A vision for more effective use of biological data in water resource management

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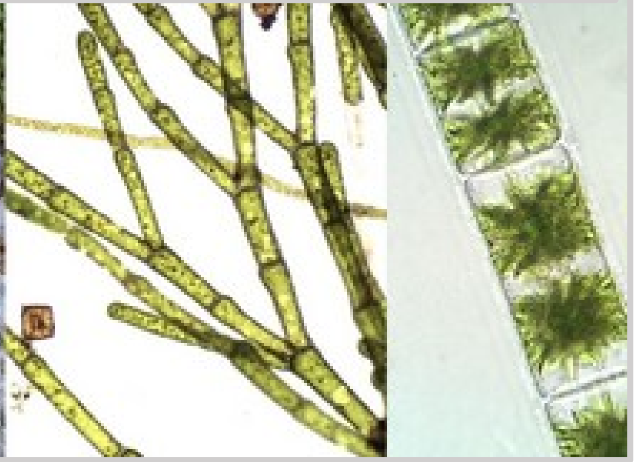
Bioassessment = direct measurement of aquatic ecosystem health from resident biota (fish, invertebrates, algae, riparian vegetation, etc.)

- Ecological indicators respond to many different kinds of waterbody stressors
- Integrate impacts over time and throughout a watershed



SWAMP’s investments are expanding and refining CA’s bioassessment capabilities

SWAMP
Surface Water Ambient Monitoring Program

- **Standard methods –** field, lab, data management, quality assurance, scoring tools, etc.
- **Multiple indicators –** BMIs, benthic algae, riparian vegetation, fish?, non-traditional indicators
- **Multiple waterbodies –** wadeable streams, non-perennial streams, large rivers, lakes, depressional wetlands, springs/seeps
- **Causal assessment** – developing rapid screening approaches

*Using biological integrity to help set targets for policies related to major stressors (hydrologic alteration, physical habitat integrity, nutrient enrichment)

Focus on ecological condition will help manage aquatic resources in face of disturbance

Building the baseline

- **Reference program** (RCMP, sites with low levels of disturbance)
- **Perennial Streams Assessment** (PSA, random locations)
- 1000's of sites with baseline data on chemistry, physical habitat and biology (see Calvin Yang's presentation)

Technical advances – defining the expected state, deviation from it and its causes

➢ *Provides basis for objective detection, quantification and prediction of impacts of disturbance*

Vision for bioassessment in California

Measures of ecological integrity are fully integrated into California's natural resource management programs; California prioritizes this information to protect and restore its waterbodies and watersheds.

What’s holding us back?

CA has made progress on many of the technical elements, but still not close to achieving the vision

Make bioassessment information:

- more accurate
- more reliable
- more interpretable

Technical Challenges

?

the “Vision”

Ecological data used to make better decisions

What's holding us back?

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Technical Hurdles

Make bioassessment information easier for managers to use

Non-Technical Hurdles

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Success will require thinking about waterbody health at multiple spatial scales

- Addressing ecological questions often requires a search for spatial patterns at different scales
- Few tools for communicating with managers in this way
- Working on tools to improve this

Part I: Tools to help interpret data within a spatial context
Part II: Tools to integrate ecological data with other information about environmental health

Example I: Spatial models that extrapolate bioassessment scores to unsampled reaches

"How many sites/samples do I need to assess a stream?"

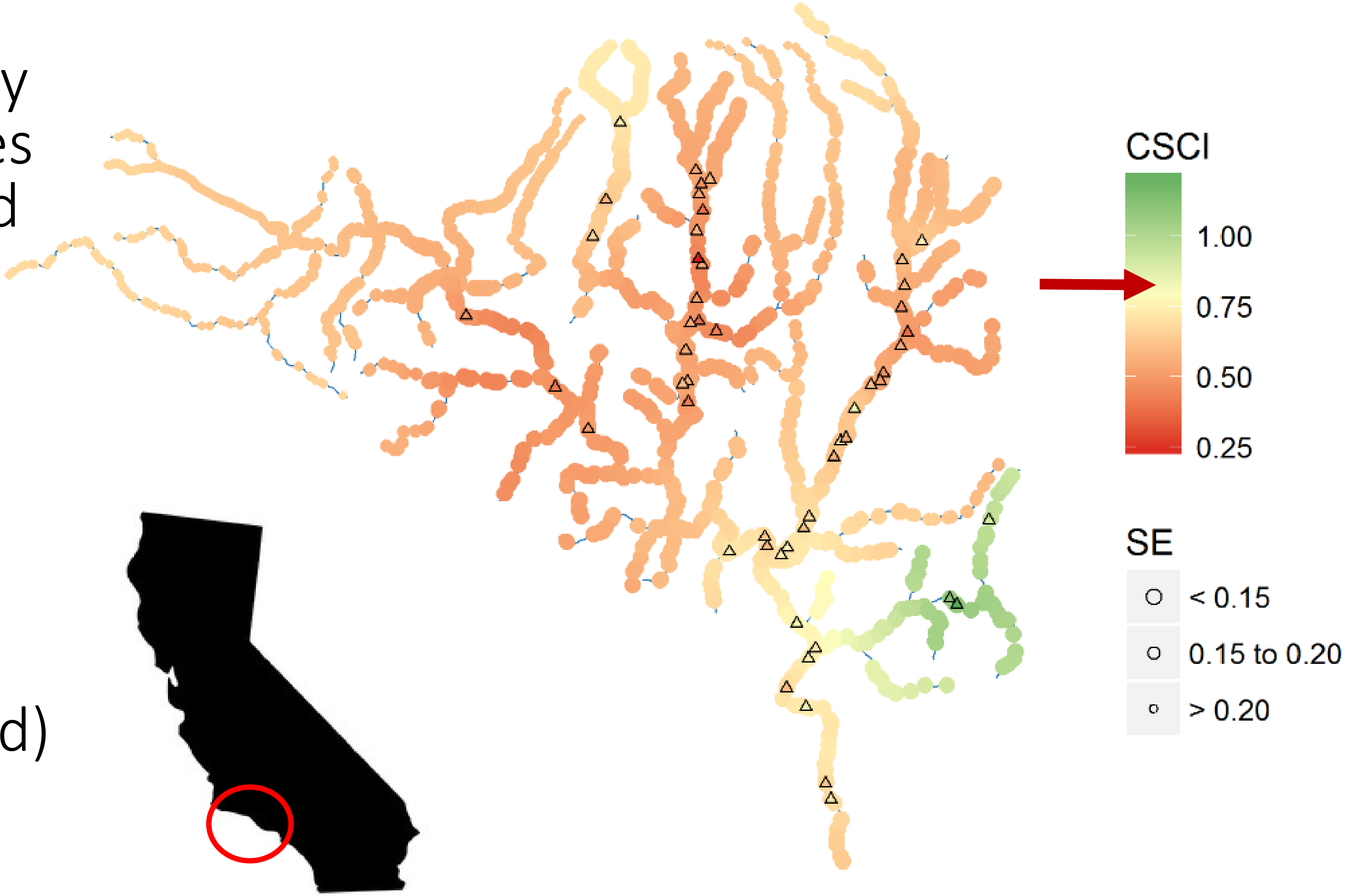
Rafi's approach: Use spatial statistical network (SSN) models to estimate scores at unsampled sites based on spatial relationships with sampled sites

