



California Water Quality Monitoring Council

September 5, 2018



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MIND THE GAP



FILL

THE GAP

Multi-phased project

- 1) Identify freshwater species in California
- 2) Map species occurrences and patterns of distribution
- 3) Identify a network of priority watersheds based on **representation of biodiversity**
- 4) Characterize the condition and threats to inform conservation strategies.

Thank You

Rodd Kelsey, Kirk R. Klausmeyer, Larry Serpa, Jackson Shedd - **TNC**

Kurt A. Fesenmyer, Rene Henery - **Trout Unlimited**

Joseph Furnish, Michael Kellett - **US Forest Service**

Tom Gardali - **Point Blue**

Ted Grantham, Peter B. Moyle, Ryan Peek, Rebecca Quinones, Nick Santos, Amber Wright – **UC Davis**

Josh Viers – **UC Merced**

Jacob Katz – **CalTrout**

Sarah Kupferberg – **McBain Associates**

Patrick McIntyre, Pete Ode, Andy Rehn, Steve Schoenig
- **CA DFW**

Joe Slusark – **California State University Chico**

1. What are freshwater species?

Criteria defined for:

- Amphibians and Reptiles
- Benthic Macroinvertebrates
- Birds
- Fish
- Mammals
- Plants



Criteria: Fishes

Freshwater fishes are defined as those that spawn in freshwater. Catadromous species wouldn't qualify, however, we do not have any catadromous species in California. This also precludes several estuarine species commonly found in brackish water such as starry flounder, striped mullet and staghorn sculpin.

Criteria: Invertebrates

- Benthic macroinvertebrates (BMIs) are those included on the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Standard Taxonomic Effort (STE) list collected as part of freshwater bioassessment in the southwestern United States. The list contains BMI species known to occur in streams, lakes, or wetlands, including vernal pools, but special emphasis was placed on stream taxa since freshwater bioassessment is most frequently conducted in that habitat type. The list was compiled from published literature sources and from records in the State Water Board's bioassessment database, the latter being derived from surveys of thousands of stream sites throughout California.
- All species in the SAFIT list are benthic in one or more life stages and utilize freshwater habitats in one or more of the following critical life functions: feeding, mating, egg deposition/development, and larval development to maturity.
- The species list is more comprehensive for some taxonomic groups than others, reflecting the knowledge base and interests of the authors and other taxonomists at California's Aquatic Bioassessment Lab, availability and regional synoptic coverage of primary taxonomic literature, and likelihood of obtaining properly preserved specimens in typical benthic samples. For example, the list is comprehensive for most aquatic insect groups such as mayflies, stoneflies, dragonflies, caddisflies, beetles, the dipteran suborder Nematocera, etc. The dipteran suborder Brachycera is a notable exception, with most taxa being listed at genus level. The species lists also include surface-dwelling groups like Gerridae (water striders, order Hemiptera) and Gyrinidae (whirligig beetles, order Coleoptera), but exclude taxa associated with riparian zones, shore-dwelling species, and plant tissue inhabitants in taxonomic groups such as Collembola, Staphylinidae, Heteroceridae, Chrysomelidae, Curculionidae, Saldidae, Isopoda and Amphipoda.
- The list is comprehensive for benthic crustaceans except Ostracoda. The list does not include planktonic microcrustacea (Copepoda and Cladocera). No attempt has been made to provide comprehensive species lists for freshwater Annelida (segmented worms) as preservation is typically poor in benthic samples, but generic lists are provided for leeches and polychaetes. Similarly, generic listings are included for Acari (water mites). An extensive taxonomic literature is available for these groups and could support compilation of species lists by appropriate experts in future versions. The list also excludes freshwater parasites such as Branchiura and mermithid Nematoda, the Branchiobdella, which are commensals on crayfish, and the Nematomorpha which are parasitic on terrestrial insects but are found in freshwater for part of their life cycle.
- Phylum Mollusca is variably treated: species lists are generally comprehensive for taxa that occur in larger streams and rivers, despite improper preservation that prevents species-level identifications in typical benthic samples that are collected for bioassessment purposes. Pebblesnails (Families Hydrobiidae and Lithoglyphidae) are a diverse group in springs of the southwestern US, but a species list has not been included.

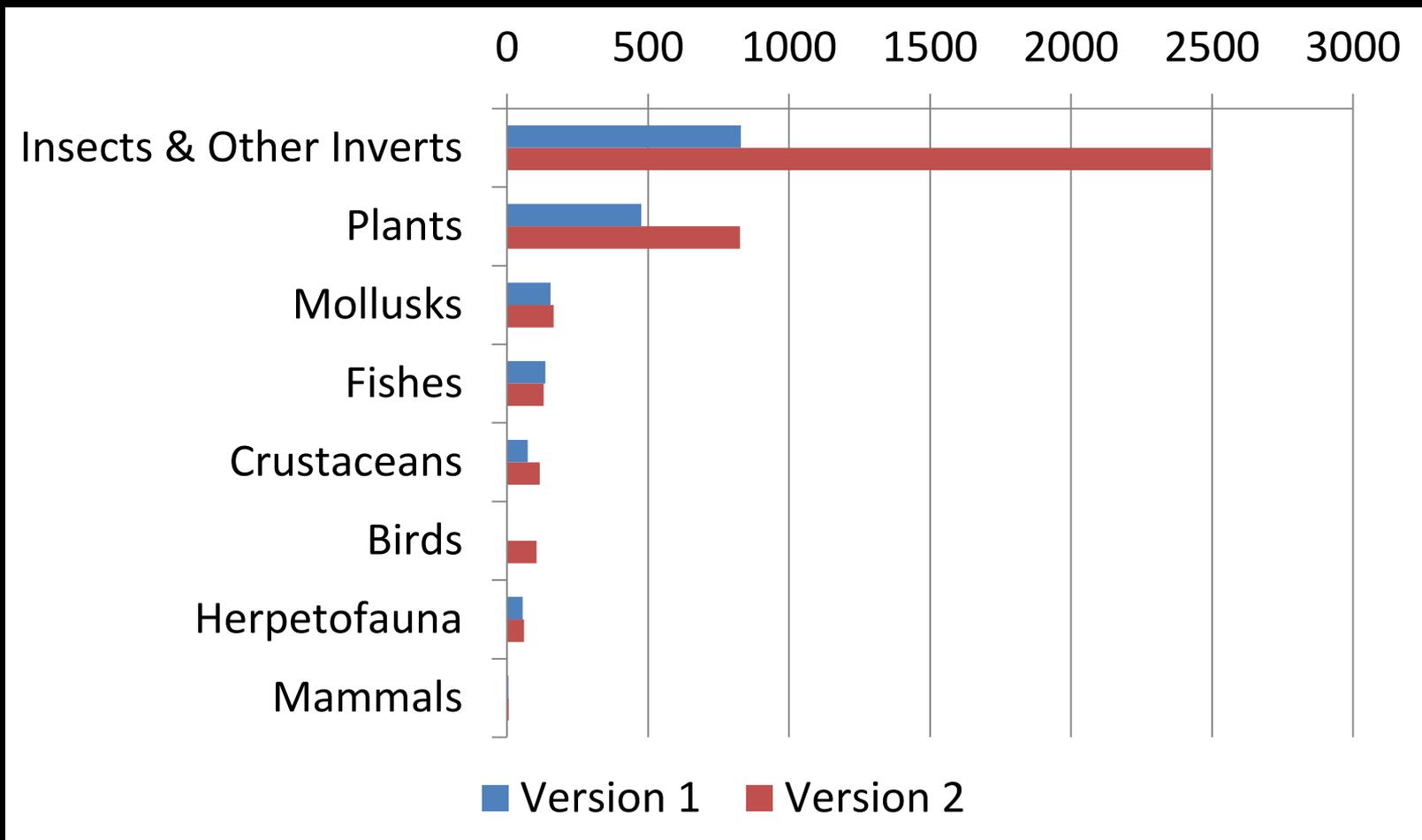
Below the Surface:

