Technical Tools to Support the State Water Board's Biological Integrity Implementation Plan

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SWAMP
Surface Water Ambient Monitoring Program

SCCWRP
Established 1969

Aquatic Bioassessment Laboratory

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

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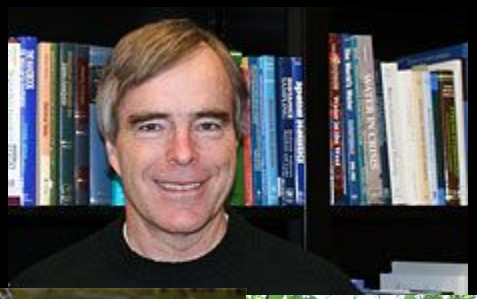
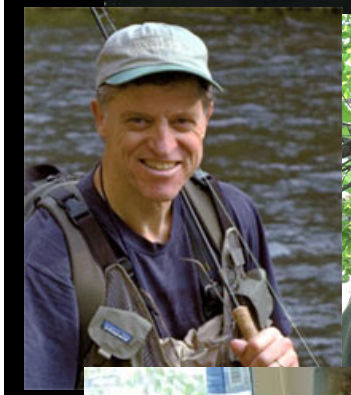
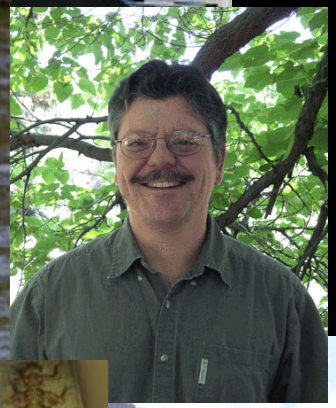
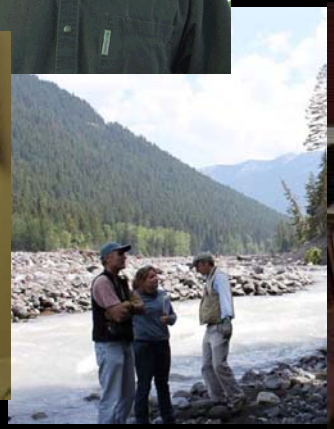
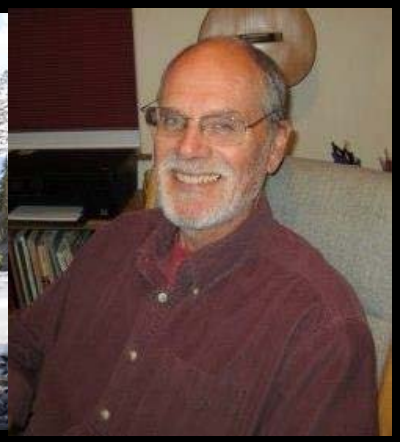
Scientific Advisory Panel











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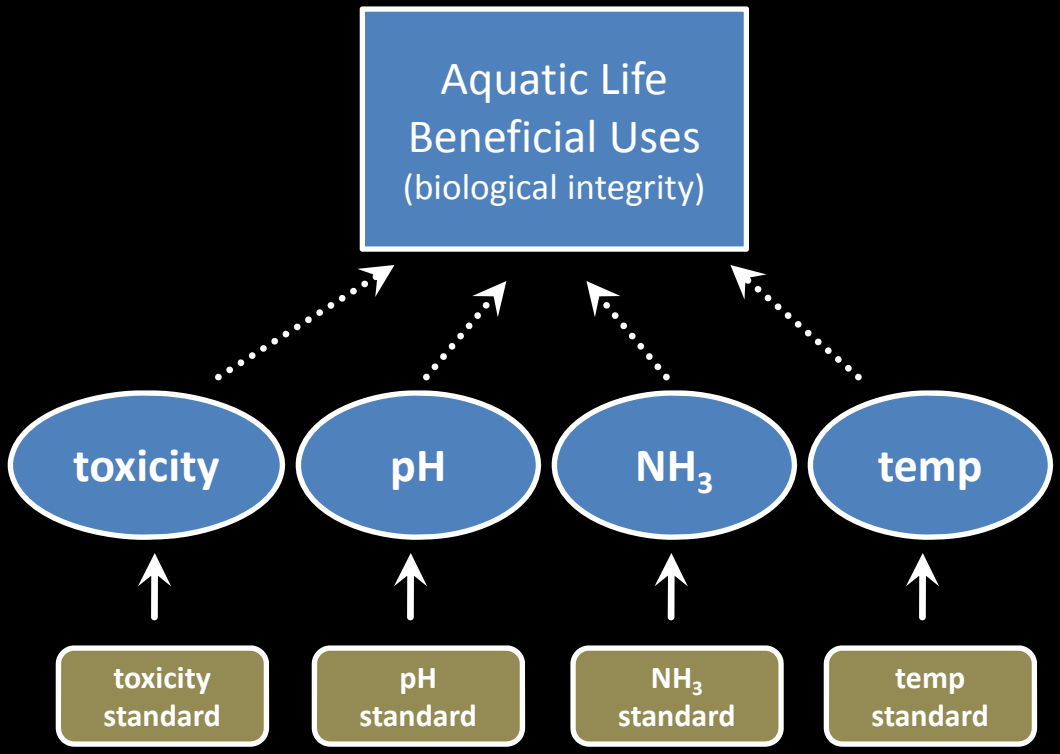
Chris Konrad, *USGS*
LeRoy Poff, *Colorado State*
John VanSickle, *EPA (retired)*
Lester Yuan*, *EPA*

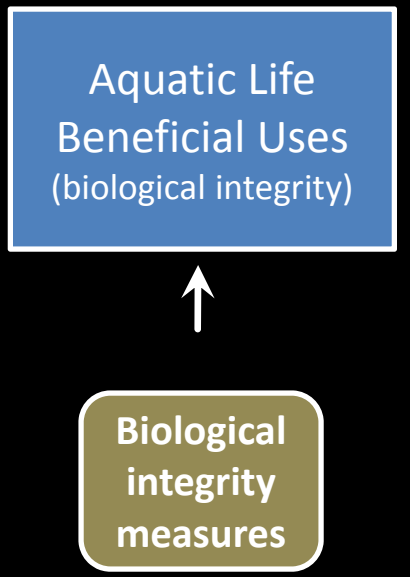
**not pictured*

Ecological integrity measures provide DIRECT measures of use attainment



Constituent-based Measures

"**CAN** the waterbody support ALU?"



Condition-based Measures

"**DOES** the waterbody support ALU?"

Project Objectives

Develop tools for directly assessing the ecological condition (health) of wadeable streams throughout California

Provide consistent meaning in different settings for both regulatory and non-regulatory uses

Project focus was on development of scoring tools (CSCI) but we also explored causal assessment

CA's Ecological Indicators

Multiple Indicators – BMIs, algae, fish/amphibians, riparian vegetation

Multiple waterbody types – large rivers, non-perennial streams, lakes, wetlands

Start with invertebrates and perennial streams

Benthic invertebrates are ideal stream assessment tools

- *Ubiquitous, abundant and diverse*
- *Responsive to stress*
- *Information rich*

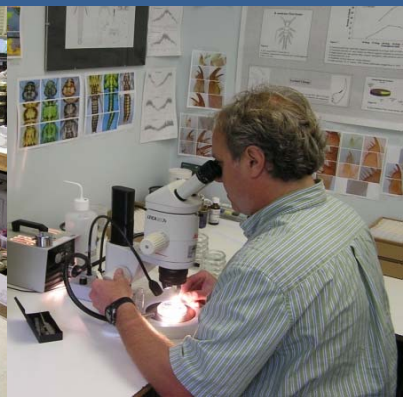
California's Standardized Bioassessment Infrastructure

Surface Water Ambient Monitoring Program (SWAMP)