- Uses National Stream Internet (NSI) Hydrography and Spatial Statistical Networks tools

Spatial Statistical Network (SSN) models

Example: Malibu Creek Watershed

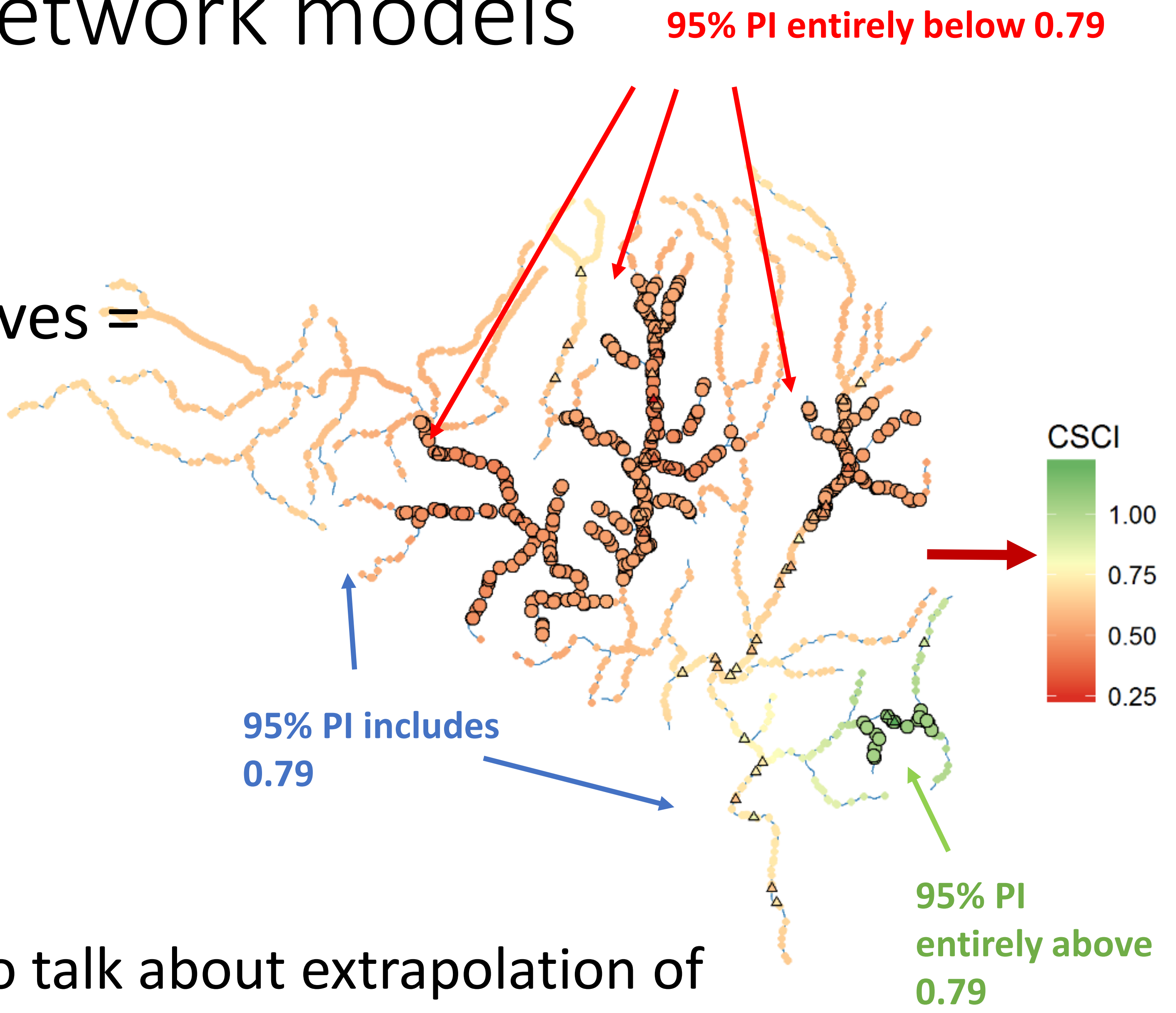
- Dots at prediction points (every km) show predicted CSCI scores (CA's BMI index) for unsampled reaches
  - Dot color corresponds to score
  - Dot size corresponds to confidence (bigger = better)
- Use patterns in outputs to assess confidence that a reach or region is above or below a threshold (CSCI > 0.79 = altered)



Spatial Statistical Network models

For regions with a lot of confidence that:

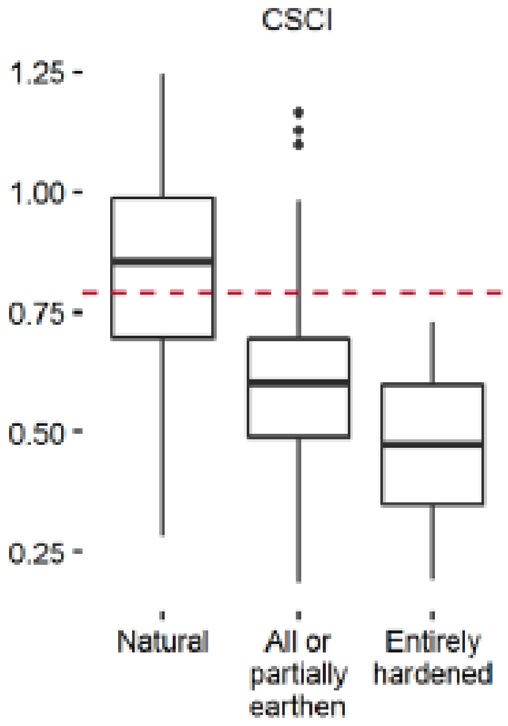
- Reaches fail to meet objectives = Prioritize restoration
- Reaches meet objectives = Prioritize protection
- Reaches where condition is uncertain = Prioritize monitoring



