ACE DATASET FACT SHEET
Terrestrial Connectivity

DS2734

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INTENT AND PURPOSE

The **Terrestrial Connectivity** dataset is one of the four key components of the California Department of Fish and Wildlife's (CDFW) Areas of Conservation Emphasis (ACE) suite of terrestrial conservation information along with terrestrial Biodiversity, Significant Habitats, and Climate Resilience. The Terrestrial Connectivity dataset summarizes information on terrestrial connectivity by ACE hexagon including the presence of mapped corridors or linkages and the juxtaposition to large, contiguous, natural areas. This dataset was developed to support conservation planning efforts by allowing user to spatially evaluate the relative contribution of an area to terrestrial connectivity based on the results of statewide, regional, and other connectivity analyses.

BACKGROUND INFORMATION

Terrestrial Connectivity was added as an ACE layer in 2017. The differences between this connectivity dataset and the previous version of ACE (ACE-II) are: 1) this dataset summarizes connectivity information by hexagon, whereas the previous version included statewide datasets from the California Essential Habitat Connectivity (CEHC) project as ancillary maps that could be overlaid within the ACE viewer but were not summarized by hexagon; and 2) this dataset includes information on regional connectivity analyses, whereas the previous version only included statewide data.

Further work developing the ACE Connectivity dataset will continue in 2018 (ACE 3, phase 2). This includes continuing to compile and incorporate new habitat connectivity information, and adding wildlife migration corridor data, based on state-of-the-art wildlife GIS tracking technology, as it becomes available.

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

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DATA SOURCES AND MODELS USED

For ACE version 3, several types of connectivity information at different spatial scales was brought together to develop ACE connectivity ranks by hexagon.

Source Data

1. Large, Unfragmented Habitat Areas: Large, intact natural areas in California were defined and mapped as Natural Landscape Blocks (NLBs) by the CEHC (ds621; Spencer et al. 2010). The NLBs represent areas of intact natural habitat >2000 acres in size, defined by ecological condition (e.g., areas with low fragmentation and high ecological integrity) and independent of ownership. Areas defined as NLBs are expected to have high connectivity value because they are large, unfragmented, natural areas. Each hexagon was attributed with the percent area of the hexagon mapped as NLB, and given an NLB rank based on percent of hex intersecting NLB: 0% = 0; >0%-20% = 1; >20%-40% = 2, >40%-60% = 3; >60%-80% = 4; >80%-100% =5.

2. Linkages and Corridors: areas identified as linkages or corridors in statewide or regional connectivity analyses. These analyses identify least-cost path corridors between landscape blocks, where cost is defined as landscape permeability. In other words, the corridor analysis identifies the optimal path to connect two natural areas, to allow for ecological connectivity and/or wildlife movement.

   If there was a mapped linkage or corridor within an ACE hexagon, that hexagon was attributed with the BIOS dataset number (dsXXXX) of the corridor dataset. Some hexagons may include mapped corridors from multiple datasets, because there was some overlap of study areas. In this case, the hexagon was ranked based on the total amount of mapped linkage area within the hexagon when looking across all studies. Note that there is also overlap between NLBs and corridors (see Ranking Criteria section below for further discussion). Each hexagon was attributed with the percent area of the hexagon mapped as a linkage or corridor and given a linkage rank as follows: 0% = 0; >0%-20% = 1; >20%-40% = 2, >40%-60% = 3; >60%-80% = 4; >80%-100% =5.

   Two main types of linkage and corridor data were included:

   a. Statewide CEHC Essential Connectivity Areas [ds620, ds623]. The CEHC Essential Connectivity Areas (ECAs) were identified at a coarse scale, to "focus attention on large areas important to maintaining ecological integrity at the broadest scale" (Spencer et al. 2010). The ECAs connect neighboring NLBs >10,000 acres in size. Landscape permeability was defined by ecological condition, including level of habitat

fragmentation, but did not include species-specific movement information. ECAs are available statewide.

b. Regional Linkages and Corridors. These finer-scale analyses have been completed for individual ecoregions or regional planning areas in the state, and are based on habitats and focal species within each study region. These analyses generally define landscape permeability based on species-specific habitat and movement needs, using finer-scale and region-specific information to identify corridors and linkages at a regional scale (Krause and Gogol-Prokurat 2014). Regional linkage analyses have been completed for about half the state to date. See the list of BIOS datasets and associated reports, below.

3. Landscape Intactness: Terrestrial landscape intactness analysis for California developed by CBI (Degagne et al. 2016; https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65). This dataset represents relative landscape intactness, or ecological condition, for California by estimating existing human impacts such as agriculture, urban development, natural resource extraction, and invasive species.