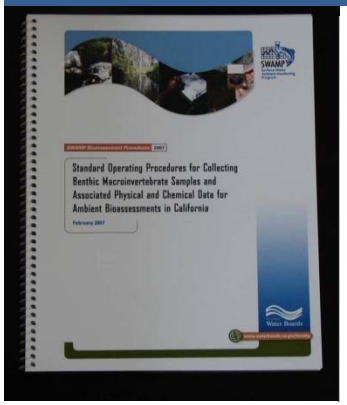
Field Methods

Data Management + Reporting

Lab Methods



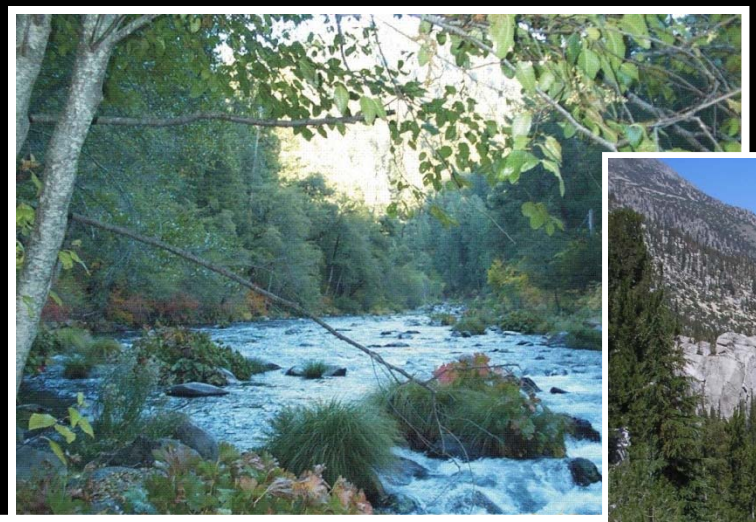
Quality Assurance Documentation

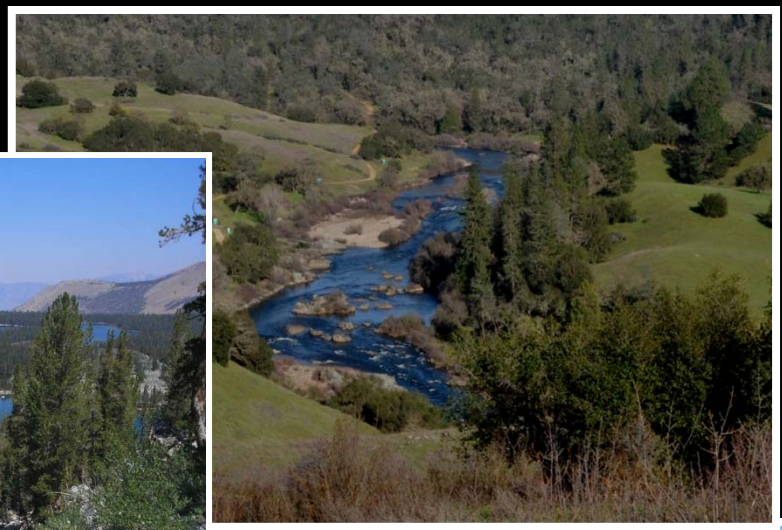


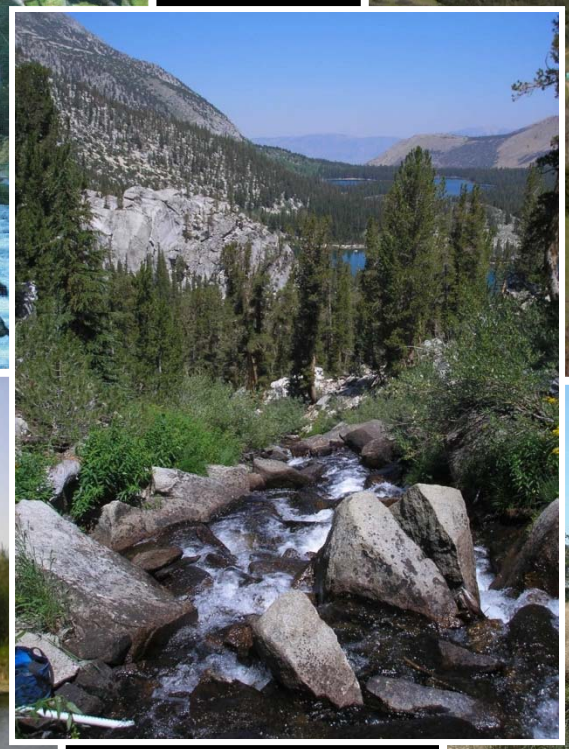
How to score condition from a species list?

Reference sites used to predict expected biota

(low levels of upstream human activity)



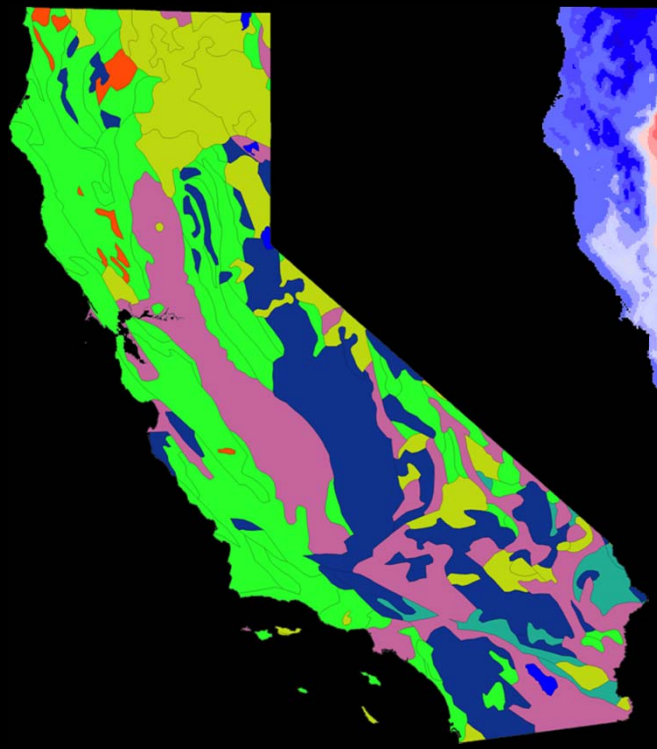




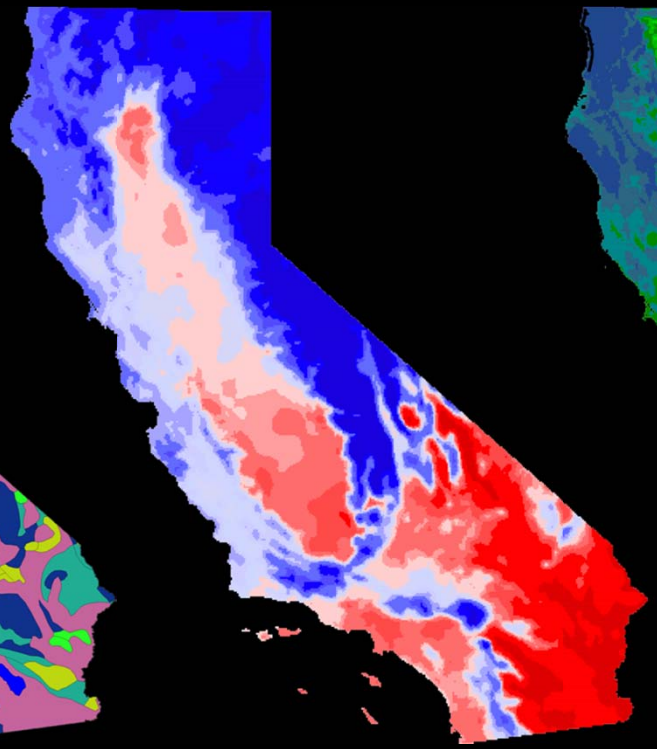
Natural Diversity: California is not Kansas

Strong natural gradients result in high **natural variation** in biological communities