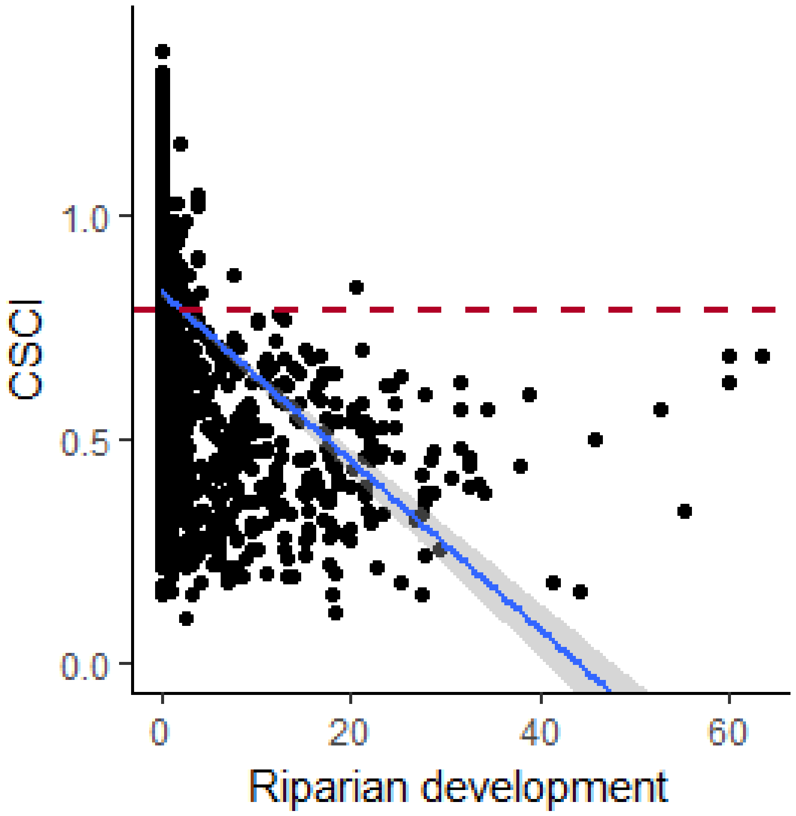
➢ Gives us an objective way to talk about extrapolation of sampled sites to unsampled sites across the watershed

Example II: Landscape models to identify regions where bio-integrity is constrained by development

Channel alteration



Landscape Development



In certain settings, high biological scores (above standard threshold) are rarely, if ever, observed

Pervasive alteration in agricultural/urban landscapes constrain biological scores across a region

Los Angeles River

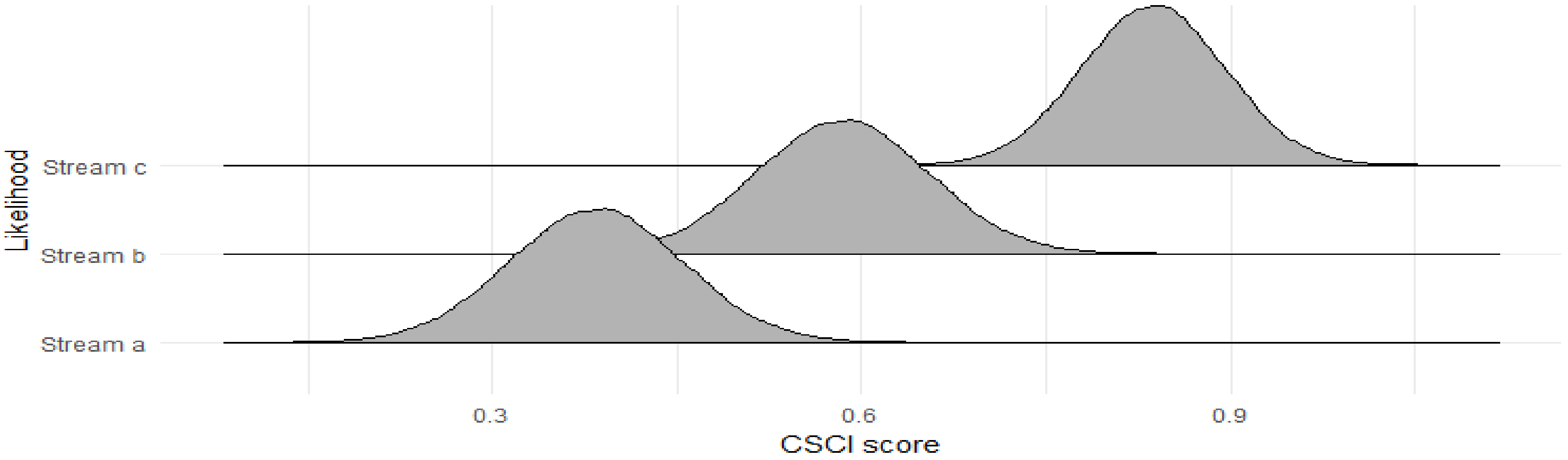
California Aqueduct

- Some constraints can't be overcome with current management tools
- Still want to use ecological data to assess health in these systems

