ACE DATASET FACT SHEET
Terrestrial Irreplaceability

DS2715

DATA BY TAXONOMIC GROUP

DS2716 – Plant Irreplaceability
DS2717 – Bird Irreplaceability
DS2718 – Mammal Irreplaceability
DS2719 – Amphibian Irreplaceability
DS2720 – Reptile Irreplaceability

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INTENT AND PURPOSE

Terrestrial Irreplaceability is a measure of the uniqueness of habitat areas for rare endemic species in the landscape, and is one measurement used to describe the **distribution of overall species biodiversity in California** for the California Department of Fish and Wildlife (CDFW) Areas of Conservation Emphasis Project (ACE). Other measures of terrestrial species biodiversity included in the ACE terrestrial biodiversity summary are native species richness and rare species richness.

Here, terrestrial irreplaceability represents the relative importance of each hexagon based on the uniqueness of habitat areas present for California rare endemic and near-endemic species. Hexagons with a high irreplaceability weight contain species or habitat conditions that occur in few places in the landscape. These areas may be of high conservation value due to their unique contribution to biodiversity. The data provides, 1) a count of the total number of endemic species per taxonomic group in each hexagon based on documented species occurrence information, and 2) the irreplaceability weight, based on the rarity-weighted index (RWI), which weights the species count by the extent of the distribution for each species, so hexagons providing habitat for narrowly distributed species are given a

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higher score. Areas with a high RWI support rare species with few documented occurrences; these areas would be expected to support unique habitats or suites of species that are limited in distribution. The data can be used to **view the distribution of rare endemic species** in California, and to **identify areas of high irreplaceability**. Users can **view a list of species** that contribute to the biodiversity summary for each hexagon.

The **terrestrial irreplaceability summary** depicts the areas of highest irreplaceability within each ecoregion across the state. To achieve this, the data was normalized by taxonomic group and by ecoregion (see Data Sources and Models Used, below). The **terrestrial irreplaceability by taxonomic group** layers give a statewide overview of irreplaceability for each individual taxonomic group, showing counts of rare endemic species per hexagon and irreplaceability weights (RWI values) for amphibians, birds, mammals, plants, and reptiles.

BACKGROUND INFORMATION

The terrestrial irreplaceability dataset replaces the rarity-weighted richness dataset in the previous version of ACE (ACE-II). The differences between these datasets are: 1) this dataset only includes terrestrial species; fish are now included in a separate aquatic irreplaceability dataset, 2) this dataset is limited to rare endemic species, whereas the previous version was based on the rarity-weighted index for all rare species, not just those that are California endemic or near-endemic species, and 3) this dataset assigns the terrestrial irreplaceability ranks based on the maximum RWI score across taxonomic groups, while the previous version assigned the ranks based on the mean RWI score across taxonomic groups.

The previous version of ACE included two different rarity-weighted richness maps: statewide RWI and RWI by ecoregion. The new viewer displays only ecoregional RWI (now called terrestrial irreplaceability), since this dataset is the scale most relevant for most planning processes in California. The statewide irreplaceability summary (highlighting high RWI areas on a statewide basis, not by ecoregion) is not shown in the ACE viewer but is still available as a separate layer in BIOS (ds1334), and the relative statewide values are available in the ACE terrestrial irreplaceability GIS attribute table.

DATA SOURCES AND MODELS USED

Rare endemic species included in this ACE version 3 analysis included species identified as endemic or near-endemic in the California Species of Special Concern reports, and California Rare Plant Rank (CRPR) 1B plants, most of which are rare endemics. Rare endemic species counts and RWI calculations were conducted for amphibians (n=38), birds (n=43), mammals (n=99), plants (n=1178), and reptiles (n=28) at the taxonomic level treated as special status (e.g., species, subspecies, ecologically significant unit). Note that this analysis focused on *rare* endemic species, where rarity was defined as State or Federally-listed species, Species of Special Concern (SSC), fully-protected species, and CRPR 1B plants. Endemic species not meeting those rarity criteria were not included.

Terrestrial rare endemic species location data were derived from available, documented, mapped species occurrences. Sources included "presumed extant" California Natural Diversity Database records (excluding extirpated and possibly extirpated records); additional museum records from the California Academy of Sciences, the Museum of Vertebrate Zoology at UC Berkeley, and the Consortium of California Herbaria (from years 1999-2009); and additional datasets from the CDFW BIOS online map viewer (https://www.wildlife.ca.gov/Data/BIOS), used with permission from the contributors. All documented occurrences with accuracy ±1 mile or better were included in order to incorporate as many known occurrences as possible. No cut-off date of observation was used, based on the assumption that occurrences still may be present if the habitat has not been modified and the occurrences have not been documented as extirpated. A one mile buffer was added to all occurrence points and polygons to standardize accuracy.