   The ecological condition index used as the basis of the CEHC was published in 2003 and was based on datasets developed prior to that date (Davis et al. 2003). This CBI landscape intactness model is based on more recent datasets and reflects changes that have occurred in the environment since the CEHC was published. The Landscape Intactness model was used as a weighting factor in the ACE connectivity ranking to 1) capture recent changes in landscape condition in areas previously identified as NLBs or Linkages by the CEHC; and 2) supplement connectivity and corridor information in regions of the state where fine-scale connectivity analyses have not yet been completed, and that may not have been fully addressed by the broad-scale statewide CEHC analysis (e.g., area does not fall between two neighboring NLBs).

Ranking Criteria

The ACE connectivity ranks were developed to provide a broad overview of connectivity across the state using the best available connectivity information for each region of the state. The scoring system was designed to bring together connectivity information at multiple scales, giving each hexagon an ACE Connectivity Rank of 1-5 based on locations of large, unfragmented habitat areas; linkages and corridors; and landscape intactness.

Ranking criteria were based on the following assumptions:

1. Large, contiguous natural areas have high connectivity value.
2. Linkages or corridors serve to connect existing habitat core areas and have high connectivity value.
3. Areas with high landscape intactness have higher connectivity value than areas with low landscape intactness.
4. Regional connectivity analyses provide information that supplements, but does not replace, the CEHC statewide linkages. Some statewide linkages identified by the CEHC were not identified in regional connectivity analyses covering the same footprint. This may be because of differences in the location of (i.e., differences in definitions for) landscape blocks between studies.
5. Areas mapped as both NLB and linkage may be of particularly high connectivity value, functioning both as unfragmented habitat and as part of a pathway connecting two blocks. In some cases high connectivity values in areas of overlap may be an artifact of modeling rules, but further work is required to assess this on a case-by-case basis.
6. Connectivity studies generally do not rank linkages by level of importance or conservation priority, so all linkages were treated equally for the purpose of this analysis.
7. Connectivity analysis maps show NLBs and linkages as distinct areas with "hard" boundaries. However, in reality, connectivity value is likely variable within a linkage or NLB, with higher connectivity value toward the core and decreasing connectivity value toward the edge. There is likely also variability in value across the area of an NLB, or across the width of a linkage (most connectivity studies establish a minimum corridor width of 2 km or greater). The ranking criteria addressed this by a) scoring the core of a linkage or NLB higher than the edge, and b) weighting the NLB and/or linkage score with a landscape intactness score.
8. Connectivity values may appear higher in areas of the state where more landscape block and linkages have been mapped (e.g., in areas where regional connectivity analyses have been conducted), or where there is overlap among studies. The scoring rules were designed to minimize inflated values in areas of overlap.

Connectivity ranks were defined as follows:

Natural Landscape Block (NLB) percentage
0 = 0, no NLB
>0%-40% = 1, marginal/edge of NLB
>40% = 2, core NLB

Linkage area percentage
0 = 0, no corridor mapped
>0%-40% = 1, marginal/edge of linkage
>40% = 2, core linkage area

Intactness potential
Intactness score 1 or 2 = 1, low intactness
Intactness score 3 or 4= 2, moderate intactness
Intactness score 5 or 6= 3, high intactness

Scores based on Intactness potential, NLB percentage and Corridor percentage were summed. Hexagons with a final sum of 5, 6, or 7 were collapsed into Connectivity Rank 5 (high connectivity), to help correct for inflated scores in areas where data from multiple studies overlapped. The final ACE Connectivity Ranks of 1-5 are shown in the viewer, while the Connectivity Rank attribute table shows the actual value 1-7. Users can interpret areas with scores 6 or 7 as areas of overlap.

List of Connectivity GIS data sources:

Statewide datasets:

Natural Landscape Blocks – California Essential Habitat Connectivity Analysis [ds621] (Spencer et al. 2010)

Essential Connectivity Areas - California Essential Habitat Connectivity Analysis [ds620, ds623] (Spencer et al. 2010)

Terrestrial Landscape Intactness (1km) - 2016 [ds2670], https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65

Regional datasets:

South Coast Missing Linkages [ds419] (South Coast Wildlands 2008)

Wildlife Linkages – San Joaquin Valley [ds417] (Endangered Species Recovery Program 1996; USFWS 1998, Table 11)

Wildlife Corridors - San Joaquin Valley [ds423]

Habitat Connectivity – Ventura County [ds565] (subset of South Coast Missing Linkages, ds419; South Coast Wildlands 2008)

Linkage Design for the California Desert Linkage Network [ds822] (Penrod et al. 2012)

Linkage Design for the California Bay Area Linkage Network [ds852] (Penrod et al. 2013)

Northern Sierra Nevada Foothills Wildlife Linkages [ds1005] (Krause et al. 2015)

Northern Sierra Nevada Foothills Riparian Corridors [ds1018] (Krause et al. 2015)

Safe Passages Connectivity Planning - Riverbank, CA - 2014 [ds1028] (Huber et al. 2014)

San Diego MSCP, MHCP, and CMSP Cores and Linkages (SDMMP and TNC 2017, Volume 2B, Section 8)

Orange County Central/Coastal NCCP Special Linkages (County of Orange 1996, Section 4.4)

HOW TO USE THE DATA LAYER

The ACE Connectivity dataset provides a single snapshot of connectivity information across the state. The scoring indicates whether the hexagon is part of a large, contiguous natural area or a mapped linkage or corridor. A score of 5 indicates that the area is within the core of a natural landscape block or linkage and has high landscape intactness. A score of 1 indicates that the area has low landscape intactness and is not part of a natural landscape block or linkage.

