Title
Scientific Review Panel Review of: Final Draft Western Riverside County MSHCP Document

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Scientific Review Panel

Review of:

Final Draft Western Riverside County MSHCP Document[1]

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Summary

The planning approach generally used the best available data. However, they chose not to use the best available scientific models because insufficient survey and population data were available to accurately parameterize the models.

The plan does incorporate NCCP concepts and modern tenants of Conservation Biology. Specifically, there was a focus on protecting large habitat units and linkages between units. These should provide for better linkages among populations and the ability to re-colonize unoccupied but suitable habitat following normal ecosystem perturbations such as drought and fire. Based on existing models, small reductions in acreage could be detrimental but small increases may not measurably improve the plan, especially if the additional lands were not focused with linkages in mind.

The species accounts generally support the protection of the majority of known populations, with a few noted exceptions.

The Reserve description is generally accurate, with some problems noted in the text.

[1] Submitted April 17, 2003

Citation sections are much improved over the previous version, but should be integrated into a single, alphabetical section.

Adaptive Management and Monitoring depends on integrating scientists and managers. The SRP recommends a modification of the Management structure.

Data management ideas need adjustment in order for adequate data to be available for adaptive management. The SRP recommends a meeting of local university researchers (e.g., the Center for Conservation Biology at UC Riverside), managers, regulators, and the San Diego SuperComputer Center (at UC San Diego) and the National Center for Ecological Analysis and Synthesis (at UC-Santa Barbara) to assist in organizing and storing data as the Monitoring and Adaptive Management activity begins.

Introduction

The Western Riverside County Multiple Species Habitat Conservation Plan has been presented to the public as a complete draft having been reviewed and modified as a result of comments from resource agencies, the Scientific Review Panel (SRP), local stakeholder groups, cities, and numerous other individuals at key intervals in the planning process. The goal is to develop a land-use plan that preserves open space for individual species of concern, protects existing natural communities that sustain the biodiversity of the planning region, and creates constraints for planned growth and development of the region that respect the rights of property owners. It seeks to use the “Best Available Science” as an approach to the planning process.

This is an immense challenge and goal. The region is within a global biodiversity ”hot-spot” with greater biological diversity than exists in many entire states. The communities are dynamic and highly variable in both space and time as a result of our unique climatological and geological underpinnings. Finally, the human population growth is among the fastest in the entire country. Indeed, the inland areas of southern California recently gained the reputation as the nation’s worst sprawl.

The SRP recognizes the enormous challenge of this enterprise. The plan is constrained by data limitations and the need to protect appropriate habitats before they disappear. Many of the most useful models of habitat connectedness, viability analyses based on metapopulation dynamics, and multiple-species approaches to planning have come only from the theoretical literature and are very recent. Most tests of those ideas are only beginning and largely being undertaken in areas exclusively within federal lands that can be surveyed. Thus, even the concept of “Best Available Science” is difficult to assess. The “best available data” was integrated. The “best available models” could not adequately be parameterized.

The SRP recognizes that the existing paradigm was that science does not make policy but should inform policy. While that remains true, it is clear that the growing gap between the rapidly-changing science and the policy makers, managers and consultants may simply be too large for a separation, of review by the scientists and action by others, to work adequately.

The future, including management and monitoring of the MSHCP, requires that science be an integral part of the process. Independent review is crucial, but it cannot continue to occur only “after the fact”.

For these reasons, the SRP recommends steps that can be undertaken to better document the science utilized in this latest version of the plan. And, the SRP recommends a modification of the monitoring and management organizational structure.

Finally, the SRP notes a heavy reliance on the Public/Quasi-Public Agencies. A process for guaranteeing coordination among these entities is important.

Reserve Design

Rationale and DUDEK approach

In this draft, DUDEK outlined the approach taken in greater detail than in the previous draft reviewed by the SRP. In essence, the database utilized for creating the MSHCP consisted of two primary sources. The first consisted of records obtained from resource agencies and the second, those that Dr. Tom Scott (UC Cooperative Extension) organized from numerous sources. Subsequently, Dr. Scott organized a workshop of regional biologists and informal knowledge was delineated on rough-draft maps. Based on those rough draft maps, combined with existing data and literature research, additional review of species occurrence data, coastal sage projected distributions existing and planned land uses, and the application of NCCP tenants and Conservation Biology principles outlined in the document, a Conceptual Conservation Scenario was developed and rough acreage was calculated. The rough acreage was based on an analysis of non-protected lands within the Conceptual Conservation Scenario.

DUDEK chose this approach because they argue that the databases and time and resource constraints proved inadequate for rigorous application of design simulation methods. The "Best Available Scientific" models were not applied because insufficient data were available to parameterize and validate the models. Specifically, DUDEK stated that the reserve selection models were reviewed and not utilized because of 4 factors: 1) lack of necessary data, 2) lack of time and resources to collect adequate data, 3) lack of time and resources to validate model results, and 4) scale differences.

The choice to take this approach reflects a dilemma inherent in the application of Conservation Biology theory and practice. While there are useful GIS-based computer simulation design programs and methods (see Root et al. 2003 for the most recently published effort), all depend on a lot of data and on high quality data that were deemed limiting to this activity (see Stokes and Morrison 2003 for further discussion). For example, SITES requires reasonable estimates of the dollar value of lands under consideration. This is acceptable in areas with a few large landowner tracts or on federal or state lands that can be studied. Western Riverside County has thousands of individual property owners with varying land sizes and shapes, and assessing reasonable figures is almost impossible. RAMAS is dependent on good distribution and metapopulation information. While some useful data sets exist (e.g., Akcakaya and Atwood 1997, Price and Kelly 1994), most of the species in the plan area have little or no relevant life history information. The lands under consideration for Preserves were also highly constrained by the patchy quiltwork of past development, cities, roads, and agricultural units. These are not in larger quarter section units or even linear, so that accurate modeling remains of limited value.

The SRP accepts the idea that, in general, the data were insufficient to use the reserve selection models for most if not all of the species noted. We also understand the task faced by DUDEK and the County because such a large amount of land to be added is in private lands, and adequate surveys on private lands was not possible due to historic lack of access to these private lands. This makes accurate applications of the GIS-based population viability-based models virtually impossible unless more intrusive approaches are employed.

