California Essential Habitat Connectivity Project
Work Plan
April 2009

Introduction: The California Department of Transportation (Caltrans), in partnership with the California Department of Fish and Game (CDFG), has commissioned a team of technical consultants (Consulting Team) to assist them in producing a statewide assessment of essential habitat connectivity. Caltrans intends to use this assessment to comply with Section 6001 of SAFETEA-LU and thus avoid, minimize, or mitigate impacts to habitat connectivity during the planning process. CDFG will also use the statewide assessment in updating the State Wildlife Action Plan and in complying with AB2785 and SB85. CDFG and USFWS intend the assessment to assist them in developing NCCPs and HCPs. The assessment may also assist metropolitan planning organizations in complying with SB375 and related laws.

On October 7, 2008, a Multidisciplinary Team (MDT) of stakeholders from various federal, state, and local agencies was convened to discuss desirable characteristics of the following three primary products of the California Essential Habitat Connectivity Project.

1. A statewide map depicting areas essential for habitat connectivity.
2. A matrix summarizing biological values of the linkages to inform conservation decisions.
3. A strategic plan that outlines an approach for finer-scale analyses and local or regional connectivity plans, which are to be performed outside the scope of this statewide assessment.

Also at the October 7, 2008 workshop, some members of the MDT volunteered to assist the Consulting Team in making key technical decisions regarding these three products. These volunteers are called the Technical Advisory Group (TAG). The TAG met at a workshop on January 29, 2009 to discuss the

Abbreviations

AB2785: Requires CDFG to map essential wildlife corridors and habitat linkages.
ACE: Areas of Conservation Emphasis being defined by CDFG.
Caltrans: California Department of Transportation.
CDFG: California Department of Fish & Game.
CNDDB: California Natural Diversity Database.
Consulting Team: Consulting Team contracted for this project, including The Dangermond Group, Conservation Biology Institute, SC Wildlands, and Paul Beier, working collaboratively with Caltrans and CDFG representatives.
HCP: Habitat Conservation Plan developed under Section 10 of the US Endangered Species Act.
MDT: Multidisciplinary Team of representatives from federal, state, and local agencies involved in conservation, land-use, or transportation planning and implementation.
NCCP: Natural Communities Conservation Plan.
SAFETEA-LU: Safe Accountable Flexible Efficient Transportation Equity Act of 2005.
SB375: Requires regional transportation plans to include strategies to meet goals for reducing greenhouse gas emissions.
SB85: Requires CDFG to develop vegetation mapping standards.
SWAP: State Wildlife Action Plan.
TNC: The Nature Conservancy.
TAG: Technical Advisory Group. A group of about 30 volunteers from local, state, and federal government who are assisting the Consulting Team make key technical decisions.

approach for producing the first two products: (1) the Statewide Essential Habitat Connectivity Map and (2) the Matrix of Biological Value of the Linkages (formerly "prioritization"). The Strategic Plan (product 3) will be developed based on ongoing input from the TAG and MDT.

Project Mission Statement: The purpose of the California Essential Habitat Connectivity Project is to develop a habitat connectivity map and a plan that will help infrastructure, land use, and conservation planners maintain and restore a connected California, while simultaneously making infrastructure planning projects more cost efficient.

Purpose of Work Plan: The purpose of this Work Plan is to guide the consultant team, provide an outline that identifies specific steps that require TAG input, and serve as the primary document for outside peer review. With distribution of this Final Work Plan we are at Action Step 2.3 (having revised the Draft Work Plan based on initial TAG input and outside peer review; see below).

Review and Input Process: We will hold web based meetings with the TAG at appropriate milestones in the process to obtain input and review of interim products. We will use Data Basin as a method of sharing, receiving input, and refining maps, models, and other work products throughout the project. Data Basin is an innovative web tool (http://databasin.org/about_data_basin) that connects users with conservation datasets, tools, and expertise. Individuals and organizations can explore and download a vast library of conservation datasets, upload their own data, comment on or add to other's data, and produce customized maps and charts that can be easily shared. In addition we will hold one additional workshop with the TAG to review products, and one final workshop with the MDT (outlined below).

Strategic Action #1: Reach Consensus on Work Plan Approach

(Completed March 2009)

Action Step 1.1: Produce a Draft Work Plan prior to the January 29, 2009 meeting that includes options for the TAG to consider.

Action Step 1.2: Develop and provide background materials to the TAG prior to meeting.

