Connectivity Monitoring Strategic Plan For the San Diego Preserve System

Prepared for the San Diego Environmental Mitigation Program Working Group

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CONNECTIVITY MONITORING STRATEGIC PLAN

"The ongoing biodiversity crisis is primarily driven by the loss and fragmentation of natural habitats" (Burdett et al. 2010)

1. Background

Purpose of Strategic Plan

In San Diego County, two large conservation plans, the Multiple Species Conservation Program (MSCP) and the Multiple Habitats Conservation Program (MHCP) are being implemented and two additional large-scale plans (North County and East County MSCP) are in preparation. These plans, in aggregate, are intended to contribute to the preservation of the biological diversity of southern California (MSCP 1998), a world-wide biological diversity hot spot. All four plans anticipate achieving their conservation goals (including species-specific and biodiversity goals), through the conservation and adaptive management of core habitat areas that are functionally connected for a wide variety of species including Covered Species identified in each plan.

The MSCP and MHCP plans and supporting and subsequent documents include information regarding the importance of functionally linked core areas in meeting preserve system goals, linkages goals, and the need for monitoring to evaluate linkage function (see Appendix 2 for key portions of these documents).

Based on the MSCP, MHCP, and supporting and subsequent documents, the overarching and interrelated goals of connectivity amongst core conserved habitat areas are:

(1) ensuring the persistence of species across the preserve system and

(2) preserving ecosystem functions across the landscape.

This Connectivity Monitoring Strategic Plan (CMSP) provides direction for connectivity monitoring that helps assess if these dual goals are being achieved, and for identifying and informing adaptive management actions to maintain, restore or improve connectivity between conserved core areas in San Diego County. (An additional section will be added to the CMSP in the near future to further address connectivity monitoring as it relates to ecosystem function.) Since significant portions of the core reserves identified in the MSCP have been assembled, the initial geographic focus of the CMSP is on the MSCP plan area. However, initial connectivity monitoring will directly or indirectly inform connectivity decisions in all plan areas. As connectivity monitoring protocols are evaluated and improved upon, they will provide the basis for consistent and effective connectivity monitoring throughout San Diego County.

The CMSP includes:

(1) Documentation of the process used to inform the development of the CMSP.
(2) Identification of specific objectives for connectivity monitoring.

(3) Identification of species functional groups for connectivity monitoring and the rationale for their selection.
(4) Identification of specific species within the functional groups that would initially be monitored and the rationale for their selection.*
(5) Prioritization of actions to meet identified objectives.
(6) Proposed timelines for initiating monitoring actions, funding needs and potential funding sources (Appendix 1).

* further analysis is required prior to selection of small animals for connectivity monitoring

The CMSP is intended to be dynamic and should be regularly updated as data are collected and analyzed and objectives are assessed. Following the adaptive approach in the CMSP will help ensure that connectivity monitoring efforts are appropriately focused and connectivity data are available to inform management decisions.

Connectivity Related Requirements of the MSCP and MHCP

Both the MSCP and MHCP require connectivity monitoring to verify that conserved lands function as anticipated (i.e. that core habitats are functionally connected). The MSCP plan states: "*the MSCP and these other subregional plans will create an interconnected preserve system"* (MSCP Plan p. 2-1). The MSCP includes thirteen linkages on the Biological Core and Linkage Area map and lists another 11 linkages to areas outside the MSCP study area (MSCP Plan Figure 2-2, pp. 2-9 to 2-11). Linkages were included in the preserve design to maintain natural processes (e.g. erosion and sediment deposition, organic litter accumulation, etc.) and movement of species between MSCP core areas and to conserved lands outside of the plan area.

The MSCP Biological Monitoring Plan (Ogden 1996) provides recommendations for monitoring locations, sampling protocols, and data management for connectivity monitoring and defined the terms *wildlife corridor*, *regional corridor*, and *local corridor*. Appendix 3 provides additional clarification of the terms related to connectivity monitoring that are used in this plan. California gnatcatcher, coastal cactus wren, mountain lion, coyote, bobcat, and mule deer were identified as focal species for wildlife connectivity monitoring in the MSCP Biological Monitoring Plan (p. 4-1). These species were selected because they "*naturally occur in relatively low densities and are unable to cross large areas of man-modified or otherwise unsuitable habitat*" (p. 4-1).

The MHCP Biological Monitoring and Management Plan (MHCP Vol. III, 2003) identifies six riparian corridors designed to maintain connections between coastal lagoons and estuaries and inland habitat areas (MHCP Vol. III, p. 4-1). These connections are intended to maintain demographic and genetic exchange for all species, and facilitate access by larger predators, particularly coyotes and bobcats. The MHCP identifies monitoring locations, and provides protocols for underpass pinch point surveys (also referred to as chokepoints in other documents) using track stations, camera traps, and road kill surveys (MHCP Vol. III, p. 4-6). California gnatcatcher dispersal across stepping stones of conserved habitat patches was also given specific consideration (MHCP Vol. III, p. 3-16).