The **irreplaceability weight** is based on the **rarity-weighted index (RWI) calculation**, which weights each species by the extent of its distribution. Whereas for the count of endemic species every species was given the same weight (1 species = 1), for RWI every species was given a weight between zero and one that is proportional to the extent of its distribution. The RWI was calculated by taking the inverse of the number of hexagons occupied by each rare endemic taxon [**RWI = Σ 1/(# occupied hexagons per taxon)**], so that taxa with the smallest distributions have the largest values. The values for each species occurring in a hexagon were then summed per hexagon by taxonomic group. The final rank was assigned by taking the maximum RWI value across taxonomic groups, so that areas of high irreplaceability for any single taxonomic group would be ranked highly in the final map.

Data normalization by taxonomic group corrected for any bias caused by differences in the number of taxa per taxonomic group. Due to large differences in total numbers of species between taxonomic groups, the raw sum of species counts or RWI totals are highly skewed toward the taxonomic group(s) with the largest numbers of species. In order to give each taxonomic group equal weight in the final model output, the RWI values for each taxonomic group were normalized (scaled from zero to one): The RWI value in each hexagon for a given taxonomic group was divided by the maximum value for that taxonomic group. To identify and highlight areas of greatest irreplaceability within each ecoregion, the count for each taxonomic group was divided by the maximum value for that taxonomic group within each ecoregion (ecoregional normalization). Statewide normalized values (the value for each taxonomic group was divided by the maximum value for that taxonomic group across the state), which give a picture of relative irreplaceability on a statewide basis, were also produced and are available in the GIS attribute table for reference.

Data processing steps:

1. **Rare endemic species richness counts**: The number of species per hexagon was counted by taxonomic group: **amphibians, birds, mammals, plants, and reptiles**. All species occurrences were buffered by one mile.
2. **RWI calculation**: Each species was assigned an RWI value equal to the inverse of the number of hexes in which the species occurs. The RWI was calculated for each taxonomic group in each

hexagon by taking the sum of the individual RWI values for each species occurring in the hexagon.

3. **Normalized RWI:** The RWI totals by taxonomic group per hexagon were normalized (scaled from zero to one) statewide [statewide irreplaceability] and ecoregionally [ecoregional irreplaceability].
4. **Terrestrial Irreplaceability summary**: The maximum ecoregional irreplaceability score was taken across taxonomic groups. Statewide irreplaceability scores are provided in the attribute table for reference, and a summarized version of these datasets is available separately in BIOS (ds1334).
5. **Final ranking**: To display the relative terrestrial irreplaceability values, the terrestrial irreplaceability summary was ranked from 1-5 using 5 quantiles by ecoregion (e.g., the 20% of hexagons with the highest scores in each ecoregion were given a 5, the 20% of hexagons with the lowest scores in each ecoregion were given a 1). Note that due to differences in size between ecoregions, and differences in the number of species and level of irreplaceability potentially occurring in each ecoregion, the number of hexagons ranked in each category (1-5) differs across ecoregions, and the value of irreplaceability weight present in a hexagon with a given score also varies across ecoregions.

HOW TO USE THE DATA LAYER

The terrestrial irreplaceability maps can be used to view and explore how irreplaceability and endemism is distributed across the state and within each ecoregion. The user can choose the view that best meets their needs: whether that be patterns of irreplaceability by ecoregion shown by the terrestrial irreplaceability summary, or the distribution of the number of rare endemic species statewide by individual taxonomic group. By selecting a hexagon in the viewer, the user can see the number of endemic species counted in the hexagon, the relative irreplaceability rank of the hexagon compared to the rest of the ecoregion and the rest of the state, and view a list of species potentially present. Note that because the irreplaceability data is based on documented occurrences, the values shown are influenced by level of survey effort in a given area.

Frequent uses of this group of datasets include:

- Identify the number of rare endemic species potentially present within a hexagon based on documented species occurrences (using identify tool or GIS attribute table)
- Obtain a list of those potential species (using 'Identify Features' on Species List dataset in ACE viewer)
- View relative richness of rare endemic species across the state for a given taxonomic group (viewing Endemism by taxonomic group)
- Identify the highest irreplaceability areas in an ecoregion for a given taxonomic group (using the Identify Features tool or GIS attribute table to obtain ecoregionally normalized values and

ranks for each taxonomic group). Compare the ecoregional rank with the statewide rank (using the Identify Features tool or GIS attribute table).

- View relative overall rare irreplaceability within each ecoregion (viewing Terrestrial Irreplaceability Summary).
- Identify the areas of highest overall rare irreplaceability within each ecoregion (Rank 5 hexagons in Terrestrial Irreplaceability Summary).
- Identify where data may be lacking (viewing 'No Data' hexes).

