Biobjectives Scoring Tool: California Stream Condition Index (CSCI)

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Biological indicators are the best way to assess biological integrity
Challenge is to use them consistently across the state
photo courtesy John Sandberg

- **Establishing Reference Conditions**
- **Developing the CSCI Scoring Tool**
- **Stressor Identification**

Fundamentals of “Reference”

Reference condition is the foundation of bio-objectives

objective basis for setting biological expectations

provides and “anchor” for bioassessment scoring tool

- Use natural condition (or something close to it) as the desired state whenever possible
  - NOT defined based on biology, but landscape setting

Stream Sites with Low Levels of Human Activity

Defining Reference

Tension of twin goals

A. ***Need sufficient numbers of sites to characterize reference across the full range of natural stream settings in California.***
B. ***Stringent enough to ensure only high quality sites are included***

1. Identify candidate sites
2. Compile landscape-scale data on a wide range of stressors
3. Examine the distribution of stressors across the state
4. Set preliminary thresholds based on literature values and BPJ
5. Refine thresholds using statistical analysis

Many Candidate Sites, Many Variables Tested

- Approximately 1,700 sites
  - 800 probabilistic
  - 900 targeted
- 20 different programs
  - 8 probabilistic
  - 12 targeted
- Statewide coverage

- More than 170 variables
  - Landscape scale measures of disturbance
- Multiple scales
  - Watershed
  - Reach
  - 5 km
  - 1 km
- Statewide coverage

Reference Thresholds

Variable	Local Scale	Local Threshold (1k/ 5k)	Watershed Threshold (ws)
% Agricultural **or** Urban	1k/5k	3 %	3 %
% Agricultural **and** Urban	1k/5k	5 %	-
% Code 21 (urban grasses)	1k/5k	7 %	10 %
Road Density	1k/5k	2 km/km²	2 km/km²
Road Crossings	1k/5k	5/10 per km	20 per km
Dam Distance	-	1 km	
% Canals/Pipes	-	10%	
Instream Gravel Mines	5k	0.1/ km	
Producer Mines	5k	1	
Conductivity	-	99/1 *	
W1_Hall (riparian veg)	-	1.5	

Threshold Evaluation

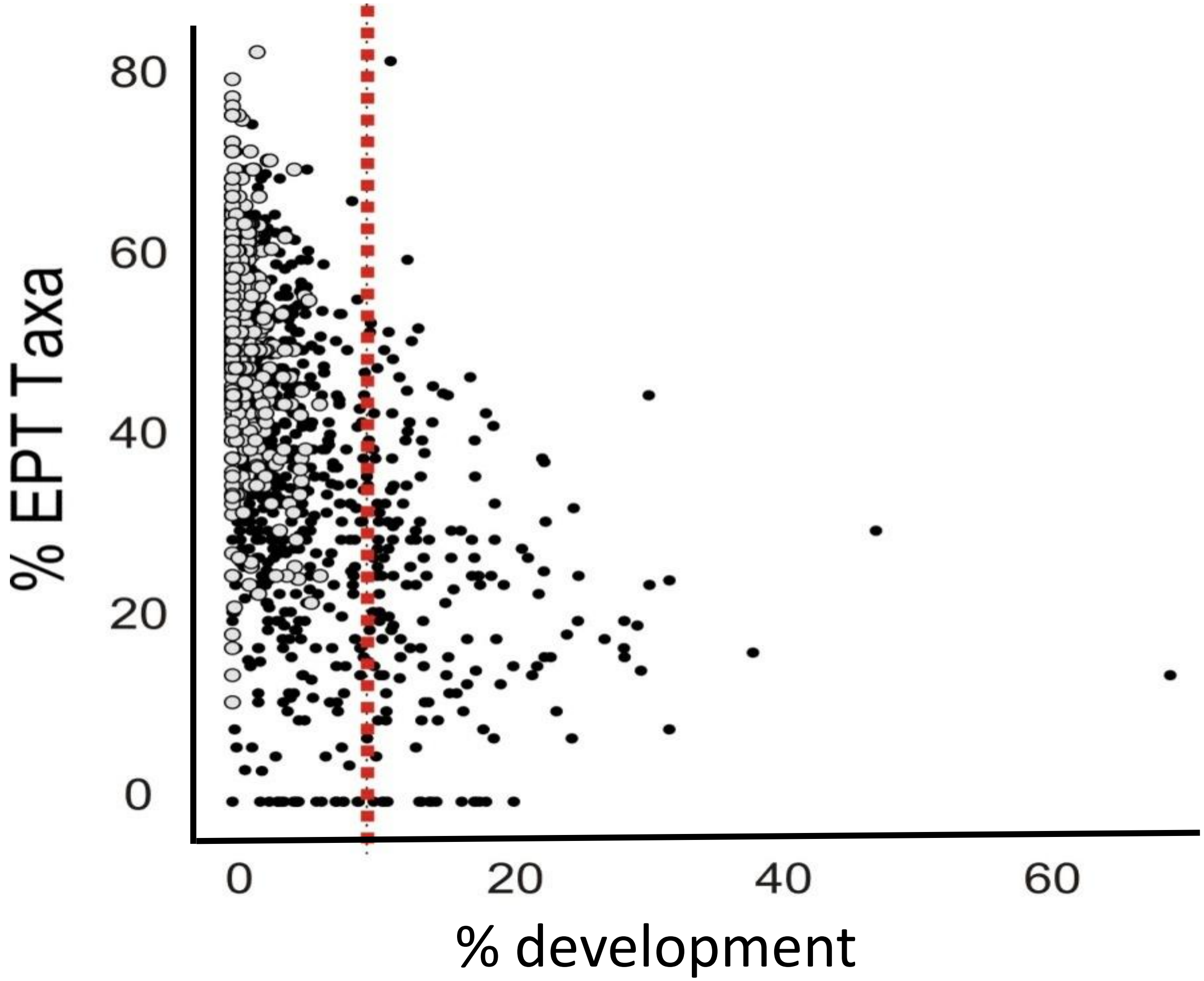
TENSION: need to represent full range of stream types vs. not relaxing thresholds to include "non-reference streams"