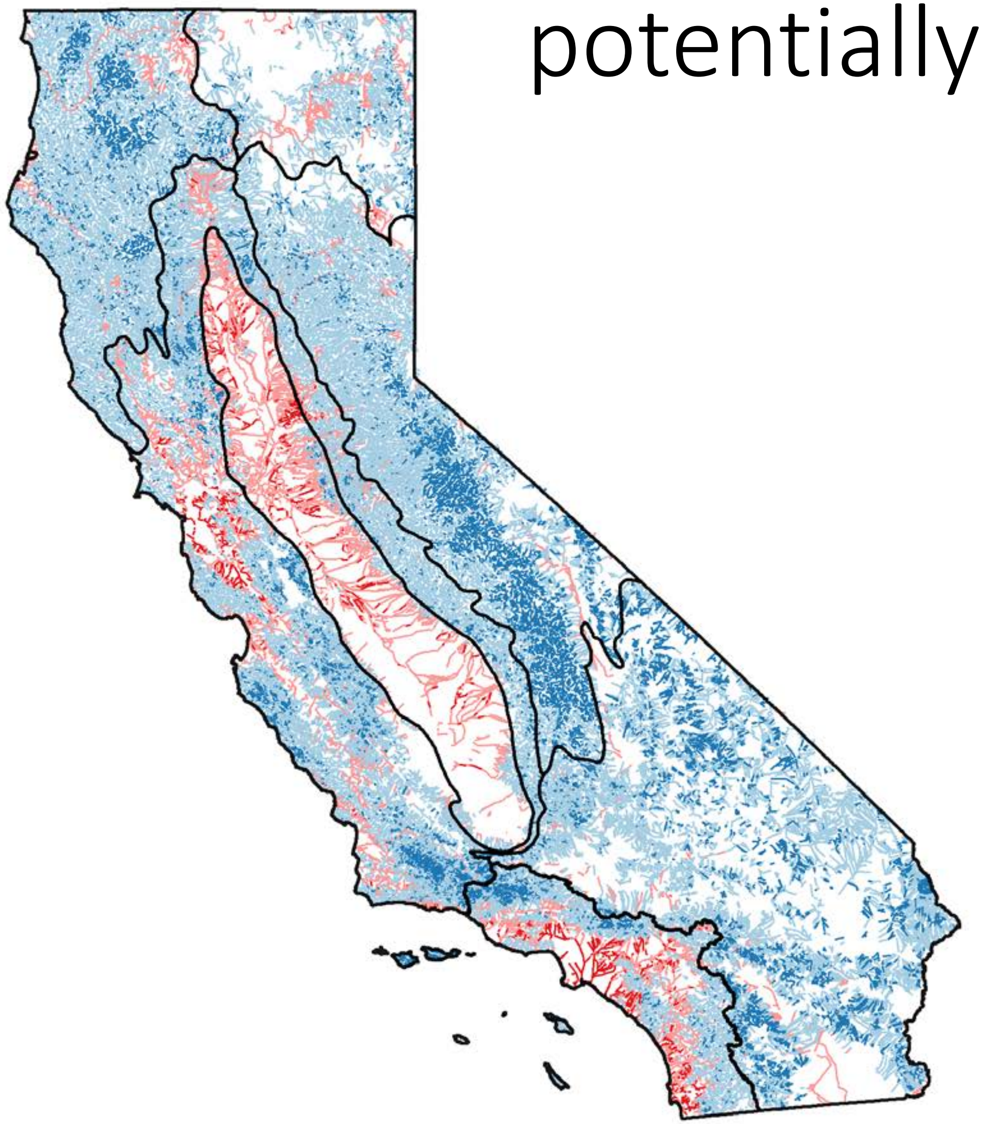
Need an objective way to identify these streams

Approach: Build empirical models to predict ranges of expected CSCI scores for each segment

- National STREAMCAT database of watershed characteristics – easy statewide application (developed by Ryan Hill, EPA-ORD)



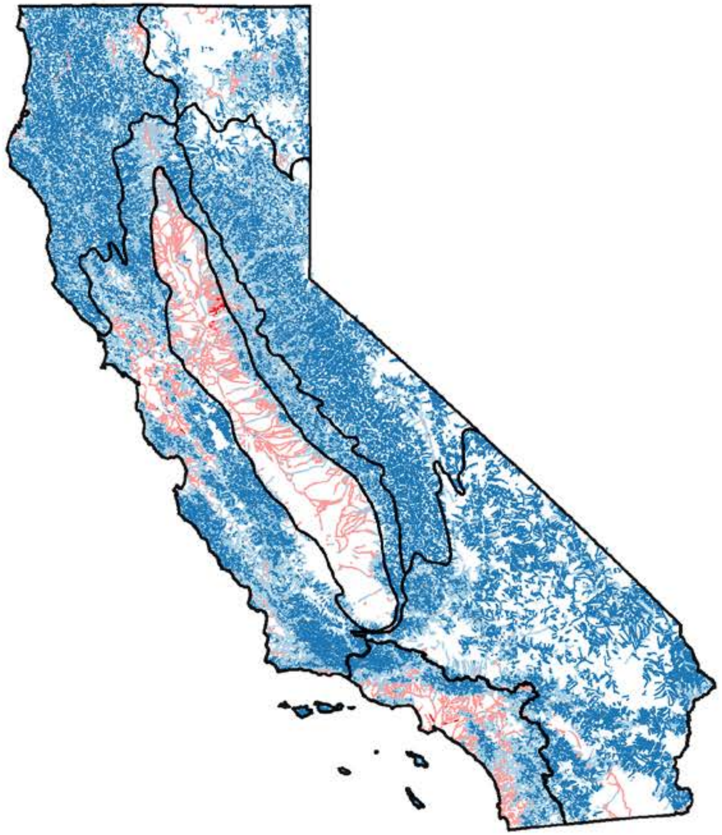
Example output: statewide classification of potentially constrained streams



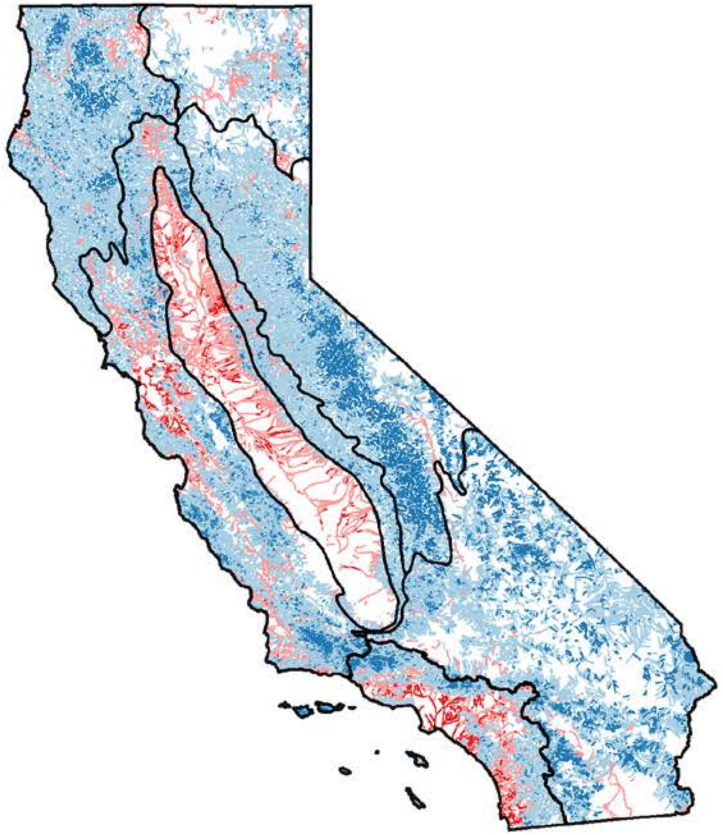
- **Likely constrained**
- **Possibly constrained**
- **Possibly unconstrained**
- **Likely constrained**