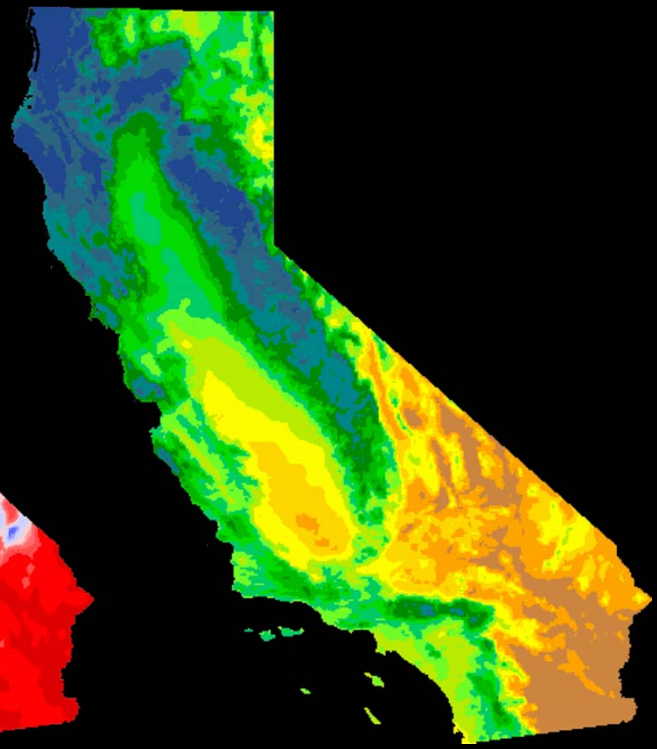
Geology



Temperature

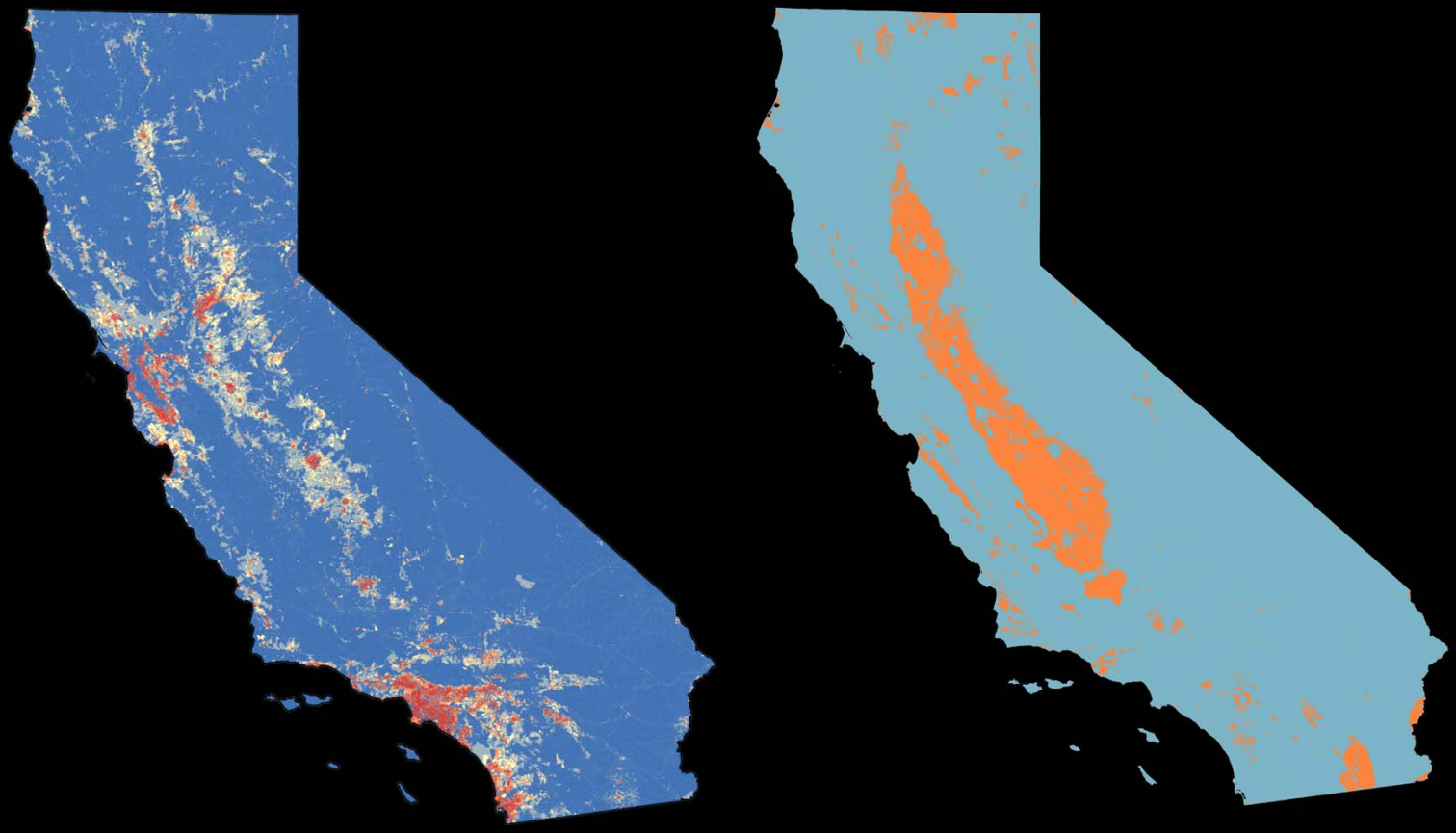


Precipitation



Technical Challenges: California IS Kansas

High degree of development (e.g., impervious surface and intensive agriculture) in some regions



Reference site selection

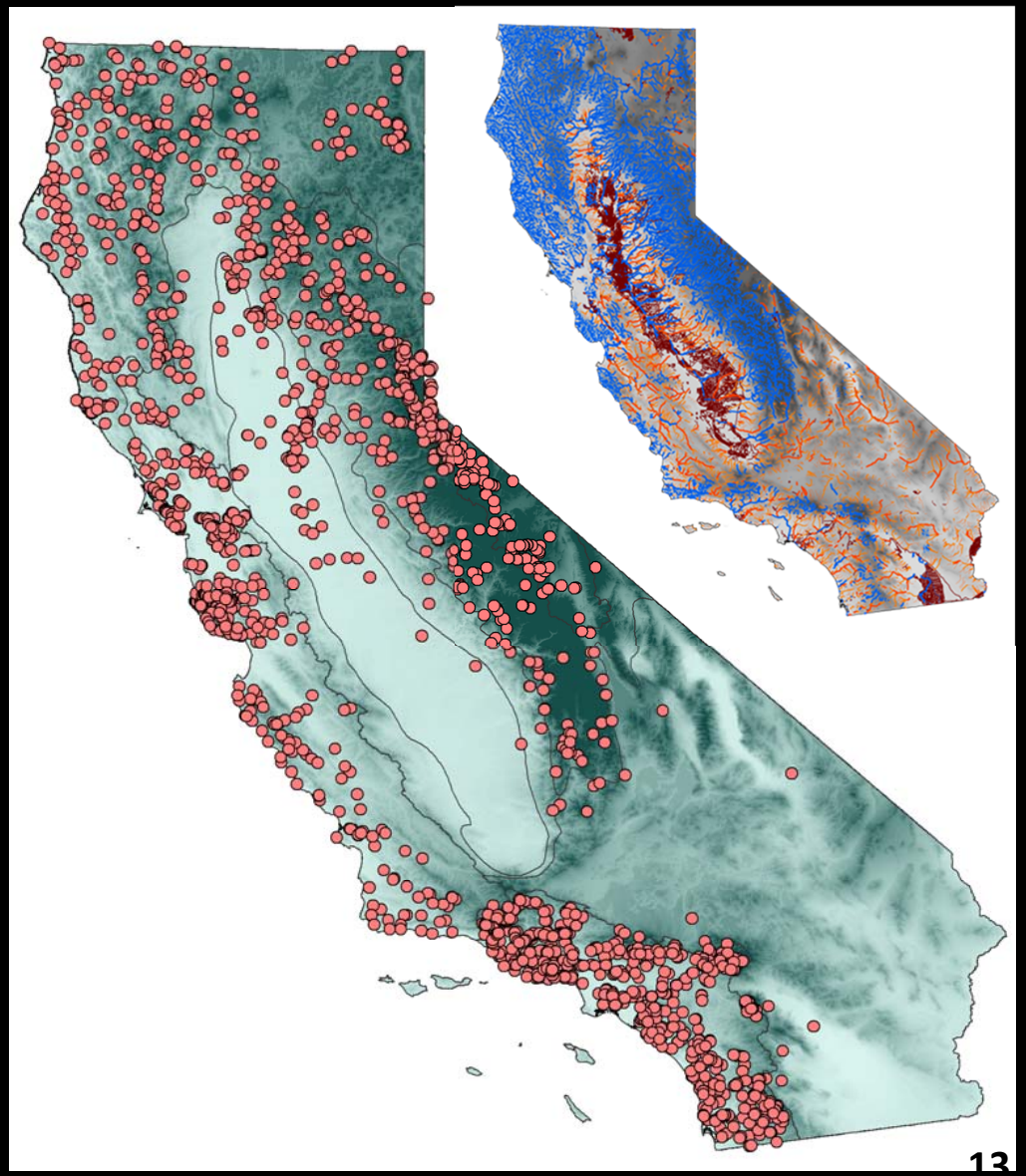
(Reference Condition Monitoring Program - RCMP)

Screened > 2400
candidate reference sites

Objectives:

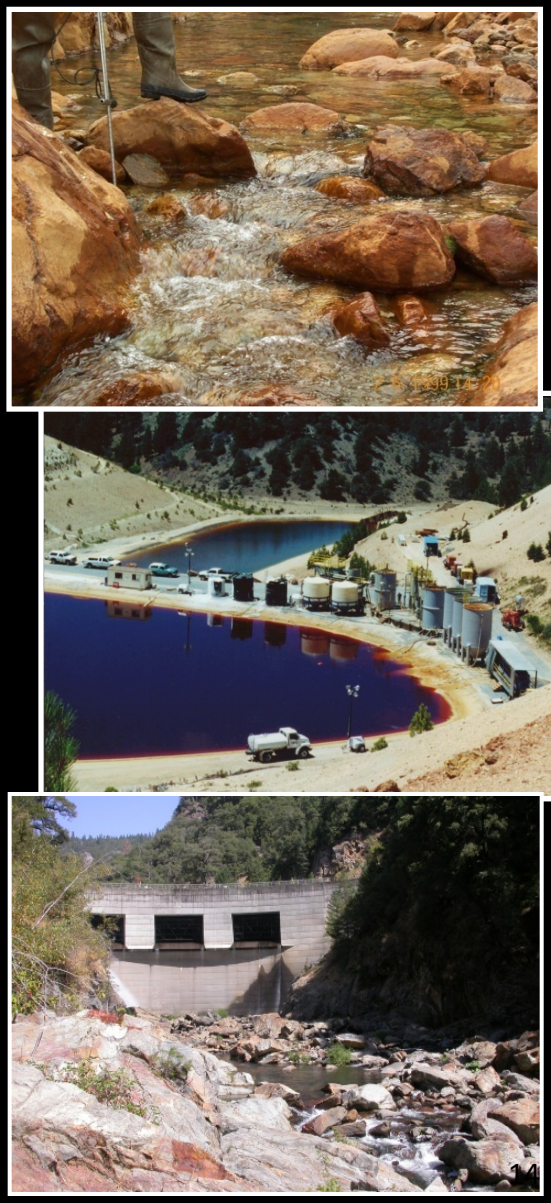
1. Reference pool represents CA stream diversity

