (USDA, Soil Conservation Service, 1994, State Soils Map (STATSGO), data base for California
7. Digital elevation model (USGS DEM)
8. Geologic Maps (bedrock formations, faulting - to be provided by RCIP geologic consultant)
9. Arterials and roads
10. ArcInfo, ArcView, Spatial Analyst

4.0 Methods

The biological tenets established by the original NCCP Scientific Review Panel in 1993 set the stage for a landscape or ecosystem approach to reserve design and evaluation. It is assumed that by using the biological tenets, which are grounded in conservation biology theory, a viable reserve system can be created. This methods section provides a brief overview of each tenet, the methods proposed to define and measure the tenets, the data to be used, unresolved technical issues, and some limitations of the analyses. It is recognized that specific features of Western Riverside County will need to be considered in the application of these biological tenets to the MSHCP.

A GIS analytic method is proposed for each biological tenet. As part of developing the overall approach, some test analyses have been run at various scales and various locations, as presented to the MSHCP Preserve Science and Design Subcommittee on October 21, 1999. (Sample graphics are also included in Attachment 7 to this document.) It is recognized that the scale of the analysis depends on the data sources for the analysis and the context in which the analysis is being conducted. The overall analysis approach incorporates the intent to relate individual analyses to the intrinsic scale of the data being used. In certain cases, analyses may be run at several scales as part of a sensitivity analysis, or to produce repeatable results. Specific decisions regarding these components of the analysis will be made on a case-by-case basis as the MSHCP planning process proceeds. For this reason, specific scales are not noted in the discussion of GIS analytic methods for each biological tenet.

General Modeling Considerations:

1. Scale of Analysis

The question of how the study area will be divided for analysis has yet to be resolved. Potential strategies include examining the proposed biological tenets for the study area as whole, portions of the study area defined by planning units (e.g., the SWAP area), biophysical regions (defined by elevation, vegetation types and landform), or areas of uniform data sources (e.g., the Forest Service lands versus other lands mapped by PSBS because the Forest Service land appears to have been mapped at coarser scale [i.e., larger minimum mapping units]). It is possible that analyses concerning connectivity and patch size would be more appropriate study area-wide, while analyses concerning habitat diversity, edge effects, and sensitive species would be more appropriately examined within subareas.

2. Pixel Size (Minimum Mapping Unit)

The majority of the analyses will be performed using a raster data structure. This structure represents map data (e.g., vegetation types) as a grid consisting of many square cells or pixels with different values. Because the pixel size can affect the analyses, it is important to choose a size appropriate to the type of analysis. A pixel too small may generate spurious resolution and false accuracy, and also increases processing time. Large pixels (e.g., several acres) may not effectively represent shapes and borders between different map values if mapping resolution is smaller than the pixel.

Modeling and analyses of reserve alternatives will rely predominantly on three different data

layers generated from a variety of sources: vegetation and land cover, derived from multiple sources and digitized upon 10 X 10 meter resolution SPOT imagery; slope, aspect and elevation data, derived from 30 X 30 meter resolution USGS Digital Elevation Models (DEMs); and a sensitive species layer, derived from a multitude of sources. The vegetation and land cover will be the most important data layer for many of the ecosystem process evaluations. This data layer has a minimum mapping unit (smallest polygon size) of 96 square feet, and a median polygon size of 279,216 square feet (6.4 acres). We are proposing to use a grid size of 100 X 100 feet (10,000 square feet or 0.23 acre) which is roughly the same resolution as the DEM. This size would be able to represent more than 99.9 percent of the vegetation patches. An evaluation of the effect of cell size and change in vegetation acres will be performed to assess the magnitude of error associated with this decision.

a. Conserve Focus Species and Their Habitats Throughout the Planning Area

The 160+ focus species represent a broad range of habitats and geographical areas in the planning area. They include listed threatened and endangered species that have very specific habitat requirements and conservation and management needs, other regionally or locally sensitive or rare species, and upper trophic or generalist species that have broad habitat requirements.

The merits of the reserve system alternatives for species conservation will need to be evaluated at a species-specific level because of each species' unique life history characteristics and requirements. However, the August 9 Draft Proposal (Proposal) included a grouping system for the species that will facilitate this analysis. Table 1, included in Attachment 3 to this document, lists the preliminary group assignments of species. We welcome review and comment by the SRP on our proposed group assignments for species as presented in Table 1. Although not all species have yet been assigned to a group and assignments may change as more information becomes available, ultimately each species will be assigned to one of three groups according to the following criteria:

Group 1: Minimal conservation action needed because of at least one of the following reasons: (1) the species is found in very high numbers in the planning area; (2) the species is insignificantly found in the planning area; or (3) the outcome of the planning process would have little impact on the species.

Group 2: Best conserved at a habitat landscape level for at least one of the following reasons: (1) the species does not require detailed, focused surveys; (2) the

species responds well to habitat management; or (3) the species is represented by robust or widespread populations in the planning area.

Group 3: Best conserved at a species-specific level for at least one of the following reasons: (1) the species has a highly specialized life history; (2) the species exhibits or would be expected to have a poor response to habitat management; (3) the species is highly sensitive to small environmental changes; (4) the species currently exists in small numbers; (5) the species is a narrow endemic; or (6) the species is dependent on intense conservation.

Such a grouping system will direct the type of information and analyses required to evaluate the conservation of the species. For example, a group 1 species will require relatively little detailed analysis because minimal conservation is needed. On the other hand, a group 3 species will require fairly detailed analysis of the reserve system alternatives in the context of species-specific factors, such as important population locales, foraging requirements, habitat linkage requirements, and other environmental factors that may affect the viability of the species.

GIS analytic method:

1. Calculate how much area and what percentage of habitat supporting known populations will be preserved. (Adjustments will be made in the analysis to reflect specific features of the data base for the project, and expected elements of the MSHCP alternatives. First, the analysis of conservation of habitats will use the existing vegetation data base, augmented by the updated existing land use layer prepared as part of the RCIP effort. This will ensure acknowledgment of development that has occurred since the vegetation map was prepared. In addition, it is anticipated that MSHCP alternatives will include both hard-line preserve components and areas where criteria or policies will be applied to achieve conservation goals. Proposed policies for the MSHCP alternatives will be evaluated and algorithms developed to assess conservation based on implementation of stated policies.)

2. Calculate how many and what percentage of known locations will be preserved.

3. Compile sensitive species data, create a species richness layer, identify species richness hotspots, and calculate how much of these areas will be preserved.

4. For species that lend themselves to habitat modeling (e.g., plants that occur only in clay soils), determine potential population locales and/or distributions that will be preserved. (Based on our research and review of data available to date, we believe it is unlikely that very much habitat modeling will be conducted for individual species.)

As discussed previously, it is anticipated that a primary method of analysis for species conservation will be use of the literature to document analysis assumptions and conclusions. The results of this research and analysis will be reported in species accounts to be incorporated in the MSHCP and will use species-specific analysis parameters based on the scientific literature. We intend to incorporate goals and objectives for species in the species accounts as a tool for analyzing species conservation. Sample draft species accounts including goals and objectives are included in Attachment 5 for review by the SRP. Attachment 6 includes species-specific analysis parameters intended to be used in the analysis. We welcome review and comment by the SRP on the suggested analysis parameters for individual species.

GIS data to be used for modeling:

1. Vegetation associations
2. Species locations
3. Slope/Aspect
4. Elevation
5. Soils
6. Geographic substrate

Questions to be resolved:

1. Which species can be modeled?
2. How complete are the data for the various species? i.e., set confidence limits for the analyses.

Limitations of approach and analyses include coarse data scales and limited data for focus species locations and population sizes.

b. Conserve Large Habitat Blocks

Conservation of large blocks of habitat as an important guiding principle of reserve design is obvious. Large blocks of habitat supporting larger populations of species are preferable to small blocks of habitat supporting smaller populations. Also, larger blocks of habitat are less subject to adverse edge effects because of the greater amount of interior habitat. However, there is no generic standard for what constitutes a large habitat block. Umbrella or surrogate species that require large areas (e.g., mountain lions, golden eagles, etc.) may help define block size such that a large block of habitat is what is capable of supporting the species, but adequate habitat areas must be defined by the life history characteristics of each species.

Within the context of the Conceptual Conservation Scenario (CCS), included in the August 9 "Draft Proposal" for the MSHCP, some upper limits of block size, outside of National Forest lands, have already been set for the planning area. For example, according to the Stephens' kangaroo rat HCP, the Lake Skinner-Domenigoni Valley Core Reserve is 12,800 acres, the Lake Mathews-Estelle Mountain Core Reserve is 10,500 acres, and the San Jacinto-Lake Perris Core Reserve 10,700 acres. Although these areas may not fit a strict criterion of an intact habitat block, they do set a practical maximum standard for what may be feasible within the planning area and a standard by which alternative reserve designs could be evaluated.

GIS analytic method:

1. Aggregate patch size (all natural habitats)
   - S define limits of patches
   - S rank patches by size in acres
   - S calculate amount of acres of large habitat patches that will be preserved

2. Vegetation association patch size
   - S rank vegetation association by acreage
   - S identify large patches of different vegetation types (e.g., chaparral, coastal sage scrub, grassland)
   - S calculate the amount of large patches by vegetation type that will be preserved

GIS data to be used:

1. Vegetation and land cover
2. Arterials map to define habitat patches
3. Other artificial or natural physical barriers (e.g., flood control channels)

Questions to be resolved:

1. Definition of patch; i.e., what functionally isolates a patch - roads, lakes, flood control channels, agriculture?

Limitations of analysis include the scale (varies for the study area) and accuracy of the vegetation mapping.

c. Conserve Habitat Diversity

The reserve system should represent the diverse environmental and physical conditions in the planning area. Diversity can be expressed in various ways. Different vegetation communities occurring in a defined area is an obvious example of the habitat diversity for an area. In the planning area, the uncollapsed vegetation map includes more than 50 vegetation categories, including several types of scrub, chaparral, and wetland/riparian communities. These different vegetation categories reflect varieties of species assemblages and species richness, and other variations of the environmental gradient such as climate, soils, elevation, slope, aspect, and geographical location. For example, redshank chaparral tends to occur at higher elevations than chamise chaparral in the planning area. The distinction between coastal sage scrub and the more xeric Riversidean sage scrub reflects geographical, climatic, and aspect variation.

Other measures that capture aspects of diversity are ecotone and habitat rarity. Ecotone areas, as defined as the boundary or transition zone between different vegetation types, are considered to be biologically important because they often support relatively high species richness. Habitat rarity is an important factor, particularly if the rare habitat supports other rare resources such as a narrow endemic plant.

GIS analytic method:

1. Local Scale Habitat Diversity--Surrogate for species diversity in a landscape.

   – Habitat Richness is defined as the number of native vegetation associations (including non-native grasslands) that occur within a given neighborhood of a particular cell. This measure is more of an ecotonal surrogate because it has no regard for the quantity of area for each particular habitat. Its weakness is that many small fractured habitats are given high values without regard to the relative abundance of each type. It appears to be less disturbance-affected than expected because disturbed areas usually have many small polygons of few different types. These data are affected by pixel size and neighborhood size.

   – Habitat Dominance is defined as the abundance and number of native vegetation associations within a particular neighborhood. This measure would rank areas by the amount one vegetation association dominates a neighborhood; less dominance equals greater diversity. Simpson's or the Shannon-Wiener diversity index would be used for this measure.

   – Measure how much of the high diversity areas are within preserve alternatives.

2. Habitat Rarity

Habitat rarity will be operationally defined by the number of acres of the habitat within the planning area, although habitats that may be very common outside of the planning area may not be considered a rare habitat. Habitats in the planning area will be assigned to the rarity categories shown in Attachment 4.

GIS data to be used:

1. Vegetation and land cover

Questions to be resolved:

1. Pixel and neighborhood size
2. Which diversity measure is most appropriate.

Limitations of Technique:

1. Do rich vegetation types have the same weight as non-rich types?
2. Does habitat diversity represent species diversity effectively?
3. Diversity measures can be controversial and difficult to interpret.
4. Pixel Size/Scale Dependent

d. Keep Reserves Contiguous and Connected

The reserve alternatives will be evaluated for contiguity and connectedness. Factors to be considered in the evaluation include the following:

- Continuity of habitat types between reserve blocks (e.g., connecting upland habitats only with riparian strips may not be adequate for the suite of species that need to use the linkage).
- Length, width and shape of the habitat linkages.
- Proximity of reserve blocks such that distances are minimized.
- Minimization of physical barriers to movement through (transit linkages) and occupation of (permanent habitat) habitat linkages. Roads, public utilities (e.g., flood control), visual barriers, etc. will be considered.

GIS analytic method:

The evaluation of contiguity and connectedness will require a combination of GIS evaluation (e.g., length, width, vegetation types, distances between reserve blocks) and manual evaluation. For example, it may be easier initially to manually delineate suitable habitat linkages than write an algorithm to identify them. Once linkages are identified, alternative reserve designs can be evaluated with regard to which have the widest and/or least impeded habitat connections, accommodate the greatest number or most critical species, best promote ecosystem function, etc.

GIS data to be used:

1. Vegetation/land covers
2. Roads
3. Habitat block coverage

Questions to be resolved:

1. Minimum width thresholds which will be related to species and ecosystem requirements.
2. What kinds of surfaces/land covers pose barriers, which also will be related to species and ecosystem requirements; e.g., dirt roads, paved roads, habitat gaps, other anthropogenic disturbances.

Limitations of the analysis include the complexity of the habitat linkage concept (i.e., defined by the specific needs of the focus species and ecosystem processes), the problem of habitat connections potentially being sink habitat for some species, and habitat connections potentially transmitting catastrophic events such as fire and disease.

e. Protect Reserves from Encroachment and Invasion by Non-native Species

The reserve alternatives will be evaluated in regard to their vulnerability to adverse edge effects. The perimeter-to-area ratio of the larger reserve blocks and key habitat linkages will be calculated. Adjacent land uses will be evaluated such that potential intrusions into the reserve by exotics species (including alien plants, non-native mesopredators) and other adverse factors (e.g., pesticides, herbicides, noise, lighting) can be determined. Reserve blocks and linkages also will be evaluated for levels of human disturbance such as roads, unauthorized recreation and illegal activities (e.g., off-road vehicles, shooting, dumping).

GIS analytic method:

1. Calculate perimeter-to-edge ratios of habitat blocks and key habitat linkages.
2. Determine habitat distances from urban land and agricultural land uses.
3. Quantify numbers of edge cells within preserve alternatives; alternatives with the fewest edge cells would be superior.

GIS data to be used:

1. Vegetation/land cover
2. Roads

Questions to be resolved:

1. Distances from urban and agriculture that define the edge effect area (e.g., 500 feet, 1,000 feet, 5,000 feet, mitigated by topography, etc.).
2. What land covers/uses should be considered edges?
3. How should dirt and paved road, utility corridors be treated?

Limitations of the analysis are lack of data on specific edge effects and information on future land uses that will introduce edges into currently undisturbed areas.

Attachment 1

Habitat Assessment & Reserve Selection Approaches

RIVERSIDE COUNTY MSHCP
HABITAT ASSESSMENT AND RESERVE SELECTION APPROACHES

Introduction

An important task of the MSHCP reserve planning process is to assess habitat quality in the study area so that informed, objective, and scientifically valid decisions regarding reserve design and selection can be made. It also is important that the methods used to assess habitat quality and ultimately reserve selection are explicit and that anyone employing the same methods would achieve essentially the same result.

At this time a draft Conceptual Conservation Scenario for the MSHCP has been proposed and rough conservation acreages estimated. While the draft Conceptual Conservation Scenario largely was based on biological information such as the regional vegetation map, sensitive species locations and habitat associations, and direct input from local biologists, as well as conservation biology theory, it was not created using an explicitly objective and repeatable methodology. The Conceptual Conservation Scenario also does not convey information about habitat value for areas not included in the scenario; e.g., what is the biological value of agricultural lands outside of the Conceptual Conservation Scenario?, or are there other biological "hotspots" overlooked under the Conceptual Conservation Scenario?

This paper presents a conceptual approach to habitat assessment and reserve selection modeling that utilize the GIS data base available for the project. The habitat assessment model discussion focuses on a general approach that could be used and potential variables that could be incorporated into the model. The variables are not parameterized (i.e., assigned scale values or weightings) because this discussion focuses more on the conceptual and some of the methodological issues of the modeling process. Parameterizing the variables will require substantial discussion among participants. The section on reserve selection models discusses some iterative and optimizing methods described in the scientific literature.

An Overview of GIS Modeling

This section provides an overview of how GIS can be used for habitat modeling. The information presented here is based on a work book for using ArcView Spatial Analyst created by ESRI (1996).
A common GIS modeling approach appropriate for habitat modeling is the suitability model. Suitability models assign relative suitability scores for whatever problem in being studied; in this case habitat value or suitability for inclusion in a reserve system. Suitability models are particularly useful when there are numerous variables that are being analyzed and their combination is too complex for a subjective or non-computer based analysis. Using a GIS suitability model also allows one to vary the relative importance (i.e., weighting) of variables in the model in order to examine alternative scenarios and analyze the sensitivity of the model to input parameters.

A common method of suitability models is to create a common utility or unit of measurement for each of

the variables because the variables likely will have different intrinsic units of measurement. For example, vegetation types are nominal measures (i.e., they can't be subjected to arithmetic functions because they are assigned to discrete categories or classes) whereas patch size is a numerical measure on a ratio scale; i.e., acres or hectares. Values on a ratio scale can be arithmetically manipulated. Because the measurement scales may be different, the variables must be converted to a common unit of measurement. A typical common unit of measurement is the numerical interval rating scale; e.g., 1-5 or 1-9. For many variables, the assignment of the variable's scale value is a subjective exercise. For example, for the variable "rarity of habitats," alkali marsh may be assigned a 5 (very rare) whereas chaparral may be assigned a 1 (very common). Although rarity could be based simply on the number of acres of the habitat in the study, other more subjective factors such as wildlife or vegetation value or commonness of the habitat elsewhere may affect the scale value assigned to the habitat. For other variables, assignment of the scale value may be more objective. For example, a large habitat patch may be defined as any patch greater than 1,000 acres. However, even with numerical measures, the interval boundaries of the common scale are subjectively defined through a process called parameterizing. Unfortunately, while conversion of variables to a common unit of measurement is necessary for combining the values in a meaningful way, information is always lost in the process. Thus modeling should be viewed with caution because its tendency to reduce information and simplify reality.

Weighting of the variables also is a common practice when some variables are considered more important than others in the suitability model. In fact, it would be unusual for weighting not to be used. Before variables are added, each scale value is multiplied by a weighting factor that reflects the relative importance or value of the variable. For example, patch size may be considered more important in the overall model than ecotone and thus would be weighted more heavily. As with scale interval boundaries, assigning weights to variables is a subjective exercise because it reflects the preferences of the group creating the model. Weightings may be based on scientific information or theory (e.g., habitat diversity), economic factors (e.g., land values), or policy decisions.

Potential Habitat Assessment Variables

This section identifies and discusses several variables that potentially could be used in a habitat assessment model. But first, in order to select appropriate variables for assessing habitat value, it is necessary to identify the general goals or purpose of a reserve system. Scott and Sullivan (1999) identify two primary goals of the MSHCP reserve system:

1. To function at the ecosystem level with the minimum of adaptive management (what Scott and Sullivan [1999] refer to as "process").

2. To preserve as many common and sensitive plant and animal species as possible (what Scott and Sullivan [1999] refer to as "state").