Common uses of the dataset include:

1. Select a hexagon and view the attribute table to determine whether there is a mapped linkage or corridor within the hexagon, and the percentage of the hexagon mapped as corridor (based on linkage rank 1-5). The BIOS dataset number of any corridor dataset that intersects the hexagon will be given in the ACE attribute table, and the user can then use that information to overlay the BIOS source dataset to see exactly where the corridor was mapped.
2. Select a hexagon to determine whether the area falls within or adjacent to a CEHC NLB. Overlay the NLB BIOS dataset [ds621] to see where exactly the NLB boundaries are.
3. Select a hexagon to view its overall connectivity rank (1-5), and how it compares with the connectivity rank of other hexagons.

Field Definitions

Using the *Identify Features* or *Select* tool in the ACE viewer, users can obtain a table of information (i.e., attribute table) for a hexagon or area of interest. The ACE viewer allows the user to print the table or save as a spreadsheet (.csv) file. The definitions below describe the attribute table fields for this dataset.

Field	Definition
Connectivity Rank	Final connectivity score of 1-5. This is a sum of the NLB_rank and the Linkage_rank, further weighted by the mean CBI Intactnessscore per hexagon.
Linkage Rank	Linkage integer based of the percent of the hexagon that is overlapped by linkage. Scored as 0-5 where 1 = 1-20%, 2 = 21-40%, 3 = 41-60%, 4 = 61-80%, 5 = 81-100% or 0 if no linkages overlap the hexagon.
Linkage datasets	List of linkage datasets that overlap each hexagon.
Natural Landscape Block Rank	Landscape block integer score based of the percent of the hexagon that is overlapped by landscape block. Scored as 0-5 where 1 = 1-20%, 2 = 21-40%, 3 = 41-60%, 4 = 61-80%, 5 = 81-100% or 0 if no landscape blocks overlap the hexagon.
Natural Landscape Block Percent	Percent of hexagon that is covered by natural landscape blocks.

DATA PRECISION AND LIMITATIONS

Connectivity models are landscape-level GIS analyses that are subject to the limitations of the source datasets (e.g., landcover data) as well as to the limitations of the connectivity modeling methods. For the purposes of this analysis, data precision in areas addressed by fine-scale regional connectivity analyses would be expected to have higher certainty than those where only CEHC data is available. The individual project reports should be referred to for a full description of the source data used and

limitations for a given area. See the Terrestrial Significant Habitats Factsheet for a full discussion of data limitations and accuracy of landcover/vegetation datasets.

Least-cost path analysis requires a set start- and end point be set for each corridor, and is therefore sensitive to the choice of landscape blocks used in each analysis. An area that is important for connectivity but does not fall between two landscape blocks may fail to be identified as a linkage or corridor. Rules used to define landscape blocks vary across regional connectivity analyses in California, which can lead to different sets of assumptions that define what the corridors represent between regions.

There is overlap between study areas of the connectivity analyses, and also between linkages and landscape blocks. For example, some regional studies have defined corridors that fall completely completely within CEHC NLBs. Areas identified both as landscape block and linkage/corridor would receive a high ACE connectivity rank. These areas may be particularly important for connectivity, but in some cases the high score could be an artifact of the modeling. Most linkage analyses do not rank linkages by level of importance or conservation priority, so all linkages were treated equally for the purpose of this analysis.

DATA ACCESS

The ACE Connectivity dataset is available for viewing and download in BIOS. For assistance with interpretation contact Melanie Gogol-Prokurat: melanie.gogol-prokurat@wildlife.ca.gov

The statewide and regional connectivity analysis datasets are available as individual datasets in BIOS and can be easily accessed in the BIOS Habitat Connectivity Viewer.

The terrestrial intactness dataset is available from CBI in Databasin: https://databasin.org/datasets/e3ee00e8d94a4de58082fdbc91248a65.

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Factsheet: Melanie Gogol-Prokurat, Shannon Lucas, and Andrew Amacher.

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For additional information and a full list of ACE 3 Factsheets, see the ACE3 Technical Report.

Areas of Conservation Emphasis, CA Dept of Fish and Wildlife, www.wildlife.ca.gov/Data/Analysis/Ace