Action Step 1.3: Hold the January 29, 2009 meeting with the TAG to evaluate options and criteria for constructing and prioritizing statewide habitat connectivity map and reach consensus on the Work Plan approach.

Action Step 1.4: Revise the Work Plan based on information received from the TAG at the January 29, 2009 meeting. Include details on specific action steps that need to be completed, determine the schedule, and identify the individuals responsible for each step.

Action Step 1.5: Circulate revised Work Plan to the TAG for review and input.

Strategic Action #2: Outside Peer Review of Planned Approach
(Completed April 2009)

Action Step 2.1: Peer review. We asked academic experts in conservation biology, conservation planning, and linkage design not associated with this project to review the Work Plan and background materials from the January 29, 2009 TAG meeting (e.g., approach document and associated appendix). We will also request that they review subsequent products as they are completed via Data Basin. Comments on the Draft Work Plan received from the following experts were used to complete this Final Work Plan: Dr. Reed Noss (University of Central Florida), Dr. Kevin Crooks (Colorado State University), Dr. Dave Theobald (Colorado State University), Dr. John Wiens (PRBO Conservation Science), and Dr. Kate Wanner (Trust for Public Land). No stipends were available for this task.

Action Step 2.2: Circulate work plan. Circulate work plan and comments from the peer reviewers to the TAG for a second review and input cycle.

Action Step 2.3: Finalize work plan. Finalize work plan based on comments received in Steps 2.1 and 2.2.

Strategic Action #3: Construct Statewide Wildlife Habitat Connectivity Map (September 2009 targeted completion date)

The goal for this strategic action is to identify, at a gross, statewide scale, areas where maintaining or restoring functional ecological connectivity is essential to conserving the state's biological diversity. The intent is to create a baseline map of essential connectivity areas, based largely on GIS data layers that reflect ecological integrity or "naturalness" of land features, and therefore likely to reflect the needs of diverse species and ecological processes. Thus, this statewide map will provide a relatively "top-down, broad-brush" depiction of essential connectivity areas, with the intent that finer resolution mapping and analysis will later be performed (outside the current scope of work) using finer resolution and "bottom-up" (e.g., species-based) modeling and analyses.

The Strategic Plan (Strategic Action #6) will provide detailed recommendations for how to perform these additional analyses and delineate essential connectivity areas at ecoregional and local scales. The approach for developing the statewide map has been designed to be conservative — erring on the side of being inclusive rather than exclusive of essential connectivity areas. It is also to be as transparent, scientifically defensible, and repeatable as possible.

This statewide connectivity map will not be developed using explicit climate-change models or other future scenario analyses. The Strategic Plan will recommend additional analyses that could be used to address future changes, including adaptation to climate change, under future scenarios.

This process will not explicitly address freshwater or marine connectivity issues. However, natural riparian corridors are considered in identifying essential connectivity

areas because they are important to maintaining diverse geological and ecological processes and facilitate movements of diverse species, including terrestrial as well as aquatic species.

Action Step 3.1: Assemble and prepare data layers. The Consulting Team will work with MDT to identify and obtain all essential and available data layers, including GIS and ancillary data that can inform the analyses.

Action Step 3.2: Define analysis area. The analysis area is defined as the entire state of California plus a buffer into adjacent Oregon, Nevada, Arizona, and Baja California to ensure that cross-border connections are also addressed.

To define the buffer into adjacent states and Baja California we will use a biologically driven but flexible set of rules. This flexible rule set may define the analysis extent by using one or more of the following techniques: (1) the edge of the nearest areas of high ecological integrity outside of the state, (2) edge of nearest protected areas (e.g., based on GAP 1 & 2 ratings)[1], and (3) the edge of known, important habitat areas for key species (e.g., desert tortoise recovery areas). We will focus our attention within the state and depict cross-border linkages with placeholder arrows, indicating future collaboration with neighbors.

Action Step 3.3: Conduct analysis to define natural landscape blocks. We will define *natural landscape blocks* as any large (size to be determined based on pilot testing and TAG input) existing natural open space having relatively high ecological integrity. For this exercise, ecological integrity will be defined by a select set of surrogate data themes that provide our best estimate of relative levels of naturalness. Additional biological modifiers may be added to further discriminate the California landscape. The model for mapping natural landscape blocks will be based on the following criteria:

- Road Density:
  ESRI StreetMapNA Major roads data (9.3, 2008) for US, 1:100,000, vector

- Percent Impervious Surface:
  National Land Cover Database 30m raster, 2001, US Geological Survey

[1] GAP Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management.