Accomplishing the first goal would go a long way toward accomplishing the second goal because conserving the integrity of existing natural habitats and ecosystem processes is critical for the vitality of species. However, the converse is not necessarily true because, in theory, through adaptive management it is possible to preserve many species without maintaining ecosystem function. The need for adaptive management implies that the ecosystem is not functioning normally and that intervention is required to conserve habitats and species. While it would be naive to believe that a reserve system could be created in the MSHCP planning area without the need for a least some adaptive management, the primary goal should be to assemble a reserve system that requires minimum management and human intervention.

With the goal of maintaining ecosystem function or "process," several factors or variables potentially could be used in the habitat assessment approach. These variables, which were identified in the Habitat Assessment Workshop conducted in April 1999, include the following:

- habitat patch size
- habitat connectivity
- watershed integrity
- fire ecology
- naturalness (e.g., absence of development, roads, disturbed habitats).
- habitat diversity (fine-grain representation of vegetation associations)
- quality of riparian habitats (e.g., lacking water diversions, dams, flood control, pollutants, etc.)
- physiographic representativeness (bioregion, elevation, topography, geology)
- surrogate or umbrella species

With the goal of maintaining "state" (i.e., sensitive and common species), variables that potentially could be used in a habitat assessment approach include the following:

- listed and other sensitive species locations and potential habitat.
- narrow endemic species
- rare habitats (e.g., alkali marsh)
- unique soil/habitat associations (e.g., alkali soils, gabbros, clays)
- unique microhabitats (cliffs, rock outcrops, caves, springs, vernal pools, etc.)
- specific habitat linkage issues (e.g., existing bottlenecks for movement [dispersal and migration] of large carnivores that need site-specific attention)

It is clear that the variables relevant to the two goals are different. Process goals are more general and not necessarily tied to specific geographical locations. State variables are more specific and tied to specific locations. A critical step in using these variables in a GIS model is translating the variable in terms of an objective measure. That is the variable must be "operationally defined," whereby the variable is defined by the operations used to measure it. For example, habitat patch size may be defined as the number of

acres in a discrete area of natural habitats. This is a relatively straightforward definition. On the other hand, watershed integrity could be operationally defined in a variety ways, including the ratio of permeable to impervious surfaces in the watershed, water quality, sedimentation rates, or some combination of objectively measured factors.

It is important in the present modeling exercise that the variables and data used in the model are as explicitly defined as possible and that the values and weightings assigned to the variables are agreed upon by the various participants in the process.

The following discusses how several habitat assessment variables could be operationally defined and used in a habitat assessment approach, as well as the feasibility or practicality of using the variable. The details of how the variables should be parameterized are not included in this discussion. The variables are not discussed in order of perceived importance. Potential habitat evaluation model variable not discussed below were omitted largely because it was difficult to conceive how they could be operationalized (e.g., fire ecology, watershed integrity) or the data for measuring the variable likely are not available (e.g., unique microhabitats such as cliffs, rock outcrops, and caves).

(With respect to watershed integrity and riparian habitat quality, it is important to note that these factors probably are better addressed under a planning level delineation of wetlands and "waters of the United States" and functional assessment approach whereby hydrologic and ecologic integrity are analyzed on a landscape scale. This work program could be addressed under a region-wide Special Area Management Plan [SAMP] and would supplement the results of the habitat evaluation model. This approach is currently being applied on the San Mateo Creek, San Juan Creek and San Diego Creek in Orange County.)

Habitat Patch Size

Habitat patch size is a fairly straightforward variable that can readily be defined using GIS. For example, habitat patch size could simply be defined as an area of contiguous natural habitat; i.e., habitat uninterrupted by roads or non-natural land covers such as development, agriculture, and other anthropogenic disturbances. Data layers would include the vegetation map and existing roads. Vegetation/land covers would be portrayed as natural or disturbed habitats. Natural habitats would be all categories of land cover except disturbed, developed, and agriculture. Habitat patches could be further refined with paved roads as the patch boundary. A confounding issue, however, would be how to treat isthmuses of habitat (narrow strips linking large blocks of habitat) and peninsulas that are subject to adverse edge effects and may functionally not be part of the larger habitat patch. One potential rule would be to segregate patches that are less than some specific width; e.g., 1,000 feet wide. Algorithms for determining perimeter to area or length to width ratios may be alternative approaches to solve this problem. Another possible difficulty in defining habitat patches would be developing an algorithm to find patches of disturbed habitat within a larger patch that constitutes interruption of the habitat patch; i.e., the hole in the donut.

This variable may be developed in a vector data base (lines and polygons) and then converted to a grid base for the general model. Each grid cell within the habitat patch would be assigned a scale value reflecting the size of patch in which it occurs. Cells in large habitat patches would be assigned high values and cells in small habitat patches would be assigned low values.

Habitat Connectivity

Habitat connectivity also can be defined using GIS. For example, the degree of connectivity of a cell containing natural habitat could be defined by the number of adjacent cells with connecting natural habitat; i.e., a neighborhood analysis. A cell with no connections to habitat in adjacent cells obviously would be assigned the lowest score, a cell connected on three sides may be assigned an intermediate score, and a cell connected on all sides by habitat would be assigned the highest score.

Naturalness

Naturalness conceptually implies the relative lack of lack of human disturbance in an area, including invasion by non-native exotics, buildings, roads, agriculture and other exploitive, extractive or exportive uses such as logging or mining (see Margules and Usher 1981). Naturalness thus may be operationally defined as the focal cell lacking anthropogenic disturbance (development, paved roads, agriculture). An important issue is whether naturalness should be limited to native habitats. The inclusion or exclusion of ubiquitous non-native habitats such as annual, non-native grassland or eucalyptus woodland, that nonetheless have biological value, would be a subjective decision. A limitation of this definition is the accuracy of the vegetation data base depicting disturbed habitat. Also, assigning a naturalness score to a cell will include a certain amount of subjectivity. For example, how much more or less "natural" is an area with disturbed habitat and no roads versus an area with roads but no other disturbance factors.

The naturalness score will be scale dependent and exhibit an inverse correlation with cell size; the bigger the cell the lower the naturalness score on average. Thus, selecting a grid cell or neighborhood size that appropriately reflects naturalness at a biologically meaningful scale and at a scale that differentiates areas will be an issue.

(It is interesting to note that several years ago CDFG used a naturalness evaluation for assessing the value of Mojave ground squirrel habitat because this species was notoriously difficult to survey for to determine presence or absence. The naturalness evaluation was made by filling out a Cumulative Human Impacts Evaluation Form, or CHIEF, which had questions regarding site disturbances such as roads, rail lines, utilities, ORV trails, trash dumping, surrounding land use, and known historic ground squirrel populations in the vicinity. A scale value was assigned to each variable with a weighting factor and additive scores for the site were tallied. Mitigation requirements were then tied to the score for the site.)

Ecotone

Ecotone is the boundary or transition zone between two different vegetation types. Ecotones are considered to be biologically important because they often support high species richness. With the existing vegetation data base, however, the true biological ecotone can only be roughly approximated because ecotone widths and gradients (sharp or fuzzy) and type of ecotone (e.g., grassland-coastal sage scrub versus chaparral-coastal sage scrub) likely are important determinants of the biological function and value of the ecotone; i.e., all ecotones are not equal.

One method of calculating ecotone would be to calculate the amount of boundary between vegetation types within a predefined neighborhood of the focal cell (e.g., adjacent cells or some specified radial distance from the focal cell) and then assign an ecotone score to that cell. A more refined ecotone analysis may include only certain types of vegetation interfaces if it is determined that some ecotone combinations are not biologically valuable.

Habitat Diversity

Habitat diversity is often used as a surrogate for biological value because it roughly correlates with species richness and is relatively easy to measure using GIS with a reasonably refined vegetation map. In its most simplistic form, habitat diversity can be operationally defined as the number of different vegetation types in a focal cell or within the predefined neighborhood of the focal cell.

One variant of calculating habitat diversity could be combining it with the patch size analysis. For example, the habitat patch size analysis could be completed using vector analysis and then diversity in relation to patch size could be examined. Cell is in large patches with high diversity would receive the highest scores and cells in small patches with low diversity would receive the lowest scores. This method may be a way of overcoming the problem of setting arbitrary area sizes for conducting neighborhood analyses.

Habitat Rarity

Habitat rarity is probably one of the more important variables in designing a reserve system. It is important for rare habitats to be represented in the reserve system, particularly if they support other rare resources such as narrow endemic plants. Habitat rarity may result from the disproportionate loss of a once common habitat types (e.g., native grassland) or from a unique combination of factors (e.g., alkali marsh, Colton dune formation, Engelmann oak woodland). Habitat rarity within a planning area may also reflect an isolated relict habitat types that is common elsewhere. For example, peninsular juniper woodland and scrub is relatively common in the San Jacinto and Santa Rosa mountains. A disjunct area of juniper woodland occurs on the Gavilan Plateau and thus represents a rare example of this vegetation community in the planning area.

Regardless of the reason for a habitat's rarity, a primary goal of reserve design is to include examples of rare habitats. Habitat rarity can be operationally defined by the number of acres of the habitat within the planning area. However, habitat types that occur in low acreages in the study area but do not represent a unique example of the habitat that is common elsewhere (e.g., Jeffrey pine forest) may not be considered a rare habitat type. Habitats that are rare as defined by acreage in the planning area alone will need to be evaluated for their inclusion in the model as a rare habitat.

Unique Soils Associations

Specific soils known to support sensitive plant species could easily be included in the model. Such soils may include alkalis, gabbros, and clays. All that would be necessary is to have a digitized soils map that includes the major mapping areas for the relevant soils. As with narrow endemics, unique soil information in the model would be important for identifying smaller satellite reserves.

Listed Species

Species locations for listed species could easily be included in a habitat evaluation model. Having this information, however, probably is more important for determining regulatory coverage than habitat quality. A drawback of using known listed species locations is the potential exclusion of suitable habitat for which survey data are lacking.

Narrow Endemic Species

Species locations for identified narrow endemics could easily be included in a habitat evaluation model. This information would be especially important for identifying smaller satellite reserves for specific habitats or species. The drawback of these data is the possibility of omitting potentially important sites for which narrow endemics information is lacking. If other information, such as soils or habitat, suggest that a narrow endemic may be present, follow up field studies may be warranted.

Topographic Diversity

Topographic diversity should be roughly correlated with habitat diversity because of the variations in slope, aspect, elevation, soil, habitats, etc. Areas with highly diverse topography may have high species richness because of the variety microhabitats and ecological niches provided. Such areas may also provide refuges for many species because of their relative naturalness and lack of access to humans. Topographic diversity could be modeled using the digital elevation model.

Habitat Linkages

Habitat linkages will be crucial for maintaining ecosystem function and biological diversity in the MSHCP

study area. Because there is no formula for what is an adequate habitat linkage - they must be site- and species-specific - initially delineating existing habitat linkages likely will be a manual exercise. However, once linkages are physically identified and delineated, the information can be utilized in the habitat evaluation model. For example, linkages could be categorized as local or regional linkages or intra- versus inter-reserve system linkages. Linkages could be rank-ordered as to their importance to the reserve system. Redundant linkages could be identified and given lower scores.

Testing the Model

A fundamental problem of building habitat evaluation models is the validity of the model (see Margules and Usher 1981 for discussion). Does the model represent the biota in a meaningful way? Are the variables appropriate for measuring the desired biological factors? Are the selected scales and weighting factors appropriate? Given that some of the factors are correlated with each other (e.g., patch size and habitat diversity), does the lack of independence between variables skew the results of the model?

These issues are inherent in any modeling process whereby an extremely complex set of factors and their interrelationships and interactions are distilled into a relatively simple additive model. As far as the selection of variables, the consensus of the participants probably is the best way to proceed. The robustness of a model can be examined using sensitivity analyses. Variables and input parameters are systematically varied to determine how sensitive the model is to changes in the variables, scaling and their weightings. A robust model will be relatively insensitive to small changes in input parameters. On the other hand, a model that produces highly variant results with small changes in input parameters would be highly suspect.

A common multivariate statistical technique for testing the sensitivity of models is multiple regression. Multiple regression also can be used to identify important and correlated variables. Variables can be systematically added or subtracted (forward and backward stepwise regression) to determine what proportion of the variance in the results of the model is accounted for by the variable. Important variables account for a large proportion of the variance. Furthermore, variables that are highly correlated with each other provide redundant or overlapping information. Multivariate analyses can be used to identify highly correlated variables that are simply different measures of the same underlying factor.

Reserve Selection Approaches

A separate task from creating a habitat assessment model is to objectively select reserve areas. While several core reserve areas and other public ownerships compatible with resource conservation are already in place in the MSHCP study area, selection of additional areas or core and linkage habitat will be necessary to complete reserve design. Thus, selection of reserves presents a different technical problem from habitat assessment. The following is a summary of modeling approaches that have been used for reserve selection.

The use of a reserve selection model assumes that a resource data base exists that can be used for specifying selection criteria or variables. The results of the habitat assessment model would be one such data base. Other criteria also could be used, such as species occurrence, habitat diversity, species richness, naturalness, etc. The common thread for the various models is that they are explicit, objective, and repeatable. A limitation of reserve selection models is that they are only as good as the quality of the data that comprise the selection criteria (e.g., species or habitat data). Also, Prendergast *et al.* (1999) provides an interesting discussion of the use of reserve selection theory and models in the real world.

Maximal Covering Location Problem (Church *et al.* 1996)

The maximal covering location problem (MCLP) model is premised on the concept of identifying sites that provide the maximum representation of some habitat value or other selected resource such as a set of sensitive species. An MCLP model provides an optimizing solution such that the outcome is the most efficient solution. In the case of a set of species, it provides the set of sites that maximizes the number of species represented. An optimizing solution differs from stepwise iterative models that include in all solutions a previously selected site. In other words, it looks at all the possible combinations of sites and selects the optimal combination for maximizing species representation.

Iterative Methods (e.g., Bedward *et al.* 1992)

Typically, iterative procedures select reserve sites in order of best to worst in a stepwise fashion. The selection criteria can be variable, but may, for example, include species richness, habitat diversity, representativeness, etc. At each step in the iterative process, the additional contribution of unselected sites is recalculated as each site is added to the reserve network. Such iterative models differ from optimizing solutions because previously selected sites are retained. They are relatively efficient in that they identify the fewest number of sites required for the solution to the problem. A limitation of the iterative selection procedure is that it often results in a scattered, diffuse set of sites that are not connected nor take into consideration other reserve design criteria.

Requirements for Use of Optimizing or Iterative Models

The data base that is used by either model has to be very explicit as to the biological/conservation value of the selection unit; presumably the habitat assessment model would provide this information. As Bedward *et al.* (1992) state, "Each selection unit [e.g., grid cell] is described in terms of the identity and, ideally, the extent or number of conservation features that it contains. Each unit is also assigned a cost of reservation, e.g., market value..."

CODA

An approach that can utilize the results of both the iterative and optimizing solutions methods is an interactive, mapped based computer program called CODA (Conservation Options and Decisions Analysis) described by Bedward *et al.* (1992). CODA allows the user to modify the reserve design criteria so that selected sites that are not suitable for the reserve for some reason (e.g., cost, isolation) can be replaced by alternative suitable sites that are more consistent with the stated reserve criteria. CODA also allows for identifying "focal selection units"; i.e., units that because of high conservation value must be included in the reserve system or already are in the existing reserve network (i.e., the core reserves).

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Attachment 2

Sample Habitat Linkages/ Connectivity Analysis

Sample Habitat Linkages/Connectivity Analysis

Theory

A fundamental concept and central issue of conservation biology theory is that habitat fragmentation and isolation leads to extinction of local populations as a result of two processes: (1) reduction in total habitat area which reduces effective population sizes; and (2) insularization of local populations which affects dispersal and immigration rates (Wilcox and Murphy 1985; Wilcove *et al.*1986). Wilcox and Murphy further point out that immigration may be impeded by conversion of natural habitat between occupied or potential habitat patches, thus increasing the probability of extinction. It is this latter point that is the crux of the habitat linkage problem. That is, isolation of habitat patches accompanied by intervening inhospitable land cover (e.g., urban development, roadways, etc.) is thought to increase the probability of permanent extinction of local populations. Because of complex community-level interactions (e.g., mutualistic species, habitat guilds, keystone species), the loss of one or a few species from a habitat patch as a direct result of habitat fragmentation (primary extinctions) also may result in multiple "secondary" extinctions within the habitat patch (Wilcox and Murphy 1986).

The theoretical benefits of habitat linkages may be mediated in the real world in variety of ways. Beier and Loe (1992) listed several concrete functions of the corridors. In their words,

1. Wide-ranging animals can travel, migrate and meet mates.
2. Plants can propagate.
3. Genetic interchange can occur.
4. Populations can move in response to environmental changes and disasters.
5. Individuals can colonize habitats from which populations have been locally extirpated.

While most theoretical treatments of habitat connectivity (e.g., in metapopulation models, source sink models) focus on the positive benefits of movement between habitat patches -- i.e., reducing extinction in the metapopulation -- there are potential drawbacks to habitat linkages, including the risk of disease transmission (e.g., Hess 1994), spread of catastrophic fires, and the poor linkages functioning as habitat sinks (Henein and Merriam 1990). For example, Hess, using a metapopulation simulation model, demonstrated that connected local populations could suffer a higher risk of extinction when a highly contagious fatal disease has a relatively low rate of mortality but reduces a population to the extent that it is more vulnerable to demographic and environmental stochastic events.

Poorly designed habitat linkages also may do more harm than good. At best, a poor habitat linkage will not effectively link habitat patches. At worst, as Soulé (1990) and Soulé and Gilpin (1991) point out, an inadequate linkage may function as a demographic sink that "drains" individuals from the source populations.

Sample Habitat Linkages/Connectivity Analysis

Harrison (1992) identified four critical variables of habitat linkages: (1) habitat; (2) width, (3) human activities; and (4) location. The utility of the corridor in regard to the five functions outlined by Beier and Loe (1992) should be considered in the context of the these four variables.

Habitat

Natural habitat linkages may provide permanent or "resident" habitat for some species, but only a movement conduit for other species, depending on each species habitat requirements with regard to size and resources. Evaluation of the corridor must then be based on the function it is intended to serve. For example, if the corridor is to provide permanent habitat for a species (i.e., "corridor dwellers"), it must contain all the features of suitable habitat for life requirements, such as prey or forage, water if necessary, refuge, and access to mates. If the corridor is only intended to provide a movement conduit it must contain features that allow for efficient movement such as adequate cover, lack of physical obstacles, etc., or as Beier and Loe (1992) state, "conditions that motivate the animal to enter and use the corridor." If the species can move through the area, access to prey and mates would not be critical factors.

Width

The minium width of the habitat linkage also depends on the needs of the focus species. If the habitat linkage is to provide permanent habitat, a rule of thumb could be that the width must be at least the diameter of the typical home range for the focus species. For example, a species with a one-acre circular home range, and thus a home range diameter of 234 feet, would require a habitat linkage with a width of a least 234 feet. However, it is important to keep in mind, almost by definition, that habitat linkages will be bordered by unsuitable habitats or inhospitable land uses that may produce adverse edge effects such as lighting, noise, invasive habitats, exotic predators (cats, dogs, opossums), hunting, trapping, off-road activities, dumping, and other forms of recreation and disturbance. It will be important to consider buffers for the habitat linkage such that the core permanent habitat is truly suitable for the species. Buffers to control for adverse edge effects may add several hundred feet of width to the habitat linkage, depending on the focus, species, adjacent land uses (including foreseeable land uses), habitat type(s), topography, and any other factors related to the depth of the edge effect. Again, utility of the linkage and the appropriate buffer will depend on the needs of the focus species (also see Soulé and Gilpin 1991, Soulé 1990).