CALIFORNIA'S FRESHWATER BIODIVERSITY



- June 2013 - Released report and public database
- June – July 2013 – Received lots of comments, critiques
- August 2013 – Formed working group to revise database

Taxa List (species and subspecies)



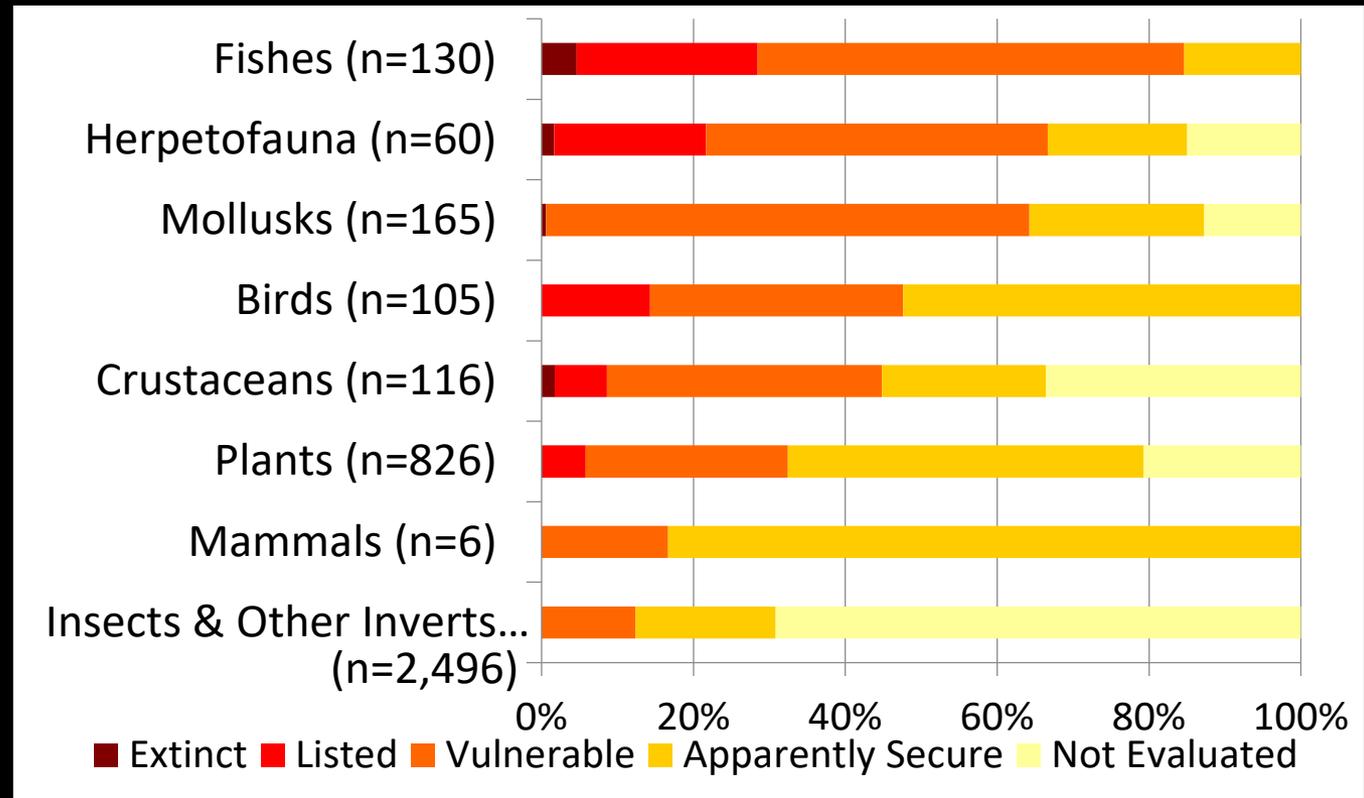
Version 1 = 1,728 species (relied on NatureServe for species list)

Version 2 = 3,904 species (relied on 20 sources for species list)
and included birds

Conservation Status

Source	Criteria for "listed ranking"	Criteria for "Vulnerable" ranking	Criteria for "Apparently Secure" ranking
ESA federal or state lists [29–30]	• Endangered OR	• Under Review in the Candidate or Petition Process OR	
	• Threatened	• Proposed Threatened OR • Species of Special Concern OR • Candidate OR • Bird of Conservation Concern OR • Special Concern OR • Special	
NatureServe [24]		Ranked at either the global (G) or state (S) scales as:	Ranked at either the global (G) or state (S) scales as:
		• Vulnerable (NatureServe ranking of 3) OR • Imperiled (NatureServe ranking of 2) OR Critically imperiled (NatureServe ranking of 1)	• Apparently Secure (NatureServe ranking of 4) OR • Secure* (NatureServe ranking of 5)
Status assessment of California's native inland fishes [20]		• EN (endangered) OR	• NT (near-threatened) OR
		• VU (vulnerable)(following IUCN definitions)	• LC (least concern)
Conservation Status of Freshwater Gastropods of Canada and the United States [31]		• Endangered OR	Currently Stable (CS)
		• Threatened OR • Vulnerable	
California Native Plant Society – Rare Plant Inventory [32]		• 1A (Plants Presumed Extirpated in California and Either Rare or Extinct Elsewhere) OR	
		• 1B (Plants Rare, Threatened, or Endangered in California and Elsewhere) OR	
		• 2A (Plants Presumed Extirpated in California, But Common Elsewhere) OR	
		• 2B (Plants Rare, Threatened, or Endangered in California, But More Common Elsewhere)	
Amphibian and Reptile Species of Special Concern (ARSSC) [33]		Appears on list	
California Department of Fish and Wildlife (CDFW) Species of Special Concern [34]		Appears on list	
USFWS Species of Concern [35]		Appears on list	
USFWS Birds of Conservation Concern [36]		Appears on list	
US Forest Service National Threatened, Endangered and Sensitive Species (TES) Program [37]		Appears on list	
US Bureau of Land Management Special Status Species [38]		Appears on list	