2. Biota at reference sites is minimally influenced by stress



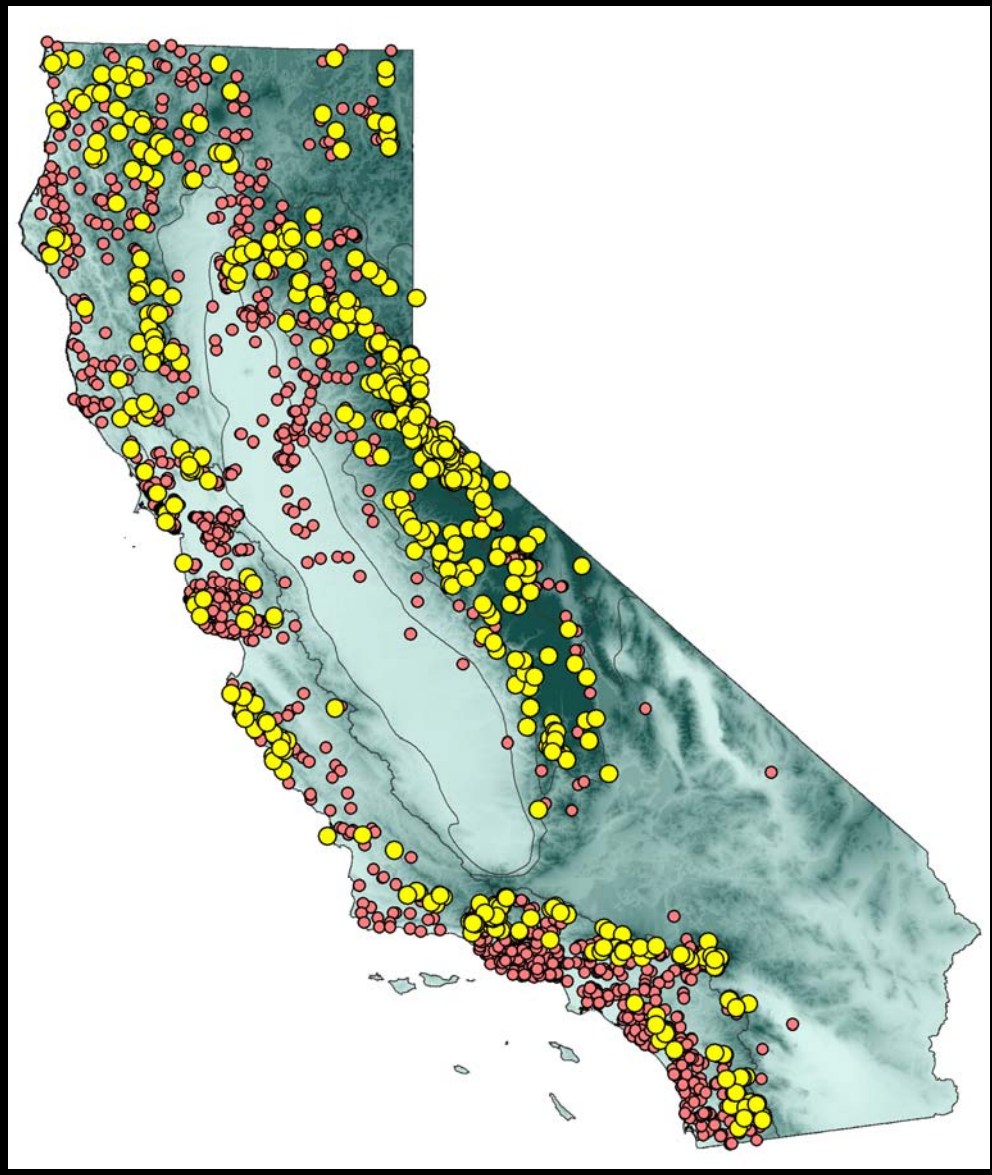
Reference sites have few sources of human stress

- **Infrastructure**: roads, railroads
- **Population**
- **Hydromodification**
  - manmade channels, canals, pipelines
- **Landuse**
  - Ag/Urban development
  - Timber Harvest, Grazing
- Fire history, dams, mines
- 303d list, known discharges
- Invasive invertebrates, plants
- Instream and riparian habitat
- Water chemistry

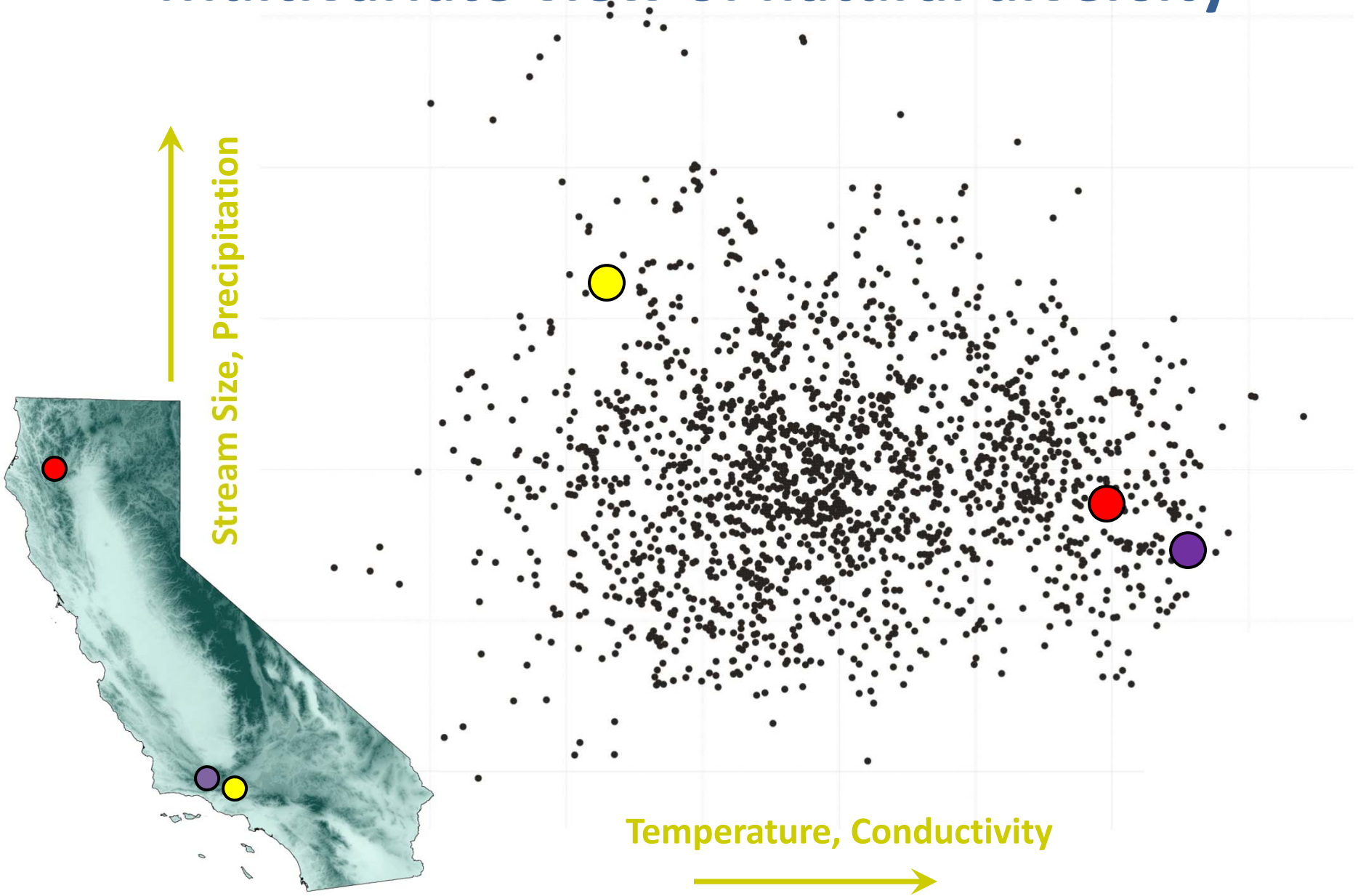


Broad geographic coverage

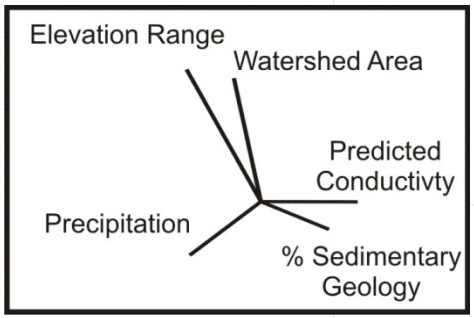
REGION	n
North Coast	75
Central Valley	1
Coastal Chaparral	57
Interior Chaparral	33
South Coast Mountains	85
South Coast Xeric	34
Western Sierra	131
Central Lahontan	114
Deserts + Modoc	27
TOTAL	**586**