An important factor to be considered in corridor design and evaluation is that habitat linkages may intrinsically expose wildlife to greater risk from predation, lack of critical resources (e.g., forage or water), and other accidents (e.g., vehicular collisions, hunting, etc.). Thus, for species that move through linkage

habitats, the move should be a quick as possible, thus reducing the risk of the movement (Harrison 1992).

Empirical Studies

There is a general lack of empirical data on the parameters of effective natural habitat linkages (Harrison 1992). What is clear is that habitat linkages must be designed and evaluated in the context of the species expected to use the linkage. Because providing a conduit for dispersal is probably the most important function of a habitat linkages, under this aspect of the focus species' natural history is essential. For example, mammals typically disperse fewer than five home-range diameters. Thus, a long strip of habitat that exceeds five-home range diameters of the focus animal may not function for the dispersal of most mammals unless it is large enough and provides the appropriate resources (e.g., food, water, cover) to function as permanent habitat. It is clear that to design an effective corridor for a focus species requires information about the species' habitat requirements, home range size, and risk factors (e.g., as prey, game, collection, etc.). Habitat linkages that would serve to reestablish populations also would need to accommodate the dispersal patterns of both males and females. For example, among sciurids (chipmunks, squirrels, marmots, prairie dogs) males typically disperse long distances whereas females establish home ranges in proximity to the natal burrow (Halpin 1987). In such species, the habitat linkage would have to provide permanent habitat for the animals to reside in order for reestablishment of the species.

Beier and Noss (1998) reviewed 32 empirical studies pertaining to the utility of wildlife corridors. While they determined that fewer than half the studies provided "persuasive data" because of design flaws and confounding variables, Beier and Noss concluded that the well designed studies supported the idea that corridors "valuable conservation tools."

Mammals

Birds

Reptiles and Amphibians

Plants

MSHCP Approach

One of the problems of designing and evaluating habitat linkages is identifying the species that are "isolation sensitive" and thus will require patch connectivity to maintain viable populations (Soulé 1990). As Soulé (1990) points out, rarity is directly related to risk of extinction for demographic and genetic reasons. Rarity/abundance thus can be used to identify species that may require habitat linkages. Where a reserve system is comprised of several large habitat patches, linkages may not be crucial for many common species because their populations will be large enough to be self-sustaining. However, if a reserve system is

comprised of many small habitat fragments, and thus smaller populations of even common or abundant species, habitat linkages may still be needed to prevent local extinctions (Soulé 1990).
High variability in population sizes or growth rates over time also is associated with risk of extinction (e.g., winking in and out of local populations in a metapopulation). Thus species exhibiting high population variability would be good candidates for needing habitat linkages.

For each species, a series of questions can be proposed as to the role of habitat linkages for the species.

1. Are habitat linkages necessary for the species? (e.g., see Soulé 1990)
   - If the answer is no, the remaining questions are moot for the species.
   - If the answer is yes, the remaining questions need to be answered as best as possible.
2. What habitat patches are proposed to be linked? (Beier and Loe 1992)
3. What is the function of the habitat linkage for the focus species?
   - dispersal
   - migration
   - resident permanent habitat or transit habitat; i.e., corridor dweller or passage species (Beier and Loe 1992)
   - frequent movement between habitat patches
   - reestablishment of population (i.e., classic metapopulation dynamics)
4. Does the habitat linkage need to be continuous or can it be a stepping stone linkage?
5. What additional resources within the linkage are required for it to function?
   - food
   - water
   - refuge
6. What are the minimum distance/width requirements of the linkage?
   - home range diameter for permanent habitat
   - sex-biased movement patterns
7. Are roads and other physical obstacles important limiters for the species?
   - will species cross roads?
   - susceptability to road collisions
   - topography
8. What other special biological factors need to be considered the evaluating the utility of the linkage?

9. Is the focus species highly sensitive to edge effects?

The role of habitat linkages for maintaining more complex community relationships also is an important question. Selective use of habitat linkages by different species can affect the community structure of the habitat patch. For example, Crooks and Soulé (1999) show that maintaining access by coyotes to small habitat fragments is necessary to control mesopredators (e.g. striped skunk, gray fox, raccoon, domestic cat, and opossum) that prey on small native birds. This study suggests that a poor linkage that adequately serves mesopredators but not coyotes could actually promote local extinctions. Thus, one aspect of the analysis of habitat linkages will be the possible effect of the linkage on predator-prey relationships. Would there be a risk of mesopredator release under certain habitat linkage scenarios?

Another community structure question that needs to be addressed is the dispersal of native and exotic plant species between habitat patches. This analysis will require an understanding of the dispersal characteristics of plants within the planning region and how important habitat linkages are to maintaining community structure.

Sample Analysis - Northwestern San Diego Pocket Mouse

The northwestern San Diego pocket mouse is relatively common in coastal sage scrub, sage scrub/grassland ecotone, and chaparral throughout the study area. There are no data for this species on the likelihood of local extinctions or need for habitat linkages to maintain viable populations. Because this species is still relatively common, large habitat patches probably support self-sustaining populations and habitat linkages between then would not be critical for this species. However, in small habitat patches that suffer high rates of predation by house cats, for example, local extinctions could occur (see Soulé 1990). For this reason, it is assumed that habitat linkages between smaller habitat patches would benefit this species and should be included in the reserve design.

Habitat linkages would provide permanent and dispersal habitat for this species. Pocket mice tend to be sedentary species and in San Diego pocket mouse (*Chaetodipus fallax*), there appears to be very little male-female overlap in home ranges (Jones 1993). There are no specific data on dispersal by the San Diego pocket mouse, but pocket mice in general show mild sexual dimorphism in dispersal, with males moving slightly farther than females (Jones 1993). Long, linear dispersal movements by pocket mice probably are rare, therefore this species should be treated as a "corridor dweller." There are only scattered data on home ranges for pocket mice species, ranging from a low average of 3,300 sq meters (0.8 acres) for *Perognathus longimembris* to a high of 4,005 sq meters (0.99 acre) for *Perognathus parvus*. Assuming a circular home range, the diameter of a home range on the larger end would be approximately 234 feet. Thus, the minimum width of a habitat linkage that would accommodate dispersal by the San Diego pocket mouse would have to be at least 234 feet. In addition, this species probably is highly susceptible to predation by exotic predators such as cats and other edge effects such as lighting may interfere with its nocturnal activities. Thus, this species probably is sensitive to edge effects. Where lighting

and cats could be a problem, additional buffer habitat would be required. An important question is the typical distance a cat would travel into the habitat linkage to hunt.

It is assumed that suitable linkage habitat would include core areas of coastal sage scrub, sage scrub/grassland ecotone, and chaparral. It is unknown whether this species would use linear riparian linkages bounded by unsuitable habitat, but based on known dispersal patterns of pocket mice, such linear strips of riparian habitat probably would not be adequate in the absence of suitable shrub/grassland upland habitats. Therefore, it is assumed that the habitat linkage must contain suitable upland habitat. Drinking water is not necessary for this species. San Diego pocket mice occur in a variety of terrains and soils (except perhaps heavy clays) and thus dispersal probably is not limited by topography. Habitat linkages along ridgelines and hillsides probably would be appropriate for this species.

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Attachment 3

Table 1 — MSHCP Species Groupings

(see Excel table under file: speciesgroups.xls)

Attachment 4

Table 2 — Habitat Rarity Groupings

(see Excel Table under File: mshcpveg2.xls)

Attachment 5

Sample Draft Species Accounts

Species: **Common Name and Scientific Name:** Wilson's warbler *(Wilsonia pusilla)*

Status: State: None
Federal: San Bernardino National Forest Sensitive

Habitat, habitat associations: Breeding habitats include montane meadows and low, dense willow thickets often on steep slopes (Garrett and Dunn 1981). Outside of the breeding season, these birds can be seen passing through woodlands and forests with shrub understories as well as chaparral habitats (Zeiner *et al.* 1990). Pairs typically nests near water or meadows, within 1 meter of the ground, under dense shrub cover (Zeiner *et al.* 1990). Wilson's warblers are migratory, arriving from Mexico in mid-April through early May. Fall migrants arrive in mid-August and remain into late fall and occasionally can be seen in early December (Unitt 1984). In migration over desert habitats, birds can use almost any available vegetation but mostly forage near the ground (Miller and Stebbins 1964).

Geographic Range: Breeding range for the species extends from northern Alaska, east to Newfoundland, south to southern California into northern New Mexico and northern New England (Terres 1980). Wintering habitat begins in southern Baja California, Mexico to Panama (Terres 1980). In California the majority of the range is occupied by summer migrants and extends along the coast and in the Sierras (Zeiner *et al.* 1990). The winter range extends into San Diego, Orange, Los Angeles, Ventura and Santa Barbara counties along the (Garrett and Dunn 1981). Inland occurrences in southern California are all summer migrants and occur in three areas in western Riverside, southwestern San Bernardino and eastern Los Angeles counties (Zeiner *et al.* 1990).

Known populations with western Riverside County: Most of the documented locations and observations of the Wilson's warbler are of transient individuals that are passing from the summer breeding residence to the winter range. These observations are located in almost all areas of western Riverside County and probably documented for any habitat type. Breeding locations are reported from San Bernardino National Forest and from Cleveland National Forest.

Planning Area Subregions: Cleveland National Forest; Santa Rosa Plateau; Temecula;Pauba Valley; Wildomar; Lake Elsinore; Lake Matthews; Norco; Pedley; March ARB; Lake Perris; Mead Valley; Quail Valley; Murrieta Hot Springs; Wilson Creek; Lake Skinner; San Jacinto Wildlife Area; Badlands; San Bernardino National Forest.

Special biological considerations: Species is a year long diurnal and nocturnal migrant (Zeiner *et al.* 1990). Home range in Marin County was reported at 125-300m from the nest while territory averaged 0.5 ha (Stewart 1973). Wilson warbler's breed from late April to early August and they are monogamous (Harrison 1951). The species may nest in loose colonies (Terres 1980). Miller and Stebbins (1964) report observing exhaustion in high temperatures. Bent (1953) reports that 93% of the food intake consisted of animal matter (n=53).

Threats to species: The species is subject to predation from accipiters, small mammals and snakes

(Zeiner *et al.* 1990). Brown-headed cowbirds regularly parasitize this species and may be partially responsible for extirpation from lowland areas (Garrett and Dunn 1981).

Status of existing information: Although the existing database information likely underestimates the population size and locations within the San Bernardino and Cleveland national forests, a habitat evaluation based on preservation of breeding habitat can be conducted. Wintering habitat is extremely general and encompasses many types of habitats.

Endemism: Not endemic to California.

Goals: Conserve the major populations of the Wilson's warbler within the San Bernardino and Cleveland National Forests. Conservation of major populations will be based on the habitat use of this species. Thus, the preservation of montane meadows, wet meadows, and dense willow thickets will be used to achieve this goal. This will provide protection of the breeding habitat of the species. The wintering habitat use of this species is extremely general. Thus, the protection of a variety of habitats within the nonbreeding area will achieve the goal of providing wintering foraging areas and winter residence areas.

Objectives: Currently three breeding locations of the Wilson's warbler are noted within the database. These areas with the associated breeding habitat should be included in the management direction of the USFS. The wintering locations of the Wilson's warbler generally tend to be located within the major drainages of the planning area. These major drainages and their associated riparian habitat should be included in the conceptual conservation scenario. The drainages include Temescal Wash, Santa Ana River, Prado Basin, Temecula Creek, and Murrieta Creek.

Strategy: Currently the known breeding locations of the Wilson's warbler are within the conceptual conservation scenario. An MOU with the USFS may be required to provide protection for the breeding habitat which includes montane meadows and low, dense willow thickets. Grazing restrictions may be required to protect wet meadow edges and willow thickets adjacent to montane meadows.

General Management: Habitat management may be required within the national forest lands to enhance or protect the montane meadows and willow thicket areas. Habitat management and enhancement may be required to preserve and protect the riparian habitat in the drainages used by wintering populations.

Monitoring: Within forest service lands, wet meadows and montane meadows should be monitored yearly to document that the habitat is not degrading. Within the wintering range, the drainages should be visited as part of the overall monitoring of the riparian system. Monitoring of the habitat for listed species will also accomplish the monitoring to provide protection of the wintering habitat of the Wilson's warbler.

Remedial Action: If it is noted that grazing impacts are reducing the quality of the breeding habitat, fencing or grazing restrictions within the forest service lands may be required. The Wilson's warbler has been noted to respond well to revegetation and habitat enhancement within its breeding range (personal observation). Recuperative management of the wintering locations and drainages will be well accomplished by the management required for other listed riparian species.

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Birds Coastal California gnatcatcher (*Polioptila californica californica*)

Species: Common Name and Scientific Name: Coastal California gnatcatcher (*Polioptila californica californica*)

Status: State: Species of Special Concern
Federal -Threatened

The gnatcatcher was proposed for listing as a threatened species in September 1991. On March 30, 1993, the final rule determining the gnatcatcher to be a threatened species was published (USFWS 1993). The Endangered Species Committee of the Building Industry Association of Southern California and other plaintiffs subsequently filed a suit challenging the listing on several grounds. In a Memorandum Opinion and Order filed in the U.S. District Court for the District of Columbia on May 2, 1994, the Court vacated the listing determination, holding that the Secretary of Interior should have made available the underlying data. By order of June 16, 1994, the Court reinstated threatened status for the gnatcatcher pending a determination by the Secretary whether the listing should be revised or revoked in light of his review of the subject data and public comments received during public comment periods. On March 27, 1995, the USFWS published a notice of determination affirming the earlier conclusion that the gnatcatcher is a distinct subspecies and, thus, meets the definition of a "species" pursuant to the Act (USFWS 1995). On May 21, 1997, the U.S. Court of Appeals for the Ninth Circuit Court issued an opinion that required the USFWS to issue a new decision regarding the prudence of determining critical habitat for the gnatcatcher. On February 8, 1999, the USFWS concluded that designation of critical habitat totaling 124,188 acres on lands within the United States portion of the range of the gnatcatcher is prudent. This total includes all Federal lands within the range of the gnatcatcher (119,508 acres) and 4,680 acres of non-Federal lands where a Federal nexus exists (USFWS 1999).

Habitat, Habitat Associations: The coastal California gnatcatcher (gnatcatcher), a subspecies of the California gnatcatcher, is a small, long-tailed member of the thrush family (Muscicapidae). The gnatcatcher typically occurs in or near sage scrub habitat, which is a broad category of vegetation that includes the following plant communities as classified by Holland (1986): Venturan coastal sage scrub, Diegan coastal sage scrub, maritime succulent scrub, Riversidean sage scrub, Riversidean alluvial fan sage scrub, southern coastal bluff scrub, and coastal sage-chaparral scrub. Coastal sage scrub is composed of relatively low-growing, dry-season deciduous, and succulent plants. Characteristic plants of this community include California sagebrush (*Artemisia californica*), various species of sage (*Salvia* sp.), California buckwheat (*Eriogonum fasciculatum*), lemonadeberry (*Rhus integrifolia*), California encelia (*Encelia californica*), and *Opuntia* spp. Ninety-nine percent of all gnatcatcher locality records occur at or below an elevation of 984 feet (Atwood 1990).

Coastal sage scrub is patchily distributed throughout the range of the gnatcatcher, and the gnatcatcher is not uniformly distributed within the structurally and floristically variable coastal sage scrub community. Rather, the subspecies tends to occur most frequently within the California sagebrush-dominated stands on mesas, gently sloping areas, and along the lower slopes of the coast ranges (Atwood 1990). Territory size increases as vegetation density

decreases and with distance from the coast, probably due to food resource availability. Therefore, gnatcatchers will use sparsely vegetated coastal sage scrub for shelter and to forage for insects as long as perennial shrubs are available. Patchily distributed habitat may also aid in dispersal by providing links of suitable foraging areas to provide movement to larger areas of suitable foraging and breeding habitat (Galvin, 1998; Bailey and Mock, 1998).

Gnatcatchers also use chaparral, grassland, and riparian habitats where they occur adjacent to sage scrub. The use of these habitats appears to be most frequent during late summer, autumn, and winter, with smaller numbers of birds using such areas during the breeding season. These non-sage scrub habitats are used for dispersal, but data on dispersal use are largely anecdotal (Bowler 1995; Campbell *et al.* 1995; Campbell et al. 1998). Although existing quantitative data may reveal relatively little about gnatcatcher use of these other habitats, these areas may be critical during certain times of year for dispersal or as foraging areas during drought conditions. Breeding territories have also been documented in non-sage scrub habitat. Campbell et al. (1998) discuss likely scenarios explaining why non-CSS is used by gnatcatchers, food source availability, dispersal areas for juveniles, temperature extremes, fire avoidance, and lowered predation rate for fledglings.

Geographic Range: Historically, gnatcatchers occurred from southern Ventura County southward through Los Angeles, Orange, Riverside, San Bernardino, and San Diego counties, and into Baja California, Mexico, to approximately 30 degrees North latitude near El Rosario (Atwood 1990). The gnatcatcher was considered locally common in the mid-1940's, but by the 1960's this subspecies had declined substantially in the United States owing to widespread destruction of its habitat (Atwood 1990). Currently, the subspecies occurs on coastal slopes of southern California, ranging from southern Ventura southward through Palos Verdes Peninsula in Los Angeles County through Orange, Riverside, San Bernardino and San Diego Counties into Baja California to El Rosario, Mexico, at about 30 degrees north latitude (Atwood 1991). In 1993, the USFWS estimated that approximately 2,562 pairs of gnatcatchers remained in the United States. Of these, 30 pairs occurred in Los Angeles County, 757 pairs occurred in Orange County, 261 pairs occurred in Riverside County, and 1,514 pairs occurred in San Diego County.

Known Populations Within Western Riverside County: The gnatcatcher is found throughout western Riverside county in coastal sage scrub habitat. The high density areas are found in the western portion of the county along the I-15 Corridor.

The distribution of gnatcatchers in the County does not appear to be uniform, instead high density patches exist in generally two locations within the planning area, one in the northwestern portion of the planning area east of the 15 Freeway in the City of Lake Elsinore. The other area is in the Temecula area including the south side of the Lake Skinner reservoir and west to Winchester Rd. From north to south these dense patches occur at the proposed El Sobrante Landfill area, Alberhill area, the proposed North Peak Conservation Bank, south to Kabian Park and the area surrounding Canyon Lake. In the southern area

the highest densities of birds reside on the Southwestern Multiple Species Reserve and west through the proposed Johnson Ranch Specific Plan, proposed Rancho Bella Vista Specific plan and the proposed SilverHawk Specific Plan. Current estimates for gnatcatchers in western Riverside number around 300 pairs (USFWS 1996).

Planning Area Subregions: Locations where gnatcatchers have been recorded within the University of California database include: Aguanga, Alberhill, Canyon Lake, El Cerrito, French Valley, Gavilan Hills, Good Hope, Home Gardens, Homeland/Lakeview, Lake Elsinore, Lake Mathews, Menifee, Murrieta, Murrieta Hot Springs, Norco, Pauba Valley, Pigeon Pass, Quail Valley, Reche Canyon, Riverside East, Rubidoux, Sage, Santa Rosa Plateau East, Santa Rosa Plateau West, Sedco Hills, Sun City, Temecula/Rancho California, Vail Lake, Valle Vista, Wildomar, Winchester, Bautista Creek, Santa Ana River, Temecula Creek, Temescal Wash, Wilson Creek and Wilson Valley, Kabian Park, Lake Mathews Reserve, Box Springs Mountain Park, Eastside Reservoir, Lake Perris SRA, Lake Skinner Reserve, Prado Park, Santa Margarita Ecological Reserve, Santa Rosa Plateau Reserve, and Santa Ana River Regional Park.