Ecological Rationale for Connectivity*:*

As habitat becomes fragmented, populations or subpopulations may become separated or even isolated in the remaining smaller habitat patches. Smaller populations are at greater risk of extirpation due to stochastic and anthropogenic events (e.g. chance demographic and genetic events, catastrophes, environmental variability, introduction of exotic species and disease, etc.) (Shaffer 1981). Connectivity between habitat patches can help reduce the risks to species and populations from stochastic and anthropogenic effects through:

- Access to resources via within-home-range movements, migration, etc.
- Demographic exchange (dispersal, recolonization, demographic rescue, etc.).
- Gene flow (including potential for adaptation and evolution).
- Maintenance of ecological function including food web dynamics and trophic interactions.
- Species movement among core areas and habitat patches.
- Shifts in species geographic ranges in response to environmental change such as wildfire and climate change.

Maintaining connectivity amongst core areas and to lands outside of the plan areas is essential for maintaining the biodiversity of the preserve system and resilience of species and natural communities in the San Diego region.

Previous Southern California Connectivity Monitoring

MSCP Connectivity Monitoring

Previous monitoring studies identified and assessed connectivity in the MSCP plan area (CBI 2002, CBI 2003a, CBI 2003b, CBI 2004, Webb and Campbell 2003). These efforts primarily focused on monitoring connectivity for predators, primarily bobcats, coyotes and mountain lions. CBI (2003a) identified potential chokepoints for monitoring, developed an MSCP Linkage Description Log form to evaluate 29 potential regional habitat linkage monitoring locations for large animals (deer, bobcat, coyote, mountain lion) and made recommendation regarding future monitoring of each linkage. Of the 29 regional linkages evaluated, CBI (2003a) recommended that 12 of the identified linkage monitoring locations not be monitored in the future and recommended alternative monitoring locations for 6 of the 12 proposed for deletion. The reasons for recommending against future monitoring of the 12 identified linkages included: the monitoring location was in a core area not a linkage; the linkage was primarily a bird linkage and could not be monitored using the same methods as for mammals, or the habitat was thought to be too fragmented for large animals.

The CBI connectivity monitoring studies at 14 chokepoints within the MSCP plan area detected one or more species (deer, bobcat, mountain lion or coyote) at all monitoring locations (CBI 2003b). Coyote was the most frequently detected species and mountain lion the least frequently detected. CBI (2003b) also compared monitoring techniques (tracking, scent stations, camera traps) and found detection levels varied by survey methodology and species.

Other Relevant Connectivity Monitoring in the Southern California Ecoregion

Connectivity monitoring for a variety of species (bobcat, coyote, mule deer, mountain lion) has occurred in other portions of the South Coast Ecoregion (Los Angeles, Orange and Riverside Counties) with habitats and preserve configurations similar to the plan areas in San Diego County. In Orange and Los Angeles Counties (Tigas et al. 2002, Riley et al. 2003, Lyren et al. 2006,) bobcat movement occurred between habitat patches (of adequate size and appropriate habitat for bobcats) within their study areas. Crooks (2002) estimated that 50% of the habitat patches greater than 180 hectares would be occupied by bobcats. Based on these studies, it is likely that many of the habitat patches in the MSCP of similar size are currently occupied by bobcats are or have recently been functionally connected to larger patches of bobcat habitat. Mitelberg and Behonak (in review) found genetic evidence for limited long-distance dispersal by deer, population subdivision that corresponds to major freeways, and loss of genetic diversity in deer due to population bottlenecks within the past 60 years. Delaney et al. (in prep) examined genetic connectivity of three lizards and one bird (wrentit) in the Santa Monica Mountains National Recreation Areas and found strong and rapid genetic divergence related to fragmentation by roads. Vandergast et al. (2009) examined Jerusalem cricket genetic connectivity in Santa Monica Mountains and Simi Hills and found genetic connectivity disrupted by highways and urban development.

Functional Connectivity

Previous MSCP connectivity monitoring has focused on determining if focal species (primarily predators and deer) are traversing identified chokepoints. Knowing if an individual of a species has traversed a chokepoint is helpful for addressing potential connectivity at a chokepoint but only allows inference regarding the functionality of the linkage as a whole. Recent connectivity studies using genetics has demonstrated that mere documentation of animal movement past a chokepoint does not necessarily demonstrate functional connectivity (Riley et. al 2006). To meet the connectivity goals of the plans, understanding if and how core areas are functionally connected is critical.

Do the conservation programs need to manage for groups of species that are part of a larger population or groups of species that are isolated from nearby groups? How does habitat fragmentation interact with normal behavioral tendencies to disperse in each species?

The current level of connectivity is important for informing management decisions for a wide variety of species, including those species that move on the ground, along or within water columns, through the air or by hitchhiking on other species. While most connectivity is achieved by an organism moving from one area to another, for plants, functional connectivity may also be the result of pollen dispersal between populations.