The SRP is not clear as to what an "Informal Gap Analysis" is. But based on the discussion in the draft MSHCP, it appears that this was the process used to identify lands that were considered desirable for conservation, but had no conservation-based protections placed on them. The core areas represent a visualization of the distribution of the species distributions based on the spatial compilations of Dr. Scott and other sources, overlain on the vegetation types indicated in the maps. Landscape linkages, movement corridors, constrained linkages, localized resources (e.g., vernal pools, delhi sands) were also added.

Despite the lack of application of more formal analyses, as far as the SRP can ascertain, NCCP tenants and Conservation Biology principles were integrated into the Reserve Design.

Structure of Design

The amount of land chosen for inclusion into the MSHCP Conservation Area is relatively large, 347,000 acres plus 153,000 acres of land to be purchased from existing private properties, for a total of 500,000 acres. This acreage will not come from condemnation but from willing sales. While this approach is laudable politically and socially, it does place constraints on the design available.

To best understand the implications of the Reserve Design chosen, three general issues must be considered. The first is, does the overlay actually provide for the protection of legally threatened and endangered species. The second issue is, does the design reflect an adequate degree of connectivity sustaining the ability of species to re-colonize suitable but unoccupied habitat in the highly variable environments that characterize this region. And the third is the organization of large units and minimal edge appropriate to sustain the species of concern, and the ecosystem processes that provide adequate habitat for them.

Individual Species Overlays. The Reserve design appears to cover much of the habitats of the species chosen for inclusion and to cover the various identified communities as defined in the document. The coverages for each species are listed in the species accounts. As a group, these are highly variable as would be expected in any single design.

Simple approaches, such as simply overlaying the threatened and endangered species and covering those as a base, will not work. We overlayed just federally-listed species onto a single grid and found no easy way to overlay a reserve configuration. The distribution is simply too widespread (Figure 1).

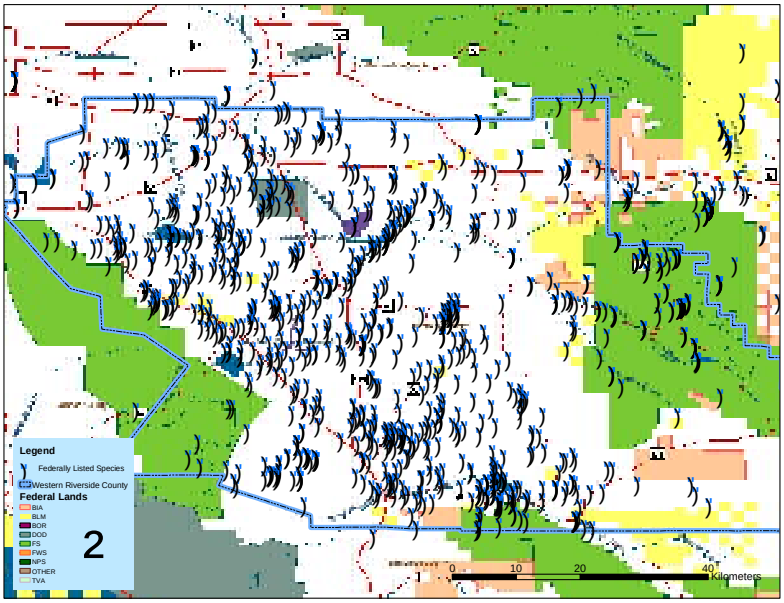

Figure 1. Generalized historical distribution of federally-listed species within the western Riverside planning area putting together all species (http://ecoregion.ucr.edu/).

In the past, efforts were made to identify an "umbrella species" whose distribution would provide coverage for all species. Unfortunately, two separate analyses of the species in this region both failed to find that adequate umbrella species were available. Chase et al. (2000) and Kryvaruchka and Scott (unpublished manuscript) both failed to find a single species that would satisfy the range necessary for the plan. Thus, each species and vegetation type (used as an indicator of habitat type) was evaluated separately. 130 of the 146 species were integrated into the general MSHCP. 16 were determined to have narrow ranges or specific requirements, and habitat was designated separately and specifically.

Of the 130 species covered by the MSHCP plus the 16 species conditionally covered, the proportion of the population within the reserves varied widely. Without additional surveys, the SRP would conclude that the reserve design probably incorporates most of the known remaining habitat for the listed species. Often a direct replacement up to a three-fold mitigation ratio is utilized for individual developments. If this were the case, one would expect that 50 to 75% of the acceptable habitat would be conserved and generally only 25 to 33% of the habitat for sensitive species would be subject to take. In the majority of cases, based on potential habitat, the range is probably acceptable. However, the habitat typing is dependent on a reduced number of vegetation types (14) derived from a coarse analysis (50 in the Holling code). In looking at individual distributions, the majority of records are incorporated into the reserve design. Unfortunately, without more detailed modeling, it remains impossible to determine if the habitat protection is adequate.

Contrary to the recommendation of the SRP, the important goals of the plan remain largely buried in the individual species accounts. This makes them hard to reference easily. Generally, 60% or more of the potential habitat and individual known populations were incorporated into the new reserves, or existing public and quasi-public lands.

Whether these levels are likely to be adequate cannot be evaluated as no viability analyses were undertaken for any species. In most cases, the existing data remain insufficient for a viability analysis.

The SRP remains concerned as to the information base and status on the Delhi Sands Flower-loving fly and the Quino Checkerspot Butterfly. The biology of the Delhi Sands Flower-loving fly remains poorly known. No data on host relationships, life history characteristics, or other important biological parameters are known. Recovery efforts for this species should address additional studies of the basic biology of the species. As for the QCB, plans are made to "funnel" it to highway over- or underpasses to allow migration. This idea was previously rejected by the recovery team (see the US FWS 2002) as the basic dispersal patterns remain unknown and may very well simply be a general percolation pattern. However, in light of the foreclosure of options of the species due to development in the Southwest Riverside Recovery Unit, application of this strategy may be warranted. Clearly, there remains much to be studied before recovery can be assessed.

Narrow Endemics. The SRP noted that narrow endemics require site-specific focused surveys where soils or habitat is present, reviewed by permittee and subject to avoidance, minimization, and mitigation. Protection thus depends on continued vigilance of the FWS.