Special Biological Considerations: The California gnatcatcher is primarily insectivorous, nonmigratory, and exhibits strong site tenacity (Atwood 1990). The breeding season of the gnatcatcher extends from mid February through mid-August, with the peak of nesting activity occurring from mid-March through mid-May. The gnatcatcher nest is a small, cup-shaped basket usually found one to three feet above the ground in a small shrub or cactus. Clutch sizes range between three and five eggs, with the average being four. Juvenile birds associate with their parents for several weeks (sometimes months) after fledging. Gnatcatchers are persistent nest builders and often attempt multiple broods, which is suggestive of a high reproductive potential. This is, however, typically offset by high rates of nest predation and brood parasitism. Gnatcatchers typically live for two to three years, although ages of up to five years have been recorded for some banded birds (Braden, McKernan, and Powell 1995). The continued fragmentation of habitat over time has increased exposure of gnatcatcher to threats associated with habitat edge. Numerous nest predators thrive on habitat edges, and brood parasitism by the brown-headed cowbird (*Molothrus ater*) appears to be exacerbated by increased edge effects.

Other factors that will be relevant for a designing a reserve system for the gnatcatcher will be the dispersal distance and average territory size. In western Riverside County, the average dispersal distance for juvenile gnatcatchers has been documented as 1.14km. The distances may be influenced by many factors such as sex, reproductive opportunities, available habitat and other factors (Braden et al, 1994a). The average territory size for gnatcatchers is 8.42 acres during the breeding season and can expand to 60 acres during the non-breeding season (Braden and Powell, 1994b). A reserve design for this species will need to maintain connections of breeding habitat such that dispersal between areas can be accomplished.

Structure of the perennial vegetation within coastal sage scrub seems to be an important component to successful gnatcatcher reproduction (Braden, 1997). Any disturbance that affects perennial structure and homogeneity within gnatcatcher territories, such as fire or grazing, also may affect gnatcatcher fitness (Braden, 1997). In fact, areas of the Southwestern Multiple Species Reserve that were occupied by gnatcatchers previous to a 1993 fire have not recovered enough to warrant occupation by gnatcatchers to date (Michelle Shaughnessy pers. comm. 1999). In general, recently burned areas are not used by gnatcatchers except on an occasional basis, and five to seven years of recovery may be necessary before gnatcatchers will nest in burned areas (Atwood et al. 1998, Beyers et al. 1995). This slow recovery of CSS in western Riverside county may be due to invasion of exotic annuals after any disturbance. CSS in the County has been reduced by frequent fire, grazing, and invasion of exotic annuals, as well as air pollution (Westman and O'Leary (1988) and O'Leary (1990)). The frequency of fires in wildland areas tends to increase as fragmentation increases due to urbanization and agricultural activity. Because of the CSS to grass conversion, protection of coastal sage scrub on gabbro basalts may be required to protect this habitat and the gnatcatcher in Riverside County (Minnich, 1998).

Fire may be one of the most important factors to consider in reserve design for this species. Consideration of habitat refugia, burn frequency, and recolonization of recovering burn areas will be necessary for designing reserve for this species (Atwood et al. 1998). Management consideration will need to take into account that large scale fires may damage gnatcatcher populations in both the burned area and the refugia area (Atwood et al. 1998). Due to the issue of periodic fires in occupied habitat and the length of time needed for recovery of CSS, large areas will be necessary to provide refugia for birds and to supply dispersing individuals to a recovered area.

Threats to Species: In 1997, the total number of gnatcatchers in the United States was estimated at 2,899 pairs, after subtracting out all gnatcatcher pairs authorized for take under Habitat Loss Permits, approved natural Community Conservation Plans, Habitat Conservation Plans, and section 7 consultations ("Reinitiation of formal consultation on implementation of the special rule for the coastal California gnatcatcher [1-6-93-FW-37R1]"). This apparent increase in abundance since 1993 is likely the result of additional surveys occurring within previously unsurveyed areas, as well as increased productivity in response to favorable climatic conditions.

Although observed declines in numbers and distribution of the gnatcatcher resulted from numerous factors, habitat destruction, fragmentation and adverse modification are the principal reasons for the gnatcatcher's current threatened status (USFWS 1993). The amount of coastal sage scrub available to gnatcatchers has continued to decrease during the period after the listing of the species. It is estimated that up to 90 percent of coastal sage scrub vegetation has been lost as a result of development and land conversion (Westman 1981a, 1981b; Barbour and Major 1977), and coastal sage scrub is considered to be one of the most depleted habitat types in the United States (Kirkpatrick and Hutchinson 1977;

Axelrod 1978; Klopatek *et al.* 1979, Westman 1987; O'Leary 1990). In addition, agricultural use, such as grazing and field crops, urbanization, air pollution, increases in fire frequency and the introduction of exotics have all had an adverse impact on extant sage scrub habitat.

Status of Existing Information: The gnatcatcher has been well studied in western Riverside county mainly due to the establishment of the Southwestern Riverside County Multiple Species Reserve and the accompanying management fund. In addition, the PSBS report provides an excellent baseline for the distribution of the gnatcatcher populations within the planning boundary. Therefore, the current information is adequate to design a reserve system in the planning area for this species.

Endemism: Endemic to southern California.

Goals: Conserve and enhance the major population of the California gnatcatcher. Conservation of major populations will be based on the habitat use of this species. Thus, the preservation of coastal sage scrub will be used to achieve this goal. In addition to conserve the major populations, dispersal linkages of coastal sage scrub and other native and non-native undeveloped habitat should be provided.

Objectives: Conserve the major populations of the California gnatcatcher including: the proposed El Sobrante Landfill area, Alberhill area, the proposed North Peak Conservation Bank, Kabian Park, the area surrounding Canyon Lake, the Southwestern Multiple Species Reserve. Conserve portions of the major populations at the remaining core populations areas including: the proposed Johnson Ranch Specific Plan, proposed Rancho Bella Vista Specific plan and the proposed SilverHawk Specific Plan. Habitat linkages should provide a duplicity of movement potential in case wild fire occurs within one linkage. The linkage need not be composed of entirely coastal sage scrub but the majority of the linkage should be native or at least undeveloped habitat. In some cases, a stepping stone linkage will be acceptable where the habitat is otherwise fragmented (Bailey and Mock 1998).

Strategy: **-Acreages**
-Areas - listed above
-Numbers

General Management:

-edge effects
-fire management
season access restrictions

Monitoring:

Remedial Actions:

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Species: Common name and Scientific Name: Peregrine falcon (*Falco peregrinus*)

Status State: Listed as Endangered; Fully Protected
Federal: Listed as Endangered; Partners in Flight Priority Bird Species;
This species is considered endangered throughout its range, Federal Register, June 2, 1970; October 13, 1970; March 20, 1984. USFS Region 5 Sensitive; San Bernardino National Forest Sensitive; Migratory Nongame Bird of Management Concern

Habitat, Habitat Associations: Throughout the species' range, peregrines are found in a large variety of open habitats, including tundra, marshes, seacoasts, and high mountains (AOU 1998). Within southern California, peregrine falcons are primarily found at coastal estuaries and inland oases (Garrett and Dunn 1981). The species breeds mostly in woodland, forest, and coastal habitats. Riparian areas and coastal and inland wetlands are important habitats yearlong, especially in nonbreeding seasons. Breeding requires cliffs or suitable surrogates (e.g., buildings) that are close to preferred foraging areas. They have been known to nest in trees and on small outcrops in other portions of their range. Some peregrines have used tall buildings, bridges or other tall man-made structures for nesting (CDFG 1992). The nest site usually provides a panoramic view of open country, often overlooking water and are always associated with an abundance of passerine, waterfowl, or shorebird prey, even in an urban setting. In general, the peregrine falcon frequents bodies of water in open areas with cliffs and canyons nearby for cover and nesting and is located in areas with abundant avian prey (Zeiner et al. 1990). In some parts of California, the home range averages 125 square miles and territories are spaced approximately 3 - 7 miles apart (Zeiner et al. 1990). The peregrine typically hunts its prey in air and prey is either struck to the ground or killed outright by the blow from the talons. The species may fly 10 to 12 miles from their nest in search of prey which are usually hunted over open habitat types such as water ways, fields and wetland areas such as swamps and marshes (USFWS 2/91). The peregrine has been known to fly as far as 79 km in one flight on a foraging excursion. They apparently obtain prey in widely separated places with no apparent dependence on any certain area (Enderson and Craig, 1997)

Geographic Range: The species breeds in North America from Alaska east to Labrador southward to southern California through Alabama. The species winters from southern Alaska to Tierra del Fuego in southernmost South America (AOU 1998). In California, the species breeds and winters throughout the state, with the exception of desert areas (Zeiner et al, 1990). The peregrine is a very uncommon breeding resident and uncommon as a migrant.

Known Population Within Western Riverside County: Could be expected (albeit rarely) virtually anywhere within the study area during all seasons. Although peregrines were observed on at least two occasions in the Prado Basin and environs in 1998 (James Pike, Fish and Wildlife Service Volunteer Field Biologist, pers. comm., 1998), the species remains quite scarce elsewhere within the study area (Michael Patten, Riverside County Editor for

American Field Notes and Past Secretary, California Bird Records Committee, pers. comm., 1998).

Planning Area Subregions: Geographic locations recorded within the U.C. Riverside database include: Prado Park, Santa Ana River, San Jacinto Wildlife Area, Lake Perris, Lake Skinner, and Hemet Lake.

Special Biological Considerations: Three distinct subspecies of peregrines may occur within the study area; all are currently protected by the Endangered Species Act due to similarity of appearance provisions. The species is most likely to be found where prey (primarily birds) concentrate. A comprehensive recovery plan was completed in 1979, and revised in 1987. The primary objective of the plan is to restore a self-sustaining population of peregrine falcons in the United States (USFWS 2/91).

Although it is important to provide protection for this species within the planning area, a recent model of the peregrine falcon population in California indicated that concentrating management efforts on the healthier, high density population in northern California, rather than on the poorly performing population in central and southern California would yield the largest overall population size (Wooton and Bell, 1992).

Threats to the Species: Although formerly critically endangered due to egg-shell thinning caused by the organochlorine pesticide DDT, the persecution of the species for falconry and "vermin" control, and habitat destruction, North American populations of this species apparently are recovering strongly. Continuing population increases and the magnitude of continuing recovery efforts by a variety of agencies, organizations, and the interested public prompted the Service to propose the demisting of the species in 1998.

Status of Existing Information: Focused surveys and extensive contact with California peregrine experts are necessary to determine if the species breeds in the study area and which sites (other than Prado Basin) are important to transient or wintering birds. Given what is known of the species' foraging ecology, locales that concentrate migratory birds should be the focus of survey efforts. In addition, focused surveys and research could reveal that the species breeds in the survey area. The San Jacinto Mountains would appear to be the most likely area where nesting could occur.

Endemism: Not endemic to California.

Goals: Conserve enhance the population of the peregrine within the planning area. This species has been noted to occur in one location on a regular basis. Provide areas that may be used for foraging and that may be used by the species in the future. Conservation of this species will be based on the species specific information.

Objectives: Currently one recurring nonbreeding location of the peregrine falcon is noted within the database. Scattered transient locations have also been noted also. The known location is within Prado Basin, other scattered locations are generally within the Mystic Lake and San Jacinto Wildlife areas. These areas with the associated foraging habitat should be included in the conceptual conservation scenario.

Strategy: Currently the known location, Prado Basin, of the peregrine falcon is within the conceptual conservation scenario. This area should be monitored and if breeding should be observed, protection should be afforded to the breeding location. Additionally, foraging areas that provide wintering populations of waterfowl should be included in the conceptual conservation scenario. The Mystic Lake and San Jacinto Wildlife areas are include in the scenario.

General Management: Habitat management may be required within Prado Basin to provide protection for the riparian habitat. Habitat management and enhancement may be required to preserve and protect the riparian habitat. Eliminate arundo.

Monitoring: Within Prado Basin, former known observation locations should be monitored yearly to document that the habitat is not degrading. Within the foraging areas, duck populations should be monitored and water levels may need monitoring to ensure that wintering duck populations continue to use the area. Breeding populations of the peregrine appear to be recovering also. Monitoring of the Prado Basin area should also focus on documenting breeding activities of the peregrine. With increased human activity in the planning area, proper management is needed to provide suitable nesting sites and to minimize human disturbances during the nesting season (Castellanos et al., 1997).

Remedial Action: If monitoring of Prado Basin indicates the riparian habitat is degraded, enhancement of the area may be required. Water level managment within the Mystic Lake area may require management if duck populations stop using the area for wintering.

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Reptiles arroyo southwestern toad (*Bufo microscaphus californicus*)

Species: Common Name and Scientific Name: arroyo southwestern toad (*Bufo microscaphus californicus*)

Status: State: Species of Special Concern
Federal: Endangered (Designated Recovery Units in Western Riverside Co. - Santa Ana watershed [San Jacinto River, Bautista Creek], Santa Margarita watershed [Santa Margarita River, Temecula Creek, Arroyo Seco Creek], Aliso-San Onofre watershed [San Juan Creek, San Mateo Creek])

Endemism: Endemic to southern California

Habitat and Habitat Associations: Arroyo toads are found in foothill canyons and intermountain valleys where the river is bordered by low hills and the stream gradient is low (Miller and Miller 1936, Sweet 1992). The arroyo toad is an extreme habitat specialist, restricted to riparian environments in the middle reaches of third order streams (Sweet 1989). Arroyo toads are known to either breed, forage, and/or aestivate in aquatic habitats, riparian, coastal sage scrub, oak, and chaparral habitats. The species is currently thought to be restricted to the headwaters of large streams with persistent water from March to mid-June that have shallow, gravely pools less than 18 inches deep, and adjacent sandy terraces. Upland burrows have been noted for this species. Patterns of habitat use by sub-adults and non-breeding adults is not well understood (Sweet 1992).

Geographic Range: Coastal plain and mountain streams of Southern California west of the desert from San Antonio River (Ft. Hunter-Liggett), in Monterey County (Fed. Reg. Vol.59, No. 241, December 16, 1994), and near Santa Margarita, San Luis Obispo County, to northwestern Baja California, Mexico. However, there are known populations along the desert slope including the Mojave River, San Bernardino County, and Little Rock Creek, Whitewater River, San Filepe Creek, Vallecito Creek, and Pinto Canyon Riverside County, California (Jennings and Hayes 1994, Patton and Myers 1992, Stebbins 1985).

Known Populations Within Western Riverside County: Scattered historic occurrences near the area southwest of Lake Elsinore, and south of Vail Lake, the Whitewater River north of I-10, and Santa Margarita River Basin below 609 meters elevation. Recent surveys have located very small populations of arroyo toads in Temecula, Arroyo Seco, San Mateo, and Teneja creeks (NBS 1996). One population occurs at Dripping Springs near Vail Lake. Other localities include San Jacinto River near the confluence of Bautista Creek, and Sitton Peak.

Special Biological Considerations: This species requires access to permanent water during the breeding season and unrestricted corridors for movement from water sources to adjacent upland stream terrace habitat where much of the remaining active season is spent. These toads have “perhaps the most specialized habitat requirements of any amphibian in

California" (Jennings and Hayes 1994). Breeding pools appear to meet specific requirements only in the middle reaches of second (or occasionally third) order streams. The species exhibits an explosive breeding period, generally forming linear, loosely organized choruses along streams (Sullivan (1992). Breeding pools must be open and shallow with minimal current, and with a sand or pea gravel substrate overlain with sand or flocculent silt (Sweet 1989). Adjacent banks must provide open, sandy or gravely terraces with very little herbaceous cover for adult and juvenile foraging areas, within a moderate riparian canopy of cottonwood, willow, or oak. Heavily shaded pools are unsuitable for larvae and juvenile toads due to lower water and soil temperatures and poor algal mat development (Sweet 1992). Episodic flooding is critical to keep the low terraces relatively vegetation free. Juveniles favor areas which remain damp and contain less than 10% cover, as these sites possess the thermal and refuge characteristics required for juvenile survival and rapid growth (Sweet 1992). Larval growth appears to be more rapid in pools with low silt loads (Jennings and Hayes 1994). Adults use terraces in the 100-year flood zone, which may extend up to 100 m from the stream (NBS 1996), however more recent data suggest that they may move between 1 and 2 km into adjacent upland habitats to estivate. Most terraces are not immediately adjacent to the stream, but are separated by a dynamic, channel margin zone of mixed sediments which is reworked as storm waters flood the primary channel (NBS 1996). Drainages with straighter courses will have broader marginal zones and fewer terraces but may have associated oak flats that provide suitable adult habitat (NBS 1996). Adults excavate shallow burrows on the terraces where they shelter during the day when the surface is damp or during longer intervals in the dry season.

This species is treated as a subspecies of *Bufo microscaphus*; however, it is becoming increasingly clear that it is morphologically differentiated from the other two subspecies *B. m. microscaphus* and *B. m. mexicanus* (Jennings and Hayes 1994). Gergus (1998) compared allozyme data between the three subspecies and found that the discrete differences support the hypothesis that they exhibit mutually exclusive evolutionary lineages and each should be recognized as a separate species.

The arroyo toad has been extirpated from 75 percent of its former range (Fed. Reg. Vol. 59, No. 241, December 16, 1994), however since the listing of the arroyo toad, numerous new locations have been located through site specific surveys. Although a substantial proportion of currently occupied habitat is found on National Forest lands, recovery of arroyo toads on privately owned lands will likely be necessary to recovery of the species. Toad habitat requirements and habitat loss may act in concert to functionally isolate populations (NBS 1996). The remaining 25 percent of occupied habitat are threatened by dam construction, river diversion, conversion of riparian wetland habitat by agriculture and urbanization, road construction, off-highway vehicle use, campground development, grazing, and mining activities.

Artificial flow augmentation and withdrawal from dam releases in February though August encourages vegetative growth in riparian corridors, and disrupts the natural fluvial processes that produce the terrace pool habitats required by arroyo toads (Sweet 1992). Currents of 5 cm/sec or greater are sufficient to displace eggs and embryos/larvae up to 82 hours post hatching (Sweet 1992). Sedimentation sources will negatively impact arroyo toad habitat, and therefore, should be monitored and controlled (Sweet 1999, pers. com.). In addition, populations which are unable to migrate across altered or otherwise inhospitable terrain between disjunct population groups result in genetic isolation. Off-road vehicle use in stream beds and along banks cause significant impacts to arroyo southwestern toads. Stream diversions leads to early drying of breeding pools, and restriction of the foraging period essential for rapid growth, and loss of damp subsurface soil, which may result in high adult mortality (Sweet 1992). Introduced plants and predators can cause substantial reductions in the size of extant populations, and may have contributed to regional extinctions of arroyo toads (Hayes and Jennings 1986). Predatory fish, such as introduced mosquito fish and arroyo chub, that prey on tadpoles are found in virtually all occupied and once occupied streams (Sweet 1992), and introduced bullfrogs which prey on adult arroyo toads are encouraged by artificially maintained perennial streams (Sweet 1993).