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
Endemic Amphibian Count	Count of endemic and near endemic amphibian taxa, as defined by the CDFW Amphibian and Reptile Species of Special Concern Report, in each hexagon. Taxa are defined and aggregated at the taxonomic unit at which they are listed and tracked by the California Natural Diversity Database (CNDDB), which may be by species, subspecies, distinct population segment (DPS), or evolutionarily significant unit (ESU). Taxa are not double counted within the hexagon.
Endemic Reptile Count	Count of endemic and near endemic reptile taxa, as defined by the CDFW Amphibian and Reptile Species of Special Concern Report, in each hexagon. Taxa are defined and aggregated at the taxonomic unit at which they are listed and tracked by the California Natural Diversity Database (CNDDB), which may be by species, subspecies, distinct population segment (DPS), or evolutionarily significant unit (ESU). Taxa are not double counted within the hexagon.
Endemic Bird Count	Count of endemic and near endemic bird taxa, as defined by the CDFW Bird Species of Special Concern Report, in each hexagon. Taxa are defined and aggregated at the taxonomic unit at which they are listed and tracked by the California Natural Diversity Database (CNDDB), which may be by species, subspecies, distinct population segment (DPS), or evolutionarily significant unit (ESU). Taxa are not double counted within the hexagon.

Field	Definition
Endemic Mammal Count	Count of endemic and near endemic mammal taxa, as defined by the CDFW Mammal Species of Special Concern Report, in each hexagon. Taxa are defined and aggregated at the taxonomic unit at which they are listed and tracked by the California Natural Diversity Database (CNDDB), which may be by species, subspecies, distinct population segment (DPS), or evolutionarily significant unit (ESU). Taxa are not double counted within the hexagon.
Endemic Plant Count	Count of plant taxa with a California plant rank of 1B in each hexagon. Plants with a California Rare Plant Rank of 1B are rare throughout their range with the majority of them endemic to California. Plant taxa are defined and aggregated at the taxonomic unit at which they are listed and tracked by the California Natural Diversity Database (CNDDB), which may be by species, or subspecies level.
AllTaxaEndem	Count of all endemic and near endemic plants and animal taxa in each hexagon.
Statewide Irreplaceability	Maximum statewide normalized rarity weighted index value for any taxonomic group in each hexagon.
Ecoregion Irreplaceability	Maximum ecoregionally normalized rarity weighted index value for any taxonomic group in each hexagon.
Statewide Irreplaceability Rank	Ranks of 1-5 assigned to the statewide normalized rarity weighted index values, with all zero values removed and remaining values broken into 5 quantiles, each containing the same number of hexagons.
Ecoregion Irreplaceability Rank	Ranks of 1-5 assigned to the ecoregionally normalized rarity weighted index values, with all zero values removed and remaining values broken into 5 quantiles, each containing the same number of hexagons.

DATA PRECISION AND LIMITATIONS

The rare endemic species occurrence data was a subset of the rare species occurrence data compiled for the rare species richness datasets. Species occurrence data with accuracy ±1 mile or better was included in the analysis. To standardize the accuracy, all species occurrences were buffered by one mile before analysis.

The rare species occurrence datasets compiled for use in ACE rely on voluntary submission of data to the Department. Surveys for rare species have not been conducted comprehensively across the entire landscape. Since rare endemic species tend to be of high conservation concern, their distributions are often well-surveyed. Even so, some **omission error** (locations where the species exists but is not documented) is expected, which would result in *underestimates* of irreplaceability scores in some hexagons.

Verified species occurrences mapped by CNDDB and museum data tend to be spatially biased toward areas with high levels of survey effort, which may result in particularly high values in well-surveyed

areas. RWI scores are sensitive to level of survey effort, because both the species-level RWI score and the total hexagon score are influenced by level of omission error.

Irreplaceability measures the uniqueness of an area, and best represents areas important for *narrow-ranging species and habitats*, but does not necessarily capture areas important for wide-ranging species that are rare within their range and may also be of high conservation concern. A separate metric should be developed to identify the areas of greatest importance for wide-ranging species.

DATA ACCESS

All ACE datasets are available for viewing and download in BIOS. Detailed maps of rare species occurrences are available with a CNDDB subscription, and are not available in ACE.

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GIS Scripting: Ryan Hill and Sandra Hill

Factsheet: Melanie Gogol-Prokurat

SELECTED PUBLICATIONS

California Department of Fish and Game (CDFG). 2010. Areas of Conservation Emphasis (ACE-II) Project Report. Sacramento, California.

California Department of Fish and Wildlife. 2015. California State Wildlife Action Plan, 2015 Update: A Conservation Legacy for Californians. Armand G. Gonzales and Junko Hoshi (editors). Prepared with assistance from Ascent Environmental, Inc., Sacramento, CA.

California Department of Fish and Wildlife (CDFW). 2017. California Natural Diversity Database (CNDDB). Accessed Sept 5, 2017. https://www.wildlife.ca.gov/Data/CNDDB

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