2. Connectivity Monitoring Goals and Objectives

Determining if the dual connectivity goals of (1) ensuring the persistence of species and (2) preserving ecosystem functions across the preserve system in San Diego County are being achieved cannot be accomplished with a single study but must be evaluated incrementally based

on spatial and temporal considerations, species, funding availability and other considerations. The CMSP is intended to help guide the short- and mid-term decisions on the type, location, and focus of connectivity studies based on multiple strategic considerations, the current state of the science, and other factors. In aggregate and over time, connectivity monitoring identified in the current and future versions of the CMSP will help the plan participants understand the performance of the preserve system in meeting identified connectivity goals and make decisions regarding where and what management actions could be implemented to improve and/or maintain preserve system connectivity.

Primary objectives of the connectivity monitoring under this plan are: (1) determine the extent to which core areas are currently functionally connected for a wide variety of species; (2) inform adaptive management and other conservation actions by identifying important movement areas/chokepoints between cores for various species; and (3) test multiple monitoring approaches/methodologies and determine which provides answers to critical questions reliably and economically. The CMSP envisions a long-term, science-based, adaptive monitoring program that provides data, analysis, and information to support decision-making regarding preserve management, assembly and location of wildlife crossings. Specific monitoring projects will be identified and prioritized based on how well they may achieve these objectives (both spatially and temporally) and to what extent the data can be utilized to assess if the connectivity goals of the plans are being met. These objectives will be regularly revisited to determine if they should be modified as data from studies in San Diego and other localities are analyzed and monitoring methodologies are evaluated.

3. Developing the CMSP

Collaboration

The development of the CMSP has been informed by expert-based discussions facilitated by the San Diego Management and Monitoring Program (SDMMP) between November 2009 and July 2010. A technical working group (Appendix 3) met to discuss connectivity issues including species, habitats, ecosystem function, monitoring methodologies and potential approaches to monitoring. As a result of initial discussions it was decided to defer evaluation of connectivity monitoring of plant and invertebrate species until progress is made in monitoring connectivity at a regional scale for vertebrate species. Deferral of connectivity monitoring for these species is not intended to imply that connectivity for the species is not important but rather was done for a variety of practical reasons including uncertainties regarding evaluation methodologies, general lack of information on some species, and a lack of understanding of how connectivity data for some species in these groups might be used to inform management decisions.

The SDMMP developed maps of the conserved lands within core areas (Figure 1). The core areas delineated are generally similar to the core areas identified in the MSCP although the specific configuration differs since only conserved lands were included. The linkages (both conserved lands and areas where lands would be conserved in the future) were added to the map (Figure 2), and identified using a numerical system based on which core areas are connected by the linkage.

Since significant portions of the core reserves identified in the MSCP have been assembled, connectivity between the assembled core areas was a major consideration in prioritizing connectivity monitoring efforts. The degree to which the conserved core areas are currently connected will help inform conservation and management of the linkages that connect them (including use of and need for adaptive management of chokepoints). Extensive wildfires in 2003 and 2007 have modified the vegetation communities utilized by species of high concern and the effects of the fires on the landscape may have created significant fragmentation of habitats that was not anticipated in the plans. Understanding the extent of this fragmentation is important to understanding the temporal and spatial habitat restoration needs and opportunities for multiple species on conserved lands.

Species were grouped into five categories:

(1) Invertebrates.
(2) Animals that primarily move through the landscape in or along a water column.
(3) Plants.
(4) Animals that primarily move through the landscape on the ground.
(5) Birds which primarily move between habitat patches by flying.

Initially, the CMSP will focus on animals that primarily move on the ground between habitat patches (Category 4 species) and those that move between habitat patches by flying (Category 5 species). Future revisions of the CMSP will address connectivity monitoring for species in other categories.

Species within these general categories* were further filtered based on the following:

- Covered Species identified in the MSCP and MHCP plans.
- The species' population status within the plan areas (stable, increasing, management focal species, etc.).
- The species' sensitivity to habitat fragmentation.
- Species that are thought to be indicators of connectivity for multiple species or system function.
- Species that help maintain ecological function of the system.

*Some species may fit within multiple categories

Species occurrence and habitat information for the conserved core areas was obtained from various reports, existing GIS data layers and other sources. Using the species lists generated, the SDMMP identified a potential list of species for focused connectivity monitoring and placed the species into three groups - large mammals (subsequently changed to large animals), small animals and birds.

The technical working group identified scientists (Appendix 3) with a variety of expertise (connectivity monitoring, species natural history, species habitats, etc.) to participate in a one-day connectivity workshop focused on further evaluating the species groupings, monitoring priorities and potential connectivity monitoring methodologies.

