Independent Science Advisors' Review:
North County Subarea Plan
County of San Diego
Multiple Species Conservation Program

Part I: Review of Habitat Evaluation Model, with Suggestions for Conservation Planning Principles, Species Coverage, and Adaptive Management

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This report constitutes a review, by a group of independent science advisors, of the North County Subarea Plan of the County of San Diego's Multiple Species Conservation Program. We were retained by the County to prepare this review of a plan in progress. Our first meeting was a workshop held May 2-4, 2001, in San Diego, where we were presented with information on the goals and structure of the planning process from the County and its consultants (AMEC, Conservation Biology Institute, and Scott Fleury). Representatives from U.S. Fish and Wildlife Service and California Department of Fish and Game were also in attendance. This workshop included a review of the methodology, assumptions, and data applied in the habitat evaluation model and a discussion of the preliminary reserve design concepts for the planning area. On the second full day of the workshop (May 4), we (the science advisors) met alone to discuss our impressions of the material presented to us by the planners. This discussion included consideration of our concerns about and preliminary recommendations for the planning process. The planners then rejoined us to hear our impressions and answer questions.

This report constitutes Part I of our review and concentrates on the habitat evaluation model, conservation planning principles, species coverage, and adaptive management. Part II of our review will constitute a brief report following a second meeting of our group with the County, its consultants, and the agencies, which is tentatively scheduled for late September of 2001. Although we are technically individual science advisors and reviewers, our comments in this report represent a consensus and the collective opinion of our team.

We are pleased to report that our review is generally positive. We are extremely impressed with the competence of the County staff and their consultants, and with their willingness to consider our critique in a positive and professional manner. Our comments are meant to help the County improve what is already a stellar planning process and to make it more defensible in the face of what will surely be intense public scrutiny (as is the case with all such plans). The specific recommendations we make with respect to the Plan are those we feel are consistent with the conservation planning principles of the Natural Community Conservation Planning (NCCP) program and with the findings of recent research in conservation biology. We present them not as rigid prescriptions but as advice to help planners achieve the conservation goals of the Plan.

Conservation Planning Principles

It is helpful to reconsider the original conservation planning principles developed by the Scientific Review Panel (SRP) for the NCCP program, then to append these principles, as needed, with more detailed recommendations that apply to the North County planning area and are consistent with lessons learned during several years of experience with such processes.

As recommended by the SRP, the California Department of Fish and Game and California Resources Agency determined that "subregional NCCPs will designate a system of interconnected reserves designed to: 1) promote biodiversity, 2) provide for high likelihoods of persistence of target species in the subregion, and 3) provide for no net loss of habitat value from the present, taking into account management and enhancement." Seven principles of reserve design were recommended by the SRP as a way to accomplish these goals. These principles are presented below, followed by additional comments and principles that we feel are appropriate for the North County Plan.

1. **Conserve target species throughout the planning area**: Species that are well-distributed across their native ranges are less susceptible to extinction than are species confined to small portions of their ranges.

    a. The distributions of species should be considered at multiple spatial scales---e.g., within the planning area, within the county, within the ecoregion, and across their entire range---in order to plan for their viability over the long term and to encompass genetic variation among populations.
    b. Wide-ranging species, such as large-bodied herbivores and carnivores, require consideration at scales well beyond the planning area, because viable populations can be conserved only across vast areas. Coordination in conservation planning among subregions, counties, ecoregions, and states often is required.
    c. Matrix communities and the species associated with them (e.g., California thrasher with chaparral) are, by definition, widespread. A conservation plan should assure that they remain so.
    d. Once the reserve design is identified conceptually, the boundaries of pre-approved mitigation areas (PAMAs) should be refined based on land ownership, topography, vegetation, and other features. Additionally, specific reserve design principles and management guidelines should be developed for each PAMA to ensure that the ultimate reserve

configuration does not compromise the long-term viability of resident target species and habitats.

2. **Larger reserves are better**: Large blocks of habitat containing large populations of the target species are superior to small blocks of habitat containing small populations.

    a. "Large" should be interpreted relative to the natural distribution of patch sizes for the habitat type in question, and to the home range sizes and population densities of the focal species inhabiting particular patches.
    b. Small "specialty" reserves may be entirely adequate for some species, at least in the short to medium term and barring pronounced changes in environmental conditions, so they should not be automatically written off as useless for conservation. For example, the designation of specialty reserves was a major component of the Recovery Plan for Upland Species of the San Joaquin Valley, wherein it was stated that "smaller specialty reserves also are a necessary part of the proposed habitat protection network. They are important for recovery of certain species with highly restricted geographic ranges or specialized habitat requirements. These reserves might be small areas surrounded by developed land, or they may be portions of larger conservation areas that require special management" (USFWS 1998).

3. **Keep reserve areas close**: Blocks of habitat that are close to one another are better than blocks of habitat far apart.

    a. "Close" and "far" must be evaluated with respect to the perception and dispersal capacity of individual species, with emphasis on those sensitive to fragmentation, rather than from a human perspective.
    b. This principle is invalidated if an absolute dispersal barrier for a particular species lies between the blocks of habitat in question. Many of the less vagile species in the region will encounter such barriers---for example, reptiles and roads. As suggested later, highway modifications to provide movement opportunities for such species should be considered.

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

    a. The scale of fragmentation or isolation that is problematic varies according to the autecology of each species under consideration.
    b. Some high-value habitat is already heavily fragmented. Before "writing off" such areas as useless, a careful consideration of their potential value for particular species should be made. Many plants and invertebrates, and some small vertebrates, are not highly sensitive to fragmentation. Heavily fragmented landscapes may be the only areas where some of these species may now be conserved.

c. Nevertheless, small and fragmented parcels of habitat are generally less defensible against external threats and are missing many key ecological processes. Hence, if small fragments are included in a reserve system, considerable management effort will be required to sustain a semblance of ecological integrity in these areas.

5. **Link reserves with corridors**: Interconnected blocks of habitat serve conservation purposes better than do isolated blocks of habitat. Corridors or linkages function better when the habitat within them resembles habitat that is preferred by target species.

    a. A broad-scale connectivity analysis should be part of the planning exercise, subsequent to the identification of potential core areas ("bubbles'). GIS-based least-cost path analysis can be used to delineate linkages between core areas identified as suitable for particular species, with emphasis on wide-ranging species and others known or suspected to be sensitive to habitat fragmentation. Linkages between core areas within the planning region as well as to adjacent regions should be assessed.
    b. A reasonable hypothesis is that matrix communities, including chaparral and agriculture, provide connectivity for at least some wide-ranging and fragmentation-sensitive species. Because chaparral is currently under-represented by the habitat evaluation model, and agricultural areas are not finely discriminated, these habitats need more attention in the Plan.
    c. Wherever possible, connect large blocks of public land throughout the planning area.
    d. Consider "stepping stones" (i.e., scattered patches of suitable habitat in an unsuitable matrix) as an alternative to discrete corridors for some species. Depending on the landscape matrix and the dispersal characteristics of the particular species, stepping stones may provide connectivity as well or better than linear corridors. For example, for certain species in the San Joaquin Valley, especially the kit fox, mini-reserves were recommended to help individuals travel through landscape bottlenecks such as urban areas. Similarly, stepping stones through agricultural matrix (e.g., through retirement of small parcels of farmland) were proposed for kit foxes and other relatively mobile species, and could perhaps serve species with similar characteristics (e.g., bobcat) in San Diego County.