1. **Sensitivity**: How many sites do you get when you adjust thresholds?

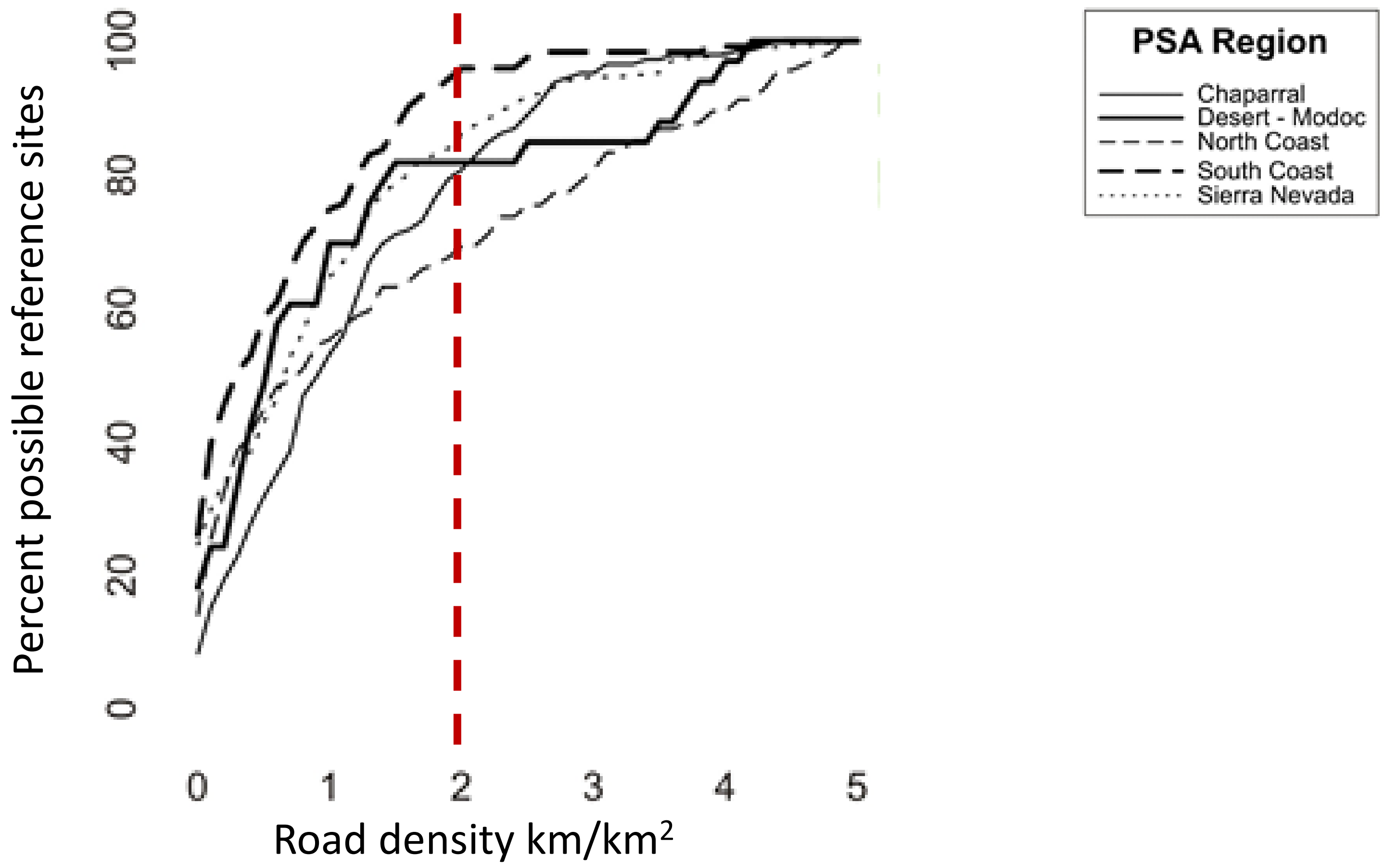
2. **Responsiveness**: Have we limited the biological response to stressors within the reference data set?