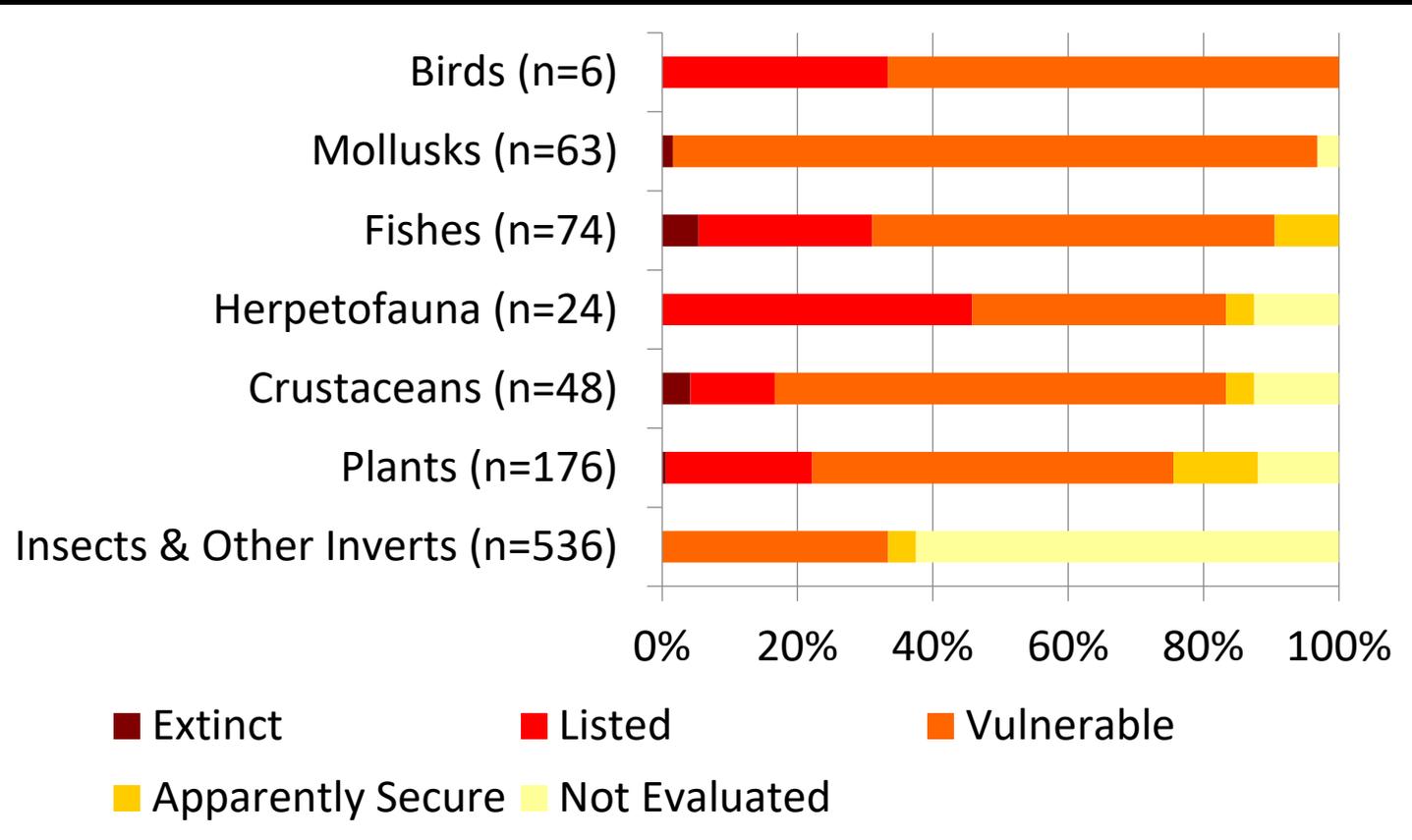
All Taxa



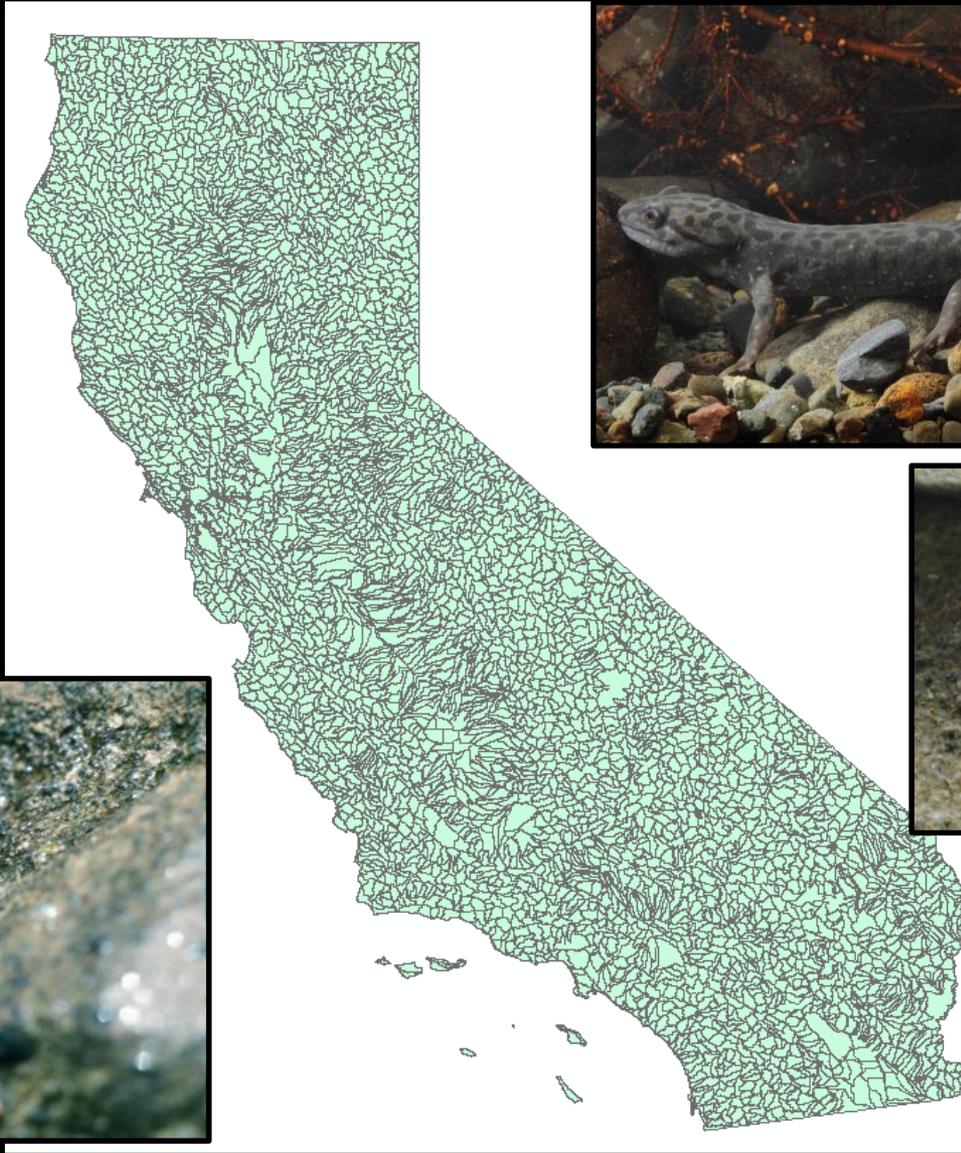
- Half of taxa evaluated for conservation status (n=1,939) are vulnerable to extinction
- 114 (6%) of those have legal mandate for protection

Endemic Taxa

- 90% of the 927 endemic taxa vulnerable to extinction.
- 14% have a legal mandate for protection