Species Analyses prior to take authorization. Sixteen species require further evaluation and, if conditions are met, will be retained as part of the MSHCP permit. For these species, little background information is available. The information sought is arbitrary but may be acceptable in many cases, subject to further research and evaluation. In some cases in the documentation, editing requires further work. For example, for the grasshopper sparrow, incidental take will not be approved until objective 3 is met, but there is no objective 3. For Lincoln's sparrow, incidental take will not be approved until objective 2 is met, but we assume the text refers to objective 3. These cases represent examples where additional editing of the document is warranted.

Specific objectives are not clear but are probably acceptable in many cases. In some cases, specific numbers are applied (100 populations, 1,000 individuals) with no citations demonstrating the scientific relevance of these numbers. If accepted that these numbers represent arbitrary values, action should depend on scientific studies developed through monitoring and adaptive management research. Then they may be of value. Otherwise, we are concerned that these numbers become ingrained into status beyond their real value.

In other cases, more information actually is in the analysis than presented and supports the reserve plan. These should be documented.

For example, the grasshopper sparrow, although 71% of the potential habitat (broadly, grasslands) remains outside the MSHCP reserve network, 96% of the native grassland is within the reserve and only 4% is outside and not conserved. Most of the 71% is exotic grassland and likely not good habitat for grasshopper sparrow. Of concern, 7 known point locations are outside the reserve.

For others, additional documentation or surveys may be needed. Many of these are noted in the plan as needing additional work.

For the Lincoln's sparrow, only 45% of the breeding habitat and 46% of the wintering habitat would be conserved, and 55% and 54% of the wintering habitat, respectively, would be subject to take. However, there is a requirement of 100% occupancy in 3 core areas, occupying 100 or 50 acres, with 20 pairs demonstrating successful reproduction. Unfortunately, the numbers appear to be arbitrary with no citations demonstrating that these values have a scientific basis.

For the San Bernardino Flying Squirrel, there are virtually no data on which to base any decision. The decision not to provide take until at least survey work is completed is appropriate. Unfortunately, we do not know where the numbers come from. For example, where does the occupancy of 2470 acres at one individual/1.23 acres values for the San Jacinto Mountains come from? (Mixing English and metric units creates confusion; one or the other should be utilized.) Clearly, additional study is needed for this species.

For the 13 plants in this status, in most cases, a two or three to-one ratio of protected to no conservation potential habitat ratio and/or point localities are preserved. Since take is dependent upon demonstrating through additional survey work, that additional populations are present, these should be adequately protected. Exceptions that should be carefully re-evaluated include the Peninsular spineflower (*Chorizanthe leptotheca*). 12 of the 17 recorded locations will not be conserved. Plummer's mariposa lily (*Calochortus plummerae*) has 9 records in herbaria, but only 5 of those in the MSHCP. Of the 17 total records, 8 are not conserved, or approximately half. The Rainbow manzanita, *Arctostaphylos rainbowensis* only has 55% in the MSHCP, with 45% potential take. The small-flowered microseris (*Microseris douglasii* var *platycarpha*), a vernal pool species, has only 33% (or 38%- both numbers are presented) of the potential habitat in the reserve. However, of the 30 recorded locations, 23 are protected. These species need careful additional consideration as indicated by the required additional surveys.

The SRP also notes that no information on pollinators is presented (or known?) for any of the species listed. Linkages provided in the plan for pollinators was not addressed in the document and should be. Many of these may, in fact, be among the poorly understood insect fauna noted elsewhere.

Reference citations. The references were much improved in this draft compared with prior drafts. Efforts were made by DUDEK to incorporate the references provided by both Dr. Scott and by the SRP. A references section was added to the proposal. Unfortunately, references were never consolidated into a single section, but was scattered for each species and, in the Reference section, broken by topic areas. This makes the search of literature very difficult.

Dr. Scott developed a scale of accuracy and information was coded as to status (voucher specimen, refereed publication). DUDEK was provided this information and it was incorporated into the information used. We did find that most of the distributional information was utilized in articulating the plan boundaries.

Grassland. The SRP remains concerned that grassland is not distinctly separated into the annual, exotic grassland that is rapidly expanding, from the native perennial grassland, which is remaining stable or declining. The MSHCP should more clearly state that nearly all (96%) of the native perennial grasslands are conserved. Unfortunately, we know little as to the animals and plants which annual exotic grasslands support and the role of these grasslands in the larger conservation plan. Although these communities support animals like the Stephens Kangaroo Rat, raptors such as the red-tailed hawk, and even reports of

grasshopper sparrows, these areas may serve as a marginal habitat or even sink for many species. However, in some cases, restoration to annual forblands or coastal sage, may someday be possible, at least on lands forming important linkages, and should be retained in the reserve. However, these annual grasslands are clearly in need of additional research and survey.

Vernal Pools. The SRP remains concerned with the wording of protection for the Vernal Pool watershed protection. Vernal pools require not only the area they directly occupy, but also protection of water quality and quantity from the watershed in which they are located. Roads and development upstream has the potential to permanently disrupt or destroy these extremely sensitive habitats. This pattern is becoming evident at the Santa Rosa Plateau. The vernal pools themselves are protected, but development up the watershed threatens to result in eutrophication of the water, which could increase competition of exotic weeds, and the input of pesticides used on lawns and houses, with unknown impacts on the vernal pool flora and fauna. The watersheds of all vernal pools need protecting.

We are also concerned with flooding areas. Many plant species of concern, and some animal species are dependent on periodic flooding. Channelization, such as along the San Jacinto River and Proposed Extension of Existing Core 4, and Constrained Linkage 19, could be devastating to many species. A process for consideration of a flood control project within the San Jacinto River is addressed in the plan, and is based on criteria to meet the stated species objectives for the plant species of concern.

New and undescribed species. We remain concerned that the efforts made to address invertebrate or insect biodiversity beyond the three species (Riverside Fairy Shrimp, Delhi Sands Flower-loving Fly, Quino Checkerspot Butterfly) was limited to indicating that new listings was possible. However, we acknowledge that the MSHCP is intended to support Permits for Take Authorization that does not include these species. There are many undescribed insect species in the plan area and the existing collections were not further consulted as far as we know. While most of the endemic collections have occurred on lands that are or will be integrated into the plan (Gavilan Hills, Lake Skinner, Delhi Sands), others are likely unexplored. The County and public should be aware that this represents a major unknown area. We recommend that the Monitoring and Management activities carefully address the issue of new and endemic taxa. The experts at the UCR Entomological Museum and other regional collections (LA County Museum) should be consulted and extant records organized.