6. **Reserves should be diverse**: Blocks of habitat should contain a diverse representation of physical and environmental conditions.

    a. A trade-off may exist between capturing a diversity of environmental conditions within reserves versus among reserves. Maximal diversity within reserves corresponds to a relatively "fine-grained" habitat mosaic, with high beta diversity (i.e., turnover of species along an environmental gradient) but relatively small patch sizes of particular habitats. In contrast, maximal diversity among reserves can be attained by locating reserves in relatively large patches of particular habitats, but with different habitats featured in different reserves. This results in a more "coarse-grained" mosaic with lower beta-diversity within reserves but larger patch sizes of particular habitats and potentially equivalent diversity across the network of reserves. We recommend trying to balance these two approaches, as different species are likely to be favored by each.

b. In any case, the diversity sought should be natural habitat diversity, not an artificially enhanced diversity, which is likely to increase fragmentation and favor weedy species.

7. **Protect reserves from encroachment**. Blocks of habitat that are roadless or otherwise inaccessible to human disturbance serve to better conserve target species than do accessible habitat blocks.

   a. Among the documented effects of roads include serving as barriers to movement of organisms and flow of natural processes, sources of direct mortality (roadkill), increased sources of ignition for anthropogenic fire, access to disruptive human activities (e.g., poaching, collecting, ORV use), and spread of invasive exotic species.
   b. Future transportation developments, such as highway widening, will change the impacts of existing roads. A road that is permeable to certain species or individuals within species today may become an absolute barrier after widening or other modifications. Conversely, a road that is a barrier today could become permeable to species if modified appropriately. We suggest that road impact mitigation options---e.g., wildlife crossings, fencing, land bridges---be discussed and recommended as part of the Plan. Moreover, we strongly urge road-building and maintenance authorities (federal, state, and local) to include wildlife mitigation measures into engineering specifications at the outset of planning, rather than later in response to CEQA/NEPA review. Further research on the effects of roads and associated structures on wildlife---and, conversely, on the effectiveness of mitigation options---should be funded by transportation authorities.
   c. Aside from roads, access to reserves by trails (whether planned or created by users) can be problematic for some species. The construction of new trails should be limited. Any new trails or other park facilities should be designed to avoid or minimize deleterious effects and should be kept out of sensitive areas. A program to design, limit, and monitor trails---and regulate recreation generally---should be part of the Plan. This recommendation could be met by requiring that a Recreation Management Plan be prepared for each new open space area designated for inclusion within the reserve system, prior to the establishment of permanent access or construction of any new park facilities or trails.
   d. Residential housing adjacent to reserves will be sources of trespassing humans, dogs and cats, other opportunistic mesopredators (e.g., raccoons, opossums), fire ignitions, chemicals, exotic plants and animals, unnatural

light regimes, and other threats. Where possible, provide buffer zones of reduced human activity and development, such as recreational parks, parking lots, etc., adjacent to reserves. The incorporation of these types of buffers/uses adjacent to a reserve may increase the effective size of the reserve, for instance by eliminating or reducing the need for fuel modification clearing and irrigation that is normally required for residential areas that abut wild lands. In addition, encroaching pests and influences must be managed to reduce their impacts. Guidelines for fencing design and lighting restrictions would be helpful. We recommend that the County devote serious attention to potential buffer zones in the Plan.

e. Fuel modification zones for developments should be established outside the reserve's boundaries. Additionally, the County should work with local fire agencies to develop fuel modification plant lists specific for developments adjacent to proposed reserve areas. Current plant lists should be revised to eliminate and prohibit the use of any exotic pest plants recognized by the California Exotic Pest Plant Council and should incorporate reserve-compatible, native, fire-resistant plant species. The Orange County Fire Authority has developed such a plant list for developments adjacent to Orange County NCCP lands.

8. **Maintain natural processes**. This tenet was added to the Southern Orange County NCCP principles and also was emphasized by Noss et al. (1997). Reserves that are designed to maintain natural processes will sustain native biodiversity better than reserves in which such processes are disrupted.

   a. Planning efforts must recognize the implications of fire within this ecosystem, as fire has played an important role in the origin and maintenance of the region's plant and animal communities. The size, boundaries, shape, and adjacent land uses of reserves should be designed to allow maximal scope and flexibility for fire management, including both prescribed burning and fire suppression activities. Moreover, the County, working with local and state fire agencies, should take the opportunity provided by this Plan to develop and implement ecological fire management programs for protected lands. The ecological fire management program would likely have two components: 1) A Prescribed Fire Plan, focused on the appropriate application of fire to enhance or maintain habitat quality, vegetative structure/composition and landscape patterns; and 2) A Fire Suppression Plan, focused on minimizing the impacts of unplanned fire events and the associated suppression activities on sensitive plant and animal communities.
   b. The placement of reserves should consider natural hydrological and erosional regimes and attempt to encompass the area necessary to sustain these regimes (including extreme events such as floods and mass movements) within reserves.

Moreover, we make the following conservation planning recommendations specific to the North County planning area:

1. A general comment on pre-approved mitigation areas (PAMAs): Our team was especially concerned that the conservation goals of the Plan could potentially be undermined by the PAMA process. The process of designing these areas must be implemented with the utmost care and with oversight from conservation biologists. The Plan should clearly define "pre-approved mitigation areas" and specify what proportion of each area is expected to be put into conservation status (i.e., reserves). Given that the actual acreage cannot be known in advance, the Plan also should estimate the minimum amount likely to be conserved. Clearly state that there are no systematic surveys (i.e., nothing except surveys that occur for a project proposed within a PAMA) to identify parcel-level biological resource values. The Plan should acknowledge that the PAMA approach inherently involves greater risk than a hard-line reserve system. Most importantly, the Plan should take all steps feasible to reduce this risk to an acceptable level.

2. The County should not assume any conservation contribution from tribal lands. Management and development of these lands is likely to be highly variable and unpredictable. The extent to which their management will be subject to federal law in the future is uncertain.