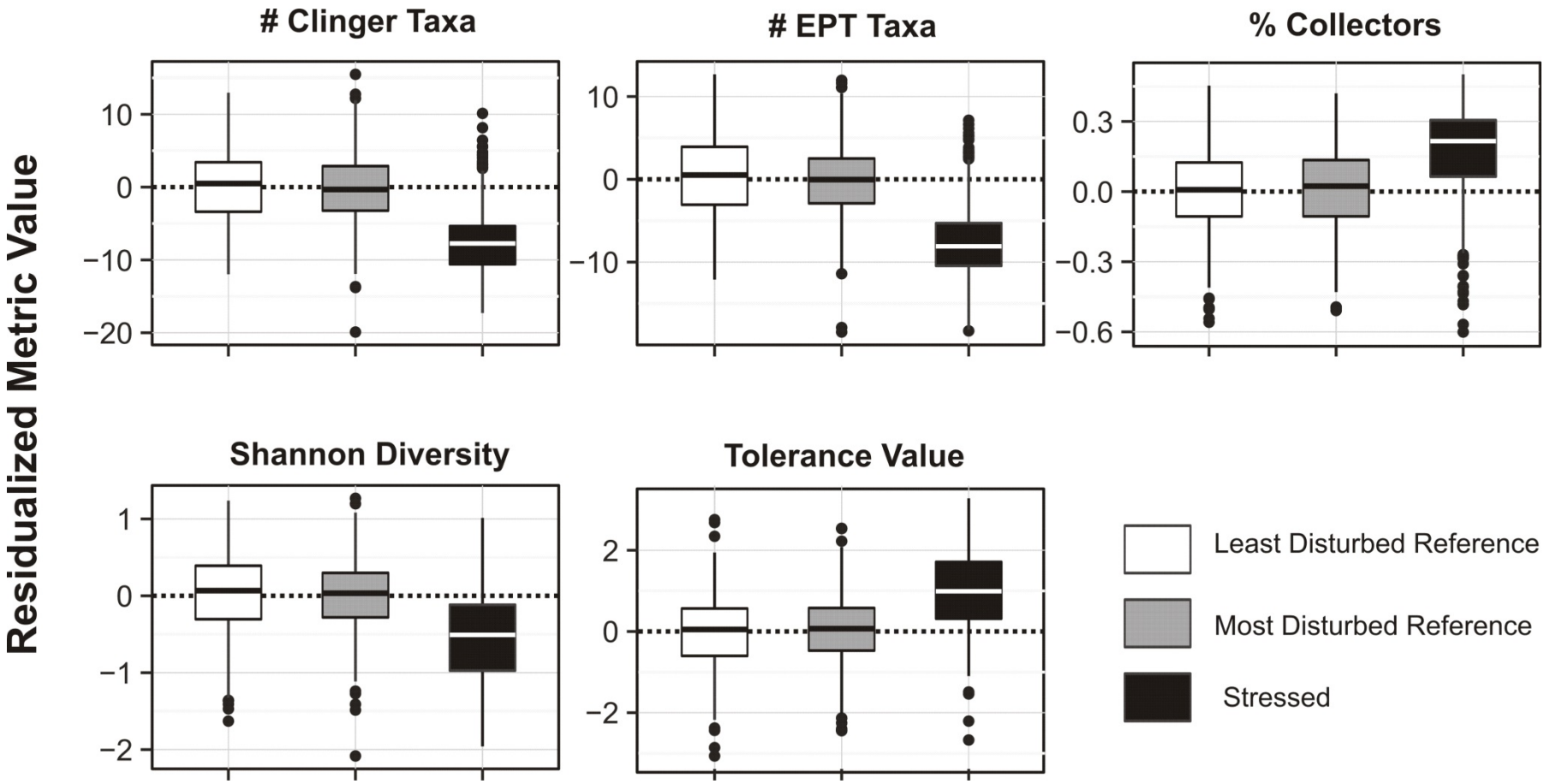
Multivariate view of natural diversity



Reference sites cover most stream types



Biology at most-disturbed reference sites was equivalent to least-disturbed sites



How to score condition from a species list?

Step 2: Compare observed to expected biota

The California Stream Condition Index (CSCI) combines two common approaches

- **Species loss component (taxonomic completeness)**
- **Ecological structure component**

Both account for natural sources of variation, but measure different aspects of biotic health

Species Loss Component

Compare number of **observed** ("O") taxa to number of **expected** ("E") taxa

- Test sites are compared to **groups of similar reference sites** to determine which taxa to "expect"

- Similarity based on 5 **natural** gradients:
  - **Latitude**
  - **Elevation**
  - **Precipitation**
  - **Temperature**
  - **Watershed area**

Species Loss Index (O/E)

Compare number of **observed** ("O") taxa to number of **expected** ("E") taxa

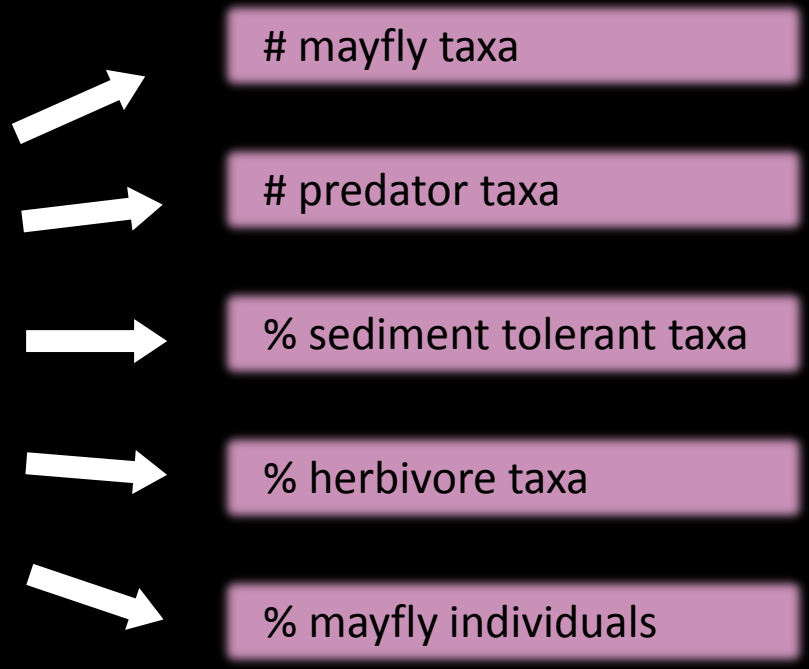
- **"E" is modeled** = predict the probability of observing specific taxa at reference sites of similar environmental settings