Plants A detailed overview of plant concerns was provided in the last review of the Draft by Steve Boyd, of the Rancho Santa Ana Botanical Garden. Incorporation of the comments was applied in a selective manner. In some cases, personal communications were integrated and some of the references considered. Others were not considered integral based on review by DUDEK and determination that the sources were lacking appropriate information. The SRP recommends that the memorandum in the last review be re-consulted to make sure all concerns were addressed. Especially concerns as to *Atriplex* systematics (*A. coronata* var *notatior*, *coulteri*, *parishii*, *serenana* var *davidsonii*) needs to be integrated and appropriate references consulted (Welsh draft on-line treatment, Flores-Olvera 1992, Flores-Olvera and Eercado-Ruaro 1997).

The lack of response to the missing reference to the CNPS updated documentation is troubling. DUDEK should consult the most recent version of the CNPS Inventory of Rare

and Endangered Plants of California, 6th edition- Tibor, D.P. editor, 2001, and make sure that appropriate information is incorporated and documented.

As discussed above, the organization of the references section makes evaluation of the scientific literature especially difficult. The SRP recommends that a single references section, alphabetized for searching, comprise the reference section.

Uncertainty. The SRP remains concerned with the lack of quantitative analysis of persistence of individual species as outlined in our first review and continuing to our last review. We recognize the reluctance of DUDEK to run PVA or other models because of the uncertainty in the quality of the data. (The proverbial garbage-in, garbage-out, analogy is often cited- see Stokes and Morrison 2003). However, there should be some appropriate data sets. The SKR HCP was initiated almost a decade ago. There are several measures of dispersal, reproduction rates, and habitat preferences in the literature. Data on the persistence within the reserves should have been collected which would allow some test runs of appropriate models. However, inadequate data records were kept and monitoring activities were relegated to low priority in many cases (Diffendorfer and Deutschman 2003). Prioritization of monitoring data collection and modeling of the resulting populations of concern must be undertaken in the MSHCP. We will address this issue again later in the Monitoring and Management section.

Note: the term corridor, as used in the conservation biology literature, is largely replaced here with linkage. Corridor is also a term used for the transportation section of the RCIP and to avoid confusion, we will remain with the term linkage as defined by the Draft MSHCP.

Degree of Connectivity. A crucial tenant in conservation biology and the NCCP design elements include large reserve units and connectivity between units (Beier and Noss 1998). Large reserves support more individuals and species, as a rule, than small reserves (e.g., Crooks et al. 2001). Connectivity allows connected small units behave as large units and large units behave like even larger units. These ideas are based on island biogeography and metapopulation theory elucidated over 3 decades ago. Linkages are critical structures within landscapes to preserve individual species and biodiversity in general. The struggle to develop appropriate levels of connectivity is well documented in the response comments to previous MSHCP drafts. Connectivity is a complex issue, and has proven to be the most difficult conservation tenet to apply to real world scenarios. There is no dispute among ecologists, geneticists, and population biologists, about the fundamental importance of maintaining natural connections among populations; however, the untested nature of connectivity proposals remain the primary reason for policy disputes over preserve linkages. While there are few experimental tests of these theories in this region, in other areas, corridors were demonstrated to increase both plant and animal movement as well as facilitate pollination and seed dispersal (Tewksbury et al. 2002). Thus, the predictions are robust enough to form the basis of appropriate design. We believe that there is a theoretical basis for evaluating the design against the no-plan alternative, and compare with proposed ideas of both greater and lesser acreages. This model (see figures below) can compare the efficiency of comprehensive planning (such as the MSHCP) versus random acquisitions (current direction of open space in the study area) in achieving ESA mandates for viable populations.

In addition, large animals need large amounts of space and, because all space in southern California is limited, linkages represent the only opportunity for animals to disperse, find mates, and search out new habitat. For example, no reserve unit in the MSHCP is adequate to support the Mountain Lion (Grigione et al. 2002), and probably few to support the coyote or bobcat as a population. Using linkages, the entire reserve can become the unit. The current reserve design largely may sustain these species by providing linkages that allow these species to perceive the environment as a larger "unit" than actually protected. Smaller animals will move across the landscape during periods of high population densities. These movements do not necessarily occur every year, but only during periods of rapid population growth. These movements are critical in our region. Most small animals exhibit metapopulation dynamics. That is, they disappear from patches (local extinction) in response to stochastic events. Those patches are then re-colonized during these high population events (such as years of high rainfall). Other patches may then suffer extirpation during the next drought or fire, but recover in the same manner. In this way, many species sustain their populations by using different patches around the landscape at different times. If unoccupied patches become inaccessible, those same stochastic events that triggered loss in one patch accumulate and eventually the entire species goes extinct.

Finally, plants are often dependent on linkages. They also migrate and show metapopulation dynamics. But, just as important, many plants are dependent on pollinators that utilize the same linkages.

These same linkages are important not only for individual species, but also for entire communities. The studies by Soule' and colleagues (Crooke and Soule' 1999) show that in patches where the top predator is lost (e.g., coyote), mesopredators increase. These animals can be much more destructive to shrub and ground-nesting birds than the larger predators. Thus, sustaining many species depends not only on providing habitat for an individual species, but also the entire food web (up and down) comprising the local community. This means providing linkages between the larger units.

Of special note, most of the threatened plants are pollinated by insects. The only means to protect this process is to integrate connectivity explicitly into a large-scale design. No information is presented in the documentation (and we know of no relevant studies) on the pollinators, or their use of the habitat. They may very well depend on linkages between widely-dispersed populations for pollination to be successful and gene flow and reproduction to be sustained. Simply protecting small patches of land surrounding individual populations may well doom these species over the long term.

Theoretical analyses using fractal geometry have examined the ability of material and energy to flow between cells across a fragmented area. Plotkin and Gardner (1993) noted that if area units were randomly chosen, 59% of the "cells" within the land area would need to be filled as a reserve if percolating clusters were to be maintained allowing organisms to migrate across the landscape and maintain re-colonization potential. This pattern is illustrated below in Figure 2. With and Crist (1995) found that, using a modeling approach, this was a critical threshold in sustaining populations if the reserve were constructed at random.