2. Where are freshwater species



Spatial Data Sources

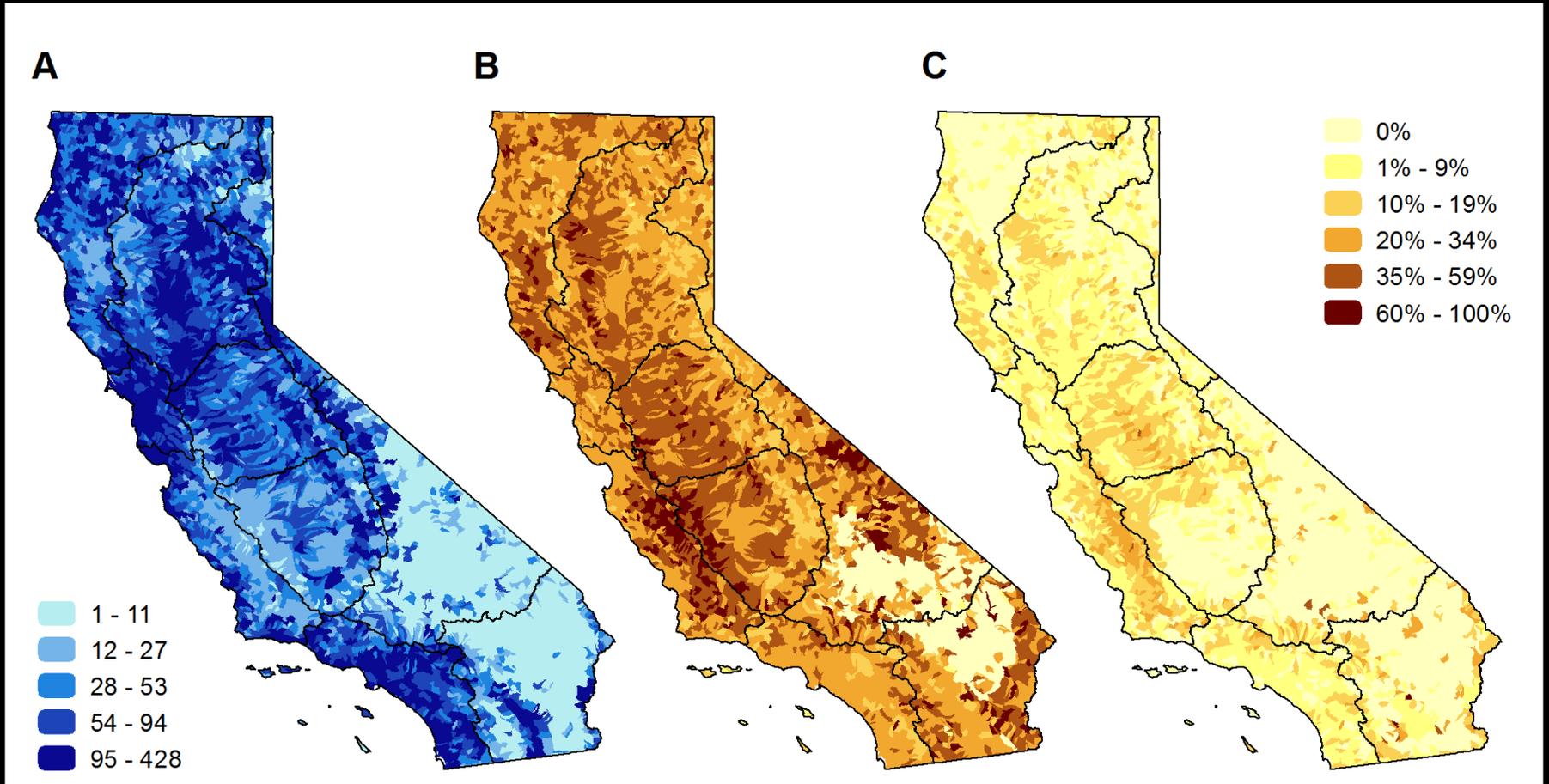
Found spatial data for:
 61% of all taxa
 68% of endemic taxa
 90% of vulnerable taxa
 ALL listed species

39% No data

Sources	Point features	Line features	Polygon features	Total features
GBIF	2,631,338			2,631,338
Buglab	356,239			356,239
SWAMP	168,702			168,702
California Avian Datacenter	125,972			125,972
Consortium of CA Herbaria	81,089			81,089
Other data sources	35,918	23,689	575	60,182
HerpNet	55,191			55,191
CNDDDB	9,914		8,394	18,308
CalBug	18,099			18,099
BIOS	1,361	33	21	1,415
PISCES			130	130
CWHR			66	66

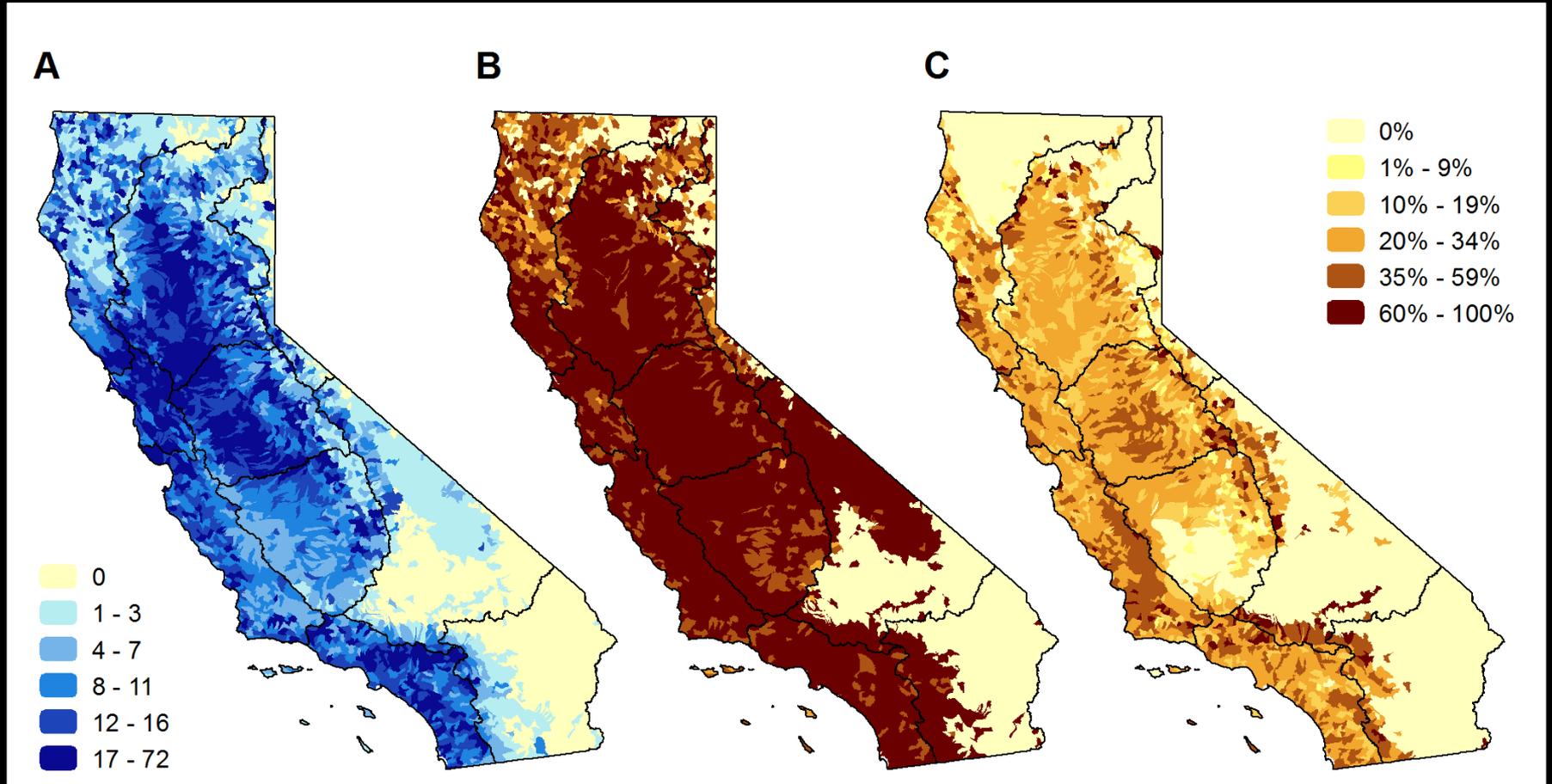
495 data sources

Patterns of Freshwater Biodiversity



All species (A), % Vulnerable (B), % Listed (C)

Patterns of Freshwater Biodiversity



Endemic species (A), % Vulnerable (B), % Listed (C)

RESEARCH ARTICLE

Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California

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OPEN ACCESS

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Data Availability Statement: All data are available from The Nature Conservancy website: scienceforconservation.org. The data used in the study are third-party data. The data sources and third-party contacts are provided in [S3 Table](#). We received permissions from all data providers to publicly use and release the data.