Identify regions where statewide assessment thresholds are *unlikely* to be met, even with good management

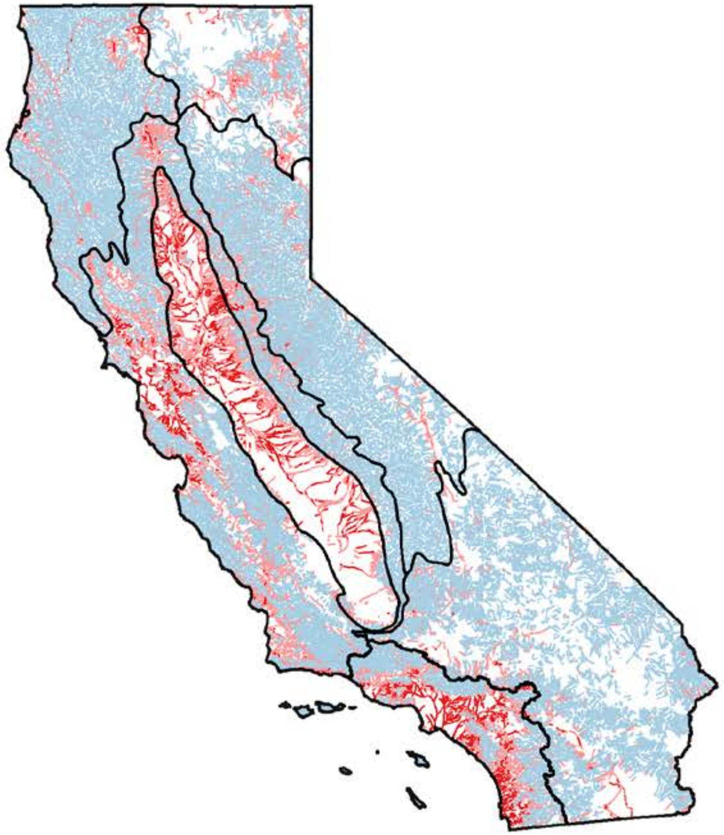
Can vary impairment thresholds used …



Streams constrained below CSCI 0.63



Streams constrained below CSCI 0.79



Streams constrained below CSCI 0.92

Applying landscape models

- Compare patterns of predicted condition with observed data
  - Look for over- and underperforming regions
- Especially useful in areas with low sampling densities
  - Can use to guide monitoring site selection
- Biocriteria applications
  - Estimate extent of streams that are unlikely to meet criteria under different threshold scenarios – helpful in stakeholder discussions
  - Ranges of scores could provide defensible basis for tiers?

- See Marcus Beck’s presentation (next) for a closer look at applications of these models

Part II: Tools to integrate ecological data with other environmental information

As more and more information becomes available, resource managers are increasingly overwhelmed – need tools for putting it together

Achievement of CWA objectives will require coordination with partners who don't always speak the CWA language

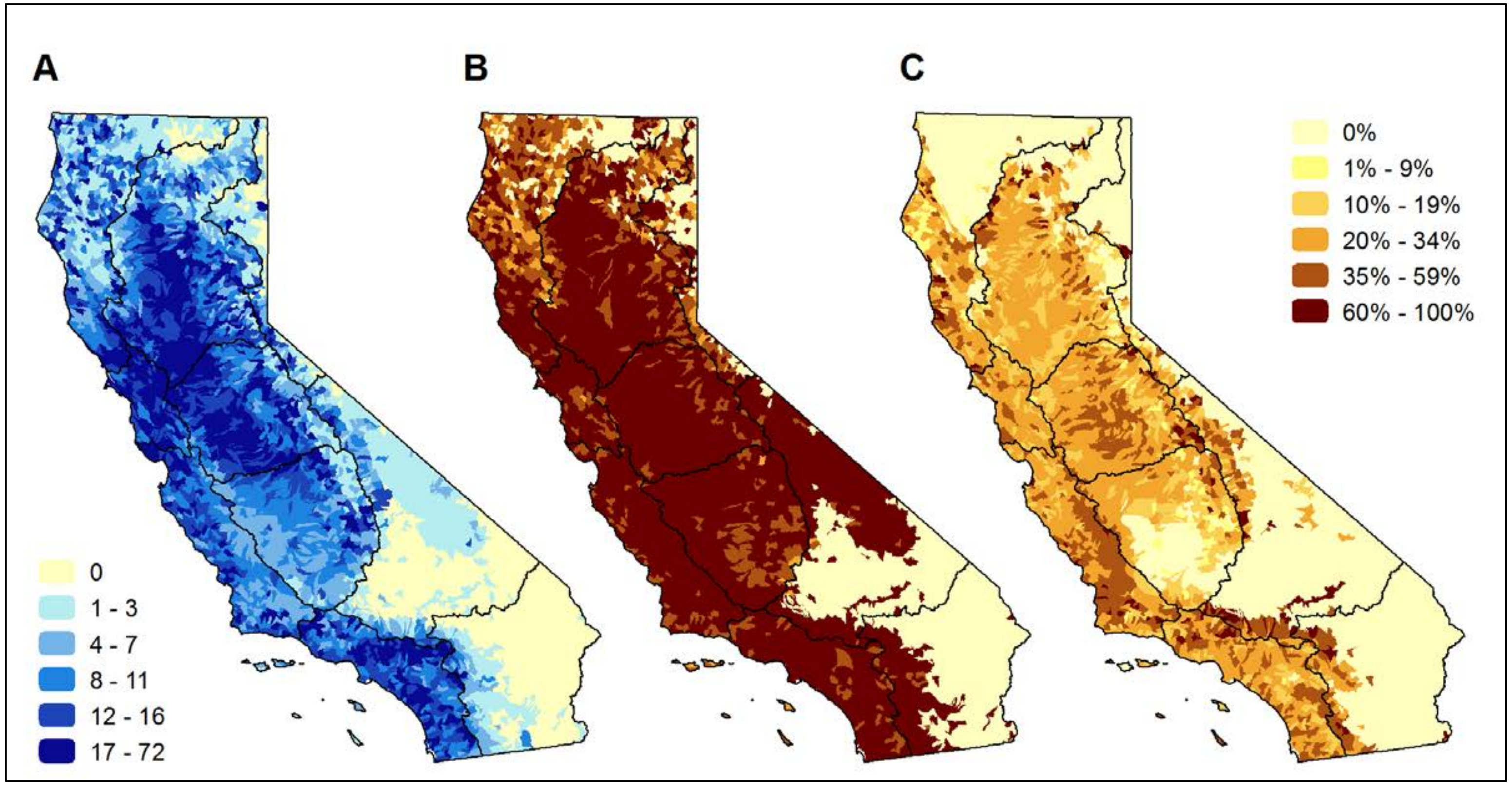
Example: Freshwater Biodiversity Mapping and the Freshwater Conservation Blueprint