GAP Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive use or management practices that degrade the quality of existing natural communities.

- Percent Agriculture (not including rangelands):
  LANDFIRE.EXISTING_VEGETATION_TYPE, USDA Forest Service, 90m grid, 2006; and FRAP

- Percent Urban (using one or more of the following):
  - FRAP, Multi-Source Land Cover Data (CWHR), raster, 2002, 100m
  - LANDFIRE.EXISTING_VEGETATION_TYPE, USDA Forest Service, 90m grid, 2006
  - FRAP, Development Footprint, 2002, 30m, 1:100,000 (derived from Census housing density, and USGS land cover data).
  - NLCD, Land Cover, 21 broad land cover classes, raster, 2001, 30m

- Conservation Status (appropriately weighted to reflect correlation with biodiversity protection, combining the following databases):
  - Conservation Biology Institute Protected Areas Database 2008
  - SC Wildlands Protected Lands for the south (using data from The Nature Conservancy, Santa Monica Mountains Conservancy, National Park Service, and California Protected Areas Database as of November 2008).
  - GAP status codes weighted according to level of protection.

<u>Potential Biological Modifiers</u>

- Vernal Pools and Wetlands:
  - Central Valley Vernal Pool Complexes, DFG, 1998
  - California Central Valley Wetlands and Riparian GIS, DFG, 1997
  - Placer County Vernal Pool Resource Inventory, DFG, 2000
  - South Coast Ranges Vernal Pools, DFG, 2003
  - California Wetlands, USFWS, 2006
  - Wetland Reserve Program Lands, if available

- Rarity-Weighted Richness Index (includes rare plants substrates):
  CDFG, 2009, grid cell size to be determined

- Essential Habitat identified by USFWS for Federally listed species.
  Essential Habitat includes geographic areas essential to a species' conservation, including those areas that may be excluded from designated Critical Habitat for economic or other reasons, such as coverage in long-term conservation agreements.

Data resolution will be 100m. We will apply a relatively fine moving-window averaging algorithm to produce a map showing a gradient of ecological integrity. We will evaluate different window sizes, weights, and criteria to avoid losing smaller natural landscape blocks in developed areas. Pilot analyses suggest that a moving window of about 5 km is best. The approach will include model logic that employs neighborhood averaging, weighting, and "or" logic functions to avoid inappropriately competing criteria against one another (for example, an area could be of high ecological integrity in part due to presence of vernal pools *or* rare plant substrates *or* Essential Habitat, etc.).

From the results, we will select thresholds for the level of integrity and the size of contiguous areas that will constitute our natural landscape blocks. Areas outside these blocks will be treated as matrix lands through which connectivity needs will be assessed. We may use different thresholds in different ecoregions in order to delineate the best remaining blocks. The threshold may be specified as a rule, (e.g., greater than a certain percentile of integrity within each ecoregion, or within a large subset of an ecoregion) but the rationale will be clearly defined. The TAG was comfortable with a minimum size of about 6,000 acres, but perhaps smaller in more developed ecoregions (e.g., <2000 acres in Central Valley), or larger in wilder ecoregions (e.g., Sierra Nevada). The TAG will have an opportunity to review the initial determinations for size thresholds in Action Step 3.5.

Action Step 3.4: Determine which pairs of natural landscape blocks to connect. After natural landscape blocks are defined, we will use expert opinion to determine which blocks should be connected using such factors as landscape context (e.g., are the blocks adjacent?), ecological context (e.g., do the blocks share species that require movement?), existence of barriers (are there absolute barriers between blocks that cannot be mitigated?), and ecological processes (would connecting these blocks accommodate migrations or ecological shifts due to climate change or disturbance factors?). We will attempt to develop a repeatable set of rules for this step, and will describe the factors we considered and our rationale for each linkage. The Consulting Team will take the first pass at identifying the proposed linkage network for the state and post the draft map and ancillary datasets (e.g., Penrod et al. 2001) on Data Basin for the TAG to review and provide input.

Action Step 3.5: Provide draft results of action step 3.3 and 3.4 to the TAG for review and comment. The maps and ancillary datasets used by the team in previous steps will be provided via Data Basin. Reviewers can also evaluate results using their own data layers. We will provide a summary document and supporting data as necessary. Members of the TAG who comment or make suggested edits to the map must also explain their rationale. We will have either a conference call or webinar with the TAG to familiarize them with Data Basin and walk them through the approach for this step. The TAG will have two weeks after the webinar to submit comments.

Action Step 3.6: Incorporate revisions from TAG.