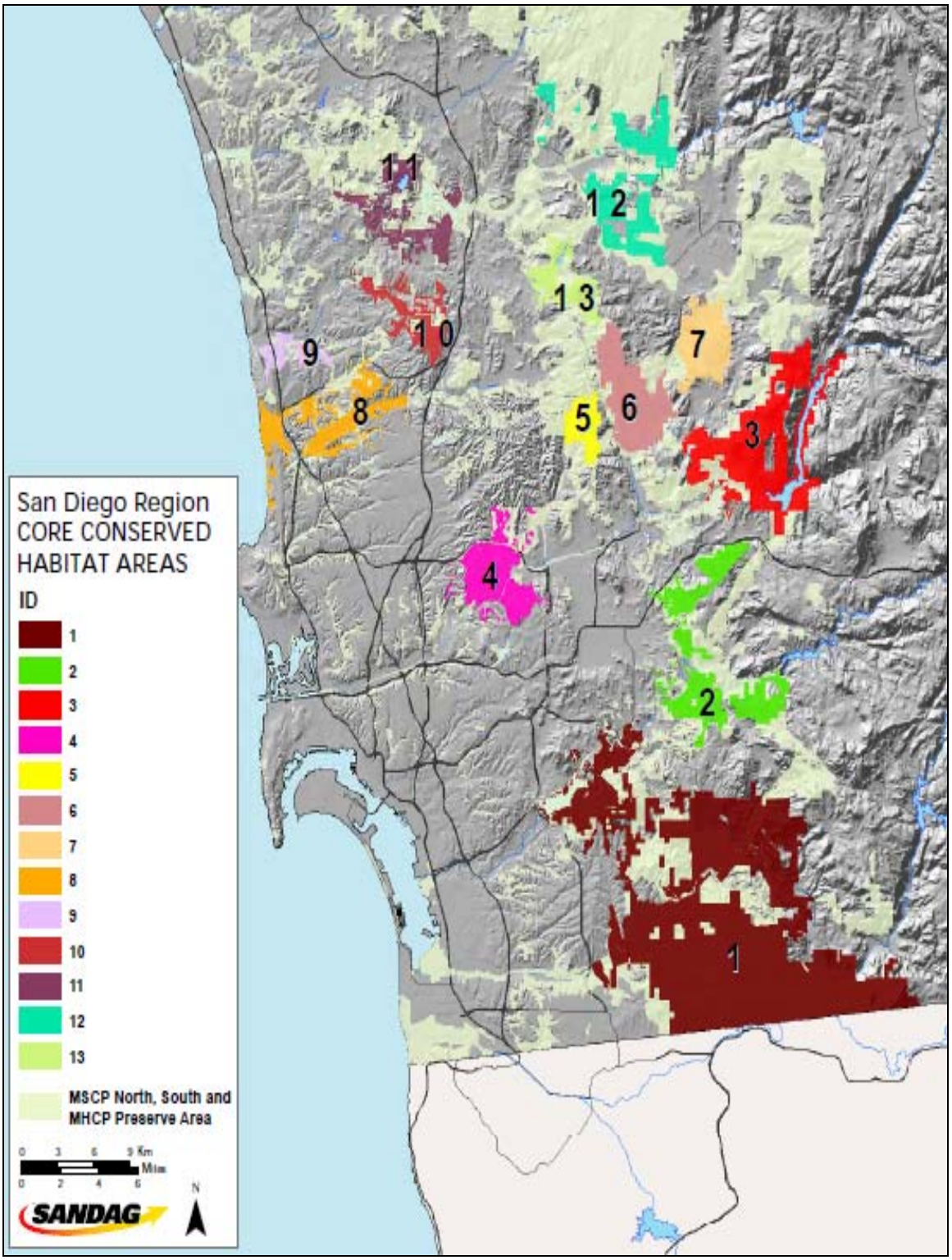

Figure 1. Conserved Lands Within MSCP Core Areas.