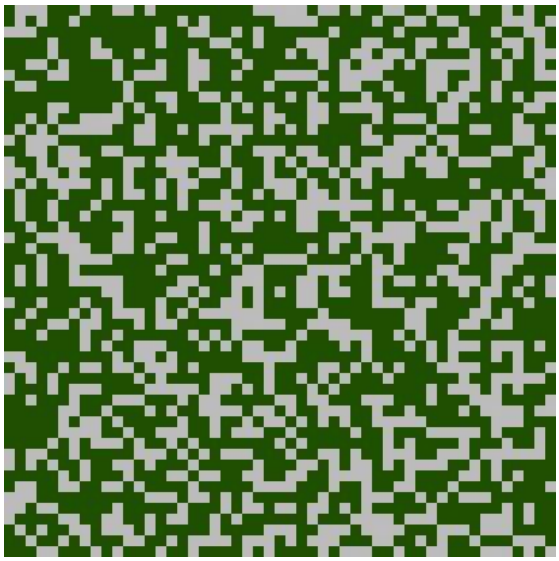

Figure 2. A simulated landscape with 60% of the land area in reserves illustrating the minimal level of connectivity with randomly chosen land units. Any less acreage, randomly chosen, would be below the threshold for sustaining dispersal and sever connectivity across the landscape (see With and Crist 1995).

The MSHCP calls for a 500,000 Conservation Area (347,000 existing, and 153,000 new purchases of private lands), which will comprise 39.7% of the land area. If no plan were accepted, we would expect that the new lands incorporated into a reserve would be negotiated between the FWS and individual landowners. This pattern would likely approach randomness, resembling the pattern of suburban units chosen over the past two decades (Scott 1993). If the land purchases continued to follow this trajectory, the MSHCP would be highly fragmented and each unit subject to extinctions with little chance of re-colonization. Further, if patches of land selected for incorporation into the plan were based on each independent distribution point, a map with these points suggests that the reserve would approach a randomly-selected design. To reach the 60% threshold, an additional 250,000 acres would need to be purchased.

However, the MSHCP was organized to try and incorporate large land units and establish connectivity through both live-in and constrained linkages. The resulting reserve is a network with a much lower D value (fractal dimension). This can be seen with the actual plan (Figure 3).

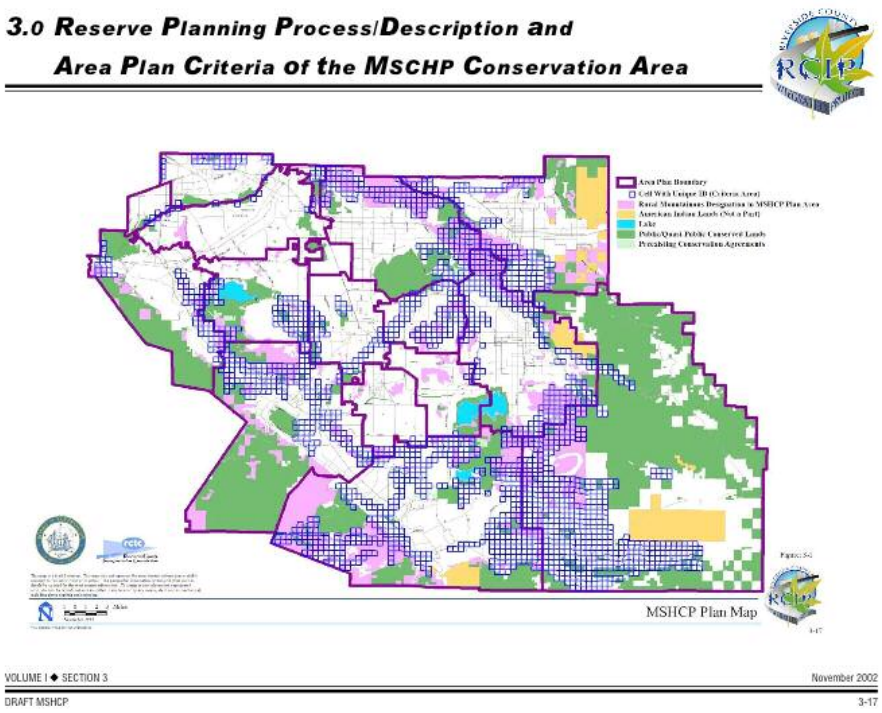

Figure 3. MSHCP plan showing comparatively low fractal dimensional character of the plan.

The importance of maintaining connectivity within populations, linkages for pollinator movement, and providing linkages for dispersal of larger animals like the mountain lion is discussed elsewhere. Those linkages can be constructed by organizing the land acquisitions to create low fractal dimension, or by purchasing large amounts of land (>60% of the area). The pattern differences are illustrated in Figure 4. A 40% land acquisition (=153,000 acres of private lands added to 347,000 acres already in a reserve) if organized with a lower fractal dimension can provide for larger units and connectivity. If randomly dispersed, that connectivity is lost. It will take a large amount of land (60%-Fig 2) to obtain the same level of connectivity as provided by the existing reserve design.

With and King (1999) explored the implications of using connectivity and clumping coupled with the metapopulation dynamics where reproductive outputs and dispersal distances are known. With an H (a measure of connectivity and clumping) of 0.5, a dispersal ability of 2 (where an animal can cross 2 habitat units), and an *r* (reproductive rate) value of 1.10 (representing generations with high reproductive output), the equilibrium patch occupancy (p*) will represent a positive value of around 0.2. A randomly chosen land area would require over 80% of the land area to be habitat before a similar occupancy rate can accrue. The curve drop off is steep, such that lower % reserve (e.g., alternatives 2, 3 and 4 in the earlier alternatives document), would likely take the p* to 0 and extinction.