- Index score is an estimate of **native species loss**

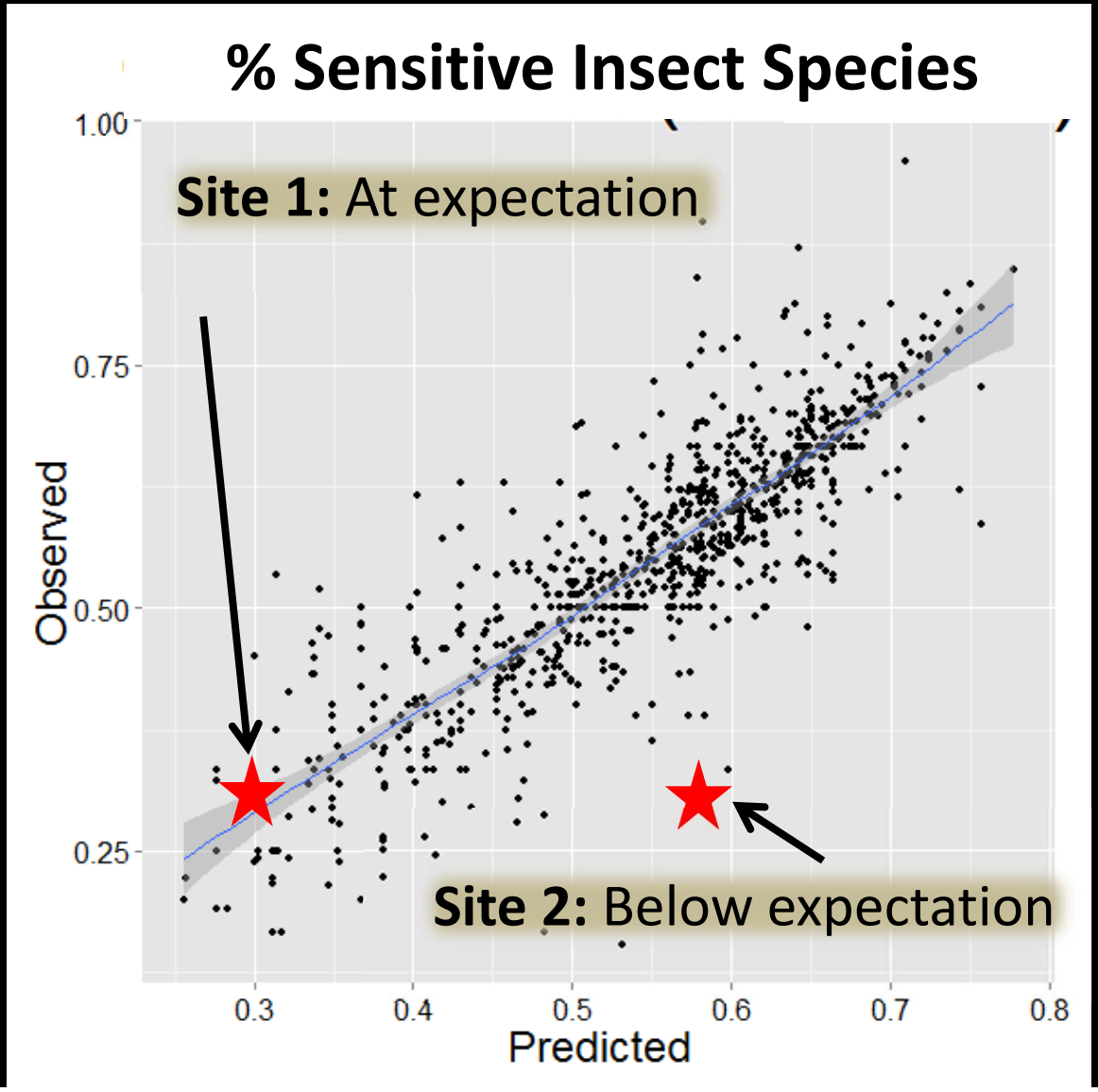
Ecological Structure Component

Species list is converted into metrics representing diversity, ecosystem function, and sensitivity to stress

Taxon	Count
Mayfly species 1	43
Mayfly species 2	12
Mayfly species 3	2
Beetle species 1	1
Beetle species 2	1
Midge genus 1	65
Midge species 1	3
Midge species 2	10
Midge genus 2	3
Dragonfly species 1	2
Stonefly species 1	1
Stonefly species 2	14
Worm species 1	9
Worm species 2	2



Expected metric values are modeled to adjust for environmental setting



Plot of observed vs. predicted (modeled) values at reference sites

Test Site 1
30% observed, 30% predicted

Test Site 2
30% observed, 60% predicted

Score depends on the *environmental setting*, not just raw metric value

CSCI predicts the species and metric values to expect at a test site based on **natural environmental factors**

- **Location** – elevation, latitude, longitude
- **Watershed size**
- **Climate** – precipitation, temperature
- **Geology** – mineral content, soils

species and metrics **measured** at test site = **Observed**

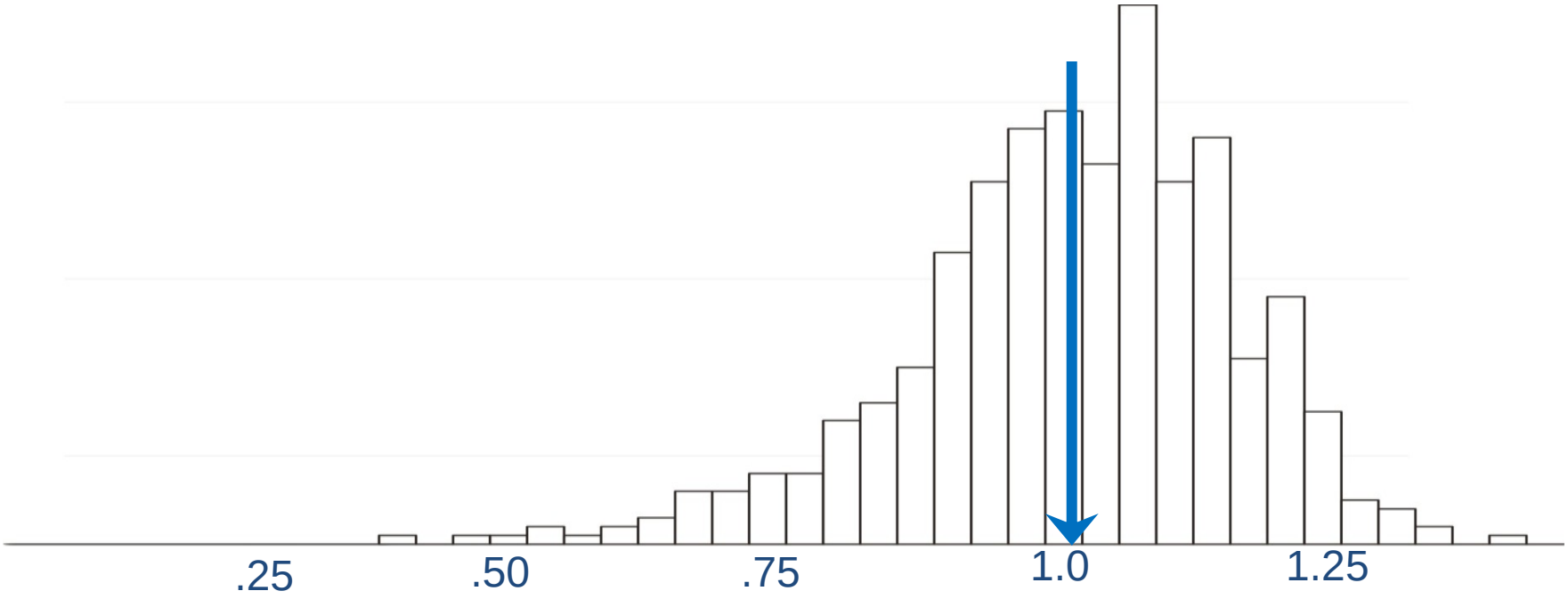
species and metrics **predicted** at site = **Expected**

If O/E is ~1.0, biological integrity is intact

If O/E << 1.0, biological integrity is altered

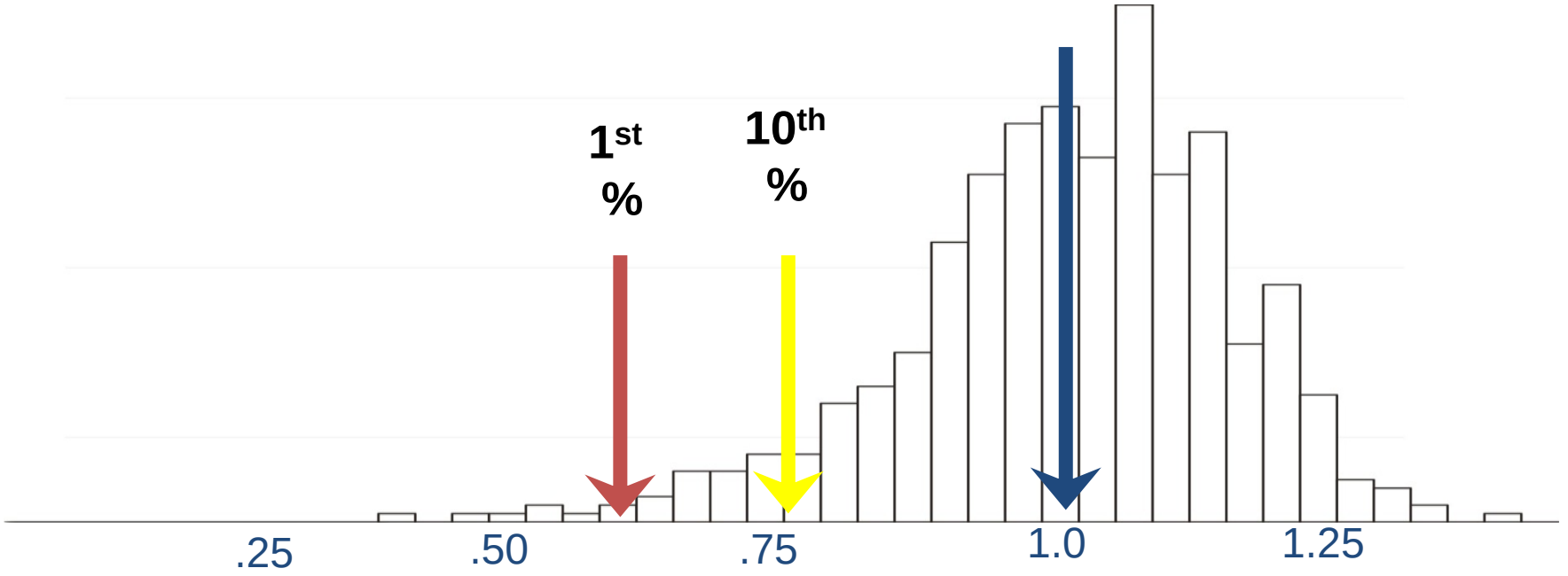
California Stream Condition Index (CSCI) is an average of the two component scores