3. The future status of lands lying between areas of high conservation value is uncertain. What assumptions might be made, for example, concerning the lands between the Valley Center and Ramona Valley? As the Lake Hodges and Santa Ysabel Creek areas below Guejito are increasingly developed, the need for a secure swath of non-urban land between Guejito Ranch south and west through the Ramona Valley will become more apparent. Now is the time to consider such trajectories of development and take actions to assure that connectivity between potential core areas of a regional reserve network (including areas outside the planning area for this Subarea Plan) is maintained.

4. Be wary of abuses of mitigation banking. Off-site mitigation banking involves protection of areas of perceived higher conservation value, at a developer's expense, while allowing areas of perceived lower value to be developed. The scientific basis for such decisions is often not well documented. Furthermore, the ostensible mitigation sometimes does not stop with the initial off-site protection; there may be a re-mitigation of lands already set aside in which a developer agrees to fund "restoration" of protected lands in exchange for further development. Hence, the mitigation bank is double-dipped, with more land lost to development than originally foreseen. The end result may be a net loss of habitat value for covered species and biodiversity generally, especially because restoration is often less successful than hoped.

5. To summarize some of the recommendations that emerge from the principles discussed above, we suggest that the Subarea Plan should promote measures or programs that:

   (a) limit the discharge and diversion of water to and from ecologically significant watersheds.
   (b) limit irrigation runoff and nuisance flows from new developments into protected areas.
   (c) specify design standards to limit intrusion of noise, light, and pets from developed areas into protected areas.
   (d) regulate recreational use of protected areas.
   (e) specify design standards to accommodate and control wildlife movement across new roads that cross connective habitats. Similar standards should promote retrofitting of existing roads that cross connective habitats. These should include overpasses, underpasses, and fencing or other methods to direct animals toward crossing structures and minimize road mortality. However, it needs to be borne in mind that the design, placement and construction of wildlife crossing structures has a very checkered history in San Diego County and elsewhere.
   (f) ensure a semblance of a natural fire regime in protected areas through the development of ecological fire management plans.
   (g) prohibit use of aggressively invasive exotic plants in new landscaping, including highway rights-of-way, fuel modification zones, and golf courses.
   (h) specify measures to limit the spread of noxious invasive weeds into protected areas from activities such as construction, road-building, and ground disturbance.

Many of these measures, we trust, already exist (at least on paper). Some measures may require new legislation or regulations promulgated by the County Board of Supervisors. Others, perhaps, under existing authority, could be written as guidelines for County staff who process development applications.

6. Agricultural lands should not be treated monolithically, as they vary in their potential roles in providing supplementary habitat and connectivity to various species. We suggest that different types of agriculture be mapped (if possible) and rated as to compatibility with conservation objectives. We have developed a potential ranking system for agricultural lands in the study region that considers habitat values in terms of both dwelling habitat for native species of plants and animals and permeability for moving/dispersing animals. The scale ranges from 1 = generally compatible to 5 = incompatible. Categories ranked 2 through 4 are of value to some species in certain circumstances. For examples, some raptors forage extensively in irrigated pastures, crop fields, and orchards, but these habitats are of marginal value for most native species. In general, most vertebrates will travel through some habitats that are unsuitable for breeding.

1 Rangelands. Natural topography, soil structure, and native plant communities generally present. Usual management practices reduce non-native plants (especially grasses). Wildlife uses include nesting, foraging, and resting habitat for many species. In some cases animal control measures may threaten native species (especially rodents and predators).

2 Irrigated Pasture. Level topography and unnatural hydrology (irrigation). Non-native plants are cultivated. Wildlife uses include resting and foraging for some birds. Generally permeable to wildlife movement (depending on species and type of fencing).

3 Cultivated Row Crops and Alfalfa; Sod Farms. Upper soil strata tilled annually or less often. Unnatural hydrology (irrigation). Non-native plants are cultivated. Wildlife uses include foraging by some insectivorous birds, raptors, and deer. Generally permeable to wildlife movement (depending on species and type of fencing).

4 Orchards. Tilled soil surface (therefore, no understory) and unnatural hydrology (irrigation). Increased nutrient and organic matter release to watershed. Wildlife uses include cover for deer and other large and medium-sized mammals. Generally permeable to wildlife movement (depending on species and type of fencing).

5 Greenhouses and Exotic Plant Nurseries. Structures occupy acreage and serve as barriers to wildlife movement. Wildlife uses are minimal. Source of non-native feral species (e.g., rats, cats, starlings).

<u>The Habitat Evaluation Model</u>

We heard fairly detailed presentations of the habitat evaluation model and were able to discuss the potential limitations of this model at some length with the planning team. The following are our comments and suggestions on the various components of the model, organized by sections of the text in the planning document and with reference made to specific figures.

1.0 Introduction

Here we suggest you refer to the general tenets of reserve design for the NCCP program, as cited above, and our suggested additional principles. The "major biological objectives" listed seem more appropriate for management of the reserve network than for its initial design.

2.0 Habitat Evaluation Modeling in San Diego County

This section is well written and basically clear.

3.0 General Methodology

This section is also clear and requires no major revision. We have concerns about several aspects of the methodology, however, which we express below under section 5.0 on Model Components and Factors.

4.0 Model Uses and Limitations

We congratulate the planning team on including this section in the report. Many planning efforts we are familiar with have made scant mention of the limitations of their methodology. The best way to prepare for potential criticism of a plan is to openly acknowledge the assumptions of the planning process, data gaps, limitations of the methodology, and other potential weaknesses. The course of action taken can be defended best when it is clear that all reasonable alternatives have been considered thoroughly and rationally.

One major limitation of the process is not acknowledged in this section. The habitat evaluation model is a scoring procedure, with scores assigned to grid cells based on their modeled value for several criteria. Like all scoring procedures, the model does not assure that all biological features (covered species, natural communities, etc.) will be represented adequately in the design. This deficiency in scoring procedures was a major impetus for the development of reserve-selection algorithms that emphasize efficiency and complementarity (see Pressey et al. 1993 for an early but pivotal review of this approach and Cabeza and Moilanen 2001 for a recent assessment). As an alternative to starting from square one with an entirely different evaluation model, representation of natural features in the penultimate design could be assessed retrospectively. Under-represented features then could be identified and the design modified to capture them. This retrospective process is not as efficient as the use of a more sophisticated site selection algorithm, however, so this weakness should be acknowledged.

We agree with the stated limitation that the results of this model should not be used to interpret site-specific (i.e., parcel-level) biological value. It may be advisable, however, to provide a basic outline for a step-down process of moving from regional planning to site-level planning.