Funding: We thank The Nature Conservancy for supporting development of this database and this research, with additional support from the U. S. Bureau of Land Management. With the exception of the authors, the funders had no role in study design,

* These authors contributed equally to this work.

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Abstract

The ranges and abundances of species that depend on freshwater habitats are declining worldwide. Efforts to counteract those trends are often hampered by a lack of information about species distribution and conservation status and are often strongly biased toward a few well-studied groups. We identified the 3,906 vascular plants, macroinvertebrates, and vertebrates native to California, USA, that depend on fresh water for at least one stage of their life history. We evaluated the conservation status for these taxa using existing government and non-governmental organization assessments (e.g., endangered species act, NatureServe), created a spatial database of locality observations or distribution information from ~400 data sources, and mapped patterns of richness, endemism, and vulnerability. Although nearly half of all taxa with conservation status ($n = 1,939$) are vulnerable to extinction, only 114 (6%) of those vulnerable taxa have a legal mandate for protection in the form of formal inclusion on a state or federal endangered species list. Endemic taxa are at greater risk than non-endemics, with 90% of the 927 endemic taxa vulnerable to extinction. Records with spatial data were available for a total of 2,276 species (61%). The patterns of species richness differ depending on the taxonomic group analyzed, but are similar across taxonomic level. No particular taxonomic group represents an umbrella for all species, but hotspots of high richness for listed species cover 40% of the hotspots for all other species and 58% of the hotspots for vulnerable freshwater species. By mapping freshwater species hotspots we show locations that represent the top priority for conservation action in the state. This study identifies opportunities to fill gaps in the evaluation of conservation status for freshwater taxa in California, to address the lack of occurrence information for nearly



Add Data: BIOS ▾

Click here to search and see list of datasets

Basemaps Layers

Identify Features ▾

Advanced Tools ▾

Active Layer: California Freshwater Species Database (Aquarius) - 2015 [ds1197]

BIOS Layers

— California Freshwater Species Database (Aquarius) - 2015 [ds1197]   

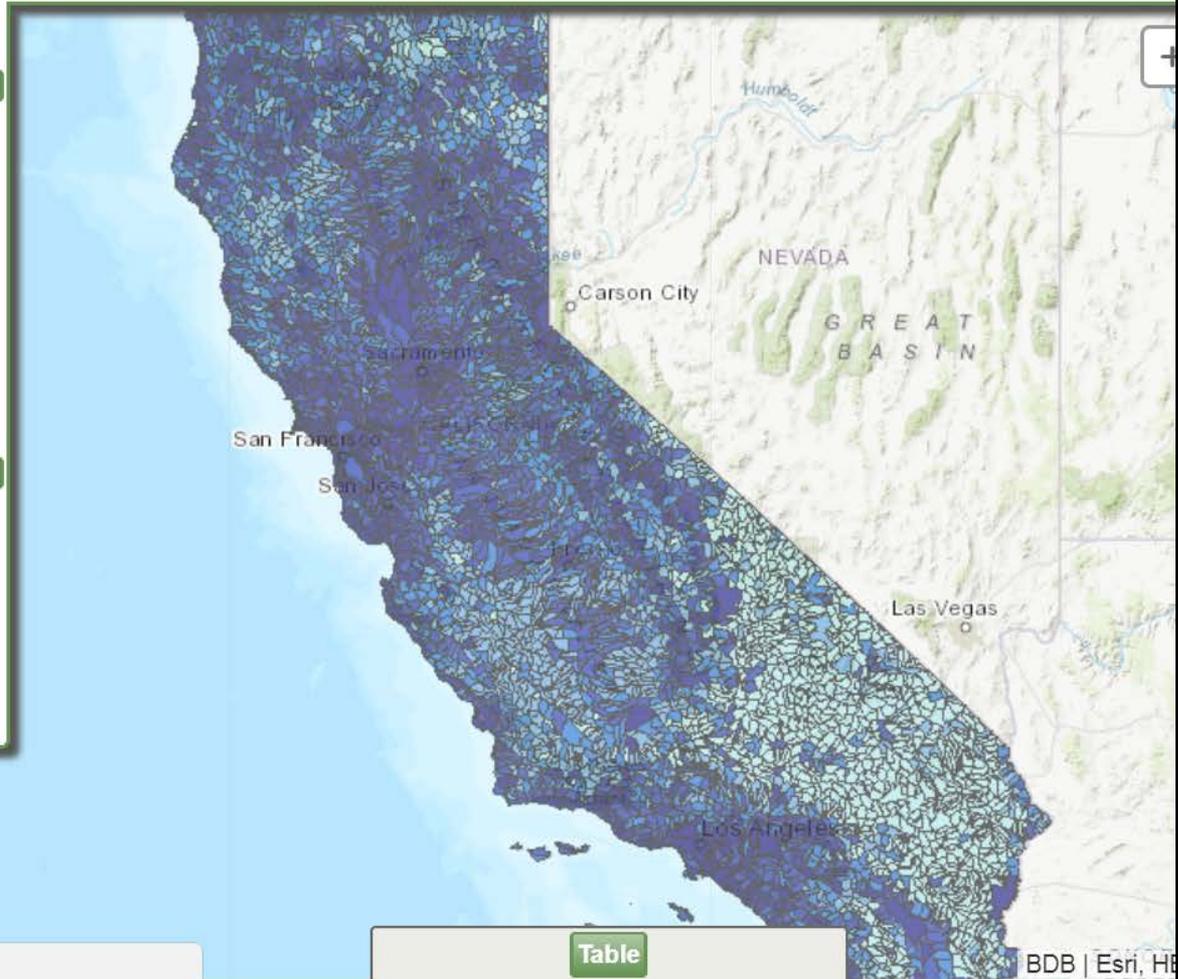
Freshwater Species Count

-  1 - 10
-  11 - 25
-  26 - 50
-  51 - 100
-  101 - 500

Reference Layers

Remove All Highlights

- ▶ Geolocation References 
- ▶ Hydrography 
- ▶ Natural Resources 
- ▶ Land Ownership 
- ▶ Political Boundaries 



Waiting for map.dfg.ca.gov...