Action Step 3.7: Conduct analyses to delineate essential connectivity areas. We will use *least-cost corridor modeling* to define *essential connectivity areas* for each pair of natural landscape blocks that are determined to require connectivity. We will use the centroid of each natural landscape block as terminuses for each analysis.

To develop the resistance surface or cost raster for least-cost modeling we will use data inputs with a resolution of 30m or 100m. Criteria that may contribute to the cost surface include:

- road density or distance to road

- railroads
- percent natural landcover (100m), or natural vs. not natural landcover (30m) Different categories of urban and agriculture will be defined relative to their likely effects on overall habitat permeability, based, for example, on number of dwelling units/acre or type of agriculture (row crops, rice, vineyards, or orchards). Rangelands will generally be considered natural grasslands rather than agriculture.
- percent impervious surface
- percent wetland or riparian

We will then add natural streams that provide potential aquatic or riparian connections between the natural landscape blocks if a linkage polygon does not encompass these streams already. Streams will be buffered on each side out to 250 m or to any substantial barriers to movement, such as urban edge.

For five sample essential connectivity areas, we will compare our coarse-level modeling results with finer scale connectivity model results based on focal species. Comparisons will be focused in areas in which fine-scale linkage designs based on multiple focal species, some of which are listed and sensitive, have been completed (e.g., for the South Coast Missing Linkages project; Beier et al. 2006). To the degree possible, these five areas will be representative of different ecoregions throughout the state.

We will define the cost threshold to apply throughout the state (or ecoregion) using a threshold that encompasses all focal species' least-cost corridors. For example, if the most permeable (lowest cost) 5% threshold based on ecological integrity encompasses all focal species' least-cost corridors in all five sample areas, we would use 5% as the threshold for least-cost modeling in all essential connectivity areas. This analysis should help reassure users who are skeptical of using ecological integrity as the resistance layer by selecting a cost threshold that is likely to accommodate the needs of diverse focal species.

If the comparison shows that the ecological integrity raster based approach is severely lacking, we will explore adding a limited number of additional datasets to improve the performance.

Action Step 3.8: Evaluate utility of essential connectivity areas. We will select an illustrative subset of essential connectivity areas (at least one per ecoregion), and describe and evaluate the utility of each through (1) review by species experts, and (2) comparison of our polygons with maps produced by other linkage planners (Davis and Cohen 2008, Penrod et al., 2008, 2006, 2005, 2004, 2003). For each essential connectivity area, we will identify a suite of species expected to use the area, and consider ecological processes, functions, and limitations. We will utilize Wildlife Habitat Relationship data (modeled habitat for 700 vertebrate species) or other existing habitat suitability models (e.g., desert tortoise, bighorn sheep) to identify the suite of species that may be served by each essential connectivity area.

Action Step 3.9: Submit essential connectivity areas results to the TAG for review via Data Basin.

Action Step 3.10: Incorporate minor changes based on input from the TAG.

Strategic Action #4: Compare Essential Connectivity Map to other Conservation Maps (October 2009 targeted completion date)

Action Step 4.1: Compare results to other conservation and pertinent maps. We will overlay the results of the analyses to delineate natural landscape blocks and essential connectivity areas with other conservation plans and assess differences. Maps used for these comparisons may include those identified in:

- Missing Linkages (Penrod et al. 2001; statewide arrows based on expert opinion)
- Existing regional linkage plans prepared by various academic or non-profit organizations (Davis and Cohen 2008)
- Conservation priority areas or portfolios identified by TNC
- Digitally available reserve designs for NCCPs, HCPs, and MSCPs
- Critical habitat designated by USFWS for threatened or endangered species, as well as Essential Habitat identified by USFWS for Federally listed species
- Protected Lands (even though protected lands will be used as input to model, this overlay will show hard line boundaries of public/private conservation lands)
- Bay area focus priority conservation areas developed by CBI
- California Rangeland Conservation Coalition Focus Area Prioritization map
- Predictive models of climate change
- Multi-taxa genetic landscapes (Vandergast et al., 2008)

We will discuss compatibility with other statewide plans (e.g., regional transportation plans, State Wildlife Action Plan) and online databases.

Action Step 4.2: Provide comparison summary to the TAG.