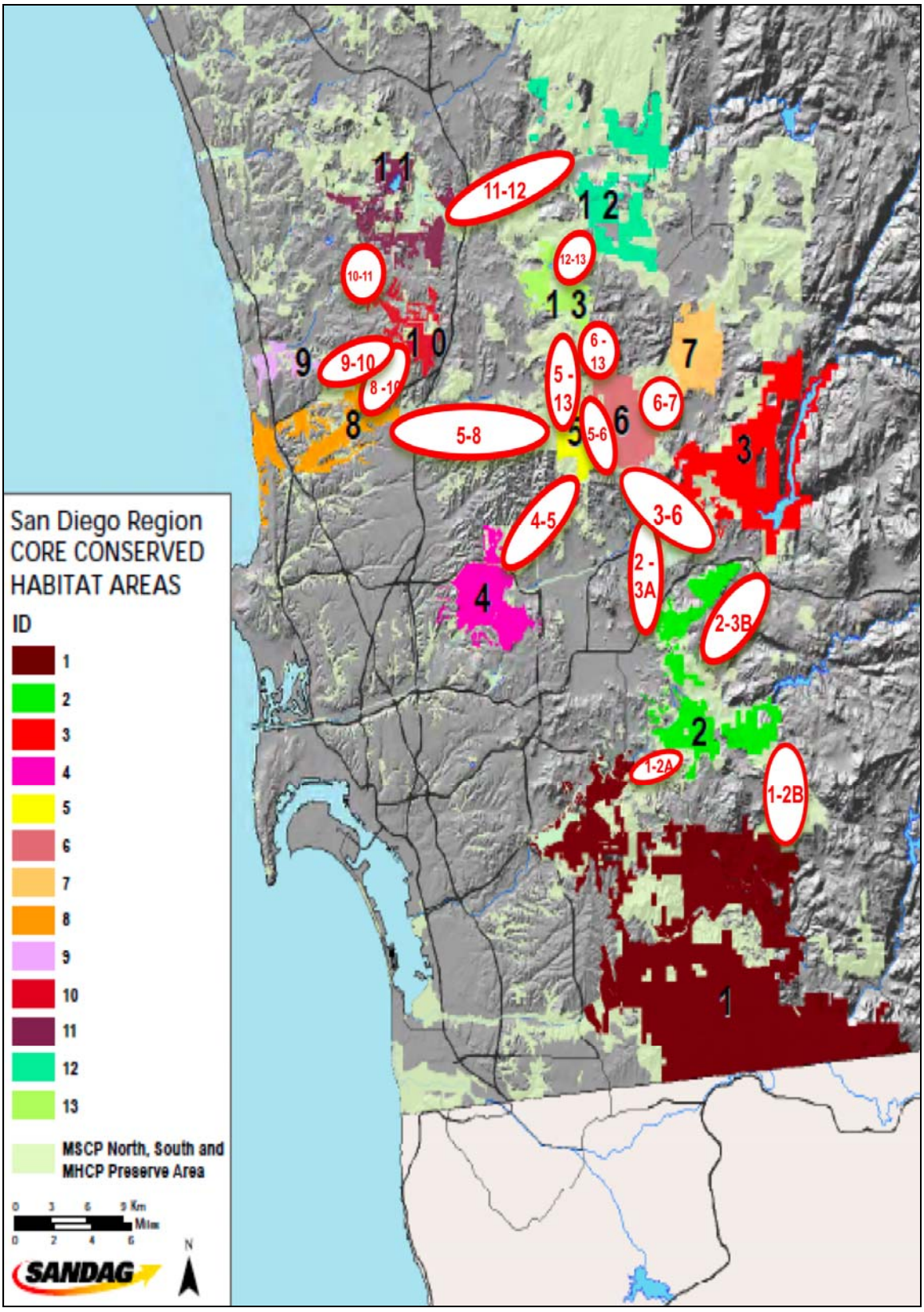

Figure 2. MSCP Linkages Connecting Conserved Core Areas.

As a result of discussions at the workshop, species and their assigned groupings were modified (Appendix 3). Follow-up meetings were held with workshop attendees representing each species group to further refine the species lists, identify potential studies to address connectivity for the identified species and to provide input to the SDMMP on initial priorities for monitoring.

The three vertebrate groups (large animals, small animals and birds) were selected to represent groups of species that may utilize linkages differently. Large animals move across the landscape and interact within the linkage differently than small animals and birds. Large animals may move between core areas in a single day, whereas it may take small animals multiple days or even generations to move between core areas. As a result of discussions at the workshop, the bird species group was further modified to divide non-migratory birds from migratory birds. This was based on:

- The MSCP's assumption that some covered resident bird species would be conserved by protecting, managing, and restoring patches of habitat in a "stepping stone" configuration and condition rather than as a continuous corridor of habitat.
- Lack of understanding of what constitutes critical connectivity for migratory bird species nesting in cores and linkages.

As a result of the workshop and subsequent discussions, roadrunners were moved from the bird group to the large animal group because it was thought that functional connectivity for this species is likely to be more closely related to functional connectivity for large animals than for other bird species.

Because of the difference in what constitutes a linkage for various vertebrate species, connectivity monitoring for these vertebrate groups may vary greatly. However, regardless of the methodology, each monitoring effort tiered to the CMSP is intended to help understand if the connectivity goals of the plan are being achieved and inform management actions.

Prioritizing functional groups and/or species (and methodology) for connectivity monitoring was an iterative process and the CMSP takes into consideration (generally in the order listed) the following:

- Potential for extirpation of a species (e.g. extirpation from previously occupied core areas, extirpation from the plan area, regional extirpation) if core areas are not functionally connected for the species.
- Species status in the plan (i.e. whether it is a Covered Species, species identified for connectivity monitoring, etc.).
- The extent to which a species can be utilized as an umbrella species for assessing connectivity goals for multiple species or identifying areas for wildlife crossing structures that would likely benefit multiple species.
- Species sensitivity to fragmentation.
- Species status in the plan area (both its habitat and its population).
- Importance of the species for maintaining ecosystem function.
- The potential that the conserved core areas are not connected for the species (i.e. if connectivity for the species is not a critical uncertainty, connectivity monitoring would

not initially focus on that species unless there are other specific uncertainties that need to be resolved such as dispersal distance).