- TNC (Jeanette Howard, et al.) assembled a large team of taxonomic specialists for first attempt to document freshwater biodiversity in California.
- Integrated best available fish, amphibians/herps, mammal and **benthic invertebrate** data.

Howard, J. K., K. R. Klausmeyer, K. A. Fesenmyer, J. Furnish, T. Gardali, T. Grantham, J. V. E. Katz, S. Kupferberg, P. McIntyre, P. B. Moyle, P. R. Ode, R. Peek, R. M. Quiñones, A. C. Rehn, N. Santos, S. Schoenig, L. Serpa, J. D. Shedd, J. Slusark, J. H. Viers, A. Wright, and S. A. Morrison. 2015. Patterns of Freshwater Species Richness, Endemism, and Vulnerability in California. PLOS ONE 10(7): e0130710. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130710

Freshwater biodiversity maps (fish, amphibians, invertebrates, mammals)

- Help identify areas of diversity, endemism and vulnerability

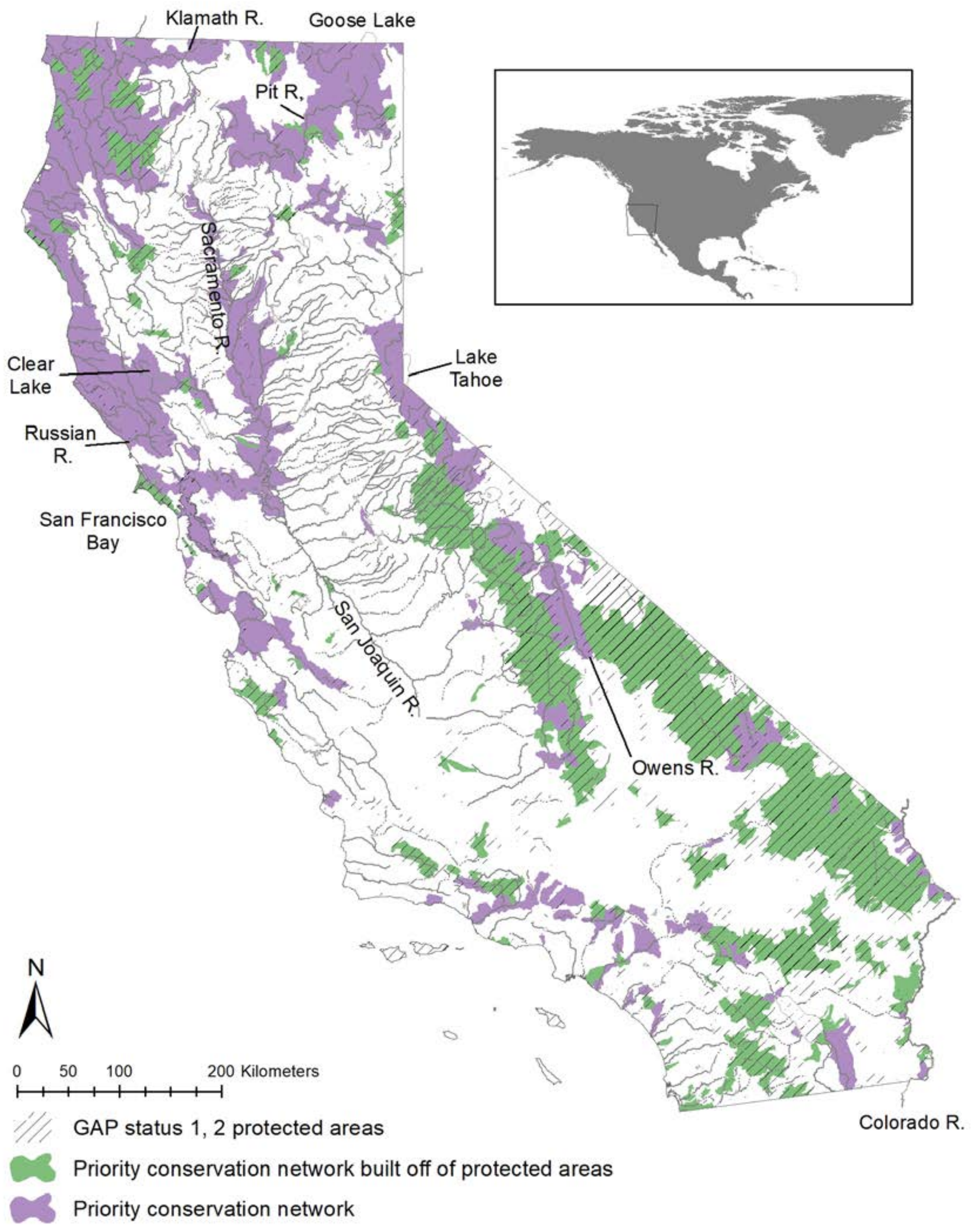


Endemic (A), % Vulnerable (B), % Listed (C)

Freshwater Conservation Blueprint for CA

Phase II: Identify a network of priority watersheds based on **representation** of **biodiversity**