5.0 Model Components and Factors

We comment on the individual components of the model below. Considering the entire model, our major recommendations are twofold: 1) A sensitivity analysis should be performed to determine the relative contribution of each model component (with various weightings) to the overall score. 2) A correlation analysis is needed to determine the correlations and covariance among model components. The results of these analyses should be used to refine the model, possibly deleting some components or at least altering weightings. It was difficult for us to fully evaluate the model without these analyses.

The fundamental reason to improve the model is to make it as defensible as possible. Where changes to make the model more defensible cannot be made, due to limitations of time or budget, a competent discussion of potential alternatives and an accounting of the strengths and weaknesses of alternative approaches will help avoid criticism (see above).

We feel intuitively that a more sophisticated and rigorous model than the one used would be unlikely, with some exceptions, to identify core areas that differ drastically from those derived from the present model. The areas of highest value for native biodiversity in the planning area were generally well known, through expert knowledge, before this planning process began. Nevertheless, experience elsewhere suggests that a model that is as rigorous as possible often reveals a few surprises (i.e., areas of value for conservation that were not previously known) and stands up better to criticism than less rigorous approaches. Moreover, a rigorous model can do something that expert opinion cannot: It can be used to evaluate trade-offs for the more marginal areas of the overall design---which areas on the margin of biological value should be included in the reserve portfolio, which should be rejected, and why?

5.1 Habitat Value Index

Refer to the following discussion of the seven components of this index.

5.1.1 Habitat Diversity Index

We have some concerns about this index. As noted earlier, habitat diversity might be maximized within reserves or among the reserves in a network. The index applied here calculated the number of different habitat types within a circular neighborhood of 0.5-miles radius around each cell. Hence, it tends to select for species that benefit from a fine-grained mosaic at the possible expense of those that would fare better in a coarse-grained mosaic with larger contiguous patch sizes of particular habitats. Given that the preferred landscape grain for various species in the planning area has not been determined, the safest strategy is probably to seek a balance between the fine-grained and coarse-grained patterns.

We are especially concerned that some habitat types that constitute matrix communities and which are characterized by large patch sizes (e.g., chaparral) will be under-represented in the Plan. Variation within these types (e.g., southern maritime chaparral) also may not be captured. An overlay of vegetation types on geoclimatic habitats (e.g., as classified by a model based on climatic and edaphic variables) might provide a stratification of habitats that is better able to assess representation of subtypes (see Noss et al. 1999).

We are not satisfied that the habitat diversity index provides a balanced approach to the worthy goals of maintaining (representing) a diversity of natural habitats in the planning area and supporting a greater number of sensitive species. Given the general failure of diversity indices to provide useful information in applied ecology (Pileou 1975, Noss and Harris 1986), we recommend deleting this component of the model and replacing it with a general assessment of the extent to which various habitat types (plant communities) are represented within a suite of alternative reserve designs. The level of representation deemed "adequate" should be determined by considering not only the present habitat cover in the planning area (i.e., with representation targets set proportional to the relative cover of each habitat type), but also the habitat cover prior to European settlement. Relatively higher representation targets should be set for habitats that have suffered greater declines in area or quality. This said, we are concerned that map accuracy does not seem to have been thoroughly evaluated. Key habitats and sites may be overlooked if map resolution or accuracy is inadequate.

5.1.2 Ecotone Index

The ecotone index is partially redundant with the habitat diversity index, in that areas with a high fine-grained diversity of habitats will also have abundant area in ecotones corresponding to high beta diversity. Natural ecotones are well documented in the literature as areas with high diversity of native species, in that they often contain species from both adjacent habitats in addition to species that specialize on the ecotone (Holland et al. 1991). Nevertheless, the fact that ecotones are sites of high species richness does not mean that more area in ecotones is better; there is no evidence to support such a linear relationship. Yet "more ecotone is better" is an implicit assumption of the ecotone index.

The Plan should justify why particular ecotones have biodiversity value in terms of the species that need such ecotones. Only those particular types of ecotones (as specified by particular pairs of vegetation types) should be assigned positive value in the Ecotone Index, if it is to be used at all in the habitat evaluation model. For example, several birds nest in trees and forage in grasslands, and some mammals (e.g., deer, cottontails) seek cover in wooded habitats and forage in grasslands. Thus, the ecotone between grassland and almost any other vegetation type has some biodiversity value. Such value has not been documented for most ecotones in the planning region and cannot necessarily be assumed from generalizations derived from studies elsewhere The process of weeding out ecotone types without known value may result in an index that is completely or nearly redundant to the grassland evaluation and habitat diversity index; if so, the ecotone index should be dropped from the habitat evaluation model.

5.1.3 Soils Known to Support Sensitive Plant Species

We believe this is a valid component of the habitat evaluation model. Nevertheless, we suggest it would be valuable to evaluate the correlation between this component and some of the individual plant species models, many of which include soils as a variable. It may turn out that this component is redundant with the species models and can be eliminated.

5.1.4 Micro-habitat Features

This is a valuable component of the index. However, it should be acknowledged that the data available for this component of the model are incomplete. An estimate of how incomplete the data are---or, at least, an acknowledgement of the scale/resolution and coverage limitations---would be helpful.

5.1.5 Rarity of Natural Features

At present, this component is based on the acreage of each habitat type within San Diego County. It would be more legitimate biologically to compute this on a regional basis, as well as across the range of each habitat type (i.e., plant community). The global/state (G/S) ranking system of the California Natural Diversity Data Base would be an appropriate basis for this ranking, and is consistent with other rankings devised by heritage programs nationwide. As with the preceding component, we recommend that the data limitations of this component be acknowledged.

5.1.6 Number of Predicted Sensitive Species

We are very impressed with the database ("Tom's Brain") that serves as the basis for this component. We doubt that an equally valid natural historic database exists in more than a few places on the continent. Nevertheless, in order to confirm the accuracy of these species models, we recommend that their prediction accuracy be validated with independent data. Although such validation is beyond the scope of this initial Plan, the required data could be supplied by other studies in the region and by the adaptive management component of this Plan. Also, we find the statement in this section that division of the county into 12 ecoregions was "based on climate zones and major geographic breaks or clines" confusing. In particular, how do clines enter into this delineation? More explanation is needed.

5.1.7 Edge Effects

This component correctly distinguishes artificial edge effects from natural ecotones (component 5.1.2). More documentation is needed, however, for how edge effect rankings were assigned. It is logical to apply different buffers and rankings for different habitat combinations (e.g., chaparral and urban vs. chaparral and agricultural), but the empirical basis for such determinations is shaky. Moreover, the edge effect intervals selected (150, 300, and 600 ft.) are highly subjective, not well supported by the literature cited, and perhaps too small. An edge effect distribution graphic for the entire study area would be informative, as would a sensitivity analysis (as mentioned above in a general sense) (see Kelly and Rotenberry 1993).