Prioritization of specific actions to meet the goals and objectives of the CMSP also took into account:

- Urgency: Is there a time constraint (e.g. are there on-going or pending management decisions or development planning decisions that should take into account the results of the study thereby reducing costs or achieving better results)?
- Cost: Are the anticipated outcomes of the study appropriate in relation to its costs and are the resources available to implement the study?
- Synergy: Would the study, if done concurrent with another proposed project, reduce the costs of the study or provide increased understanding of connectivity for a species?
- Feasibility: Does the proposed monitoring approach (including data analysis) utilize known methods or do new methods need to be developed?

4. Functional Groups, Species, Objectives and Priorities

Large Animals - (deer, bobcat, mountain lion, badger, roadrunner)

Rationale for monitoring:

- Large animals are often considered indicators of functional connectivity.
- Many are wide ranging and may be considered "passage species" (Beier and Loe 1992). For these species, linkages provide opportunities to move between larger core areas rather than serving as habitat for essential resources and behavior (food, water, reproduction). Linkages for large animals are generally not continuously occupied by the species. Two species, mountain lions and badgers (the largest covered predators in the region) are examples of species that primarily use linkages as movement corridors and generally traverse even the longest linkages in short periods of time.
- Most will utilize multiple habitats to move through linkages.
- Results from previous connectivity studies (primarily focused on mountain lions and bobcats) in San Diego, Riverside, Los Angeles and Orange Counties can help inform decisions on the selection of species for connectivity monitoring and study methodologies.
- Due to their size, they are more easily detected by tracks and cameras and can be captured and fitted with GPS tracking devices (e.g. collars and implants) thereby providing specific information on location and timing of linkage use.
- Genetic material obtained by a variety of methods can be utilized to look at relatedness of individuals and populations and potentially population size.
- Roadrunners were included in this group because they appear to utilize linkages in similar ways to large mammals, generally travel on the ground, and because of their large home range sizes, may disperse through linkages over short time frames rather than utilizing them as "live-in habitat". Their home ranges are significantly larger than those of species included in the small animal group and based on information in Folse and Arnold (1978) and Ferguson

et al. (2009) roadrunner home ranges (6-81 ha) approach the size of some bobcat home ranges (43-98 ha).

It is believed that for mountain lion and badger (both MSCP Covered Species), north-south connectivity between core areas generally east of Interstate 15 in the central and northern portions of the County and easterly of State Route 125 in the southern portion of the County, and easterly to public lands east of the MSCP plan area are critical for population persistence in the MSCP plan area. Additionally, because of the significant road mortality these species experience, information on specific areas where they cross roads is needed to inform adaptive management decisions including where and what types of wildlife road crossings are needed. In the Netherlands, it was estimated that 20% of the badger population was killed annually on roads prior to the installation of badger culverts and fencing (FHW 2000).

For deer, movement between adjacent core areas is thought to be critical along with connectivity through the longer east-west linkages to larger habitat patches east of the plan areas. It may be possible to infer functional connectivity for bobcats based on their continued occupancy of many of the core cores and larger habitat patches within and adjacent to linkages based on patch size and other factors Crooks (2002) Tigas et al. 2002; Riley et al. 2003 and Markovchik-Nicholls et al. (2008). Riley et al. (2007) identified significant bobcat mortality from mange (likely associated with bobcat exposure to toxicants) in an urban environment in Los Angeles County. If similar mortality is occurring in San Diego County, it may be confounding the analysis of the data analyzed by Markovchik-Nicholls et al. (2008), if bobcat populations nearest urban areas were depressed by disease. Lyren et al. (2009) analyzed connectivity for bobcats in Orange County and recommended camera surveys, GPS telemetry and mortality surveys as methods for long-term connectivity monitoring in their study area.

Roadrunners are functionally a top predator and play a similar role to bobcats and coyotes for a suite of smaller prey species. The greater roadrunner may be much more sensitive to habitat change and fragmentation than bobcats (Famolaro 2002; Tigas et al. 2002; Riley et al. 2003). Little is known about roadrunner movement between core areas.

Markovchik-Nicholls et al. (2008) found that gray fox were significantly and negatively associated with increasing road intensity [i.e. the type (dirt or paved) and size (one lane, two lane, etc.) of roads] that may indicate that this species is sensitive to habitat fragmentation associated with roads. They did not find a similar association for bobcats.
Future revisions of the CMSP should further evaluate gray fox for addition to the large animal connectivity monitoring group.

First Priority Large Animal (LA1) Connectivity Objectives

1. Determine where mountain lion movement is occurring between inland core areas (core areas 1, 2, 3, 6, 7 and 12) and areas to the east, identify specific movement areas and locations of regular crossing of major roads, and determine whether and the extent to which there is genetic exchange between inland core areas.
2. Determine where badger movement is occurring between inland core areas (core areas 1, 2, 3, 6, 7 and 12) and areas to the east, identify specific movement areas and locations of

regular crossing of major roads, and determine whether and the extent to which there is genetic exchange between inland core areas.
3. Determine if crossing structures previously surveyed (CBI 2002, CBI 2003a and CBI 2004) continue to be used by large animals
4. Determine which methodologies should be utilized for long-term connectivity monitoring of chokepoints.