Useful for communicating and coordinating with wildlife and fisheries entities

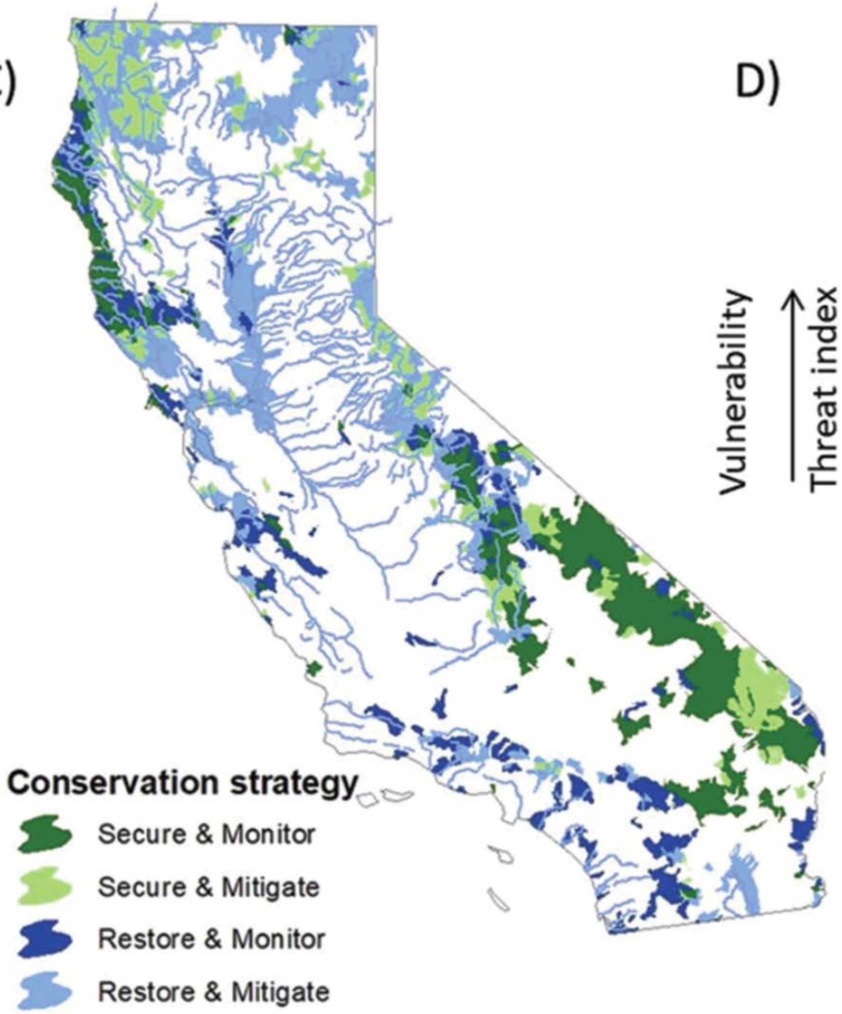


Freshwater Conservation Blueprint for CA

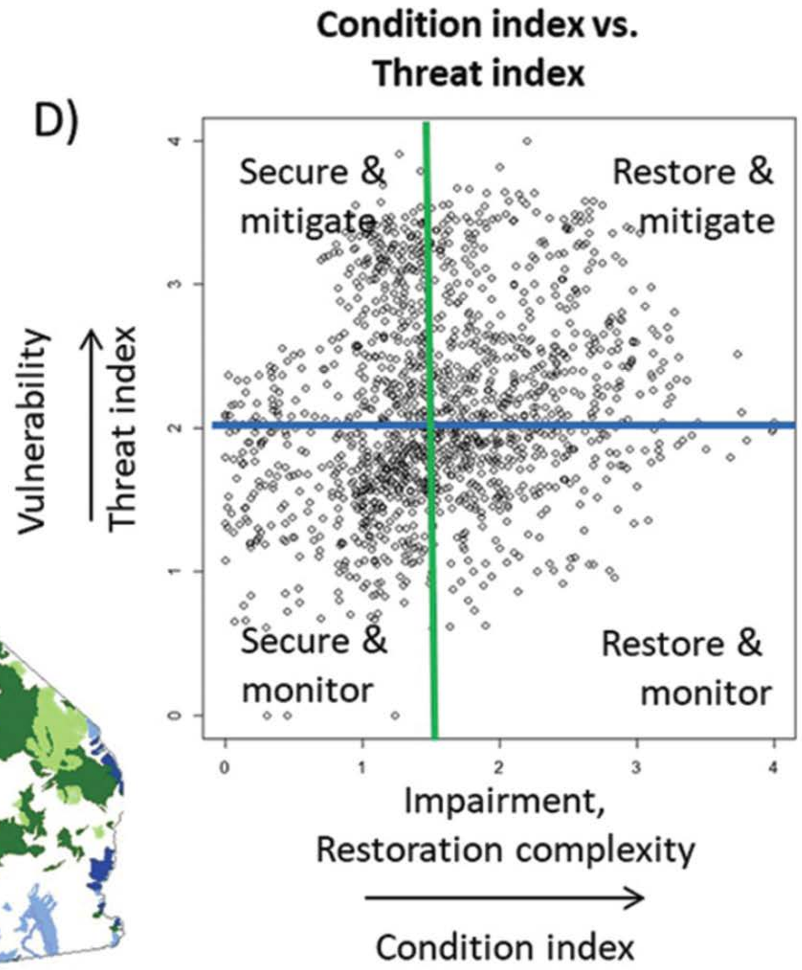
Phase III: Combine condition and vulnerability to inform conservation strategies

We need a lot more synthesis tools like these.