Table

BDB | Esri, H

BIOS: <https://map.dfg.ca.gov/bios/?al=ds1197>

3. Freshwater Blueprint for Biodiversity

Identify network
of priority
watersheds based
on the
representation of
freshwater
biodiversity

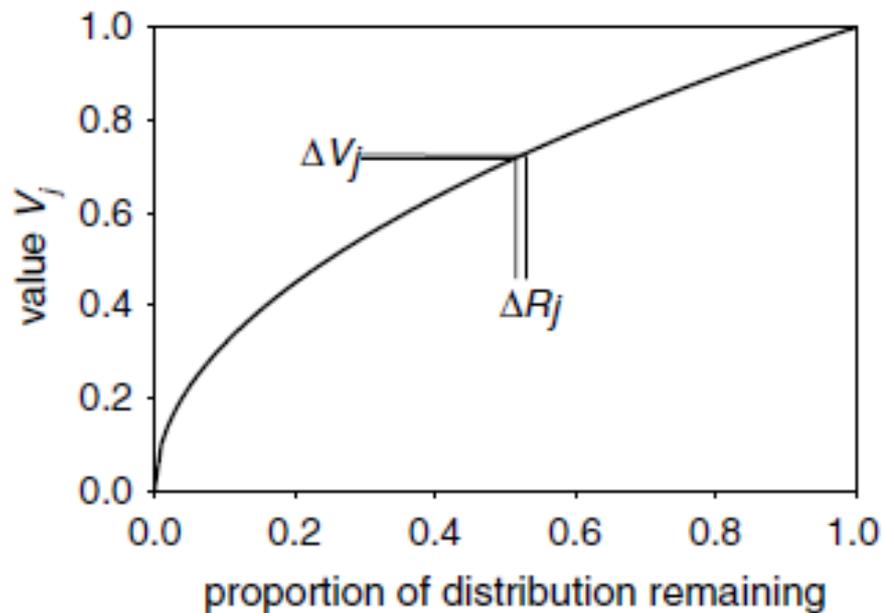


California Tiger Salamander (*Ambystoma californiense*)
(Solano County) Photo by Jackson Shedd

Zonation

Evaluates observed or modeled species distributions in a complementarity-based reserve selection approach

Implements cell-based algorithm, removing least valuable cell first, resulting in hierarchy of 'conservation value'



Value determined by cell occupancy, species weights, and range sizes of species

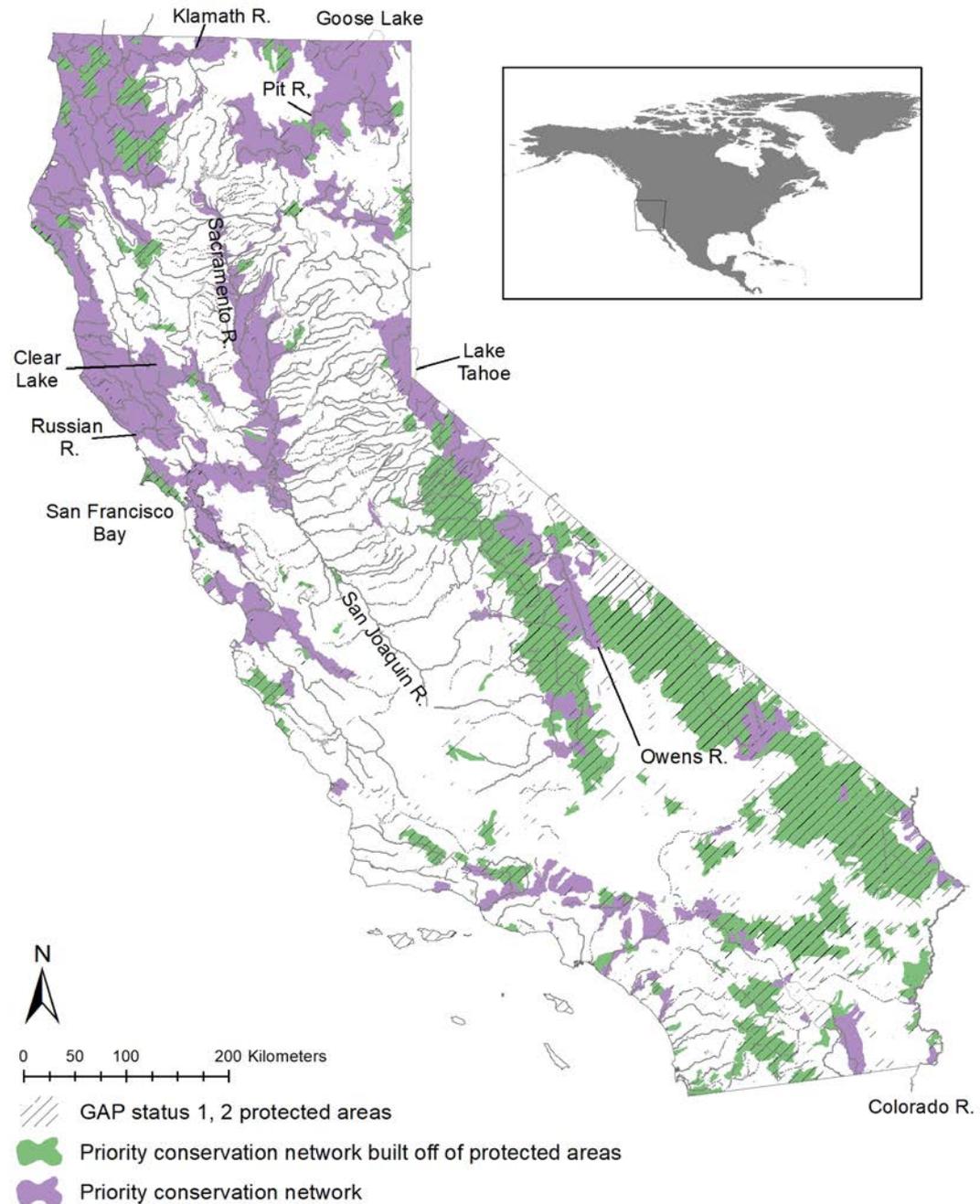
Target Taxa for Analysis

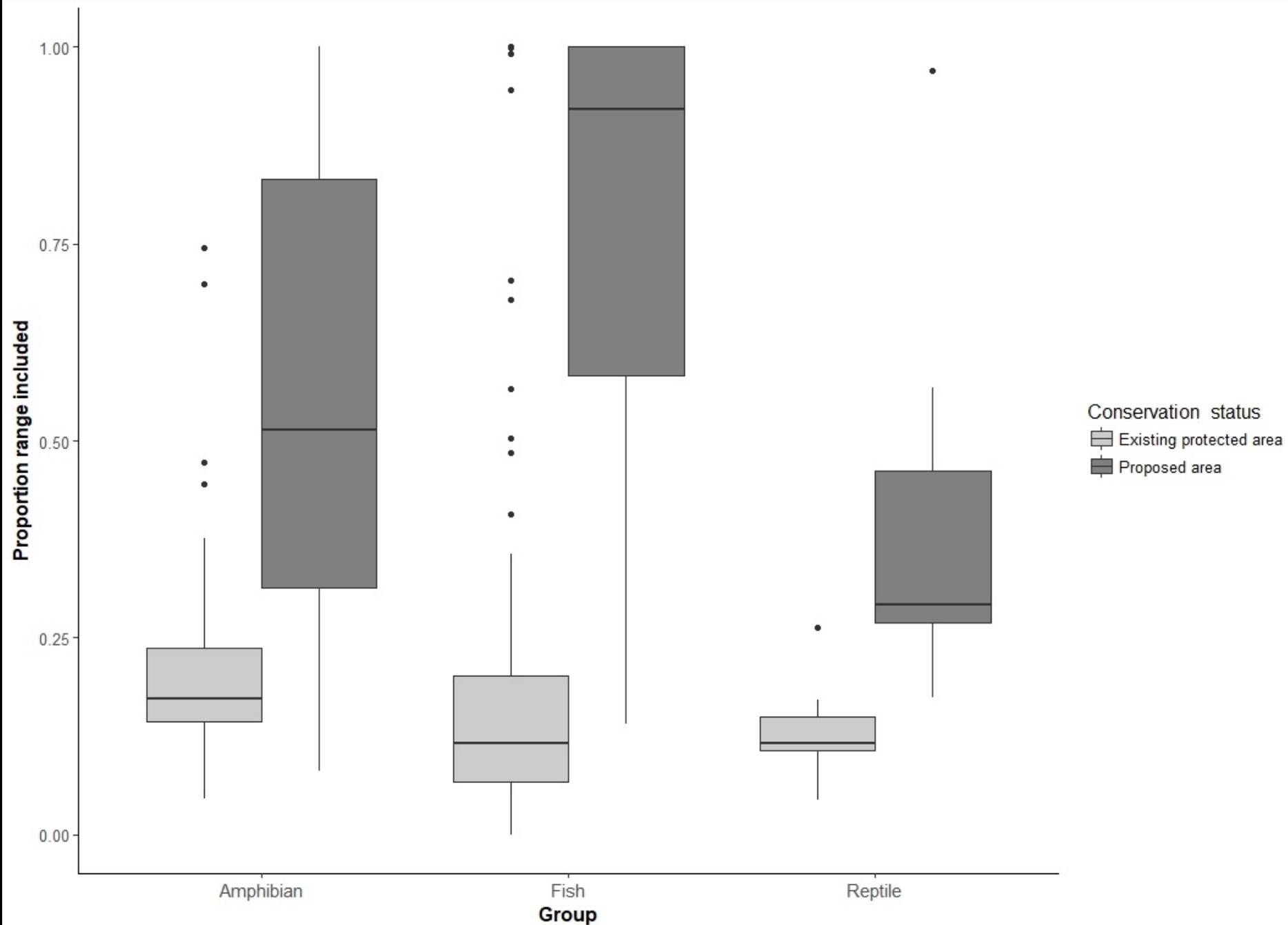
- Final focal taxon list included 3 taxonomic groups: fishes, amphibians, and reptiles.
- Fish selected because of the availability of well-reviewed, recent range data
- Reptile and amphibian taxa based on the availability of an expert-reviewed observational data set (Thomson et al. 2016) supplemented with generalized range data (CDFW 2014).
- Excluded mammals, invertebrates, and vascular plants as targets because of the lack of comprehensive distributional data sets, but reserved observational data sets for post hoc evaluation of our priority areas.
- Excluded birds as a focal group because of existing conservation planning efforts