Strategic Action #5: Describe Relative Biological Value of Connectivity Areas (November 2009 targeted completion date)

The goal of this strategic action is to describe the mapped linkages according to their *biological value*. The values assigned are emphatically *not* intended to set agendas for any regulatory, management, or conservation entity. Rather the assigned values of each linkage are intended to serve the following limited purposes:

- Each agency can use these description of statewide biological value as one of several inputs into their own prioritization scheme. The agency will continue to set its own priorities based on its particular mission.
- CDFG, Caltrans, or another state or regional entity can voluntarily allocate planning resources for development of fine-scale linkage conservation plans, modification of the SWAP, or development of a new NCCP or HCP.
- To allow agencies and conservation planners to focus conservation or mitigation in particular areas of high biological importance.
- To provide public information that can highlight essential connectivity areas in California.

Action Step 5.1: Select and calculate metrics for biological value of essential connectivity areas. We will use at least the following criteria:

- size of each natural landscape block associated with the essential connectivity area
- ecological integrity of the essential connectivity areas
- fraction or area of the natural landscape blocks and essential connectivity areas in protected status
- a metric derived from graph theory called the "integral index of connectivity" that integrates landscape value (e.g., ecological integrity) and graph connectedness into a single measure (Pascual-Hortal and Suarta 2008).

Several additional metrics for biological value of an essential connectivity area were proposed by members of the TAG. Any metric must meet the following two criteria (1) it must be calculated from *unambiguous, existing* data, and (2) the appropriate data must be available *for the entire analysis area* (State of California plus buffer). We will attempt to find data layers meeting these standards for the following proposed metrics:

- Presence of aquatic features (streams, lakes, wetlands, etc.)
- Irreplaceability (e.g., rarity hotspots from CNDDB)
- Number of life zones (or magnitude of elevation gradients)
- Number of taxa potentially supported (from previous strategic action)
- Importance as migration route (existing or restorable)

Rather than assign relative weights to each metric, we will provide a matrix of scores for each metric by essential connectivity area. The matrix will also identify which ecoregion(s) and which county(s) the essential connectivity area falls within. Subject to input from the TAG, we may classify the relative importance of each area to biodiversity protection in two or more classes (e.g., truly essential vs. important) and if possible, further identify conservation potential (e.g., contribution to existing conservation investments, land condition, restoration opportunities) to assist agencies in prioritizing actions.

Action Step 5.2: Provide Draft Results to the TAG. Provide results of draft analyses for Assigning Biological Value to Connectivity Areas via Data Basin for TAG review and input. Include summary document.

Action Step 5.3: Hold Second Meeting with the TAG to discuss results of analyses for natural landscape blocks, essential connectivity areas, and biological value of connectivity areas (anticipated for October 14 or 15, 2009).

Action Step 5.4: Revise Analyses based on input from the TAG and provide results to the TAG for final review and input.

Action Step 5.5: Address Final Revisions.

Strategic Action #6: Strategic Plan Development (December 2009 targeted completion date)

The goal of this strategic action is to produce a strategic plan that will guide future regional and fine scale connectivity analyses, planning, and implementation.

Action Step 6.1: Circulate strategic plan outline. Provide detailed outline for Strategic Plan to MDT for review and input. Topics likely addressed include:

- Describe goals of the Strategic Plan.
- Summarize methods and results of the preceding analyses, including their limitations.
- Describe steps required to complete ecoregional level analyses.
- Describe steps required to complete local-scale analyses.
- Describe strategies for integrating essential connectivity areas into other planning and implementation strategies (e.g., General Plans, transportation plans, NCCP plans).
- Compare this approach with that of other plans.
- Describe necessary coordination and collaboration efforts.
- Describe threats and opportunities for implementation, including strategies for rating threats (e.g., development, climate change, fires, pests) and opportunities (e.g., state and regional transportation plans).
- Describe climate change assumptions and recommend future scenario analyses.
- Describe how to integrate results into transportation and land use models.

Action Step 6.2: Draft strategic plan. Develop full draft of Strategic Plan based on input received from MDT.

Strategic Action #7: Project Wrap-up (February 2010 targeted completion date)

Action Step 7.1: Develop presentation(s) summarizing the project and how to use the products.

Action Step 7.2: Obtain input from MDT on distribution list for final products.

Action Step 7.3: Hold final meeting with full MDT. Provide all products produced to date. Use meeting to get input on strategic plan (e.g., framework to use products) before finalizing.

Action Step 7.4: Circulate draft strategic plan to full MDT for review and input.

Action Step 7.5: Revise draft strategic plan based on input from MDT.

Action Step 7.6: Circulate final strategic plan to full MDT.

Action Step 7.7: Distribute final products. Compile and distribute final products to comprehensive distribution list.

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