The extended 5-year drought in Southern California during the late 1980's, when combined with water diversions from streams created extremely stressful conditions for most aquatic species. The effect of drought and water diversion on arroyo toads is that female toads may find insufficient insect prey to acquire enough fat storage for egg production before males cease their courtship behavior of calling, resulting in no reproduction that year (Sweet 1992). The recent years of extremely low reproductive success has likely resulted in a reproductive bottleneck in the remaining populations of arroyo toads, in which few individuals reached sexual maturity from 1990 to 1995 (Sweet 1992). Sullivan (1992) found that there is a differentiation in the sound frequency between larger and smaller males. This may affect mate selection by females. Low reproductive rates or success affects the size and extent of the resulting cohorts. Missing or reduced cohorts combined with the possibility that females select for certain frequencies when selecting a mate, may further reduce the reproductive rate of the population.

Numerous local extinctions likely occurred during the 1990 to 1995 droughts. In addition to drought, other deleterious factors are many: trampling of toads or crushing them within burrows on stream terraces by grazing animals and wild pigs and crushing of toads in open areas, such as campground roads and off-highway vehicle use areas, where they forage at night. Campground garbage also attracts artificially high populations of racoons which predate on arroyo toads (Sweet 1999, pers com). Finally, suction dredge mining often occurs in and adjacent to breeding pools, which are destroyed by dredging (NBS 1996). Siltation in arroyo toad breeding pools can asphyxiate eggs and newly hatched larvae and make foraging impossible.

Goals: Conserve and enhance all populations of the arroyo southwestern toad within the USFWS

recovery plan recovery unit (i.e., San Jacinto River, Bautista Creek, Santa Margarita River, Temecula Creek, Arroyo Seco Creek, San Juan Creek, and San Mateo Creek) so as to meet the recovery goal (self-sustaining populations which are documented to have successful recruitment, i.e., inclusion of newly matured individuals into the breeding population, equal to 20% or more of the average number of breeding adults in 7 to 10 years of average to above average rainfall amounts with normal rainfall patterns). Conserve other known populations and provide 1km natural habitat buffers where feasible along the length of recovery unit river systems. Maintain 1st through 6th order connections between occupied systems for re-colonization or reintroduction.

Conserve all riparian systems within the recovery unit and provide adequate buffers where feasible.

Promote connections between units via small order streams and upland habitats.

Management: Many potential management measures should be implemented to achieve the goals. These measures have been outlined in the Recovery Plan (USFWS 1999).

Populations should be secured by protecting, maintaining, restoring, and enhancing breeding and upland habitats by developing and implementing management plans; coordination with other agencies; managing dams, water releases, and diversions; and reducing adverse effects to toads and habitat by acquiring land.

Management plans need to be developed and implemented at or near campgrounds to prevent take of all stages of arroyo toad life. Trails and roads adjacent to breeding arroyo toad sites may require closure. Control of mining and prospecting activities in known or potential arroyo toad drainages can reduce impacts. Stricter regulation of fishing and other recreational activities within known or potential arroyo toad drainages will reduce trampling and siltation of eggs, larvae, and juveniles Removal of exotic vegetation (particularly *Tamarisk*, *Arundo*, and *Cortederia*) will enhance toad habitat. Replacement of “Arizona” type road crossings with culverted crossings in breeding habitat, will reduce vehicle-induced mortalities and siltation downstream. Development and implementation of livestock management plans within federal lands will reduce trampling and degradation of habitat. Finally, removal of introduced fishes, bullfrogs, and crayfish from recovery areas will be an essential management tool for enhancing the population.

Coordination with the Border Patrol, other law enforcement, utility companies, service districts, and other local and state agency jurisdictions to reduce river and creek impacts due to road crossings or road development, off-road driving, and inappropriate use of spotlights will reduce negative effects on arroyo toad populations.

Stream flows downstream of dams should be managed to reduce negative effects on arroyo toads. Stream flows should mimic as possible, historic rainfall records and hydrologic data.

In short, original hydrologic regimes should be restored as feasible.

If monitoring indicates that the population is declining, or not increasing according to the recovery plan, then remedial measures should be implemented. These measures may include, but are not limited to, more severe closures of habitat areas, reintroduction into unoccupied historical systems, genetic injections into marginally occupied systems, and capture breeding programs.

Monitoring: Populations will need to be surveyed according to the most current protocol every other year for 12 years and then every 4 years thereafter, within recovery unit creeks and rivers and other populations as they become established or discovered. Surveys should be conducted in drainages for which there is no data. Care should be taken when correlating survey results when survey methodologies differ (i.e., official protocol modifications which increase or decrease survey effort) between years. Surveys should be correlated to vegetation cover, streambed, invasive plant species, native and non-native predator presence, climatological data and management plans.

General amphibian populations should be monitored yearly, by audible sampling to determine general amphibian population robustness. This yearly sampling should be fashioned after the National frog sampling effort which is similar to numerous national bird sampling endeavors.

A general assessment of available habitat should be completed every two years by remote sensing techniques.

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Additional References

MANY

Plants Santa Ana woolly star (*Eriastrum densifolium* ssp. *sanctorum*)

Species: **Common Name and Scientific Name:** Santa Ana woolly star (*Eriastrum densifolium* ssp. *sanctorum*)

Status: State: Endangered
Federal: Endangered (September 28 1987)
CNPS: 1B (Red Code: 3-3-3)

Geographic Range: *Eriastrum densifolium* ssp. *sanctorum* occurs along the Santa Ana River and Lytle and Cajon Creek flood plains from the base of the San Bernardino Mountains in San Bernardino County southwest along the Santa Ana River through Riverside County into the Santa Ana Canyon of northeastern Orange County from about 150 to 450 meters (Munz 1974, Patterson 1993, Roberts 1998). *E. densifolium* ssp. *sanctorum* is found on coarse, sandy flood plains in association with early (pioneer) alluvial fan scrub or open washes (U.S. Fish and Wildlife Service 1987).

Known Populations within Western Riverside County: Within the planning area, *Eriastrum densifolium* ssp. *sanctorum* probably occurred in open areas along the length of the Santa Ana River. Currently *E. densifolium* ssp. *sanctorum* is known only from two small populations (less then 10 individuals) near Market Street within the City of Riverside and west of Fairmont Park and Golf Course (CNDDB 1998). The status of these populations is uncertain.

Special Biological Considerations: This species is a low shrubby perennial that blooms from June to August (Munz 1974). *E. densifolium* spp. *sanctorum* is pollinated by giant flower-loving flies. This species is dependent on early to moderate successional alluvial scrub, and thus, periodic flooding and silting.

Threats to Species: This species is primarily threatened by alteration of hydrology and mining (CNDDB 1998, U.S. Fish and Wildlife Service 1987). In Riverside County this species is primarily threatened by flood control management (clearing for channel maintenance and construction of flood control structures) and loss of habitat and competition with aggressive non-native species such as river cane (*Arundo donax*).

Goals: Conserve all known and any newly-discovered populations of the Santa Ana woolly star within the Santa Ana River conservation area. Conserve potential habitat along the Santa Ana River conservation area.

Objectives: Identify all potential habitat areas in the Santa Ana River conservation area. Confirm locations of the two known populations along the Santa Ana River. Conduct annual surveys and update the mapping data once a year to include additional populations along the Santa Ana River (CNDDB 1998). Conserve the alluvial floodplains along the Santa Ana River between Wilson Street in the north and Green River Golf Club in the south at the County line boundary.

Plants Santa Ana woolly star (*Eriastrum densifolium* ssp. *sanctorum*)

General Management: Surveys will be conducted annually (between June and August)within alluvial scrub along the Santa Ana River prior to implementation of any flood control management (clearing for channel maintenance and construction of flood control structures). As an element of flood control management, exotics should be removed (*i.e.*, specifically periodic clearing or herbicide applications) within 100 meters of occupied sites. The Santa Ana woolly star will not be removed during flood control maintenance procedures. Mining will not be conducted within the conservation area between Wilson Street in the north and Green River Golf Club in the south at the County line boundary.

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Plants San Diego button celery (*Eryngium aristulatum* var. *parishii*)

Species: **Common Name and Scientific Name:** San Diego button celery (*Eryngium aristulatum* var. *parishii*)

Status: State: Endangered
Federal: Endangered (58 FR 41391, August 3, 1993)
CNPS List 1B

Geographic Range: Southwestern California and northwestern Baja California, Mexico. This vernal pool species is known historically from about 75 locations from southern coastal Camp Pendleton, and southern Riverside County, south to the Mexican border (CNDDB 1998, Reiser 1996 Skinner and Pavlik 1994, Constance 1993, Munz 1974). The species is known from about 10 locations in Baja California extending south to vicinity of Cabo Colnett (Reiser 1996).

Known Range in Western Riverside County: *E. aristulatum* var. *parishii* is known only from four populations on the Santa Rosa Plateau (CNDDB 1998). Two populations are on Mesa de Colorado, and two are on Mesa de Burro. All populations are within the Santa Rosa Plateau Ecological Preserve. The populations in total contain fewer than 1,000 individuals.

Special Biological Considerations: This species is restricted to vernal pool habitats with clay soils. As with other vernal pool species, this one is dependent on maintaining hydrology and the surrounding watershed. *E. aristulatum* var. *parishii* blooms from April to June, but is detectable year round if left undisturbed (Munz 1974).

Threats to Species: This species is primarily threatened by urbanization and agricultural conversion throughout much of its range (U.S. Fish and Wildlife Service 1993). There does not appear to be any significant threat to known populations within Riverside County at this time.

Goals: Conserve all known populations of the San Diego button celery. Conserve potential habitat within the Santa Rosa Plateau Ecological Reserve.

Objectives: Identify all potential habitat areas in the Santa Rosa Plateau Ecological Reserve. Conduct annual surveys and update the mapping data once a year to include additional populations within the Santa Rosa Plateau Ecological Reserve. Conserve the vernal pools within the Santa Rosa Plateau Ecological Reserve.

General Management: The limits of all vernal pools identified within the Santa Rosa Plateau Ecological Reserve will be delineated and all foot trails will be located outside of the vernal pools. Surveys of the vernal pools will be conducted annually (between April and June) to identify any new populations and monitor changes in the size and numbers of know populations. Management measures will be coordinated with the Nature Conservancy which manages the reserve.

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Attachment 6

Draft Species Analysis Parameters Tables

ATTACHMENT 6

BIRDS

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Accipiter cooperii / Cooper's hawk	1	1	311 ha	100 m radius around nest	resident	—	probably high	probably yes	nests 1.6 mi apart		woodland, riparian		landscape
Accipiter gentilis / northern Goshawk	1	1	1.6 - 39 sq. km	same as home range	resident	—	probably high	maybe	nests 1.8-3.5 mi apart		woodland in mountains		species specific
Accipiter striatus / sharp-shinned hawk	1	1	67 -132 ha	4.1 km between nests	both	winter throughout may nest in mountains	probably high	probably yes	2.5 mi between nests		woodland; conifers for nesting		landscape
Agelaius tricolor / tricolored blackbird - colony	2	1	78 sq km	3.3 sq m.; usually only vicinity of nest	Resident	—	probably high	probably ok	need dense cattails	feeds in grassland, ag.; may travel 4 mi from nest to forage	emergent	dense vegetation , even shrubs for nesting	species specific
Aimophila ruficeps canescens / rufous-crowned sparrow	1	1	3.7 ac	1.2 - 3.2 ac	resident	—	may be low	probably needs linkage of habitat			sage scrub and sparse mixed chaparral	steep, dry, shrub covered hillsides with scattered shrubs and rock outcrops	landscape

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Ammodramus savannarum perpallidus / grasshopper sparrow	1	1	4-30 pairs per 100 ac	0.8-4.3 ac	migrant	summer	probably low	probably needs linkage of habitat			dry dense grassland	variety of grass spp and forbs and scattered shrubs for singing perches; nest on ground	landscape
Amphispiza bellii bellii / Bell's sage sparrow	2	1	24-33 pair per 100 acres	about 50 yards apart?	resident	-	probably low	probably needs linkage of habitat			chaparral dominated by chamise and sage scrub dominated by sage brush	nest usu on ground under a shrub; breeds in fairly dense chaparral and forages on ground	landscape
Aquila chryseatos / golden eagle	`1	1	23 - 124 sq km	same as home range; related to prey density and avail-ability	resident	-	probably high	probably yes			grassland, ag., scrub	cliff or large tree for nest	landscape for foraging; species specific for nest sites

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Asio flammeus / short-eared owl - breeding	2	1	3-4 pair per sq mi	0.3 sq mi. May vary depending on prey	resident localized	-		probably ok		size may vary depending on small mammal density	grassland, emergent wetlands, needs treeless areas with dense cover	nest on ground	species specific
Asio otus / long-eared owl - breeding	2	1	83 - 262 ac	n.d.	Resident localized	winter visitor also				uses forest edge	riparian - oak and willow	uses old crow, magpie, hawk, heron , or squirrrel nest in trees with dense canopy, oak woodland esp import	landscape
Athene cunicularia / burrowing owl	1	1	0.1 - 4 ac	ave. Distance between burrows = 436 ft.	resident	-			burrow defended when another owl came within 10 m		grassland	uses rodent or other burrow for roosting and nesting	species specific

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Botaurus lentiginosus / American bittern	1	1	5 nests in 40 ac	n.d.	resident	localized		maybe not	57 to 150 m between nests		emergent		species specific
Buteo regalis / ferruginous hawk	1	1	17-117 sq km	5 sq km	migrant	winter	does not breed in area	probably yes	does not breed in California	requires large open tracts for foraging - preys mostly on rabbits and squirrels	grassland, ag.	Large tree for roosting	landscape
Buteo swainsoni / Swainson's hawk	2	1	1.2-2.1 sq mi	does not establish territory in planning area	migrant	spring and fall transient	does not breed in area	probably yes	1.1 mi between nests		grassland, ag.	Large trees for roosting	landscape
Campylorhynchus brunneicapillus couesi / San Diego cactus wren	1	1	same as territory	2.9 - 6.9 ac, maintained year-round	resident	-		probably needs habitat connection	may build more than one nest		sage scrub	large patches of cactus for nests	species specific
Cathartes aura / turkey vulture - breeding	2	1	probably large - forage out 15-20 mi	not	resident	-	at least 15-20 mi.	Ok within at least 15-20 mi.		15-20 mi.	grassland/ ag.	cliff/large trees	species specific

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Catharus ustulatus / Swainson's thrush - breeding	2	1	n.d.	40 pairs per 100 ac	migrant	summer				may forage in woodland near nest area	wooded riparian habitat	near water, usually in willows, needs dense understory	landscape
Chaetura vauxi / Vaux's swift	2	1	n.d.	Probably limited to nest site	migrant	wintering irregularly - mostly occurs as transient foraging in area irregularly	probably high	probably ok	does not breeding in area	probably large	forages over most terrains and habitats- breeds in Douglas fir and redwoods	needs hollow tree for nest site	minimal
Charadrius alexandrinus nivosus / western snowy plover - breeding	2	1		1 nest per 15 ac to 20 nests per 15 ac	migrant	summer - localized	probably high	probably yes	adults stay near nest while breeding	may move 1 mi. To foraging area	mudflats at edge of lake	predation pressure is high	species specific
Charadrius montanus / mountain plover	1	1	nests widely spaced, 21 per162 ac; winter flocks of 100 or more	40 ac; not territorial in winter, may defend small mobile feeding space	migrant	winter	migrates between Great plains winters in CA, AZ, TX, and Mexico	probably yes	does not breed in planning area	small moving area within San Jacinto Wildlife area	grasslands, plowed fields	needs open, short grass and plowed fields	species specific

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Circus cyaneus / northern harrier - breeding	2	1	363-518 ha	28 ha	both	some localized breeding locations	probably high	probably yes	may fly 1 to 5.5 mi from nest to forage	30-40 ac	grassland, ag., scrub, emergent	nests on ground.	species specific for nest sites
Coccyzus americanus occidentalis / western yellow-billed cuckoo	1	1	not determined.	n. d.	Migrant	summer	winters in South America	probably yes but will need large area of suitable habitat			riparian	needs dense cover, river bottoms, high humidity	species specific
Cypseloides niger / black swift - breeding	2	1	very large, not measured	defends nest site only presum-ably	migrant	summer			nest in colony of few pairs	forages widely	montane, forages over variety of habitats	nest in moist crevice or cave near waterfalls	species specific
Dendroica petechia brewsteri / yellow warbler	1	1	0.5 ac	0.08-0.9 ac	migrant	summer	probably high	probably ok		may move 1600 feet to forage	riparian deciduous	open to medium density woodland with heavy brush understory	species specific
Elanus leucurus / white-tailed kite	2	1	3 sq km	0.8 km radius	resident	-		probably yes	0.5 mi radius	1.9 sq mi	grassland, ag.	trees for nesting	landscape

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Empidonax traillii extimus / southwestern willow flycatcher	1	1	9.2 pairs per 100 ac	1.7 ac	migrant	summer, arrives in May, leaves in August					willow riparian	usually needs open water under tree canopy, dense willow thicket	species specific
Eremophila alpestris actia / California horned lark	1	1	no data	4 ac; 1.5 to 8 ac	resident	-	forages in flocks, probably high dispersal ability	probably ok			grassland, open habitat	nest on ground	landscape
Falco columbarius / merlin	1	1	n.d.	N.d. Not territorial when not breeding	migrant	winter and transient	probably high	probably yes	does not breed in study area		variety of open habitats, woodlands wetlands, habitat edge, early success-ional	usu near water	minimal

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Falco mexicanus / prairie falcon - breeding	2	1	26 sq km	6.5 to 5.7 sq km	both	winters throughout planning area, breeds in central part	probably high	probably yes	need to not be in line of sight with other nesting prairie falcons		grassland, ag., open terrain	Nest on cliffs, escarp-ments, bluff, or rock outcrop	species specific for nesting sites
Falco peregrinus / peregrine falcon	1	1	23km radius, 320 sq km	96 m radius around nest	migrant	winter	move 3.3 mi from nest to foraging area; does not breed in planning area	probably yes	nest spaces 3-7 mi apart		riparian, wetlands, lakes and open water	forages over open water, nest on cliff	species specific
Glaucidium gnoma / northern pygmy-owl	2	not enough info	n. d.	n. d.	Resident, may move up-downslope	-	unknown	unknown			forest habitats, riparian, montane	usually near streams	not enough information to analyze
Grus canadensis / greater sandhill crane	2	not present, will not be analyzed											not analyzed

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Haliaeetus leucocephalus / bald eagle	1	1	n.d.	11-45 ha, 23 ha average	migrant	winter	probably high	probably yes	min dist. Between nests 0.6 mi to 10 mi		aquatic	large water bodies, trees for roost	species specific
Icteria virens auricollis / yellow-breasted chat	1	1	10pair per 100 ac	0.3 to 3.1 ac	migrant	summer	probably high	probably ok			riparian thicket of willow and other brush	usually near water	species specific
Ixobrychus exilis hesperis / western least bittern	2	1	15 nest in 2ac, 26 nests in 65 ac, and 19 nests in 44 ac	n.d.	resident	localized		probably not	appears to be able to be densely situated		emergent	secretive	landscape
Lanius ludovicianus / loggerhead shrike	2	1	same as territory	18.7 ac, vary from 11-40 ac	resident	-			central area for breeding	feeding areas within territory	open habitat with scattered trees	needs perches on fences, etc., and tree or shrub for nest site	landscape
Laterallus jamaicensis / California black rail	2	not present, will not be analyzed											not analyzed