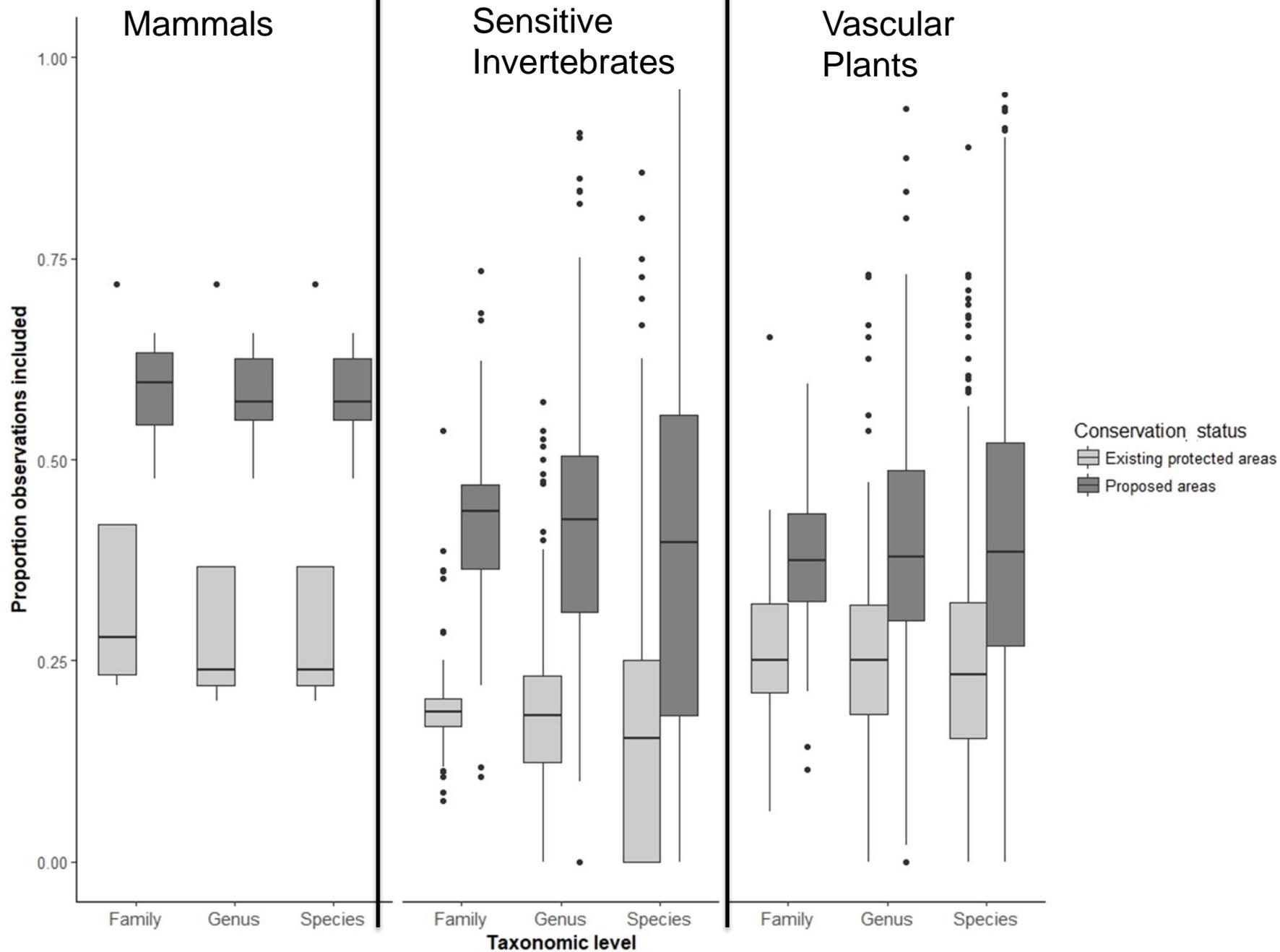
Connectivity

- Zonation's directed connectivity module was used to represent hydrologic connectivity among catchments.
- Module applies a penalty for removing interconnected catchments and therefore favors solutions that preserve contiguous river basins.
- We were less interested as the patterns of fragmentation within HUC12s (which PAD would inform) and more interested in bigger picture fragmentation between HUC12s (from the large dams).
- To account for the effect of dams on river network connectivity, each catchment with a large dam (USACE 2010) on the mainstem river was manually bisected, and the catchment connectivity matrix was modified to treat all catchments below dams as headwaters (i.e., no upstream contributing catchments).