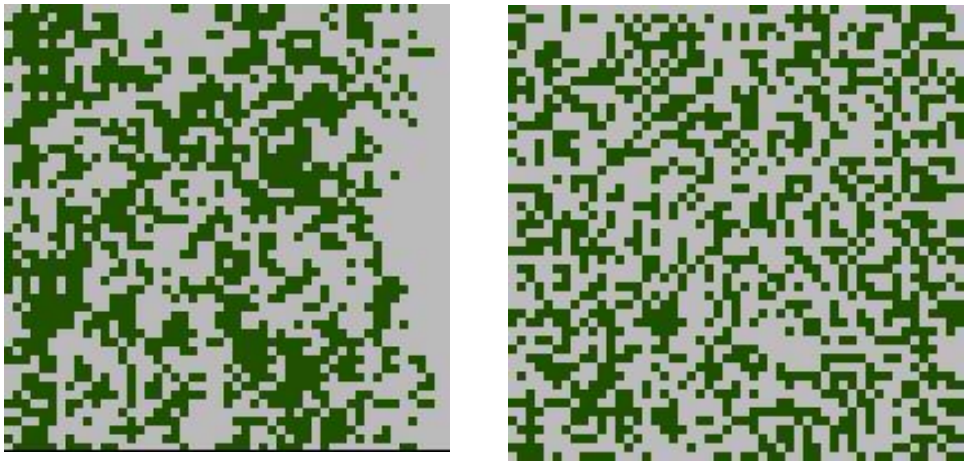

Figure 4. Simulated low-fractal dimension (left) with same % reserve as the proposed MSHCP, using randomly chosen cells contrasted with the same % of area using a completely random set of cells (right).

This represents an important point. If the land acquisition declined from the 153,000 acres to 70,000 (35%) or less, p* drops precipitously. A small increase in land area would have little impact on connectivity, especially if the purchases did not focus on connecting units. It may take more than an additional 250,000 acres of land purchases to measurably improve the p* value if connectivity were lost as a focus. This is because the relationship between p* is curvilinear (With and King 1999).

The analysis shown above assumes a high *r* value and a relatively high m (dispersal) value. The *r* value is above the mean value that reported for Stephen's Kangaroo Rat but within the range depending on the spatial location and year (Price and Kelly 1994, McClenahgan and Taylor 1993). We infer that the higher reproductive output necessary for sustaining occupancy will come only during good years. During years of extended drought, individual metapopulations may well go extinct. But, under the linked MSHCP design, the reproduction should be adequate for many of the species to recolonize. The *m* value (dispersal distance) also appears to be within the range of many species if linkages are real and maintained. Kangaroo rats will preferentially occupy their local habitats, but when the habitat is occupied, may move greater than 400 m (Price et al. 1994). Horned lizards will move over a km in search of food resources or mates if they can follow appropriately-maintained linkage.

Another concern derived from this simple exercise, is that p* is still only about 0.2, meaning that at any time, even under equilibrium conditions, many of the patches will remain unoccupied. Even for species with a high dispersal ability (e.g., *m*= 20) the p* will only approach 0.7 with a 40% preserve. This poses a dilemma for the plan and the management agencies. If a patch is unoccupied, there will be pressure to declare the site uninhabitable and developable. Alternatively, there may be calls to do something to "recover" the species because less than 70 or 80% of the habitat remains occupied. Developing a long-term database to test these models is absolutely essential in the Monitoring and Management process.

This simple analysis remains theoretical. Moreover, we do not have the actual D values, but have estimated them from visual similarity and simulation. Thus, the other point this

analysis raises is the critical importance of a careful monitoring and adaptive management program. A solid monitoring and research program is essential to developing the data sets necessary to create predictive models. And, management strategies must be developed that allow for flexibility that will act to sustain these populations.

Linkage Structure. The current MSHCP incorporates many connections including riparian and flood strips as either live-in or constrained linkages. For these linkages to be effective, they must not become severed by super or busy highways and must follow natural movement patterns of the species in the region. However, there are points at which proposed highways directly cross the linkages. For example existing linkages A, B and E and proposed linkages 17 and 18 are bisected by highway 79. Careful design of the points of intersection is essential.

Some species follow natural features. For example, mountain lions move along riparian strips (Dickson and Beier 2002). These landmarks must not dead end into suburbs and shopping malls. This immediately sets up conflicts between wildlife (mountain lions) and people. Temecula Creek (linkage 14 and constrained linkage 24) is an example of a dead end trapping mountain lions and other species.

A culvert is not a linkage for most species if they cannot see what is waiting for them. In other cases, many species, such as the Quino Checkerspot, diffuse across the landscape and fly at approximately 1 to 2 m high across the landscape. This puts them at the right height to be devastated by a major highway bisecting migration points. Unfortunately, we know of no evidence that these species will use “butterfly bridges” such as are placed in Europe. New designs of transportation corridors for and monitoring of the ability of animals to traverse these points of intersection are an essential step in the actual building of these highways and floodways.

The linkage barriers should be evaluated at the design level of planning for these facilities through the application of conservation goals and guidelines provided in the plan.

Finally, in the plan editing, each linkage must address particular needs. Simply linking to bobcat, coyote or mountain lion movement is not a good justification for a linkage. The current draft contains many improvements in this regard. However, each particular species needs need careful assessment as to the linkages important for it. This will be critical when the actual land purchases are underway. Some are live-in linkages (such as constrained linkage 19 and linkage 7) are essential for maintaining genetic connections for kangaroo rats and mesopredators, or pollinators for particular plant species. The linkages should not just have a general function, but should serve particular goals and should be independently justified as to particular species or communities. This justification will also serve as the basis for the monitoring program for each unit.

Unit Size and Biodiversity. The land area of a reserve unit is related to the numbers of individuals supported and the number of species comprising the natural community. Large vertebrates are indirectly very important to songbirds by regulating the densities of mesopredators. Large predators require large land areas to have an adequate food base to sustain their own populations (for example, a single mountain lion needs about 43,000 acres- Grigione et al. 2002). The largest block new block is 50,000 acres (new core 7), which would support no more than 2 individuals. As the MSHCP acknowledges, any single unit would provide inadequate habitat for mountain lions. The importance of the plan is that the entire plan focuses on functioning as a linkage, such as between the Santa

Ana, Palomar and San Jacinto mountains, and as temporary habitat for dispersing juveniles. Just as important, those land units have to support some individuals during poor conditions (such as drought and fire) in mountainous areas. With an adequate linkage structure, it is possible that many of the larger predators will survive by migrating between reserves.