- CSCI ranges from 0 to >1
- Mean of reference sites ~1.0

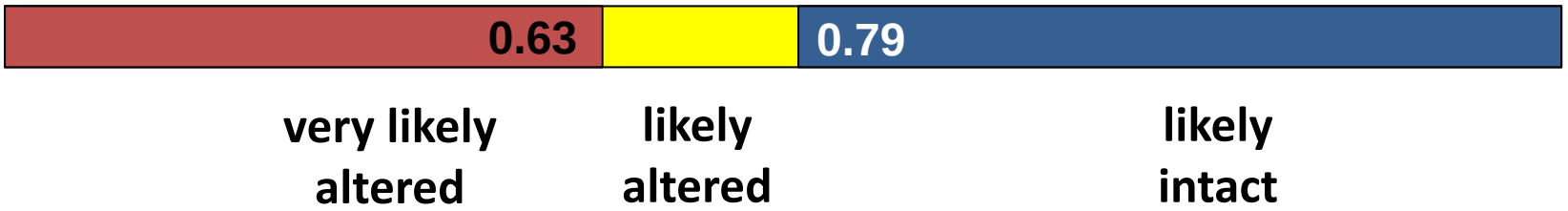


CSCI scores at reference sites

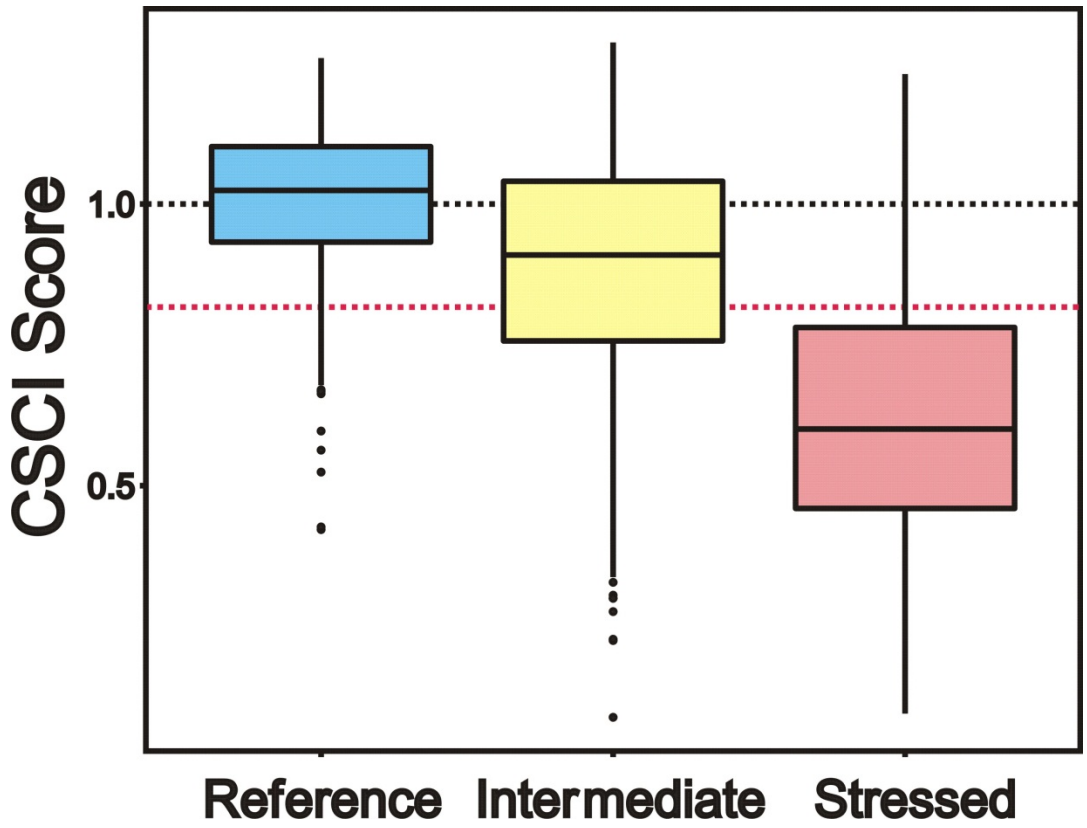
California Stream Condition Index



CA Stream Condition Index Value

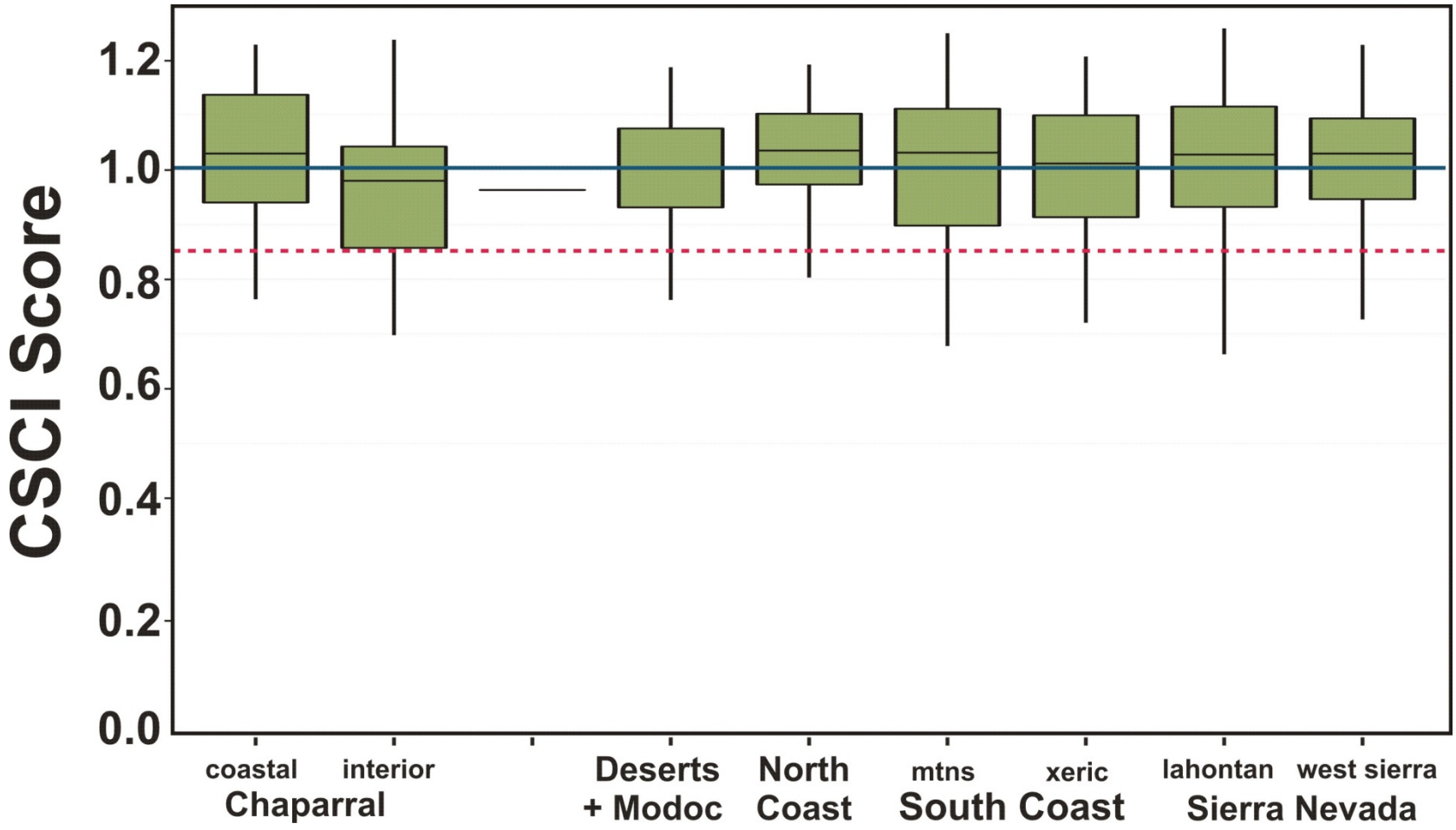


CSCI is responsive to stress



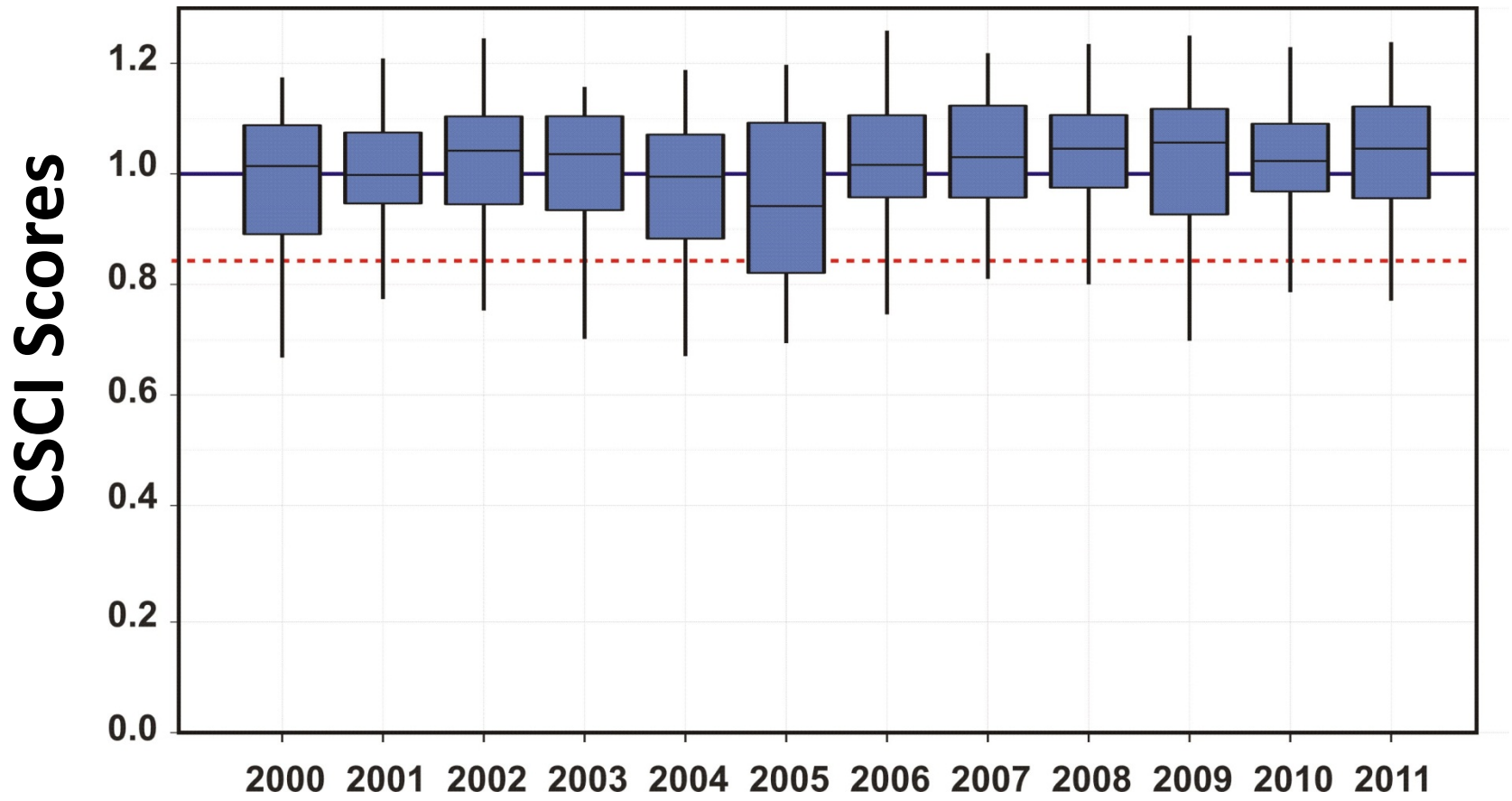
CSCI is consistent in all regions

CSCI scores at reference sites in major CA ecoregions



CSCI is consistent over time

CSCI scores at reference sites 2000 - 2011

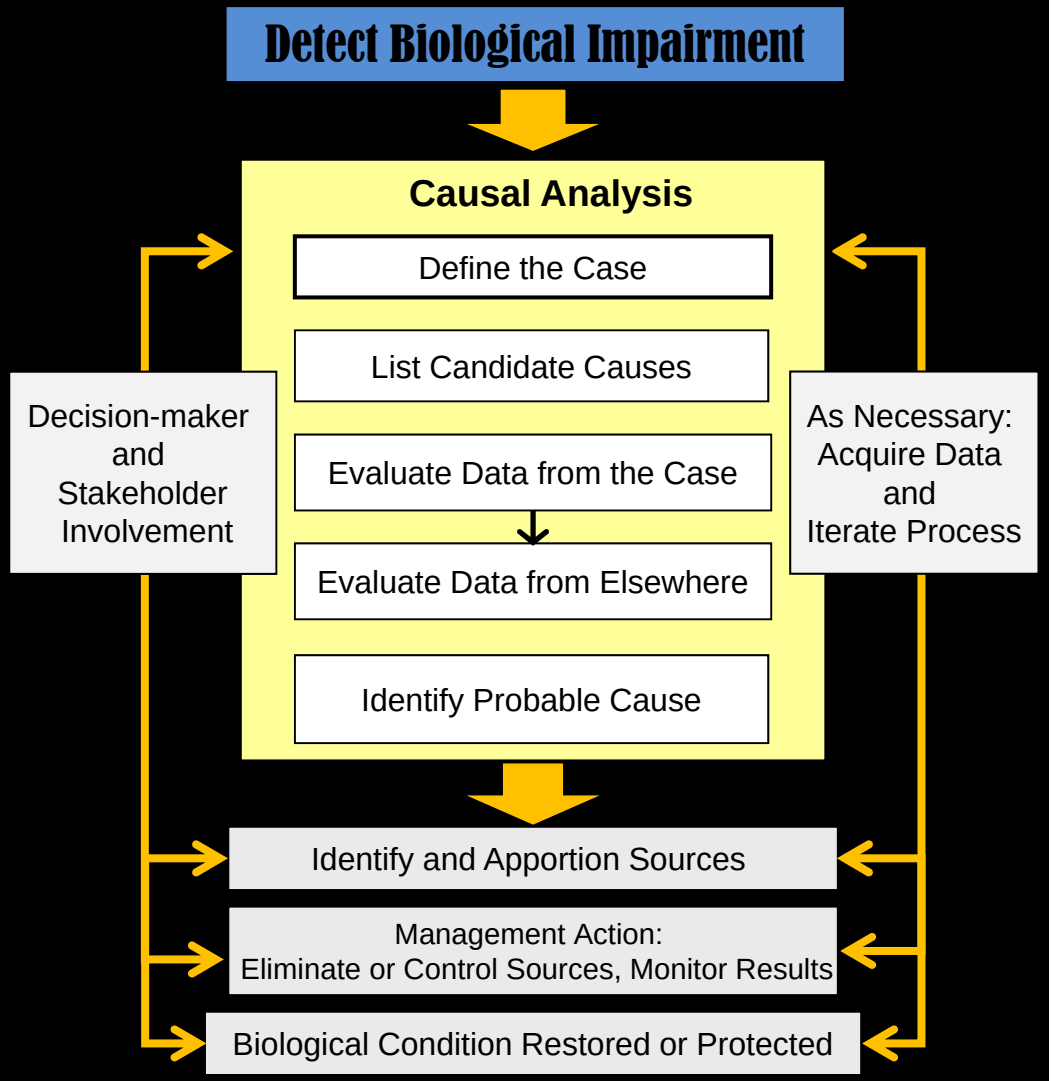


Summary: The CSCI is a significant advance over previous CA biotic indices

- ***Much better reference data set***
  - Bigger, broader, and more rigorously screened
- ***More comprehensive*** assessment of biological integrity
- ***Site-specific expectations***
  - Expected values are customized to each location
- ***Statewide applicability***
  - All perennial wadeable streams can be assessed
  - Consistent meaning throughout California

Causal Assessment/ Stressor Diagnosis

- When we find biological impacts, then what?
- We anticipated need for tools to identify sources of stress
- Tested US EPA's CADDIS Framework for suitability in California



EPA's CADDIS Tools:

Causal Analysis/Diagnosis Decision Information System

- SCCWRP led stakeholder/scientist teams to test CADDIS methods in CA (Garcia River, Salinas River, Santa Clara River, San Diego River)

- Guidance Document:
  - Tools have promise for CA
  - Needs additional work and tools to tailor to CA setting

- SCCWRP has been following up on recommendations
  - See SCCWRP's NorCal SETAC Short Course @CalEPA on April 29th https://norcalsetac.wordpress.com/annual-meeting/short-course-2/

- **State Water Board's Biological Integrity Website**
  http://www.waterboards.ca.gov/plans_policies/biological_objective.shtml
  - All development presentations
  - Reference and CSCI papers (in press @ Freshwater Science)
- **CSCI automation**
  - Semi-automated tools available
  - Full automation (funding available to scope the project)
- **Causal Assessment**
  - see SCCWRP's NorCal SETAC Short Course @CalEPA on April 29th
  - https://norcalsetac.wordpress.com/annual-meeting/short-course-2/

Questions?

photo courtesy John Sandberg