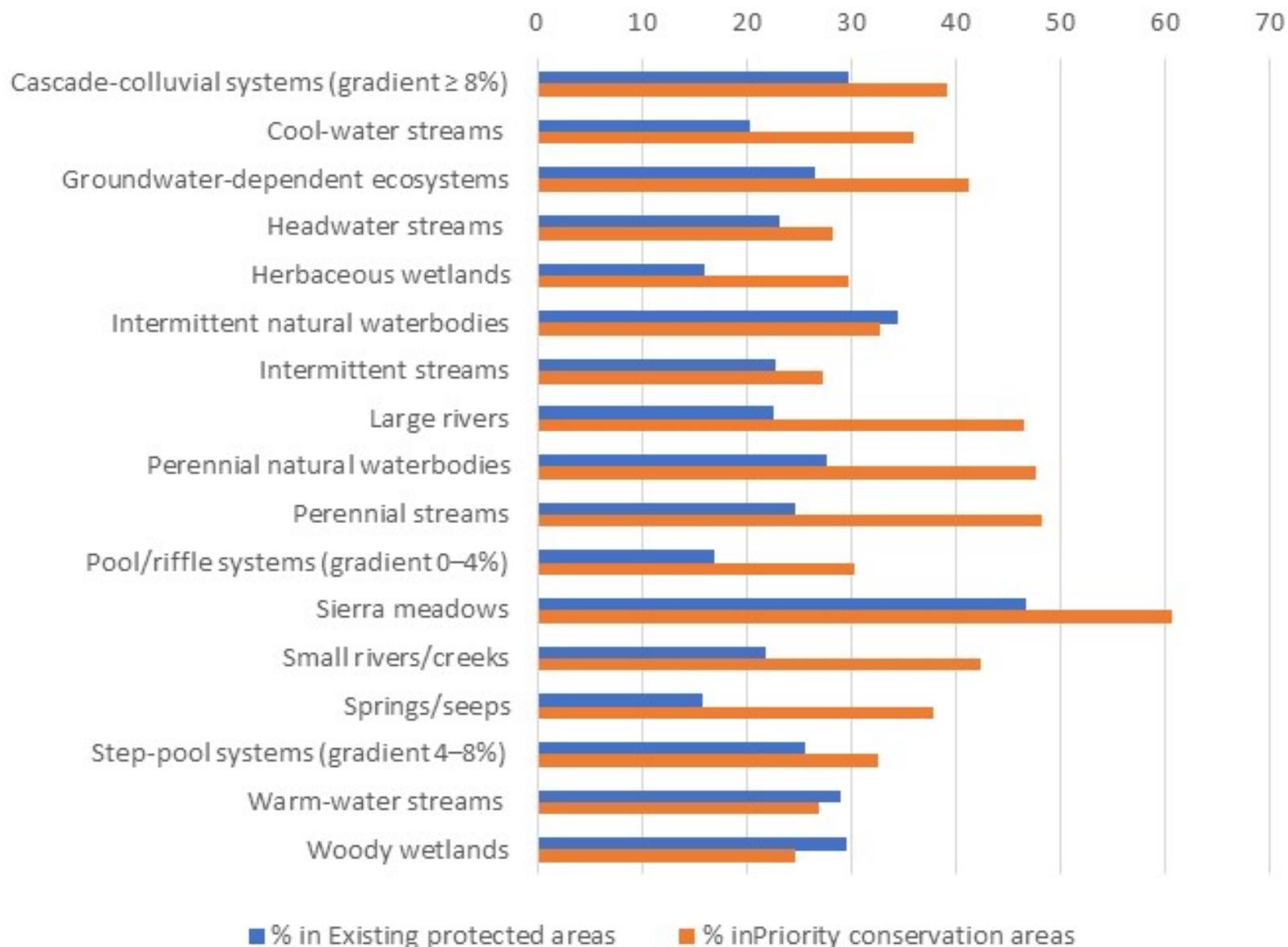
Freshwater Blueprint for freshwater biodiversity



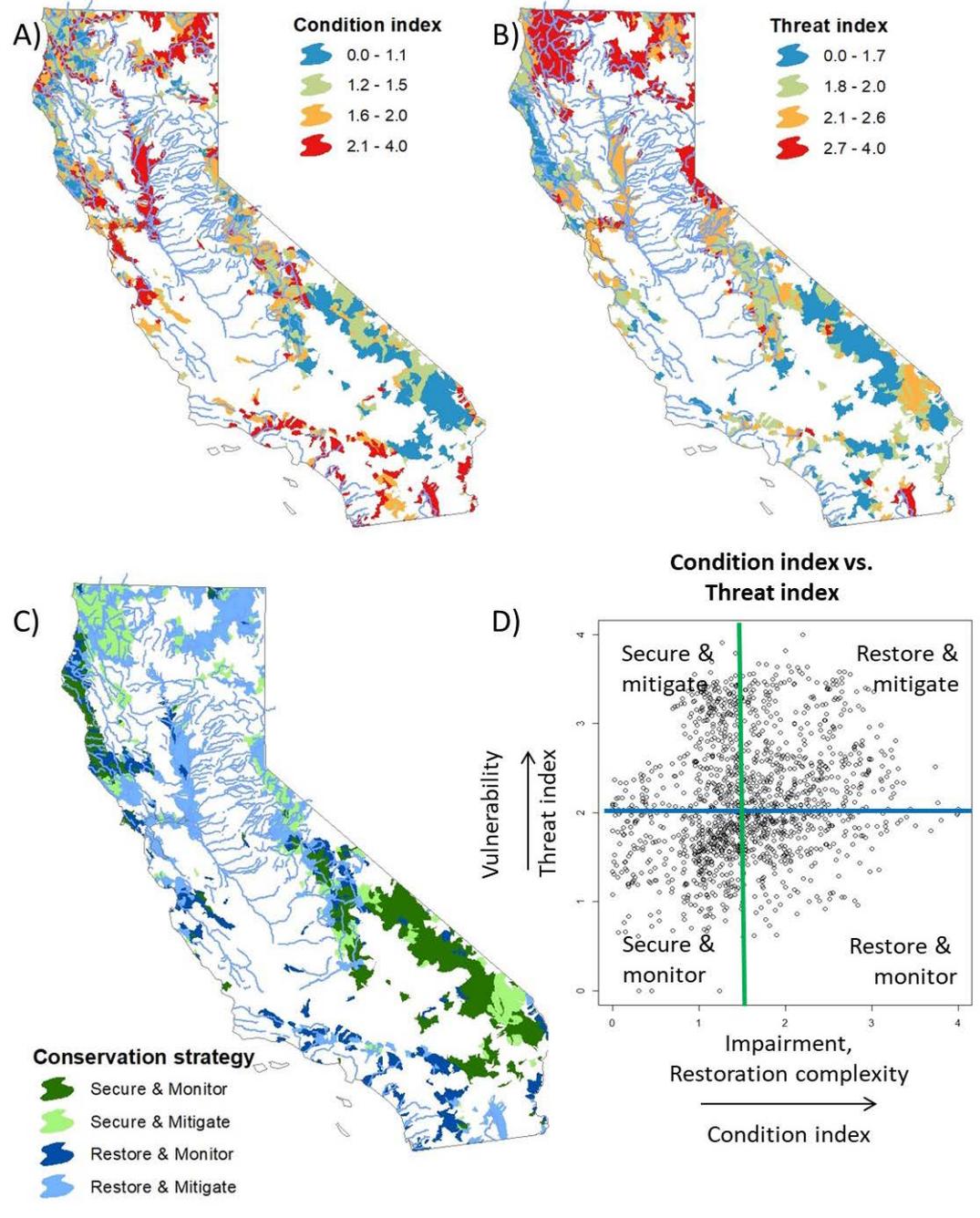




Habitat



4. Characterize condition and threats to inform conservation strategies



Papers

- PlosOne: J. Howard et al 2015 “Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California” July 6, 2015
- Freshwater Science, J. Howard et al. 2018, "A freshwater conservation blueprint for California: prioritizing watersheds for freshwater biodiversity" June 2018

Data and web tools

- Freshwater Species Database via TNC:
<https://www.scienceforconservation.org/products/california-freshwater-species-database>
- Freshwater Species Database in BIOS:
<https://map.dfg.ca.gov/bios/?al=ds1197>
- Blueprint web mapping application:
<http://trout.maps.arcgis.com/apps/webappviewer/index.html?id=abb58c1fc06b49869f62dbc90067ffe1>
- Visualization tool to evaluate condition, threats and potential strategies:
<https://public.tableau.com/profile/kurt.fesenmyer#!/vizhome/CAFWBlueprint/CaliforniaFreshwaterBlueprintPriorityAreas?publish=yes>

Thank you!





The End