In the case of many smaller animals and plants, they will not be able to migrate between the reserves. Thus, these need to be appropriately large to sustain them. Further, because the MSHCP is based on the NCCP concept, we must consider the status of entire communities. Based on island biogeography theory, the number of species (s) is related to the area (a) to an exponent (z) that is related to the degree of habitat diversity at a scale perceived by the organism, where: $S = ca^z$ (c is a constant derived for each setting). The z value can be relatively low for animals in a continental setting (generally in the range of 0.15 to 0.25). However, for insects (including pollinators) and fungi (including symbionts essential to growth of trees, shrubs), that value can range up to 0.5 to 0.6. A single reserve severed by a transportation or suburban corridor will likely result in a large amount of undetected extinction of the many organisms that contribute to the persistence of the overall community. An example is the proposed core 1 (divided by highways 60 and 79) and core 1 (I-15). These would be multiple cores, not a single management unit.

What this means is that to sustain a viable community that supports the suite of species important to the region, that individual reserves need to be as large as possible. Further, the linkages between them need to be adequate to allow persistence of population connections and dispersal.

Increases in the total land area, if less organized, could provide less protection for the community.

Edges. The MSHCP has focused on incorporating many large units scattered around the plan area. This minimizes the edge area. This is an appropriate direction. We are concerned with two aspects in the plan. The modified reserve outline was never re-calculated based on individual units. For example, what is the new size and edge of the new Shipley-Skinner Reserve, consisting of the existing reserve J plus extensions 5, 6, and 7? These presumably are not independent but have a new boundary structure. This would add an important justification to the plan design by reducing the actual edge.

We remain concerned with the viability of the live-in linkages and constrained linkages. Much of the validation of the plan acreage is dependent on real connectivity and the ability of metapopulation species to re-colonize unoccupied but suitable habitats rendered open by stochastic events. The long-term viability of many of these species depends on the viability of these linkages. Linkages are not the equivalents of smaller cores. Each linkage has unique characteristics and often supports a unique species grouping (Perault and Lomolino 2000).

Careful assessment of species responses to edges and community-level analyses should be undertaken as part of the monitoring and management. The SRP is especially concerned with ecosystem-level dynamics of edges (invasive species, fire). Edges have often been subjected to repeated disking, a process that promotes the growth and persistence of exotic grasses, as a method of “fire control”. The grass production is a causal agent of increasing fire cycle (from 35 years in coastal sage to 3-5 years in annual grasslands), which is detrimental to both wildlands and suburban housing.

Isolated Reserves. The SRP is concerned with the persistence and viability of isolated reserves, as noted in our prior review. In particular, the Motte Reserve, the Hemet Vernal Pools, Sycamore Canyon, the Box Springs Mountains, the North Shore of Diamond Valley Lake, and Bogart County Park, are all becoming isolated. Special efforts to provide linkages are important to the viability of these reserves. If these become isolated, relaxation can be expected and some species will be extirpated (Crooks et al. 2001).

NCCP principles and ecosystem processes

Biodiversity and Community

In addition to protecting individual species, the State of California recognized that organisms do not exist outside the context of their environment. This led to the natural communities conservation protection (NCCP) principles. In essence, the western Riverside MSHCP seeks to make more than individual small zoos for the current species of concern. It attempts to protect the larger biodiversity of the unique ecosystems of the region. Thus, one focus is to define and protect examples of the different communities within the region. Natural Communities were delineated based on the 1995 vegetation map. While the map needs updating, and that is a task under the monitoring and management activity, it is a process that will take several years. Moreover, no vegetation map will precisely delineate a "natural community" because communities are heurestic tools. Two groupings of communities exist in the scientific literature. The first is the organisms existing in a visually-similar unit. This has obvious mapping value, but boundaries are exceedingly difficult to define. A second is the species that influence each other's fitness. This definition is impossible to map.

Thus, the SRP recognizes that the current communities classification, while it was created in 1995, still represents an appropriate initial organizing tool for the reserve. A more detailed mapping activity (underway as a collaboration between the CNPS, the CDFG, and the UCR-CCB) is needed for management and monitoring.

Natural Disturbance and Reserve Design

Fire and drought are dominant features of ecosystems in this region. Coastal sage has an average fire frequency of about 35 years, chaparral of 65, and the forests (in dispute among fire ecologists see special issue in Conservation Biology on fire frequency) something longer (see papers on fire in Conservation Forum, published in Conservation Biology vol 15, no 6, Keeley and Fotheringham 2001, Minnich 2001). Importantly, the invasion of exotic grasses has increased the fire frequencies to every 3 to 5 years. These fluctuations vary due to the time taken to build up adequate dry (dead biomass) fuel in the different vegetation types. An example can be seen on the north side of Mount Rubidoux in Riverside. Prior to an intensive and expensive mowing program, the invasive grasses burned almost every year in conjunction with the annual 4th of July fireworks. However, a restoration project using coastal sage species resisted the spring 1998 fire, because it occurred when the restored shrub stands were young and fuel load had not built up (several years are required) and because the grass production was inhibited by the shrub stand (Cione et al. 2002). Because even during years of high precipitation (e.g., El Nino years), there remains a long dry season, fires can occur at any time dependent on the fuel loading. Because the exotic grasses represent such a fine fuel loading, fires in coastal sage with a heavy understory of grasses, or grasslands often burn extensively during relatively wet years. Examples include the large fire outbreaks in fall of 1993, including

the Shipley-Skinner Reserve, which burned 6,000 acres of the reserve. Chaparral fires are most prevalent when the dead material has accumulated (greater than 60 years) and associated with drought. Examples include the large fires of fall 2002.

Drought is important because of its impact on the fuels that drive fires and because it directly affects growth and seed production of plants, forming the base of food webs for animal species of concern. Climatological analyses have improved dramatically in the past decade. Analyses have shown that during the 1990s, precipitation was among the highest in many centuries. Most analyses indicate that we are headed into a prolonged period of lowered precipitation including strengthened La Ninas and weakened El Ninos (Minnich personal communications, Milne et al. in press).

Long-term climate models project increased average precipitation in response to increasing ocean temperatures, especially creating increasing summer precipitation. Under this scenario, the major change will be an increasing grass frequency and a concomitant increase in fire frequency.