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Melospiza lincolnii / Lincoln's sparrow - breeding	2	1	approx. 25 pairs per 100 ac	0.4 ha	migrant	winters throughout, breeds in mountains	probably high	probably ok			montane riparian for breeding; in winter occupies thickets of brush in grassy areas or near water	willow thickets or other tall shrubs; nest on ground; usually near water	landscape
Nycticorax nycticorax nycticorax / black-crowned night heron	1	1	5 mi radius	nest perimeter in colony	resident	-	at least 5 mi.	Ok within at least 5 mi.	Nest colony	5 mi.	emergent	trees near water	species specific
Oporornis tolmiei / MacGillivray's warbler	2	1	10 - 85 pair per 100 ac	probablyably same as home range, may be territorial in winter	migrant	summer breeding in mountains; winter transient	probably high	probably ok			breeds in dense brush in moist habitat; valley foothill riparian, douglas fir and montane riparian; in desert riparian during migration	riparian thickets of willow, alder, woodland, near water	landscape

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Oreortyx picta / mountain quail	1	1	2.6 sq km	5-50 ac	resident	moves up- and down slope seasonally	20mi.	needs some cover between summer and winter sites	few movement exceed 0.5 mi in breeding season	few movement exceed 0.5 mi in breeding season	montane chaparral, brushy stands of conifer and deciduous	nests on ground	landscape
Otus flammeolus / flammulated owl	2	1	100 ac	4-10 ac	migrant	summer	probably high	probably yes	900 ft diam		montane, ponderosa pine	favors openings and edges, snags	landscape
Pandion haliaetus / osprey - breeding	2	1	5-6 mi radius	1700 sq.ft.	resident	localized	at least 8-10 mi	ok within at least 8-10 mi		5-6 mi	aquatic	large trees for nest	species specific
Phalacrocorax auritus / double-crested cormorant	1	1	8-16 km foraging radius	colony	resident	-	probably high	probably	9 sq.ft		aquatic	perch sites	landscape
Picoides pubescens / downy woodpecker	1	1	same as territory	5 - 9 ac	resident	-		probably needs riparian corridor			riparian woodland	snag or dead branch for nest	species specific

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Plegadis chihi / white-faced ibis	1	1	transient	nomadic	migrant, may also be resident for breeding population	summer as localized breeding spp; winter nomadic	probably high	probably. Ok	large patch of emergent	open muddy, fields grasslands and marshes	emergent for nesting; grassland/ ag., emergent for wintering	requires dense emergent veg for breeding	species specific for breeding; minimal for wintering population
Polioptila californica californica / coastal California gnatcatcher	1	1			resident	-		probably needs habitat connection			sage scrub	usually below 2,500 feet elevation, favors California sagebrush	landscape
Progne subis / purple martin	1	1	no data	nest hole entrance is defended	migrant	summer	probably high	probably ok	may breed colonially depending on avail-ability of nest sites		wooded habitat in conifer forest, montane, Douglas fir, ponderosa pine	nest in old wood-pecker cavity, old tree or snag	species specific

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Sphyrapicus thyroideus / Williamson's sapsucker	2	1	2.2 - 8.2 per 100 ac	16.9 ac	resident	may move downslope or wander in winter					montane coniferous forest.	Prefers lodgepole pine, requires snags or live trees with rotted heartwood	landscape
Strix occidentalis occidentalis / California spotted owl	1	1	450 ac	100 - 340 ac	resident	-			nest spaced 1-2 mi apart in suitable habitat	patch probably requires water source	dense montane forest, oak and oak-conifer habitat		species specific
Tachycineta bicolor / tree swallow	1	1	"large"	restricted to nest, 4-18 pair per 100 ac	migrant	summer very localized, winter more wide-spread	probably high	probably ok			riparian forest and woodland	requires cavity for nest - needs to be near water for breeding locations, needs old wood-pecker hole or in nest box	species specific

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Toxostoma lecontei / Le Conte's thrasher	2	1	100 ac	15 ac, territorial all year	resident	-			may nest in cactus or spiny shrubs		desert scrub, saltbush and cholla scrub	desert wash with scattered shrubs, may not need water	landscape
Vermivora ruficapilla / Nashville warbler	2	1	n.d.	0.5 ac	migrant	summer and transient		probably ok			mixed conifer oak forest, hgiher elevation conifer forest, also ponderosa pine, montane hardwood, montane chaparral	nests on ground under dense brush in sparse to open woodland	landscape

Species *Scientific Name* / Common Name	Original USFWS Table #	Aug. 9 Proposal*	Home Range Size	Territory Size	Migrant? Or Resident?	Winter or Summer Present?	Dispersal Ability - distance or Qualitative	Stepping Stone Preserve OK?	Patch size - Breeding	Patch size - Foraging	Habitat Association	Habitat Features, Patterns	Preserve Planning Species Group
Vireo bellii pusillus / least Bell's vireo	1	1	2 ac	0.26 - 3.1 ac	migrant	summer		needs riparian corridor			willow riparian and scrub	usu found near water but may occur in thickets. Needs understory in riparian	species specific
Wilsonia pusilla / Wilson's warbler	2	1	125-300 m in radius	1.3 ac	migrant	summer breeding in mountains; winter transient	probably high	probably ok			montane riparian up to lodgepole; while migrating occurs in almost all woodland and shrub habitat	needs dense shrubs near water	landscape

* "1" = adequate info to analyze or information obtainable within timeframe and scope of the MSHCP. "Not present" - does not occur within planning area, will not be analyzed or considered for "adequately conserved status". " Not enough info" - not enough information is available within the timeframe and scope of the MSHCP to analyze for adequacy of conservation.

Attachment 7

Sample Test GIS Analysis Outputs

ATTACHMENT 6

REPTILES

SPECIES	Territory Size	Dispersal Ability	Dispersal Distance	Primary Habitat	Elevation Range	Soils	Patch Size for Breeding	Patch Size for Foraging	Type of Linkage	Linkage Distance	Linkage Width
arroyo southwestern toad	no information	Hindered by dams or unsuitable habitat[1]	< 3km[1]	shallow, slow-moving streams (1-6th order) & riparian habitats that are disturbed by flooding[1,2]	300-1,400m[1,2]	sandy, fine gravel[1]	< 30cm deep clear water[2], with < 5cm/second flow rate[1]	1-4km[1]	continuous[1]	(probably 3km)	(probably between 1-4km)
large-blotched salamander	60 m square[3]	no information	no information	montane woodlands and chaparral under leaf litter and logs[5,6,7]	518-1646m[5]	moist soils[4] & rocky granitic parent substrate[5]	(60m square)	(60m square)	(continuous)	(60m square)	(60m square)
California red-legged frog	congregates at breeding sites[5], seasonal movement between breeding and foraging grounds[20]	no information	no information	dense shruby riparian vegetation (*Salix, typha, Scirpus*) associated with permanent, deep (> 0.7m), still or slow-moving water[21,22]; closely tied to small drainage areas (< 300km^2)[20]	0-1500m[5]	no information	no information	no information	linear, contiguous	movement occurs through aquatic habitat[20]	stays close to aquatic habitat[20]
mountain yellow-legged frog	10m^2[6]; defends around self during breeding[6]	no information	50m[6]	ponds, tarns, lakes, & streams[18] where predatory fishes are absent[19] and have open shorelines	1370-3650m[17,18]	no information	perrenial waterbody[12]	no information	continuous	(50m)	(50m)
western spadefoot	some agression at breeding sites[16] otherwise not territorial[6]	no information	no information	grasslands[5], springpools(vernal pools)[15]	0-1363m[6]	varied	pool needs to stay for at least 3 weeks[5]	no information	continuous	no information	no information

SPECIES	Territory Size	Dispersal Ability	Dispersal Distance	Primary Habitat	Elevation Range	Soils	Patch Size for Breeding	Patch Size for Foraging	Type of Linkage	Linkage Distance	Linkage Width
coast range newt	not territorial[6]	site tenacious [13] (probably hindered by unsuitable habitat)	(> 1km)	uses upland habitats but breeds in ponds, reservoirs, and slow-moving streams[3,8,10]	0-1830m[8]	no information	> 1km migration to breeding sites[9], cannibalistic to eggs and larvae[12] ---	(continuous)	(< 1km)	(< 1km)	(< 1 km)
southwestern pond turtle	home range restricted[23,24]; typically not territorial[6]; home range size ranges between 976m^2 to248m^2[24]	no information	can move up to 2km to find suitable habitat[5]	mixed shallow and deep slow or still water pools with abundant basking sites[5,26], uplands for oviposition; nests occur in clayey or silty soils on unshaded, mostly south-facing slopes[5,26,27]	0-1430m[5]	clayey or silty soils for nesting[26]	may move up to 350m to overwinter of nest[25]; most nests are within 200m of streamcourse[5]	no information	(may be an archipelago species)	(< 2km)	500m from aquatic areas known to support turtles[28]
western whiptail											
orange-throated whiptail											

SPECIES	Territory Size	Dispersal Ability	Dispersal Distance	Primary Habitat	Elevation Range	Soils	Patch Size for Breeding	Patch Size for Foraging	Type of Linkage	Linkage Distance	Linkage Width
San Diego banded gecko	density=12-25/ha[49]	no information	no information	all habitats but most common in sandy flats and washes; uncommon in coastal sage scrub and chaparral[48]	0-1500m[6]	sandy flats and desert washes[48]	no information	no information	continuous	no information	no information
San Diego horned lizard.											
southern sagebrush lizard	Males defend territories up to 7.5m[46]	no information	male = 24m; female = 18m[45]	sagebrush;forests[6];most habitats in range[32,41,42,47]	900-3200m[6]	mainly on fine gravel soil but also on sandy or rocky soil and boulder regions[41]	no information	no information	continuous	no information	no information
granite spiny lizard	densities=23/ac[6]; home range=150m radius[43]; males territorial	no information	no information	granite outcrops in oak and chaparral habitats and in yellow pine habitats[32]	up to 1680m[32]	granite outcrops cliffs and boulders[32];not small rock areas[41,42]	no information	no information	continuous	no information	no information

SPECIES	Territory Size	Dispersal Ability	Dispersal Distance	Primary Habitat	Elevation Range	Soils	Patch Size for Breeding	Patch Size for Foraging	Type of Linkage	Linkage Distance	Linkage Width
granite night lizard	no information	no information	no information	many habitats with fractured and exfoliating granite, boulders, or outcrops[6]	200-1200m[6]	exfoliating and fractured granite rocks[6]	no information		continuous	no information	no information
long-nosed leopard lizard	home range several ha[6]	no information	no information	sparse scruband open grasland habitats[32]	0-1800m6	hardpan, gravel, sandy soils[32]	no information		continuous	no information	no information
glossy snake	Approximate 1/acre density[31]	no information	no information	tied to friable soils not vegetation associations; agricultural areas important due to loose soils[29]; prefers grasslands/shrublands to woodlands[31]; hibernates at shallow depths in open habitats[32]	0-2200m[30]	sandy or loamy soils; friable soils[29]	no information		continuous	no information	no information
ringneck snake	not territorial[33];140m or less diameter home range-often elongate in shape[33]; density = 1266/hectare	slow distance traveler (due to small size?)[33]	upto 520m; average distance = 80m[33]	shrubby with many openings during warm season; open with a little cover during cool season (medium and highly grazed areas preferred)[33]	0-1687m[33]	friable or lots of leaf litter[33]	no information		continuous	no information	no information

SPECIES	Territory Size	Dispersal Ability	Dispersal Distance	Primary Habitat	Elevation Range	Soils	Patch Size for Breeding	Patch Size for Foraging	Type of Linkage	Linkage Distance	Linkage Width
southern rubber boa	no information	no information	no information	coniferous forest with rock outcrops, snags & debris and possible riparian areas in the San Bernardino and San Jacinto Mountains[34]	1540-2460m[34]	rocky[6]	no information		continuous	no information	no information
coastal rosy boa	no information	no information	no information	chaparral and scrub habitats[36]	0-1219m[35]	rocky;topographically diverse terrain[6]	no information		continuous	no information	no information
San Bernardino mountain kingsnake	no information	highly philopatric[39]	no information	coniferous and chaparral habitats at lower elevations and coniferous and black oak habitats at higher elevations; also moist riparian zones[38]; San Bernardino/San Jacinto Mountains	370-2470m[5]	rock outcrops or talus[37]	no information	no information	continuous	no information	no information
San Diego mountain kingsnake	no information	highly philopatric[39]	no information	coniferous and chaparral habitats at lower elevations and coniferous and black oak habitats at higher elevations; also moist riparian zones[38]; Santa Ana/Santa Rosa Mountains	0-1800m[5]	rock outcrops or talus[37]	no information	no information	continuous	no information	no information

SPECIES	Territory Size	Dispersal Ability	Dispersal Distance	Primary Habitat	Elevation Range	Soils	Patch Size for Breeding	Patch Size for Foraging	Type of Linkage	Linkage Distance	Linkage Width
two-striped gartersnake	winter average= 3400m^2; summer average = 1500m^2[27]	no information	no information	coastal sage scrub and grasslands adjacent to riparian areas during winter; along stream courses during the summer[27]	0-2450m	no information	no information	no information	continuous	no information	no information
red-sided gartersnake	no information	no information	no information	marsh and uplands adjacent to permanent water with good riparian strips[5]	0-832m	no information	no information	no information	continuous	no information	no information
northern red-diamond rattlesnake	no information	no information	no information	dense coastal sage scrub or chaparral with large rocks or boulders[40]	0-1520m[5]; 0-1200m mainly[40]	rock/boulder[5]	no information	no information	continuous	no information	no information

1 USFWS. 1999. Arroyo southwestern toad (*Bufo microscaphus californicus*) recovery plan. U.S. Fish and Wildlife Service, Portland, Oregon. Vi+119pp.
2 Sweet, S > S. 1992. Ecology and Status of the Arroyo Toad (*Bufo microscaphus californicus*) on the Los Padres National Forest of Southern California with Management Recomendations. Report to USDA, Forest Service, Los Padres National Forest, Goleta, California ii+198pp.
3 Stebbins 1954
4 Cohen 1952
5 Jennings and Hayes 1994
6 Zeiner et al 1988
7 Aubry et al 1988
8 Stebbins 1985
9 Hedgecock 1978
10 Bishop 1947
11 Stromberg 1997
12 Hanson et al 1994
13 Gamradt and Kats 1997
14 Gamradt et al 1997
15 Stebbins 1951
16 Whitford 1967
17 Zweifel 1955
18 Mullally and Cunningham 1956
19 Bradford 1989
20 Jennings and Hayes 1989
21 Jennings and Hayes 1988a
22 Jennings and Hayes 1988b
23 Bury 1970
24 Bury 1972
25 Rathbun et al
26 Holland 1991
27 Rathbun et al 1993
28 Rathbun et al 1992
29 Shaw and Cambell1974
30 Rodriguez-Robles et al 1999
31 Klauber 1946
32 Stebbins 1985
33 Fitch 1975
34 Stewart 1988
35 Spiteri 1988
36 Stebbins 1954
37 Zweifel 1952
38 Newton and Smith 1975
39 McGurty 1988
40 Klauber 1972
41 Smith 1946
42 Van Denburgh
43 Mayhew 1963
44 Turner 1977
45 Stebbins 1944
46 Ferguson 1971
47 Woodburn and Woodburn 1945
48 Klauber 194_
49 Parker 1972

Species Alpha Code

A	Coast Range newt
B	large-blotched salamander
C	western spadefoot
D	arroyo southwestern toad
E	mountain yellow-legged frog
F	California red-legged frog
G	southwestern pond turtle
H	San Diego banded gecko
I	long-nosed leopard lizard
J	granite spiny lizard
K	sagebrush lizard
L	San Diego horned lizard
M	granite night lizard
N	orange-throated whiptail
O	western whiptail
P	California legless lizard
Q	southern rubber boa
R	coastal rosy boa
S	ringneck snake
T	coastal glossy snake
U	San Bernardino mountain kingsnake
V	San Diego mountain kingsnake
W	California patch-nosed snake
X	red-sided garter snake
Y	two-striped garter snake
Z	northern red-diamond rattlesnake

Life-form Matrix - Elevation

Species (Vertical Column) -vs- Elevational Range (Horizontal Column)

	0-499m	500-999m	1000-1499m	1500-1999m	2000-2499m	2500-2999m	3000-3499m	3500-3999m	4000-4499m	4500+
A	X	X	X	X						
B		X	X	X						
C	X	X	X							
D	X	X	X							
E			X	X	X	X	X	X		
F	X	X	X							
G	X	X	X							
H	X	X	X							
I	X	X	X	X						
J	X	X	X	X						
K			X (900)	X	X	X	X			
L										
M	X	X	X							
N										
O										
P										
Q				X	X					
R	X	X	X							
S	X	X	X	X						
T	X	X	X	X	X					
U	X	X	X	X	X					
V	X	X	X	X						
W										
X	X	X								
Y	X	X	X	X	X					
Z	X	X	X							

Life-form Matrix - Habitat

Typical Reproduction Habitat (Vertical Column) -vs- Typical Foraging Habitat (Horizontal Column)

	Aquatic-open shallow	Aquatic-open deep	Aquatic-freshwater marsh	Aquatic-riparian woodland	Upland-granitic outcrop	Upland-grassland	Upland-open scrub	Upland-chaparral	Upland-deciduous woodland	Upland-coniferous forest
Vernal pools						C	C			
Shallow water	D,E,X,Y	E,X,Y	E,X,Y	X,Y		D,Y[1]	D,X,Y[1]	A	A	A
Deep water	F,E,X,Y	F,E,X,Y	F,E,X,Y	F,X,Y		Y[1]	X,Y[1]	A	A	A
Freshwater marsh	X,Y	X,Y	X,Y	X,Y		Y[1]	X,Y[1]	A	A	A
Riparian woodland	X,Y	X,Y	X,Y	A,Q,X,Y		Y[1]	X,Y[1]	A,B	A,B,Q	A,B,Q
Granitic outcrops				Q	M,Q,R,U,V,Z	M	M,R,Z	M,R,U,V,Z	M,Q,U,V	Q,U,V
Agricultural						T	T			
Grassland	G,Y[1]	G,Y[1]	G,Y[1]	X,Y[1]	H,K,M	H,S,T	I,K,S,T	K	H,K	K
Open scrub	G,X,Y[1]	G,X,Y[1]	G,X,Y[1]	X,Y[1]	K,M,R,Z	I,K,S,T	I,K,R,S,T,Z	K,R,Z	K	K
Chaparral	G	G	G	A	J,K,M,R,U,V,Z	K	K,R,Z	B,J,K,R,U,V,Z	B,J,K,U,V	B,K,U,V
Deciduous woodland				A,Q	H,J,K,M,Q,U,V	H,K	K	B,J,K,U,V	B,H,J,K,Q,U,V	B,K,Q,U,V
Coniferous forest				A,Q	K,Q,U,V	K	K	B,K,U,V	B,K,Q,U,V	B,K,Q,U,V

Y[1] = Winter use only

	Habitat Linkages Necessary for Species																		
SPECIES	NO	YES																	
		Patches proposed to be linked	Function of Linkage					Linkage Type		Resources within Linkage Needed			Minimum Linkage Distance/Width		Roads and Other Physical Obstacales/Limiters			Other Factors	Species Sensitive to Edge Effects	
			Dispersal	Migration	Resident	Frequent Movement	Re-establish Population	Continuous	Stepping Stone	Food	Water	Refuge	Home range diameter	Sex-biased Movement	Will Cross roads	Road Casualty Suscept.	Topography Limited		Yes	No
A	1																			
B	2																			
C		Subpops. w/in corridors & patches	Unk		X		X	Unk	Unk	X	X	X	Unk	Unk	X	X	Unk	Sem to be sedentary near pool areas	Probably	
D		Subpops. W/in creek systems	X		X		X	X		X	X	X	1-4km	Unk	X	X	Unk	Disperse upto 3km	Probably	
E	2																			
F	3																			
G		Subpops. Within creek systems	X		X		X	X		X	X	X	976-248m	Yes	X	X	Unk	Disperse upto 2km	Probably	
H			X		X			X		X		X	unk	unk	unk	unk	unk		Probably	
I			X		X		X	X		X		X	several ha	unk	unk	unk	unk		Probably	
J		granite boulders	X		X		X	X		X		X	300m	unk	unk	unk	doubtful	large granite boulders/ outcrops	Probably	
K			X		X		X	X		X		X	7.5m defended	X	X	X	doubtful		Probably	
L																				
M			X		X		X	X		X		X	unk	unk	unk	unk	unk		Probably	

	Habitat Linkages Necessary for Species																			
SPECIES	NO	YES																		
		Patches proposed to be linked	Function of Linkage					Linkage Type		Resources within Linkage Needed			Minimum Linkage Distance/Width		Roads and Other Physical Obstacales/Limiters			Other Factors	Species Sensitive to Edge Effects	
			Dispersal	Migration	Resident	Frequent Movement	Re-establish Population	Continuous	Stepping Stone	Food	Water	Refuge	Home range diameter	Sex-biased Movement	Will Cross roads	Road Casualty Suscept.	Topography Limited		Yes	No
N																				
O																				
P																				
Q	2																			
R			X		X		X	X		X		X	unk	unk	X	X	no		Probably	
S			X		X		X	X		X		X	< 140m							
T			X		X		X	X		X		X	unk							
U	2																			
V	1																			
W																				
X		riparian	X		X		X	X		X	X	X	unk	unk	X	X	Probably		Probably	
Y		riparian	X		X		X	X		X	X	X	1500-3400m	unk	X	X	Probably		Probably	
Z			X		X		X	X		X		X	unk	unk	X	X	no		Probably	

1 Core population in Cleveland National Forest - population management will be dependent on forest management.

2 Core population in San Bernardino National Forest - population management will be dependent on forest management.

3 Only population on Santa Rosa Plateau - future reintroductions throughout the study area may or may not have viable linkages.