Actions to Achieve Large Animal Priority One Objectives

- Conduct GPS telemetry studies of mountain lions utilizing core areas generally east of I-15 and SR 125 to determine extent and specific location of lion movement between core areas. Include collection and analysis of genetic material to determine gene flow among core areas and relatedness of individuals and population size.
- Conduct initial surveys of habitat potentially occupied by badgers and assess the potential (both feasibility and cost) of conducting GPS telemetry studies to identify specific locations important to badger movement in habitats fragmented by roads. Include collection of genetic material to determine gene flow within and between occupied core areas.
- Monitor large animal chokepoints identified by CBI (2002) and compare monitoring methodologies (cameras, tracks, etc.) as part of a long-term monitoring strategy for chokepoints.

Second Priority Large Animal (LA2) Connectivity Objectives

1. Determine the extent of deer movement between core areas and if it is occurring within identified linkages.
2. Determine if bobcats continue to utilize habitat patches within identified linkages and near core areas, and continue to traverse the chokepoints evaluated by CBI (2002, 2003a, 2003b). Determine the current connectivity of core areas for bobcats (this objective should be considered for inclusion as a first priority objective based on further evaluation and if an appropriate funding source is identified).
3. Determine the current connectivity of core areas for roadrunners.

Actions to Achieve Large Animal Priority Two Objectives

- Analyze existing genetic data from deer fecal analysis and utilize the data to evaluate core area connectivity for deer.
- Analyze San Diego Tracking Team (SDTT) data collected subsequent to the data analyzed by Markovchick-Nicholls et al. (2008) to determine if SDTT data can be used to determine occupancy of habitat patches and infer connectivity for bobcats over time.
- Obtain bobcat genetic material for core areas and utilize it to assess current connectivity for bobcats. Further evaluate multiple long-term monitoring strategies (e.g. genetic monitoring in a manner similar to that proposed by Vandergast et. al

(2009) "Building better roads for wildlife: assessing the effects of roads on animal dispersal and genetic connectivity" or using camera traps as recommended by USGS for a preserve in Orange County or other or combination of methodologies).
- Utilize radio telemetry to determine where bobcats frequently cross roads.
- Conduct review of roadrunner literature and identify potential connectivity monitoring considerations and costs.

Small Animal Species - (orange-throated whiptail, San Diego horned lizard, Dulzura kangaroo rat, California ground squirrel, San Diego black-tailed jackrabbit, western spadefoot toad, coastal whiptail, deer mouse, big-eared wood rat, desert woodrat, cactus mouse, San Diego pocket mouse, California swollenstinger scorpion, Jerusalem cricket and others)

Rationale for monitoring:

- Small animal species typically have small home ranges and maintaining viable populations may be achieved in smaller geographic areas.
- Some small animal species may occupy restricted niches (e.g. salamanders, toads, scorpions, etc.) within a larger conserved landscape.
- Intra-core connectivity may be as important as inter-core connectivity for some small animal species.
- In large diverse linkages, some small animal species may utilize the linkages as "live in" or even core habitat and their presence across a linkage may be an indicator that connectivity goals are being partially achieved.
- Research has demonstrated that some small animals may avoid habitat adjacent to roads and other structures.
- Habitat fragmentation and alteration of micro-habitat areas by fire and other activities may profoundly affect maintenance and recovery of small animal biodiversity of core areas.

First Priority Small Animal (SA1) Connectivity Objectives

1. Determine current connectivity for a suite of small animal species sensitive to both inter- and intra-core area habitat fragmentation.

Actions to Achieve Small Animal Priority One Objectives

- Determine which small animal species are most sensitive to habitat fragmentation including fragmentation due to wildfire.
- Determine (1) what type of genetic analysis (mitochondrial, micro satellite, single nucleotide polymorphisms (SNPs) would provide the meaningful data regarding connectivity and (2) which species have appropriate genetic markers already identified.
- Using existing information and the new vegetation map (in prep), identify what portions of selected core areas and linkages are occupied by a suite of small animal species sensitive to habitat fragmentation and already have key genetics issues resolved.

- Analyze genetic material previously collected (or evaluate existing analyzed data) to help inform decisions on appropriate approaches (sampling design, species, etc.) to genetic monitoring of connectivity for small animals.
- Analyze post-fire monitoring data to identify small animal species that are slow to re-colonize burned areas, identify potential re-colonization points and methodologies to evaluate potential re-colonization routes/mechanism.
- Identify adaptive management actions that could improve inter- and intra-core area connectivity for the identified species.
- Evaluate monitoring methods that are available, tested, feasible and cost-effective to determine which species will be selected for connectivity monitoring.