5.1.8 Composite Results for Habitat Value Index

As discussed earlier, the composite results for the habitat value index will suffer from the general limitations of scoring procedures: inefficiency and lack of assurance that all features are adequately represented. These limitations need to be addressed and, to the extent possible, remedied. Moreover, we understand from the presentations at the workshop that component weightings were applied subjectively and retrospectively to compensate for certain components not contributing much to the composite score. This is probably not the most defensible way to determine weightings. As recommended earlier, sensitivity analysis and correlation analysis should provide a basis for more defensible weightings. We also suggest that a thorough description be provided for the "equal area" rank-ordering into quartiles, which we found somewhat confusing. A comparison of relative value and absolute value of cells would be useful.

5.2.1 California Gnatcatcher Habitat Evaluation

We note that the elevation variable in the model is a surrogate for temperature and precipitation, for which data are now available and which would provide for a more precise model.

5.2.2 Stephens' Kangaroo Rat (SKR) Habitat Evaluation

Because substantial habitat information is available for this species, this component of the model is defensible. More than two slope categories might have been used, but we doubt the outcome would be significantly different, since the highest population densities are found on flat to gently-sloping land. One complicating factor regarding the output, however, is that not all grasslands are of equal value to kangaroo rats. Non-native grasses (e.g., *Bromus* spp.) can thrive in years of average and above rainfall, leading to the development of a thick thatch (mulch) that excludes many native species of plants and animals, including kangaroo rats. Kangaroo rats and many other terrestrial vertebrates (e.g., lizards) may be severely restricted in their movements by the dense thatch of exotic grasses and are consequently more susceptible to predation. Selective use of control burns and grazing appears to enhance habitat conditions for kangaroo rats and other terrestrial species in semi-desert grasslands in California (see Goldingay et al. 1997 and references therein under habitat management). Nevertheless, even with control of exotic vegetation, kangaroo rat populations may not increase following treatment (Uptain et al., 1999). Please refer to our comments on the grassland evaluation (below).

5.2.3 Arroyo Southwestern Toad Habitat Evaluation

One concern we have about this component is that it appears to be politically biased: the FWS has requested that high value habitat not be identified outside of designated critical habitat. We suggest that this request be denied, as it appears to be politically, rather than biologically, based. Also, this model should be compared to the model of Wendy Barto, with the differences discussed and the reasons for the preference for this model explained.

5.3 Grassland Evaluation

We appreciate the importance of grasslands within the study region and agree that these habitats deserve special consideration in the Plan. Nevertheless, the purpose of the grasslands component of the habitat evaluation model is unclear. If the purpose is to assure that the model identifies habitat suitable for SKR, then that goal could be accomplished through the SKR parameter; i.e., there are interrelated and interdependent aspects to the SKR and grassland components. Assuming, however, that adding a separate grassland evaluation to benefit SKR is appropriate (which is implicit in the model), a moderate score (2) could be given to a patch of land that is highly suitable for SKR but is quite fragmented, with significant edge effects. This hypothetical example assumes the patch had grassland (+2), was less than 100 acres (+0), had suitable soils (+1), had development <600' away (-1), but was connected by roads (and soft shoulders), or better still fire roads, to a network of other small habitat patches scattered through the landscape (many kangaroo rat species are known to use dirt roads for movements---think of a string of pearls, with the pearls being semi-isolated subpopulations connected by roads). Such an area could have high densities of SKR but be of limited use to other native species. We note that, in Fig. 23, the Ramona Grasslands area shows a low edge effect along the roads and none in the grassland interior. In fact, the habitat for SKR is likely to be equally if not more patchy in the interior than along the road rights-of-way.

A conceptual model for cis-montane, low elevation (<2000 ft) California grasslands was constructed by staff of The Nature Conservancy for the Sacramento Valley. It focuses on management actions that directly affect the grassland plant community, specifically the abundance of non-native annual grasses. The starting point is assumed to be a mixed association of native and introduced annual grasses. One "management cycle" as represented in the model is one year for the grazing management actions and 3-10 years for the fire management actions. The preferred management action is spring prescribed fire (i.e., a post annual seed-set burn), which results in improved quality native grassland with high native grass vigor and low non-native recruitment. However, if the grassland is not periodically burned (no action) it will gradually be reinvaded by non-native grasses, which exclude most native plants by means of build-up of mulch.

We offer this model (Appendix A), modified to include the SKR, as a working hypothesis for the North San Diego County planning area. We acknowledge, however, that our model has several limitations. Aside from the SKR, the model contains no animal species except cattle and presumes that the grassland in question supports a relatively high proportion of native grasses. Although some animals, such as the SKR, would be expected to benefit from less mulch from non-native grasses, effects on other species of proposed management actions are less certain and could be detrimental. For example, the short- and long-term impacts of spring fires on adjacent target communities such as Engelmann oak woodlands and many ground-dwelling vertebrates could be negative and possibly non-reversible (as experienced on the Santa Rosa Plateau Preserve).

Prescribed burns must be carefully planned and implemented to minimize fire size and intensity in a way that provides for adequate refugia and protects adjacent or embedded habitat types that are sensitive to fire. Grasslands do not exist in isolation; positive grassland management action can "spill over" into other natural communities where the consequences can be quite negative.

With respect to cattle, spring grazing is preferable to year-round grazing, but the level of impact (through overgrazing and soil erosion and compaction) is also dependent on the stocking rate. Heavy spring stocking can be as detrimental as year-round stocking.

Livestock management also commonly involves a number of practices---for example, fencing, water withdrawals, and predator control---that may have negative consequences for native biodiversity.

Because of differing site characteristics as well as disparate grazing and fire histories, different grassland sites will respond differently to the same management actions. In any case, no single management strategy is appropriate for all grassland sites. Management must be determined on a site-by-site basis. We are continuing work on the grassland model (Appendix A) and may offer a refinement or revision of the model in Part II of this report. We would be interested in obtaining additional information the County may have on sites within the Subarea that still support native grassland.

5.4 Potential Wildlife Corridors Analysis

We have some serious concerns about this component. We suggest that the potential wildlife corridors analysis should not be part of the habitat evaluation model, i.e., it should not be used to develop the first cut of PAMAs. By definition, corridors have value because they link core areas (such as PAMAs) (Noss and Cooperrider 1994, Beier and Noss 1998). The map (Fig. 25) of all canyon bottoms that touch parcels of >100 acres seems to have little relevance to connectivity among core areas.