C)



D)



Achieving the vision will require (a lot of) both

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Non-Technical Challenges

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An expanding network of partners …

United States Environmental Protection Agency

State of California San Diego Region Regional Water Quality Control Board

USGS science for a changing world

UtahStateUniversity

California State University Long Beach 1949

Forest Service U S Department of Agriculture

The California State University Vox Veritas Vita 1857

Department of Water Resources State of California

California State University, Chico Ars Probat Artificem 1887

TROUT UNLIMITED

University of California Santa Barbara Let There Be Light

Moss Landing Marine Laboratories

SCCWRP Established 1969

California Healthy Streams Partnership

Marine Pollution Studies Laboratory Granite Canyon

The Nature Conservancy Protecting nature. Preserving life.™

The University of California Davis Let There Be Light

California State University San Marcos

Aquatic Bioassessment Laboratory

Resources Agency California Department Fish & Game

Colorado State University

Clean Water Team Citizen Monitoring Program of the State Water Resources Control Board

California Water Boards State Water Resources Control Board Regional Water Quality Control Boards

SWAMP Surface Water Ambient Monitoring Program

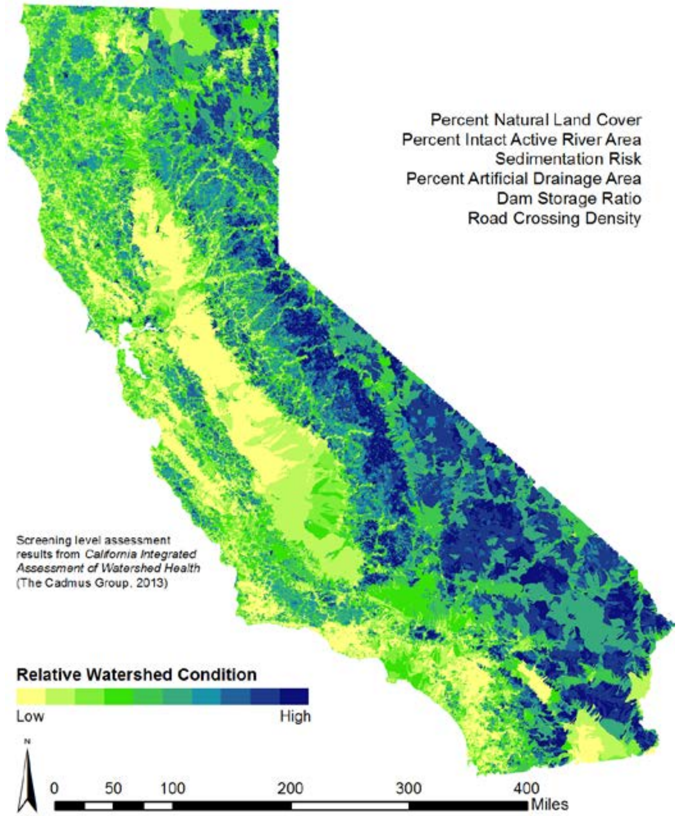
Berkeley University of California

California State University, Northridge 1958

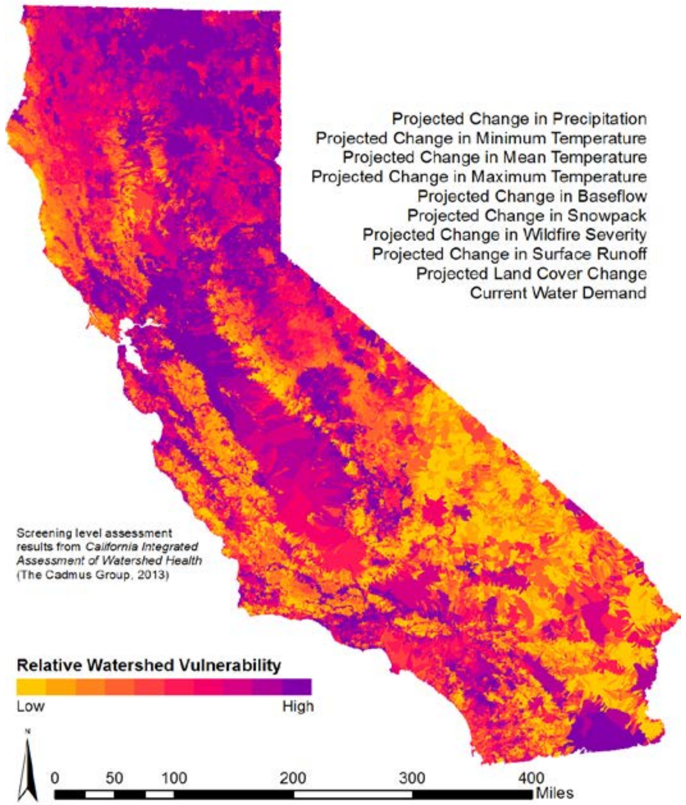
Special thanks to:
Marcus Beck, Jeanette Howard, Kurt Fesenmeyer, Ryan Hill and Andy Rehn

Questions?

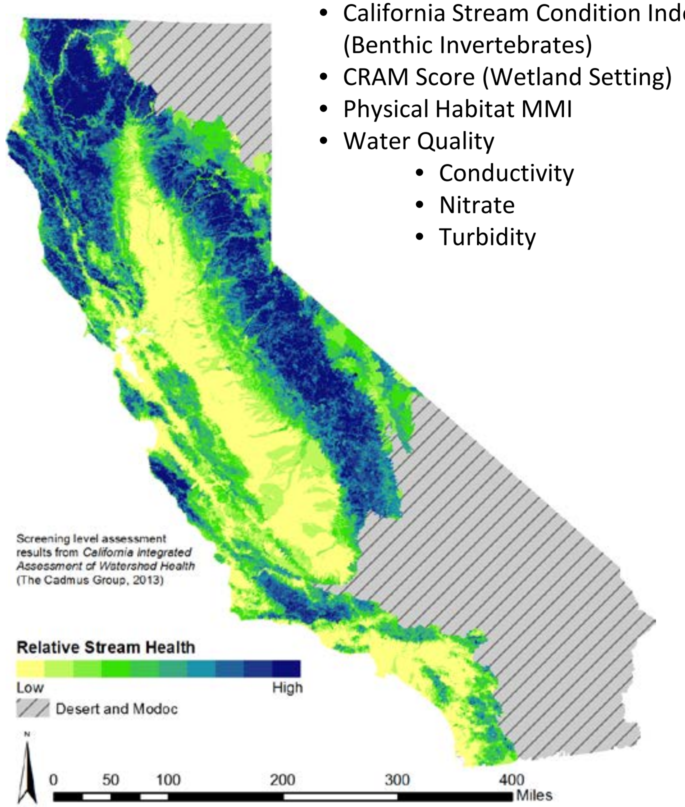
Healthy Watersheds summary maps – integrate multiple indicators of watershed condition and vulnerability



Relative Watershed Condition Index



Relative Watershed Vulnerability Index



- California Stream Condition Index (Benthic Invertebrates)
- CRAM Score (Wetland Setting)
- Physical Habitat MMI
- Water Quality
    - Conductivity
    - Nitrate
    - Turbidity

Relative Stream Health Index*