ATTACHMENT 6

PLANTS

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Allium munzii (Munz's onion)	State: Threatened Federal: Endangered (63 FR 54975 , October 13, 1998) CNPS: List 1 B	3	Yes	bulb-bearing perennial herb, flowers from March-May with seed set in July	no data		"Clay soil flora" Many-stemmed Dudleya	Grassy openings of coastal sage scrub, chaparral, juniper woodland, valley and foothill grasslands	300-1000	Restricted to Clay Soils	Mesic	Flowering may be suppressed by heavy infestations of weedy grass	Boyd 1988
Ambrosia pumila (San Diego ambrosia)	State: None Federal: Petitioned for listing as Threatened or Endangered CNPS: List 1 B	3	Yes	Clonal, perennial herb, flowers June-September	Primarily wind-pollinated	Propagation is primarily through extensions of rhizomes. Sexual reproduction and seed-set is not common; propagation and dispersal by seed is limited		Open, flat grasslands		Associated with alkaline soils			Munz 1974, Payne 1993 pers. comm. Payne 1998
Arabis johnstoni (Johnston's rock-cress)	State: None Federal: None CNPS: List 1 B	2	Yes	Perennial herb, flowers February-June			Munz's mariposa lily	On pebble plain-like surfaces in mixed chaparral, redshanks chaparral, and coniferous forests					

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Arctostaphylos rainbowensis (Rainbow manzanita)	State: None Federal: None CNPS: List 1 B	3	No	Flowers January-February				Ultramafic southern mixed chaparral		Principally gabbro soils or related soils rich in fero-magnesian minerals			
Atriplex coronata var. *notatior* (San Jacinto Valley crownscale)	State: None Federal: Endangered (FR 63:54975, October 13, 1998) CNPS: List 1 B	2	Yes	Annual herb. Requires seasonal inundation; germinates after water has receded. Flowers in April and sets fruit by May or June. Population size varies considerably from year to year and appears in different site from year to year.				Floodplains (seasonal wetlands) dominated by alkali scrub, alkali playas, vernal pools, and, to a lesser extent, alkali grasslands		Highly alkaline, silty-clay soils, associated with Willows soils and to a lesser extent Traver and Domino alkaline soils		Plants not detectable every year. Can recover from infrequent disturbances if impacts occur during non-growing season or after seed set.	Bramlet 1993 Robert 1993 D. Bramlet, biologist, in litt., 1992 USFWS 1998

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Atriplex parishii (Parish's brittlescale)	State: None Federal: None CNPS: List 1 B	2	Yes	Flowers from June-October, Population size varies from year to year depending upon rainfall and local flooding.				Associated with alkali flats and flood plains in alkali playa, alkali annual grassland, alkali scrub, and alkali vernal pool plant communities					Bramlet 1993, CNDDB 1999 Skinner and Pavlik 1994
Atriplex serenana var. *davidsonii* (Davidson's saltscale)	State: None Federal: None CNPS: List 1 B	2	Yes	Flowers from May -October. Population size varies from year to year depending upon rainfall, local flooding, and disturbance.				Cismontane, Associated with alkali flats and flood plains in alkali playa, alkali annual grassland, alkali scrub and alkali vernal pool plant communities		Domino-Willows-Traver Soils series			Bramlet 1993, Ogden 1996 Munz 1974
Berberis nevinii (Nevin's barberry)	State: Endangered Federal: Endangered (1998) CNPS: List 1 B	3	Yes	Rhizomatous evergreen shrub, flower from March through April				Chaparral and alluvial scrub	Found between 300 and 659	Coarse soils in chaparral and gravelly wash margins in alluvial scrub		fire frequency important factor in ecology	

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Brodiaea filifolia (thread-leaved brodiaea)	State: Endangered Federal: Threatened (FR 63:54975, October 13, 1998) CNPS: List 1 B	2	Yes	Flowers from March-June, but only a fraction of mature individuals flower in a given year. Geophyte[1]. Population size and extent vary in response to timing and amount of rainfall, as temperature patterns.			Associated with vernal pool complexes	Gentle hillsides, valleys, and floodplains in mesic, southern needlegrass grassland and alkali grassland plant communities	0-600	Clay, loamy sand or alkaline silty-clay soils of the Willows series			CDFG 1981, Bramlet 1993
Brodiaea orcutti (Orcutt's brodiaea)	State: Endangered Federal: Sensitive CNPS: List 1 B	3	No	Herbaceous perennial that flowers from March-May. Hybridizes with three-leaved brodiaea				Coastal sage scrub, cismontane woodland, valley and foothill grasslands, vernal pools	0-1600	Associated with clay soils			

[1]Geophyte: originating from a corm

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Calochortus palmeri var. *munzii* (Munz's mariposa lily)	State: Species of Special Concern Federal: None CNPS: List 1 B	2	Yes	Flowers from June-July				Exposed knolls in shade of yellow pine woodland, on seasonally moist, fine granitic loam and chaparral on moist sandy clay, and native grassland.					
Caulanthus simulans (Payson's jewelflower)	State: None Federal: None CNPS: List 4	3	No	Annual herb, flowers March-June				Chaparral, coastal sage scrub	400-2200	Sandy-granitic soils		Associated with post-burn successional phases and is considered a "fire follower"	
Ceanothus ophiochilus (Vail Lake ceanothus)	State: Threatened Federal: Threatened (FR 63:54956, October 13, 1998) CNPS: List 1 B	3	Yes	Flowers mid-February to March, Fruit matures late May to mid-June.				Dense chaparral and ridegetops in pyroxenite[2] rich outcrops		Possibly gabbro soils with pyroxenite rich outcrops	North-facing		
Chorizanthe leptotheca (peninsular spineflower)	State: None Federal: None CNPS: List 4	2	No	Annual herb, Flowers May-August				Chaparral, sage scrub, coniferous forest		Granite derived or alluvial surfaces			

[2]Pyroxenite n. An igneous rock consisting chiefly of pyroxenes. Pyroxenes n. Any group of crystalline silicate minerals common in igneous and metamorphic rocks and containing two metallic oxides, and of magnesium, iron, or calcium.

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Chorizanthe parryi var. *parryi* (Parry's spineflower)	State: None Federal: None CNPS: List 4	2	No	Annual herb, Flowers April-June				Alluvial fan scrub, chaparral, and coastal sage scrub					
Chorizanthe polygonoides var. *longispina* (long-spined spineflower)	State: None Federal: None CNPS: List 1B	3	No	Annual herb, flowers April-July			Associated with Munz's onion and Palmer's grapplinhook in Riverside.	Meadows, valley and foothill grasslands, openings in coastal sage scrub and chaparral	Below 1400	Strongly associated with clay soils			
Chorizanthe procumbens (prostrate spineflower)	State: None Federal: None CNPS: List 4	2	No	Annual herb, flowers April-July				Chaparral, coastal sage scrub and occasionally grasslands. Requires open areas.	Below 800	Variety of soils including those derived from the dominant granitic rocks of western Riverside County. Also found in sandy soil.		Tolerates minimal soil disturbance and frequently found along margins of dirt roads or brushed chaparral	Munz 1973, Reiser 1996
Convolvulus simulans (small flowered morning glory)	State: None Federal: None CNPS: List 4	3	No	Annual herb, flowers March-June				Grassland, coastal sage scrub and Riversidian sage scrub		Upland clay soils			Boyd and Roberts, pers. comm.

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Dodecahema leptoceras (slender-horned spineflower)	State: Endangered Federal: Endangered (September 28, 1987) CNPS: List 1 B	3	Yes	Flowers from April-June. Population size varies considerably from year to year depending on rainfall.				Mature alluvial scrub and open chamise chaparral.		Primarily found in sandy soil associations. Also found in gravel soil.			Reveal and Hardham 1989, Rey-Vizgirdes 1994 Boyd and Banks 1995
Dudleya multicaulis (many-stemmed dudleya)	State: None Federal: None CNPS: List 1 B	3	Yes	Perennial herb, flowers from May-July				Chaparral, coastal sage scrub, valley and foothill grasslands	Below 600	Associated with heavy Clay soils			
Dudleya viscida (sticky-leaved dudleya)	State: None Federal: None CNPS: List 1 B	3	No	Succulent perennial	insect-pollinated*	Seeds self-dispersed*		Mesic rocky canyons slopes					*Carlsbad HMP-specific source to be identified.

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Eriastrum densifolium ssp. *sanctorum* (Santa Ana River wooly-star)	State: Endangered Federal: Endangered (September 28, 1987) CNPS: List 1 B	1	Yes	Perennial herb, flowers June-August. Appears to be a successional species.	Field observations indicate the hummingbird, digger bees, the anise swallow-tail butterfly and the giant flower-loving fly are pollinators. Possible that the giant flower loving fly (*Raphiomidas actoni* ssp. *actoni*) are mutually dependent.	Dispersal distance is approximately one foot from parent plant unless flooding carries seed further.		Dunes, dry river beds, open slopes. Plants located above the main watercourse on fluvial deposits where flooding and scouring have been infrequent enough to allow the persistence of open shrublands in the flood plain.	Approximately 375-580	Sandy soil with low amounts of silt, clay and micro-organic material, usually by a broken surface crust.		Endemic to Santa Ana River drainage. Polyphyletic, independently derived ecotype.	Zembel and Kramer 1985 Brunell 1994 Burk, Jones, and Wheeler 1989
Eryngium aristulatum var. *parishii* (San Diego button celery)	State: Endangered Federal: Endangered (September 28, 1987) CNPS: List 1 B	3	No	Annual/ Perennial herb, Flowers April-June				Restricted to vernal pool habitat		Restricted to clay soils			
Galium angustifolium ssp. *jacintum* (narrow-leaved bedstraw)	State: None Federal: None CNPS: List 1 B	1	Yes	Perennial herb, Flowers June-August				Open mixed forest, Lower montane coniferous forest					Skinner and Pavlik 1994

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Harpagonella palmeri ssp. *palmeri* (Palmer's grapplinghook)	State: None Federal: None CNPS: List 2	3	No	Annual herb, flowers May-April			Associated with Munz's onion and many-stemmed dudleya, Plantain (*Plantago erecta*)	Riversidian sage scrub, open coastal sage scrub, chaparral, valley and foothill grasslands.	Typically less than 450	Restricted to upland clay soils			
Hemizonia pungens ssp. *laevis* (smooth tarplant)	State: None Federal: None CNPS: List 1 B	2	Yes	Annual herb, flowers April-November			Associated with San Jacinto Valley crownscale and *Atriplex coulteri*	Coastal sage scrub, alkali meadows, alkali playas, riparian woodlands, grasslands					
Holocarpha virgata ssp. *elongata* (graceful tarplant)	State: None Federal: None CNPS: List 4	2	No	Annual herb, flowers from August-November				Associated with native grasslands around vernal pools and wet meadows, cismontane woodland and coastal sage scrub	Cismontane	Heavy clay soils			

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Hordeum intercedens (vernal barley)	State: None Federal: None CNPS: List 3	2	No	Flowers from March-June. Population size varies considerably from year to year depending on local rainfall, local flooding and disturbance.			Associated with vernal pool sites and therefore vernal pool species	Associated with alkali flats and floodplains in alkali playa, alkali annual grassland, alkali scrub, and alkali vernal pool plant communities	Below 1000	Domino-Willows-Traver soil series and associated with alkali soils			Barkworth 1993 Skinner and Pavlik 1994
Hulsea vestita ssp. *callicarpha* (beautiful hulsea)	State: None Federal: None CNPS: List 4	1	No	herbaceous perennial, flowers May-October				Mountainous areas, chaparral, and lower montane coniferous forest.	1300-2500 m	mildly disturbed rocky soils		Fire follower	
Juglans californica var. *californica* (NCN)	State: None Federal: None CNPS: List 4	3	No	Deciduous tree, flowers March-May				Chaparral, cismontane coastal scrub, non-native grasslands on alluvial soils of freshwater floodplains, low flow margins, seeps, river terraces, etc.		Deep shale-derived soils.	North-facing slopes, flats and terraces		

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Lasthenia glabrata ssp. *coulteri* (Coulter's goldfieds)	State: None Federal: None CNPS: List 1 B	2	Yes	Flowers February-June				Alkali playas, annual alkali grassland, vernal pool and alkali scrub in inland valleys.		Primarily restricted to willows soils series or soils that are inundated every 3-5 years,			Reisner 1944
Lilium humboldtii var. *ocellatum* (ocellated Humboldt lily)	State: None Federal: None CNPS: List 4	2	No	Herbaceous perennial, flowers April-July				Riparian in lower montane coniferous forest and coastal chaparral. Upland montane forms are on dry slopes, beneath dense coniferous canopy pine (*Pinus coulteri*) and bigcone spruce (*Pseudotsuga macrocarpa*), and cismontane (*Quercus* ssp.) woodland.					

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Lilium parryi (lemon lily)	State: None Federal: None CNPS: List 1 B	1	No	herbaceous perennial from bulb-like, scaly rhizomes, flowers from July-August				Meadows, streams in montane coniferous forest Riparian forest					
Limnanthes gracilis var. *parishii* (Parish's meadowfoam)	State: Endangered Federal: None CNPS: List 1 B	1	No	Annual herb, flowers from April-June				Restricted to vernal pool habitat, wet meadows, ephemeral stream edges	600-2000 m				
Microseris douglasii var. *platycarpha* (small-flowered microseris)	State: None Federal: None CNPS: List 4	3	No	Annual	facultative self-pollination	Disperses through animal movement, can attach to feathers and fur	vernal pool plants	plains, hillsides, and foothill slopes associated with native grasslands or vernal pools	below 1000	Clay soils	no data		Kenton Chambers, pers. comm.
Mimulus clevelandii (Cleveland's bush monkeyflower)	State: None Federal: None CNPS: List 4	1	No	Perennial Hybridizes with aurantiacus at lower elevations, flowers May-June				disturbed areas, open borders of woodlands, chaparral Chaparral, lower montane coniferous forest in open areas,	1000-2000 m Often found near summits of mountain peaks.	Metavolcanic of gabbroic soils			Reisner 1944

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Mimulus diffusus (Palomar monkey flower)	State: None Federal: None CNPS: List 4	1	No	Annual, flowers from April-June				Chaparral and yellow pine forest, sandy washes, disturbed areas	"higher elevations of Santa Ana Mountains" <2100 m	Sandy soils			Boyd et. al., 1992, Service, unpublished data Munz 1974
Muhlenbergia californica (California muhly)	State: None Federal: None CNPS: List 1 B	3	No	Annual herb, flowers April-May				Mesic seeps, streamsides, meadows, and mid-elevation canyons in chaparral and coastal sage scrub		Mesic soils			
Myosurus minimus var. *apus* (little mousetail)	State: None Federal: None CNPS: List 3	2	Yes	Annual herb, flowers from March-June				Vernal pools	Below 1500	Alkaline soils			
Navarretia fossalis (spreading navarettia)	State: None Federal: Threatened FR 63:54975, October 13, 1998) CNPS: List 1 B	2	Yes	Flowers from April-June. Population varies is size depending on response to timing and amount of rainfall and temperature.			San Jacinto Valley crownscale, three-leaved brodieae, little mousetail, vernal barley, smooth tarplant	Relatively undisturbed and moderately disturbed vernal pools, within a larger vernal pool plain dominated by alkali grassland		Primarily silty clay soils in the Willows and Travers series in the Hemet area. On the Santa Rosa Plateau, associated with southern basalitic claypan			Bramlet 1993

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Orcuttia californica (California Orcutt grass)	State: Endangered Federal: Endangered (FR 58:41384, August 3, 1993) CNPS:	2	Yes	Annual herb, flowers from April-June.				Deep vernal pools including southern basalitic claypan and alkaline vernal pools. Grow only in vernal pools that retain standing water into the late spring or early summer					Munz 1994 Griggs 1981
Oxytheca caryophylloides (chickweed oxytheca)	State: None Federal: None CNPS: List 4	2	No	Flowers from July-September				Yellow pine forest		Sandy soils			Munz 1974
Penstemon californicus (California beardtongue)	State: None Federal: None CNPS: List 1 B	2	No	Perennial herb, flowers May-June			Johnston's rock cress and Munz's mariposa lily	Chaparral, coniferous forest and pinyon-juniper woodland		Sandy soils			
Polygala cornuta var. *fishiae* (Fish's milkwort)	State: None Federal: None CNPS: List 4	2	No	Flowers from June-August				Oak woodlands and in shaded chaparral	100-1100	Edaphic endemic			Munz 1974, Wendt 1993, Reisner 1996, Boyd and Banks, 1995

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Quercus engelmannii (Engelmann oak)	State: None Federal: None CNPS: List 4	2	No	Deciduous tree, flowers from April-May. Hybridizes with scrub oak				Oak savannah, chaparral, cismontane woodland, riparian woodland, valley and foothill needlegrass, valley bottoms, raised stream terraces, and stream corridors in canyons in deep soils, as well as open stands					
Romneya coulteri (Coulter's matilija poppy)	State: None Federal: None CNPS: List 4	3	No	Flowers May-July				open mildly disturbed coastal sage scrub, chaparral, rocky riparian vegetative communities				Mature chaparral and sage scrub may limit expansion.	
Satureja chandleri (San Miguel savory)	State: None Federal: None CNPS: List 4	2	Yes	Perennial herb, flowers March-May									

Scientific Name Common Name	Status	Group	Narrow Endemic (Yes/No)	Life History	Pollination Biology	Dispersal Mechanism	Associations With Other Potentially Covered Species	Habitat Type	Elevational Range (meters)	Soils	Exposure	Additional Comments	Key References
Trichocoronis wrightii ssp. *wrightii* (Wright's trichocoronis)	State: None Federal: None CNPS: List 2	2	Yes	Annual herb, flowers from May-September				Alkali playa, alkali annual grassland, and alkali vernal pool habitats within mesic portions of these habitats		Alkaline soils			

Attachment 7

Sample Test GIS Analysis Outputs

SENSITIVITY ANALYSES
RIVERSIDE COUNTY MSHCP

A concern of using GIS modeling is the sensitivity, and consequently validity, of the modeling with regard to how variables are selected and measured to reflect some aspect of the physical world. For example, there are a variety of ways of measuring the factor "habitat diversity": simply enumerating the number of habitat types in a pixel; the number of habitat types in a pre-defined neighborhood for the pixel; or applying an abundance correction factor such as the Shannon-Weiner Index or Simpson Index for the number of habitat types in a pre-defined neighborhood for the pixel. A further complicating factor is scale size; i.e., what is the size of the neighborhood? Each of these approaches, in combination with using different scales, will yield somewhat different results. If the results are relatively similar (i.e., they show little variance), it can be said that habitat diversity, as defined by the different approaches, is a robust factor that is relatively **insensitive** to how the variable was defined; i.e., the measure and scale values used. If, however, the approaches yield highly variable results (e.g., one measure shows high diversity and another shows low diversity for the same pixel), it would be concluded that the factor is highly **sensitive** to the way it is measured or scaled and the validity of the results are questionable or should at least be viewed with caution. In principle, if the factor is relatively robust, the method used to measure the factor is relatively unimportant because, no matter how it is measured, one gets the same results. On the other hand, if the factor is very sensitive to the measures used and how they are scaled, one would have to interpret the results with caution and perhaps consider the range of results obtained.