We suggest removing the potential wildlife corridors analysis from being 1 of 5 factors that feed into the preliminary PAMA map. Instead, in the flow diagram (Fig. 2) the delineation of preliminary PAMAs (now the only blue box in the flow diagram) should flow to a second blue box, with connectivity analysis feeding in to the transition as follows: Identify the need for linkages among preliminary PAMAs and key conservation areas outside the planning area. Draw any such linkages as double-arrowed lines that run the full distance between the conservation areas to be linked. Such clarity will provide guidance to those implementing the Plan. In particular, the critical Santa Ana-Palomar linkage zone along the Riverside-San Diego County line should be clearly mapped, including those portions in Riverside County. For major linkages that have only one or few alternative routes, or one clear "best" route (such as a major drainage or swath of natural vegetation), the Plan should delineate a new PAMA to encompass the linkage area.

For situations where two PAMAs are separated by a broad area of marginally suitable habitat (in which permeability could be achieved by maintaining rural land uses), no connective PAMA may be needed, but the Plan should specify restrictions on new agricultural or development activities to enhance connectivity. In particular, any new fences in agricultural areas must be permeable to wildlife, including deer and mountain lions. Landowners with existing fences should be offered incentives to make those fences permeable to wildlife. When a riparian area that potentially connects two conservation areas crosses a farm, construction of new buildings, and new outdoor lighting, should avoid the riparian area. Through educational efforts and appropriate incentives, affected landowners should be encouraged to keep their pets indoors and keep livestock in predator-proof pens at night. We recognize, of course, that such actions will be difficult to achieve in practice; ultimately, ordinances may be needed.

Finally, the exclusive consideration of valley floors in the corridor analysis is not justified biologically. Wide-ranging species typically follow a path of least resistance through a landscape; valley floors often provide such a path, but so do ridgelines and other reasonably linear features that lack significant barriers. As suggested earlier, the connectivity analysis would benefit from a least-cost path analysis based on simple habitat suitability models for wide-ranging species and following the delineation of preliminary core areas (PAMAs). Using selected target species, including birds such as gnatcatchers and thrashers, and defining suitable habitat for movement can be an effective method to define corridors that include more than just drainages. Potential corridors should include an array of options, representing different biological functions.

5.5 High Priority Species and Vernal Pool Habitat

This component could be improved by not limiting it to federal and state listed species, Category 1 species, and species proposed for listing. A more defensible list of imperiled taxa, which is more consistent with conservation planning efforts elsewhere, is the list of species that are critically imperiled and imperiled globally (G1/G2), according to The Nature Conservancy and the Association for Biodiversity Information (and available through the California Natural Diversity Data Base). We note, however, that this component is at least partially redundant with previous components that considered rare species and habitats. How skewed is the overall model toward rarity as opposed to other conservation criteria?

The recent report on the vernal pools of the Ramona Area (Documentary Report for the Vernal Pools of the Ramona Area, April 2001, RECON) is a thorough description of the current extent of vernal pool habitat in the area. Included in the report are maps of the known locations of three listed plants and one invertebrate. Many of the mapped vernal pools do not contain any of these species. We suggest that additional vernal pool-obligate species be identified to serve as indicators of vernal pool habitat. Adding, for example, *Downingia* and *Psilocarphus* occurrences to the maps would ensure a biological definition for vernal pools, even if particular pools do not support any of the rare, listed species.

We also suggest that reserve design recommendations are needed for vernal pools identified in the Ramona area and elsewhere. A number of small vernal pool reserves have been in place for several years in other parts of California and could provide useful lessons about management needs and level of success at protection.

5.6 Composite Habitat Evaluation Model Results

We are not surprised that the habitat value index component has the largest influence on the composite model results. As discussed above, we believe that several components of this index could be profitably deleted, and that thorough sensitivity analysis and correlation analysis should be used to delete redundant components and/or modify weightings. We also suggest that the cells (and ultimately sites) that fall into the “very high” category need further discrimination and prioritization. A useful method for such prioritization is plotting sites along axes of irreplaceability and vulnerability (Margules and Pressey 2000).

Furthermore, an additional criterion that is central to the efficacy of a reserve system could be integrated to further discriminate and prioritize the value of cells: the shape or configuration of patches that compose a reserve and the position of individual cells within patches. These both influence the contribution of a cell to the overall value of a patch. GIS algorithms exist that can be used to address the shape of patches and the position of cells in a patch, and thus add another measure of value for a cell.

Additional Management Action Needed for Covered Species

We suggest that a number of species in the planning area will require species-based management to assure their viability over time. Below are a few thoughts on management considerations and actions required for persistence of these species.

Rainbow trout- steelhead form: Recognizing that the San Luis Rey River is potential recovery area for steelhead, amend county regulations to prohibit activities that would block fish migration, including upstream diversions that would deprive the San Luis Rey River of needed flows. Ensure adequate water quality and stream channel conditions for migration and spawning. In general, we suggest more attention be given to the San Luis Rey River and its multiple values.

Southwest pond turtle, and all 4 listed amphibians: Surveys for occurrence are needed. Also, specify steps to maintain water quality and a natural flow regime, including seasonal dry-up where appropriate to favor natives over more water-demanding exotic species.

Least Bell’s vireo, southwestern willow flycatcher. Maintain and enhance willow and other riparian habitats. Participate in watershed-level giant reed and tamarisk control after ongoing experiments (not part of this Plan) to identify appropriate host-specific insect herbivores and USFWS approves these insects for release in willow flycatcher habitat. (This will probably occur within 5 years.) The removal of opportunistic species, such as the brown-headed cowbird (but also including crows and ravens in some areas), that have a negative effect on these birds and other sensitive avian species also should be encouraged.

The species distribution (species-habitat relationships) models for these and other birds need to be tested. For example, the predicted habitat has not been rigorously checked against records of the breeding bird atlas to determine prediction accuracy. Other bird species that should be considered for coverage or, perhaps better, increased conservation attention include long-eared owl, short-eared owl, mountain plover, white-tailed kite, California horned lark, and loggerhead shrike. All of these species have been declining.

Maintain disturbance regimes that allow for long-term vigor of riverine habitats for fish, reptiles, and riparian birds.

Mule deer: Manage chaparral and other scrub communities for a disturbance regime that maintains natural successional stages. Maintaining a vigorous deer population is also important to maintain a population of mountain lions.

SKR: One or more SKR management plans will ultimately be required for the North San Diego County Subarea Plan. These must involve grassland management with grazing and burning components. Management that strives to mimic the natural variability of these Mediterranean ecosystems is preferable to regimental adherence to annual or semi-annual treatments of predefined acreages.