Birds Species - (coastal cactus wren, California gnatcatcher, southwestern willow flycatcher, least Bell's vireo, burrowing owl*)

Rationale for monitoring:

- Because of their capacity for flight, birds may be less dependent on linkages for movement than are terrestrial vertebrates.
- Connectivity for birds may be achieved very differently than that for terrestrial species that utilizes habitat linkages for connectivity.
- What constitutes connectivity for migratory birds is likely quite different than that for resident species.
- Large fires in 2003 and 2007 may have resulted in unanticipated habitat fragmentation for some bird species.
- California gnatcatcher and coastal cactus wren are flagship species for the San Diego conservation plans.
- Extensive and costly cactus patch restoration efforts are on-going yet little is known about appropriate spatial distribution of cactus patches for cactus wrens or how/where cactus wrens (probably young) disperse across the landscape to repopulate unoccupied or restored cactus patches.
- Habitat for California gnatcatcher and coastal cactus wren often occurs in smaller patches in a matrix of urban development or in larger conserved areas that have been impacted by fire. Connectivity among habitat fragments and larger habitat areas is likely to be essential for regional-scale connectivity and persistence of these species.
- Least Bell's vireo and southwestern willow flycatcher are flagship species for riparian habitat.

* Connectivity issues and monitoring for burrowing owl will be addressed in the south San Diego County adaptive management and recovery strategy currently in preparation.

First Priority Bird Connectivity (B1) Objectives

1. Determine the current level of connectivity between cactus wren subpopulations, populations, etc. (see MSCP Species Evaluations, FWS and DFG 1996 regarding cactus wren core areas).

2. Determine dispersal distances and habitats (corridors) utilized for dispersal of cactus wrens (i.e. what types of habitats, disturbed areas or urban areas will cactus wrens disperse through?).
3. Determine the current level of connectivity between gnatcatcher populations and subpopulations, etc. (see MSCP Species Evaluations, FWS and DFG 1996 regarding gnatcatcher core areas).
4. Determine dispersal distances and habitats (corridors) utilized for dispersal of gnatcatchers (i.e. what types of habitats, disturbed areas or urban areas will cactus wrens disperse through?).

Actions to achieve priority 1 bird species objectives

- Obtain and analyze cactus wren genetic samples from San Diego County.
- Conduct banding studies to track dispersal of young cactus wrens to determine what habitats/corridors they utilize for dispersal and their dispersal distances.
- Obtain and analyze gnatcatcher genetic samples from San Diego County.
- Conduct banding studies to track dispersal of gnatcatchers to determine what habitats/corridors they utilize for dispersal and their dispersal distances.

Second Priority Bird Connectivity (B2) Objectives

1. Evaluate the need for connectivity studies for least Bell's vireo and how results of such studies would be used to inform management decisions.
2. Evaluate the need for connectivity studies for southwestern willow flycatcher.

Actions to achieve priority 2 bird species objectives

- Analyze collected least Bell's vireo genetic samples to determine current degree of connectivity and evaluate the need for further study of factors limiting connectivity.
- Evaluate the results of existing genetic analyses for southwestern willow flycatcher populations and assess the need for sampling for additional populations and evaluate the need for further study of factors limiting connectivity.

5. Implementation of the CMSP

Priorities, Objectives, Funding

Appendix 1 identifies the priority actions by species group and species, timelines for their implementation, estimated costs, and potential funding sources. Since some funding sources are constrained (e.g. FESA Section 6 funds must be used for federally listed species) while others are more flexible (e.g. Transnet and state local assistance funds), it will be important to utilize flexible funds for connectivity monitoring focused on non-federally listed species. If funds cannot be secured from the identified funding source, the actions should be re-evaluated and not automatically funded from the flexible fund sources. Priorities identified are the priorities within the functional group and it is not intended that all priority 1 actions for all functional groups

would be implemented before any priority 2 actions. Tradeoffs between functional groups in regards to funding allocations should be made when funding levels and sources are known.

In addition to identifying priorities for connectivity monitoring, Appendix 1 includes a recommendation for evaluating specific chokepoints to inform implementation of immediate management actions (2011-2012) to improve connectivity at important locations.

A Dynamic Monitoring Program

Effective monitoring programs (1) address identified goals, objectives and answer *a priori* questions, (2) require appropriate statistical design and (3) pass the test of management relevance. The CMSP is designed to be an effective monitoring program and is intended to help focus near and mid-term, science-based, adaptive monitoring that provides data, analysis, and information to support conservation and management decision-making to improve connectivity of preserve lands in San Diego County.

As the CMSP is implemented it will; (1) improve the understanding of the species and landscapes monitored and managed as part of the San Diego preserve system, (2) re-evaluate objectives, actions, and priorities, (3) pose new questions, and (4) refine existing methodologies or incorporate new ones. Therefore, implementation of the CMSP must also include review and reconsideration of connectivity monitoring efforts annually. To accomplish this it is imperative to:

1. Analyze data yearly, or as appropriate for the specific projects that generate the data,
2. Re-evaluate the objectives, actions, and prioritization yearly, and
3. Revise the CMSP every three years, or more frequently, if appropriate.

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