In general, the scale of analysis used should be appropriate to the precision of the data and the universe to which the analysis is applied. A fine-grained scale is inappropriate for coarse-grained data. In the MSHCP study area, for example, the appropriate scale used to analyze vegetation data in non-Forest Service lands versus Forest Service lands may be different because of the more generalized vegetation map for Forest Service lands. Conversely, applying a coarse-grained analysis to fine-grained data may result in unnecessary loss of the information.

The scale should also be appropriate for the size of the area being analyzed. For example, the scale used to analyze alternative configurations of a potential reserve area of 1,000 acres probably would be smaller than the scale to characterize the entire study area or reserve system because a more refined analysis is warranted.

Examples of Sensitivity Analyses

The following examples provide some ways we have begun to look at factors in reserve design and analysis for habitat patch size, habitat diversity, and edge areas.

Habitat Patch Size

Two distinct methods to measure habitat patch sizes will be used: (1) aggregate patch size including all natural habitats; and (2) vegetation association patch size. Patches also need to be operationally defined in regard to roads, flood control channels, disturbed/developed areas and agriculture as potential isolators that functionally isolate patches. A proposed method to test the sensitivity of patch size to these variables is to combine the variables in the following systematic way and then conduct a series of analyses for comparison.

Patch Type:
10. Aggregate
11. Vegetation Type

Roads:
1. 4 lanes or greater
2. 2 lanes of greater

Agriculture:
1. Yes
2. No

Disturbed/Developed:
1. 1 acre
2. 10 acres
3. 25 acres

Concrete Flood Control Facility
1. Yes
2. No

The following combinations of patch size variables would be as follows:

Patch Type	Roads	Agriculture	Developed/Disturbed	Flood Control
Aggregate	4 lane+	Yes	1 acre	Yes
Aggregate	4 lane+	Yes	1 acre	No
Aggregate	4 lane+	Yes	10 acres	Yes
Aggregate	4 lane+	Yes	10 acres	No
Aggregate	4 lane+	Yes	25 acres	Yes
Aggregate	4 lane+	Yes	25 acres	No
Aggregate	2 lane+	Yes	1 acre	Yes
etc.				

If the table were completely filled out, there would be 48 different combinations of the five different variables (i.e., 2 x 2 x 2 x 3 x 2 = 48). The distribution of patch polygons sizes is generated for each combination. The distributions could then be compared with regard to their central tendency (i.e., mean, median, and modal sizes) and variation (range, variance, standard error). One objective would be to identify a combination of variables that resulted in a broad distribution of patch sizes that would then provide a discriminatory tool for comparing reserve alternatives. A combination that produced a very narrow or highly skewed distribution of patch sizes would not be as useful as a combination than resulted in a broader, more even distribution. A second objective would be to compare the different combinations, identify those that are significantly different, and then determine which variable(s) are most responsible for the differences. For example, the variable "roads" is expected to emerge as a critical variable for defining patch sizes, but it is not obviously clear how much difference there will be in the patch size distributions when 4-lane roads or greater is compared to 2-lane roads or greater. That is, how sensitive is the patch size analysis to the size of the road?

Habitat Diversity

There are a variety of approaches to measuring habitat diversity, in terms of the diversity indices and the scale of the analysis. We propose to use at least two methods:

1. Habitat Richness which is defined as the number of natural vegetation communities (including non-native grasslands) that occur within a given neighborhood of a pixel. This measure is an ecotonal surrogate because it does not control for the amount of area of each contributing vegetation type. A bias of this measure is that many small, fractured habitats are given high values without regard to the relative abundance of each type.
2. Habitat dominance which is defined as the abundance and number of native vegetation associations within a particular neighborhood. This measure ranks areas by the degree one vegetation association dominates a neighborhood; less dominance reflects greater habitat diversity. Simpson's and the Shannon-Weiner diversity indices would used for this measure.

An example result using the Habitat Richness measure was applied to the SWAP area. Neighborhoods of 500, 1,000 and 5,000 feet were used. The neighborhood is the area contain within the radial distance set; i.e., 500, 1,000, or 5,000 feet. Pixel size was set at 10,000 sq ft (0.23 acre) because of the input data scale (the vegetation map) and the relatively small area of analysis (in this example, pixel size is not important because the area of analysis is the neighborhood). Attached are maps and frequency distributions showing the results of the analysis.

As expected, the arithmetic mean of the number of vegetation communities in the pixel's neighborhood was positively related to the size of the neighborhood: 2.0 for the 500-foot neighbor; 2.7 for the 1,000-foot neighborhood; and 6.1 for the 5,000-foot neighborhood. A trivial result of this analysis is that the Habitat

Richness measure is sensitive to neighborhood size. The more important question is how this measure, Habitat Richness, can facilitate reserve design and analysis. One possible use is to compare the Habitat Richness distribution for a particular reserve design alternative to the baseline distribution for the relevant study area, in this case the SWAP area. If the mean of the reserve alternative is greater than the mean for the baseline, it can be concluded the reserve alternative has captured greater habitat richness on average than is present in the SWAP. Likewise, the distributions for different reserve alternatives can be compared to determine which alternative captures the highest average habitat richness. This analysis also could be applied to alternative potential acquisition areas as one measure of their biological value.

Because neighborhood size is important, the appropriate neighborhood must be used to provide adequate discrimination between areas. A good rule of thumb may be to use the largest neighborhood possible to maximize the spread of the distribution, but a neighborhood no larger than the entire area under consideration. For example, a circular neighborhood with a radius of 5,000 feet is 1,800 acres in size, whereas a neighborhood with a radius of 1,000 feet is only 72.1 acres. Thus, a 5,000-foot neighborhood would be more suitable for analyzing large, core areas of at least several thousand acres, whereas the 1,000-foot neighborhood would be more appropriate for areas of a few hundred acres or less.

Edge Areas

Edge effects are an important design consideration, and all things being equal, a reserve system with less edge is superior to one with more edge. One method to analyze potential edge effects is to reclassify land covers as natural habitats, urban lands, and agricultural lands under the assumption that urban and agricultural lands cause possible edge effects. The existing distances from natural habitats to urban lands only and urban lands and agriculture combined are then calculated. These measures allow an examination of the distribution of natural habitats in relation to their distance to urbanized and agricultural areas, under the assumption that the more distance from urban and agricultural lands the better. The GIS analysis is straightforward. For each 10,000 sq ft pixel, the distance to the nearest urban development or urban development and agriculture was calculated. The pixels for each distance interval were then summed to calculate total acreage for the distance category. The numerical summary is provided in the attached table and graph. The two attached figures show the spatial results of the analysis. It can be seen in the table that the distribution of acreages is skewed toward the greater distance intervals; that is, there still is a substantial amount of land in the SWAP that is distant from urban and agricultural lands. For example, for the Urban Only category 62% of the habitat in the SWAP is more than 600 feet from an urban edge and 47% is more than 2,000 feet from an urban edge. For Urban and Agriculture combined, the percentages are 46% for 600 feet and 34% for 2,000 feet. This analysis thus would allow one to examine the relative amount of existing edge for different reserve alternatives compared to the existing baseline. Also, once reserve alternative lines are established one could analyze the relative amounts of edge for the alternatives, assuming that everything along the boundary of the reserve would be edge (unlike existing conditions). This measure would reveal which scenario would had the least edge upon buildout outside the reserve system. Another

way of interpreting the results of the analysis is which alternatives would have the best shape in terms of the smallest perimeter to area ratio (i.e., less edge).

(See separate charts and graphics)

Attachment 8

Adaptive Management Strategies

ADAPTIVE MANAGEMENT STRATEGIES
WESTERN RIVERSIDE COUNTY MSHCP

The Need for Land Management

An overriding issue for maintaining ecosystem processes and structures in western Riverside County is the management of the reserve system. While conserving existing habitat is an important priority in the design of the reserve system, establishing a land management approach is at least equally important. Under existing conditions, western Riverside County already is a highly fragmented landscape that probably cannot function without substantial human intervention through land-based management. With a projected doubling of the population from 1.4 million to 2.8 million people by 2020, the increased future demands on the ecosystem and the need for effective land management is obvious.

A general definition of the term "management" used here is "human intervention in the dynamic processes which determine the composition of plant and animal communities, so as to maintain a particular desired pattern or series of processes." (pg 1 in Holdgate 1991). Land management activities should follow two broad principles:

1. Where existing ecosystem processes currently are functioning well, monitoring and management should be implemented to maintain native habitat communities and abiotic processes (e.g., hydrology, erosion and sedimentation, etc.) and to ensure that the ecosystem continues to function well.
2. Where the existing ecosystem is degraded, management activities should be directed toward returning the system to a functional level.

Effective management of any system presumes that one understands how the system works and applies management techniques in such a way to preserve or improve function; much like a thermostat working to maintain room temperature at a preset value. Any significant perturbation is responded to with a corrective action that returns the system to the desired state. Unfortunately, southern California ecosystems are not adequately understood to simply prescribe corrective management actions, such as "burn coastal sage scrub every 10 years" or "provide fenced edge buffers of at least 500 feet between residential development and reserve areas." Furthermore, even within the southern California ecoregion, proper management likely will vary geographically so that what works in Orange County, for example, may not work in Riverside County and vice versa.

Adaptive Management

The concept of "adaptive management" was developed to address management uncertainties and provide a method for correcting and refining management strategies (e.g., see California Department of Fish and Game 1998, Section III(A)(2)(g) on page 5). By definition, "adaptive management" relies on feedback from ongoing management activities in a specific area that directs future management actions toward a

desired state in that area; i.e., the management strategy is adapted to the particular management issue and may change as a result of the feedback from ongoing management activities. Those strategies that work well are retained and those that do not are discarded or refined and, hopefully, improved. For example, it is possible that controlled burning is an effective adaptive management technique for maintaining and improving Stephens' kangaroo rat habitat at Lake Perris, but that low level cattle grazing works better in the Anza Valley. In the sense that strategies are tested, modified, and retested, adaptive management is an applied example of hypothesis testing whereby the outcomes of management, whether good or bad, are used to direct and refine future management.

In order to implement adaptive management actions that will maintain ecosystem processes, it is necessary to understand of the constituents, structure, and dynamics of the system; the current and future probable impacts or demands on the system; and the capacity of the system to meet those demands.

Components of the Adaptive Management Program

The NCCP General Process Guidelines (California Department of Fish and Game 1998) identify at least four distinct, but not mutually exclusive, foci of an adaptive management program:

- Habitat management and enhancement
- Fire management
- Management of human impacts
- Exotic species control

Additional components of a comprehensive adaptive management program are biotic and abiotic issues, including:

- Native species management
- Erosion and sediment control
- Hydrology and flooding

The adaptive management strategy in the overall MSHCP cannot be a detailed, prescriptive management plan because, by definition, the management must be site- and issue-specific. Individual reserve land managers will be responsible for developing the specific adaptive management program for their respective reserve areas. However, the MSHCP will provide a framework and menu of management options or alternatives for an overall adaptive management strategy. For example, specific management issues will be identified for the 164 focus species to the extent understood (based on the literature and experience of land managers) and relevant (management may not be important for all the species).

Management Issues in Western Riverside County

Potential management issues for the MSHCP planning were identified in part by reviewing the existing threats to the focus species and by reviewing comments from local biologists during the April and June 1999 Habitat Assessment workshops. Some of the management issues relate to specific species, others relate to ecological processes, and many relate to both species and processes (e.g., fire, water quality and hydrology). Management issues followed by an asterisk are those that probably are of particular importance in the MSHCP planning area because they are known to be relevant to a large number of species, habitats, or basic ecosystem processes.

- Habitat and microhabitat manipulations; e.g., creation, restoration, enhancement, controlled burns, creating refugia (rocks for rattlesnakes or nest boxes for tree swallows), weeding and thinning, etc.*
- Translocation and restocking of species to supplement depleted populations
- Fire management; e.g., coastal sage scrub transitions to grassland.*
- Fire suppression and control related to weed abatement and fire protection zones (discing and plowing, fire breaks)*
- Hydrology and flooding*
- Water quality and eutrophication*
- Non-native habitat creation (e.g., duck ponds)
- Flood control and utilities facilities maintenance (clearing, access roads, mowing, etc.)
- Sheep and cattle grazing *
- Mining activities
- Exotic, invasive, and parasitic species control*
  - non-native Mediterranean grasses and annual forbs
  - Russian-thistle
  - black mustard
  - giant reed (*Arundo donax*)
  - tamarisk
  - Argentine ants
  - fire ants
  - mosquito fish
  - introduced bullfrogs
  - introduced crayfish
  - pet and feral dogs and cats
  - skunks
  - opossums
  - raccoons
  - brown-headed cowbirds
  - European starlings (nest cavity competitors)
  - earwigs and sowbugs (quino checkerspot butterfly)

- soil nitrogen levels related to air pollution promoting weed growth

- Avian diseases (e.g., avian botulism)
- Hybridization with more common species (e.g., Vail Lake ceanothus, Engelmann oak)
- Loss of genetic variability (resulting from population isolation)
- Off-road vehicles*
- A variety of legal and illegal human activities such as trash, toxic waste, and manure dumping, hunting, general trespass, trampling of vegetation*
- Recreational facilities - density of visitors, allowed activities (e.g., mountain biking, equestrian, skiing and snowboarding), campground garbage.*
- Pesticides, insecticides and herbicides
- Unauthorized collection of wildlife and plants (e.g., several reptiles)
- Logging, firewood harvesting and fern picking
- Lighting
- Noise

It is almost certain that additional management issues will be identified in the course of completing the MSHCP and implementing and managing the reserve system.

The Role of Adaptive Management Issues in Reserve Design

Although adaptive management will be an important component of the MSHCP and will need to be tailored over time by reserve managers, the management issues described above will be considered in reserve design. For example, in evaluating reserve alternatives, if it is known that off-road vehicles would be a management problem in one alternative, but not in another, all things being equal, the area requiring less management of off-road activities would be preferable. Management issues will be taken into account as tradeoffs for the selection of reserve areas.

The Role of Adaptive Management in Evaluating the Success of the MSHCP

Monitoring the performance of the individual adaptive management programs will be an important component of evaluating the overall success of the MSHCP. In the absence of *a priori* information regarding species populations and distributions and other essential biotic and abiotic processes, it is often difficult to specify precise and measurable objectives by which to gauge the success of the program. However, it is possible to develop specific goals and objectives for the adaptive management program. For example, as lands are added to the reserve system, a goal would be to identify management issues and develop an adaptive management program with specific performance criteria for the reserve in the first year. The management strategies would then be applied, for example, over the next five years, with management monitoring reports due at 5-year intervals. By reviewing and synthesizing the monitoring reports, the overall performance of the reserve system could be evaluated; e.g., are adequate species populations being maintained throughout the reserve system based on conditions in the different reserve areas? One of the tasks of the MSHCP will be to develop the overall framework for a landscape level analysis of the performance of the reserve system.

Outline of the Adaptive Management Strategy

An adaptive management strategy may be based on fairly simple premises such as maintaining open habitat for kangaroo rats or it may require a fairly complex framework model or theory of ecosystem function, such as the relationship between fire and successional processes chaparral, coastal sage scrub, and grassland (e.g., a state-transition model). Whatever the complexity of the management issue, the basic steps for implementing the management plan are the same.

1. Set Goals and Objectives

The first step for a land manager is to set specific goals and objectives. In setting goals and objectives, the manager must first identify and define the component being managed, such as "habitat" or "exotic species." Second, the management problem or issue relevant to the component must be identified. For example, are Argentine ants a problem in the reserve area? A **goal** is the desired state of the reserve with regard to the identified problem. For example, if Argentine ants are a problem, the desired state may be total eradication of the ants, or control of their distribution in the reserve. An **objective** is a measurable variable, such as the acreage occupied by the ants, or the number of ant colonies in the reserve, etc.

2. Conduct Study of Management Alternatives

A field study or experiment should be implemented to test management alternatives. Experimental hypotheses should be stated prior to conducting the study in order to frame the problem, identify appropriate experimental treatments, and identify the appropriate quantitative analysis that will allow for objective evaluation of the results. For example, different management strategies for controlling Argentine ants could be evaluated in the following simple experiment:

Plot	Treatment
Plot A	Pesticide
Plot B	Biological control
Plot C	Urban water sources control

Of course, a certain number of replicates of each treatment would be required for statistical analysis, but the principle of the study is straightforward.

3. Evaluate and Refine Management Strategies

The outcome, in this case the area occupied by ants or their distribution, is measured and a statistical analysis may be applied, if appropriate, to assess the efficacy of the treatment; e.g., a "within plot" before-after (repeated measures) test or a "between plots" test to determine which treatment is most effective. Based on the results, a primary treatment may be selected and continued to be monitored. If none of the

strategies is successful, new treatments may be tried and evaluated in the same way. The process of testing and refining would be continued until the issue or system is understood well enough to hone in on a single or set of successful strategies.

Literature Cited

California Department of Fish and Game. 1998 (January 22). Natural Communities Conservation Planning General Process Guidelines.7 pp.

Holdgate, M.W. 1991. Conservation in a world context. Pp 1-26 in Spellerberg, I.F., F.B. Goldsmith, and M.G. Morris (eds), The Scientific Management of Temperate Communities for Conservation. Blackwell Scientific Publications, Oxford.