Invertebrates: The most important factor for long-term population persistence of invertebrates may be the presence of adequate connectivity among areas of suitable habitat. In particular:

a. Water courses should not have obstructions that prevent the movement of aquatic organisms. Many vertebrates can bypass obstructions that are complete barriers to aquatic invertebrates.

b. The riparian areas adjacent to streams and creeks, especially those that are primarily seasonal, need to be protected even when water is not flowing. This habitat provides for aestivating immature and adult invertebrates.

c. Ridgelines along with associated hilltops are used as flight corridors for many insects, most noticeable being the butterflies. The removal of these habitats will impact mating behavior as well as dispersal. Agricultural development in the Subarea has already affected much of this habitat.

d. For the southern section of the Subarea, and perhaps unknown sites to the north, the Quino checkerspot butterflly is the most obvious example of an invertebrate that has suffered from fragmentation by roads and urbanization. Other sensitive insects may also reflect this pattern.

Lights need to be restricted in areas adjacent to reserves, especially for the protection of certain large and uncommon moth species in the region.

The species of invertebrates in the region that are listed as protected or sensitive are few, but some of them have well-known life histories. Since most are rather restricted in their range of habitat requirements, it would be possible to establish needed habitat parameters for each taxon and develop models to predict their distribution in the region. Of special concern would be Harbison's dun skipper, Hermes copper butterfly, Laguna Mountain skipper, Quino checkerspot butterfly, and perhaps a few others.

Insects and other invertebrates comprise a large component of the local ecosystem. Although it would be impossible to protect all invertebrates on a species-by-species basis, surveys to determine the invertebrate fauna of the region are badly needed. A survey on Miramar Marine Airstation completed in the last few years revealed 625+ species of

Lepidoptera alone, including at least 2 previously undescribed species of moths. The county should undertake similar research/surveys, especially in areas threatened by imminent development, to assess the possible impacts.

Vernal Pool Plant Species: thread-leaf brodiaea, Orcutt's brodiaea, southern tarplant, spreading navarettia, little mousetail, San Diego button celery: Ensuring the long-term persistence of vernal pool plant species within the planning area will require fairly intensive management given their current level of fragmentation and proximity to urbanization. A comprehensive vernal pool management program will likely be necessary for the vernal pool complex in the Santa Maria Valley to ensure a consistent level of protection, management, and monitoring across all vernal pool sites ultimately preserved in this area. Management will need to focus on abating key threats from adjoining development areas, including exotics, urban runoff, and human intrusion. Management programs should include monitoring and management of exotic plant populations, particularly problem exotics such as *Brachypodium distachyon*; monitoring/restriction of public access to pools; construction of perimeter fencing on small vernal pool reserves to protect them from unauthorized uses (dumping, etc.), and development of public outreach programs (brochures, signage, volunteer programs) for vernal pool complexes in downtown Ramona. In addition, local planners/cities will need to work with adjacent landowners to 1) maintain local hydrology to preserved pools, 2) limit the amount of hardscape and landform alteration adjacent to proposed vernal pool preserves, and 3) promote the use of water quality "best management practices" for developments directly adjacent to vernal pool sites.

Engelmann oak: Oak regeneration is the primary management concern, particularly in areas that are grazed. The development of long-term management strategies for Engelmann oak may require some experimentation to determine grazing regimes, restoration methods, and fire management techniques that best promote oak recruitment. Populations need to be protected from intense wildfire or prescribed fire. It is also necessary to maintain or restore connectivity of between populations of Engelmann oaks in the planning area and those in Santa Ysabel/Mesa Grande.

Chaparral Species: Del Mar manzanita, wart-stemmed ceanothus, chaparral beargrass, pitcher sage: Although these species are fire adapted and may even require periodic fires for their reproduction, fires that are too frequent can have a detrimental effect on their long-term viability. Fire return intervals of 5, 10, or even 20 years could eliminate some of these plant populations within the planning area. To abate this threat, we suggest that the County work with state/local fire agencies to develop ecological fire management/suppression plans that identify protection measures for known rare plant populations and other sensitive resources when wildfires occur.

Concerning other species, we refer the reader to the report of the Science Advisors for the Southern Orange County NCCP. We concur with the recommendations offered there for those species that also occur on the covered species list for the North San Diego County Subarea Plan.

Adaptive Management

We do not provide here yet another lengthy treatise on adaptive management. We refer the reader to several recent documents that provide extensive discussions and recommendations for adaptive management, specifically: 1) the 5/97 report on Principles of Reserve Design and Adaptive Management for the Proposed Southern Orange County NCCP, prepared by the science advisors for that process; 2) the adaptive management section, prepared by Dick Tracy, of the 4/01 report of the independent science advisors of the draft Coachella Valley MSHCP/NCCP; 3) the adaptive management program of the Sierra Nevada Framework (http://www.r5.fs.fed.us/sncf/); 4) the extensive published literature on the topic, much of which is cited in the documents listed above. We offer a few summary comments on the application of adaptive management to the North County Subarea Plan.

Adaptive management is a way to address the uncertainties inherent in predicting how ecosystems will respond to human interventions. When adaptive management is applied to habitat conservation planning, it requires a commitment to science as an integral part of land management in perpetuity. It also requires an explicit willingness to modify reserve designs and management practices, to the extent feasible, in response to lessons learned through rigorous monitoring and research (Noss et al. 1997). Hence, an effective adaptive management program includes a method for evaluating plan performance and specifies the alternative conservation measures that will be triggered in the event that performance fails to meet conservation goals (Thomas 2001).

The central component of adaptive management is a competent monitoring program. Monitoring can be divided into implementation monitoring, effectiveness monitoring, and validation monitoring (Noss and Cooperrider 1994). Our comments, below, are organized under these categories, with some additional suggestions for feedback.

Implementation Monitoring

Implementation monitoring should determine how well rules for development in and outside of Pre-Approved Mitigation Areas (PAMAs) have been implemented. Perhaps the most consequential rule is the stipulated mitigation ratio (ratio of acres of dedicated open space to acres developed). (Note: The more basic question of how well these acres have served the conservation goals will be addressed under Effectiveness Monitoring.) For implementation monitoring, we suggest an annual reporting of:

- Actual mitigation for each development project within a PAMA and outside of a PAMA.
- For each PAMA, the average mitigation ratio for all development projects within and outside of the PAMA.
- Progress implementing the Subarea Plan recommendations for limiting discharge and diversion of water to and from significant watersheds; limiting intrusion of noise, light, and pets from developed areas into protected areas; regulating recreational use of protected areas; regulating grazing on protected lands; managing and abating fire;

and implementing design standards to accommodate wildlife movement across new and existing roads.