Importantly, some species in the plan depend on fire; these are considered fire-following annual plants. Thus, fires are essential to maintaining some species. Just as importantly, some only exist in older successional stands, those with long periods without fire. Both groups therefore depend on patches of different ages of plant communities scattered across the landscape to which they can persist (in the seed bank, or as long-lived species) or to which they can migrate.

The only protection for these species is a well-integrated plan with large land units and linkages that protect migration and unoccupied, but suitable habitat. These patch dynamics exist at several time scales, most of which exceed the recent documentation of existing populations. For example, the California gnatcatcher requires coastal shrub vegetation, whereas kangaroo rats need open patches primarily forb communities. Because fire is dynamic at the landscape level, these may readily alternate positions over a century. Coulter pine requires fire for the serotinous cones to open. Removing trees by cutting without fire may be a disaster for this species. A fire occurring within a century may be essential for many habitats.

The current MSHCP addresses these needs by incorporating large land units as much as possible.

Human Disturbances and Reserve Design

These issues become especially acute with the growth of the human population in Riverside County. Rangelands have sustained many of the populations over the past centuries. Even tillage agriculture has provided some important habitat, such as compacted soils supporting *Plantago erecta*, the host plant for the Quino Checkerspot Butterfly. However, the current rapid buildup of suburban housing units adjacent to wildlands creates conflicts that must be addressed. Infrequent tillage of reserve edges for fire often encourages annual grass production and can increase fire. Subsidized predators (house cats, in some cases, crows and ravens) can migrate completely across some of the "live-in" linkages.

Boundaries and edges are addressed in the MSHCP, but the integrity of the linkages and even edges of the reserve will be just as much a function of the actual purchasing process as of the design. These edges need to be carefully evaluated upon purchase, and carefully managed to protect the integrity of the reserve.

MSHCP Adaptive Management and Monitoring

Goals for further survey as a function of the monitoring and adaptive management strategy are laudable. However, the SRP notes that we have little information on the population viability of the individual species. No PVA analyses based on life tables, or based on metapopulation dynamics exist for any species in the reserve. Further, no analyses at the community level are discussed in the document. Because of this lack of analytical activity, the numbers (10 sites, 100 individuals, or other arbitrary numbers) presented in individual species goals of the MSHCP are chimeras. Real goals will require scientific surveys and metapopulation models based on distribution and, in some cases, population models as an integral part of the monitoring and management activities.

Much of the monitoring data that have been collected reside with resource agencies. Those data sets collected and retained by the FWS or with the BRD remain unavailable (e.g., the 1993 post-fire surveys of the Shipley-Skinner Reserve) to research scientists. Data on the status of the Stephens Kangaroo Rat, which should be continuous since the designation of the reserves, were collected in a haphazard manner and have provided little information to scientists or to managers of the individual reserves (see Diffendorfer and Deutschman 2003). Documentation of the impacts of the fire treatments at the Santa Rosa Plateau was lost because of a lack of data management by the reserve managers and the resource agencies.

Collaborations between the University of California and the California Department of Fish and Game hold promise, by building and supporting the NDDB database, and by supporting a separate dispersed set at UC facilities.

Thus, intensive data management needs to be funded and remain independent and objective. The National Center for Ecological Analysis and Synthesis (NCEAS) at UCSB and the San Diego SuperComputer Center at UCSD as well as scientists at regional universities should be consulted as to how best to organize such an activity as part of the monitoring and management process.

The importance of the Monitoring and Adaptive Management of the plan cannot be underestimated, but must be an evolving and iterative component. Little can be written in this section that will provide specific guidelines because these must come with the necessary surveys, improved vegetation mapping, careful scientific descriptions of initial and changing conditions, and further research on viability modeling, restoration, and landscape ecology. The CDFG and UC collaborative efforts provide promise. But these efforts must continue and expand to collaborations with the FWS and the Reserve Managers.

Management Structure

In this context, the management needs re-consideration. As per Section 6.6.6 and 6.6.7, this structure calls for a Committee of the Reserve Managers, an Executive Director, and a Scientific Review Panel. The Executive Director oversees the Reserve Managers from a variety of agencies. The Independent Science Advisors (ISA) *assists* the Executive Director in the form of recommendations on specific issues (as determined by the ED) and reviews reports. The ED reports to a politically-appointed body (RMOC) making decisions. The ISA can make contrary recommendations, but in that case, the RMOC makes the decision. The resource agencies then determine permitting.

Science needs to be built into the process. Having "independent scientists" as largely reviewers, places demands on time that are incompatible with the goals of individual university scientists. Further, by placing scientists in a "review" context, this means that the critical decisions often are already made or the time when meaningful input can be made is past. Independent, Ph.D.-level scientists from within the region need to be **part** of each management teams. The Executive Director must have a science background. Data need to be well curated and shared. When deficient, the scientists, as part of and in collaboration with the management teams and Executive Director must have adequate resources and funding to undertake the necessary research. Only in this manner can scientific participation be guaranteed. Further, only in this manner can **Adaptive Management** be pursued. Independent scientific reviews should be relatively infrequent and should be conducted by scientists outside the region. The board needs to consider the recommendations carefully, as these should guide the permitting process. If the science does not support a management action, permits should not be granted or maintained.

Conclusion

The best available data were utilized in the preparation of the MSHCP. However, because of the lack of organized surveys, the lack of use of viability analyses, and the lack of independent data management, the "best available models" could not be utilized. The MSHCP design may well approach as good as it gets given the constraints important to modeling long-range protection to both individual species of concern and to protecting natural communities, in the face of the intensive and rapid development of the region. The demand for housing, roads and infrastructure placed requires the creation of a plan dependent on today's data and science. The models that we evaluated indicate that small increases would not appreciably increase the viability of the plan, and small decreases could be detrimental. The SRP recognizes that the plan needs additional scientific input. However, we are not convinced that the plan is unworkable or that new science would dramatically change the design.

The success of the MSHCP depends as much on the actualization as of the development of the plan. Surveys of lands to be purchased to demonstrate that these will support the species and communities of concern are essential. Incorporating the survey data into current and newly developing models of viability for both single and multiple species must be on-going.

The SRP recommends is that science be an integral working partner in the Monitoring and Management activities of the MSHCP and even in the land purchasing process. This will ensure that the scientific content will be integrated into all decisions at a time when it can matter most.

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