ACE DATASET FACT SHEET
Aquatic Irreplaceability

DS2752

SUBSETS BY TAXONOMIC GROUP

DS2753 – Fish Irreplaceability
DS2754 – Aquatic Amphibian Irreplaceability
DS2755 – Aquatic Reptile Irreplaceability

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INTENT AND PURPOSE

Aquatic Irreplaceability is a measure of the uniqueness of habitat areas for aquatic 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's (CDFW) Areas of Conservation Emphasis Project (ACE). Other measures of aquatic species biodiversity included in the ACE aquatic biodiversity summary are aquatic native species richness and aquatic rare species richness.

Here, aquatic irreplaceability represents the relative importance of each watershed based on the uniqueness of habitat areas present for rare and endemic aquatic species. Watersheds with high irreplaceability 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) 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 watersheds providing habitat for narrowly distributed species are given a higher score, and 2) a count of the total number of endemic species per taxonomic group in each watershed based on documented species occurrence information for aquatic reptiles and amphibians. 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

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limited in distribution. The data can be used to **identify areas of high irreplaceability**. Users can **view a list of species** that contribute to the biodiversity summary for each watershed.

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

BACKGROUND INFORMATION

The separate Aquatic Biodiversity datasets were a new addition to ACE in 2017. The previous version of ACE (ACE-II) combined aquatic information, including fish distribution data, in the terrestrial hexagons, and did not include aquatic invertebrate data. Ace version 3 models aquatic data by watershed (National Hydrography Dataset at the HUC 12 level (HUC 12) rather than by hexagon.

Further work developing the ACE Aquatic data will continue in 2018 (ACE 3, phase 2). This includes continuing to compile and incorporate new aquatic species distribution and occurrence information as it becomes available, and further refining the aquatic species list.

DATA SOURCES AND MODELS USED

For ACE version 3, aquatic irreplaceability was based on documented occurrence data for fish, endemic aquatic amphibians, and endemic aquatic reptiles. Taxa were 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). Aquatic invertebrates were included in the overall native richness counts but not in the aquatic rarity or irreplaceability calculations because much of the aquatic invertebrate occurrence data was only available at the taxonomic level of family, while rarity and endemism is usually designated at the level of species or subspecies. Data for aquatic members of other taxonomic groups, including plants, mammals, and birds, have not yet been included in ACE. Fish species are included in the overall irreplaceability score, but are not included in the endemic species counts by taxonomic group.

Data Sources

Aquatic rare species location data were derived from available documented, mapped species occurrences. Sources included "presumed extant" California Natural Diversity Database (CDFW 2017) 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 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. Aquatic rare species data was not buffered by 1 mile as the terrestrial rare species data was. 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. Each species was counted for each HUC12 watershed(s) with which its occurrence locations intersected.

Data Processing Steps and Ranking Criteria

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 watersheds occupied by each taxon [**RWI = Σ 1/(# occupied watersheds per taxon)**], so that taxa with the smallest distributions have the largest values. The values for each species occurring in a watershed were then summed per watershed 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 watershed for a given taxonomic group was divided by the maximum value for that taxonomic group across the state. Aquatic data was not normalized by ecoregion as the terrestrial data was. To identify and highlight areas of greatest irreplaceability across the state, statewide normalized values for each taxonomic group were summed by watershed to create the Aquatic Irreplaceability summary.

Data processing steps:

1. **Rare endemic species richness counts**: The number of endemic species per HUC 12 watershed was counted by taxonomic group: **amphibians and reptiles**.
2. **RWI calculation**: Each species was assigned an RWI value equal to the inverse of the number of watersheds in which the species occurs. The RWI was calculated for each taxonomic group in each watershed by taking the sum of the individual RWI values for each species occurring in the watershed.
3. **Normalized RWI:** The RWI totals by taxonomic group per HUC 12 watershed were normalized (scaled from zero to one) statewide [statewide irreplaceability].

4. **Aquatic Irreplaceability summary**: The maximum irreplaceability score per HUC 12 watershed was taken across taxonomic groups.
5. **Final ranking**: To display the relative aquatic irreplaceability values, the aquatic irreplaceability summary was ranked from 1-5 using 5 quantiles statewide (e.g., the 20% of watersheds with the highest scores in the state were given a 5, the 20% of watersheds with the lowest scores in the state were given a 1).

HOW TO USE THE DATA LAYER

The aquatic irreplaceability maps can be used to view and explore how irreplaceability and endemism is distributed by watershed across the state. The user can choose the view that best meets their needs: whether that be patterns of irreplaceability by watershed shown by the terrestrial irreplaceability summary, or patterns of irreplaceability for individual taxonomic group. Note that a dataset depicting counts of endemic aquatic species is not currently available, but is expected to be added in a future ACE update. By selecting a watershed in the viewer, the user can see the relative irreplaceability rank of the watershed compared to the rest of the state, and view a list of species potentially present. 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:

- Obtain a list of rare and endemic aquatic species per watershed (using the Identify Features tool on the Species List dataset in the ACE viewer)
- Identify the highest irreplaceability areas in the state 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).
- View and identify the areas of highest overall irreplaceability across the state (Rank 5 watersheds in Aquatic Irreplaceability Summary).

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 watershed 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
Aquatic Irreplaceability	Maximum statewide normalized RWI value for any taxonomic group in each HUC12 watershed.

Field	Definition
Aquatic 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 HUC 12 watersheds.
Fish Irreplaceability	Statewide normalized sum of rarity weighted fish values.
Aquatic Amphibian Irreplaceability	Statewide normalized sum of rarity weighted amphibian values.
Aquatic Reptile Irreplaceability	Statewide normalized sum of rarity weighted reptile values.

DATA PRECISION AND LIMITATIONS

The data used included rare species occurrence data for fish, and endemic species occurrence data for reptiles and amphibians, which was a subset of the rare species occurrence data compiled for aquatic rare species richness.

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. Therefore, current maps of verified rare species occurrences are expected to be biased by level of survey effort and have **high rates of omission error** (locations where the species exists but is not documented). For this reason, counts of rare species richness would be expected to be *underestimates* in some watersheds, particularly those for which no survey data are available. 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 rare species richness values in well-surveyed areas. RWI scores are sensitive to level of survey effort, because both the species-level RWI score and the total watershed 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 species occurrences are available with a CNDDB subscription, and are not available in ACE.

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SELECTED PUBLICATIONS

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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