Effectiveness Monitoring

This is the most important type of monitoring for adaptive management and conservation planning generally (Noss and Cooperrider 1994). We suggest the following as essential elements:

- For each PAMA, annually report acres (by vegetation type) that have been protected versus lost to development. A map showing the spatial configuration of parcels in each PAMA and across the planning area is essential to evaluating these data. A narrative should describe how actions to date address the specific conservation objectives of each PAMA (currently listed in Table 1 of *Proposed Gap Analysis Approach and Preliminary Results*). The focus of the narrative should be on whether the PAMA is on a trajectory to achieve its goals, and if not, what adjustments would be appropriate. The qualitative evaluation via such maps and narratives is at least as meaningful as the report of the raw acreages.
- For the entire project area, a map and narrative addressing the effectiveness of the emerging *reserve system* (i.e., whatever the PAMAs will be called at build-out). This broader scale is most appropriate for evaluating connectivity among protected areas in the reserve system, connectivity between the reserve system and adjacent wildlands outside the planning area, and the contribution of the emerging reserve system to regional biodiversity. This scale of assessment is critical not just for conservation of wide-ranging species whose metapopulations operate on such a scale, but also to assess representation of vegetation types and species in reserves, problems with invasive species, operation of ecological processes, etc. This report should describe the variability within protected habitat types (e.g., varieties of soil types, elevation gradients, or aspects within a vegetation type that have been protected).
- Ideally, the status of covered species would be assessed individually---albeit it is not feasible to base an adaptive management program on the monitoring of individual species (see the 4/01 report of the independent science advisors of the draft Coachella Valley MSHCP/NCCP). Nevertheless, data on the population status and trends of covered species should be reported when available. At a minimum, surveys should be conducted to confirm (or refute) the presence of covered species in parcels acquired for protection.
- For the San Luis Rey River and other major watersheds, report water volume and quality and any impediments to fish movement that have been added or removed to date.

In addition, we suggest the following as valuable (albeit more expensive) components of effectiveness monitoring. Because of the cost involved, these monitoring efforts could be implemented at longer than annual intervals, such as every 3-5 years, but should be implemented initially within one year of an area being placed within the reserve. To allow timely feedback, the first such efforts should occur at a shorter interval (e.g., 2 or 3 years).

- Surveys of protected areas for presence & abundance of exotic plants, fish, frogs, and other taxa.
- Measures of anthropogenic disturbance within reserves and the steps that were taken by reserve managers to mitigate these disturbances. Such disturbances include wildcat roads and trails, unauthorized clearing within reserve boundaries, landslides/erosion caused by adjacent development, human-caused wildfires, and acres in which a natural fire regime cannot be established because of adjacent developments.
- Surveys for presence or movement of carnivores in areas intended to serve as dwelling habitat or connective habitat for these species.
- For vegetation types that co-evolved with a frequent fire regime, report acreage in each seral stage, and how this compares with the proportions expected under a natural fire regime.
- Surveys for feral and domestic cats in reserves. Evaluate whether relevant regulations in newly-approved developments (compared to existing developments lacking regulations) appear effective in addressing this issue.
- Evaluations of weed management strategies.
- Surveys to document mortality along roads with and without design modifications to allow wildlife movement.

Finally, we recommend an independent external review early in the life of the Plan. The PAMA approach involves more uncertainty than a "hard-line" reserve network, because the ultimate reserve design is not known in advance, but emerges as the result of many individual permitting decisions and mitigation measures. Although we appreciate the political necessity for the PAMA approach, we strongly feel that a timely reality check is needed to confirm whether the emerging reserve system is on a trajectory to meet overall conservation goals and the goals of particular PAMAs.

We recommend the review date be set as that at which 25% of total PAMA acreage has been committed either to protection or development. This should be late enough for a trajectory to be evident, and early enough to implement adjustments if needed. This review should consist of two phases, namely an evaluation of individual permitting decisions and an evaluation of the trajectory of the emerging reserve network. Alternately, a time deadline for the outside review could be established. If 25% of the PAMA is not quickly committed to protection or given over to development, it would be prudent to initiate independent review, perhaps no later than two years after the Plan has been approved.

- **Review of Specific Decisions**: The County should solicit comments from USFWS, CDFG, developers, consultants, environmental groups, and other interested parties and stakeholders regarding the effectiveness of specific implementation decisions in meeting conservation goals. From this, the county should draw up a list of permitting decisions that at least some observers considered ineffective (or overkill) as conservation measures. The County should convene a panel of independent conservation biologists to review 10 such decisions (either by subsampling, by the panel, from a longer list or randomly adding to a small list of controversial decisions) and provide a written evaluation on the effectiveness of each decision in reaching the Plan's conservation goals.

- **Review of overall effectiveness of the Plan**: The County should provide monitoring results (outlined above) to the review panel to judge whether the Plan appears to be meeting its objectives on 3 spatial scales (PAMA, planning area, and larger region), and to recommend appropriate adjustments.

Validation Monitoring

Validation monitoring involves an assessment of the validity of assumptions underlying the adaptive management plan and, ultimately, the entire conservation plan. The Habitat Evaluation Model contains many assumptions about factors that govern the distribution and abundance of species in the planning area (and beyond). Based on these assumptions, the model makes predictions about the relative value of different areas of the region for conservation. Although the coarse scale of the model and its components may prohibit rigorous testing of model predictions as they apply to particular parcels, we encourage such testing when possible. More importantly, the overall process of identifying and delineating PAMAs implies a family of related hypotheses, such as: "This procedure can yield a reserve system that protects viable populations of Stephen's kangaroo rats and California gnatcatchers, vernal pool ecosystems capable of functioning with the historic range of variation of this ecosystem type," etc.

Whether or not the hypotheses associated with the Habitat Evaluation Model are true depends, in large part, on the validity of underlying assumptions. Focused research is required to test model predictions and assumptions. Indeed, validation monitoring can be considered synonymous with research (Noss and Cooperrider 1994). Although generally not considered part of adaptive management per se---mostly because of the time and expense involved---the results from research funded by other sources should be taken advantage of whenever possible. The County should keep in contact with academic and government researchers to keep abreast of relevant findings and to suggest worthwhile research topics that may yield information useful in the implementation of the Plan.

Feedback Mechanism

The outside review at 25% implementation or 2 years (see above) will provide a valuable feedback mechanism, but it may not be sufficient. It is necessary to have a mechanism whereby by the Plan or its implementing regulations are modified in a timely fashion in light of monitoring results---as noted earlier, such a trigger mechanisms is an essential component of adaptive management. One way to initiate such a feedback mechanism would be to convene a committee that would be charged with reviewing and discussing the annual reports mentioned above. Such a committee might be dominated by County staff and supplemented by representatives from CDFG, USFWS, TNC, consultants, and other knowledgeable individuals.

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Appendix A: SKR/Grassland Management Model