3. **Representativeness**: Have we captured important natural gradients within the reference data set?

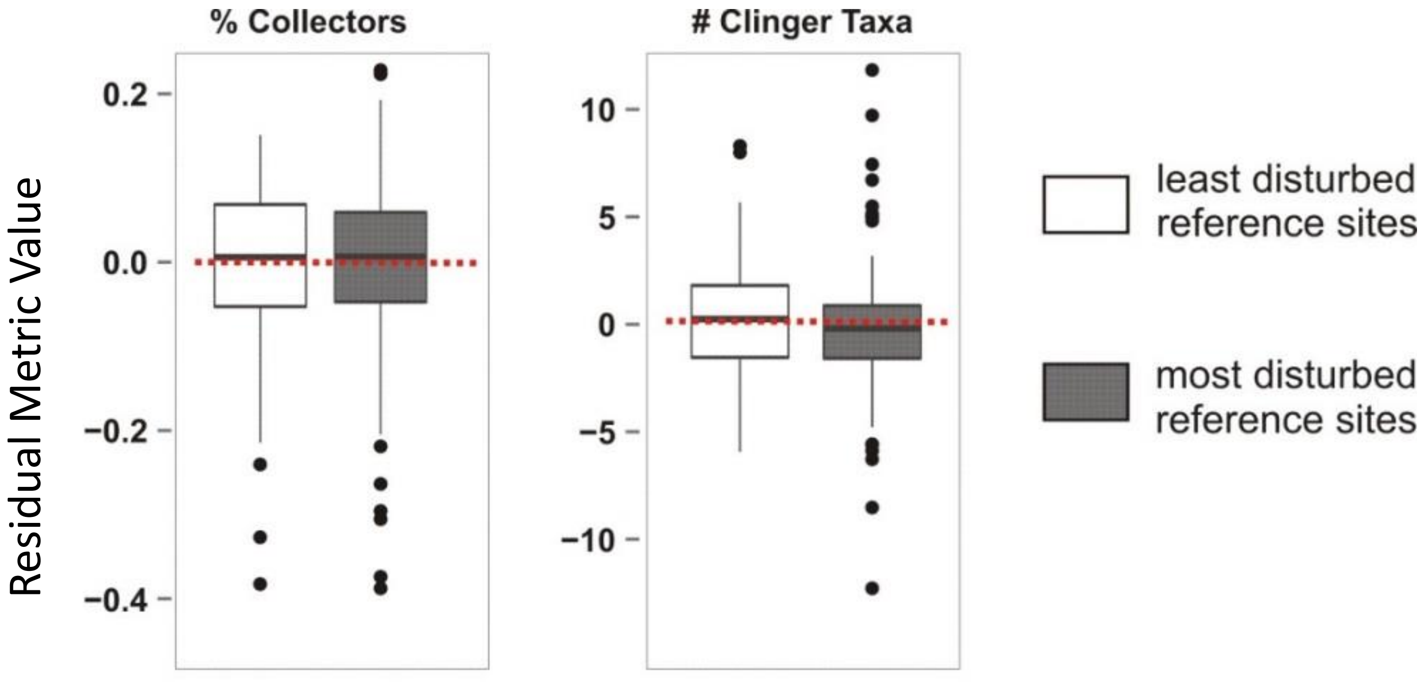
Are Thresholds Appropriate?



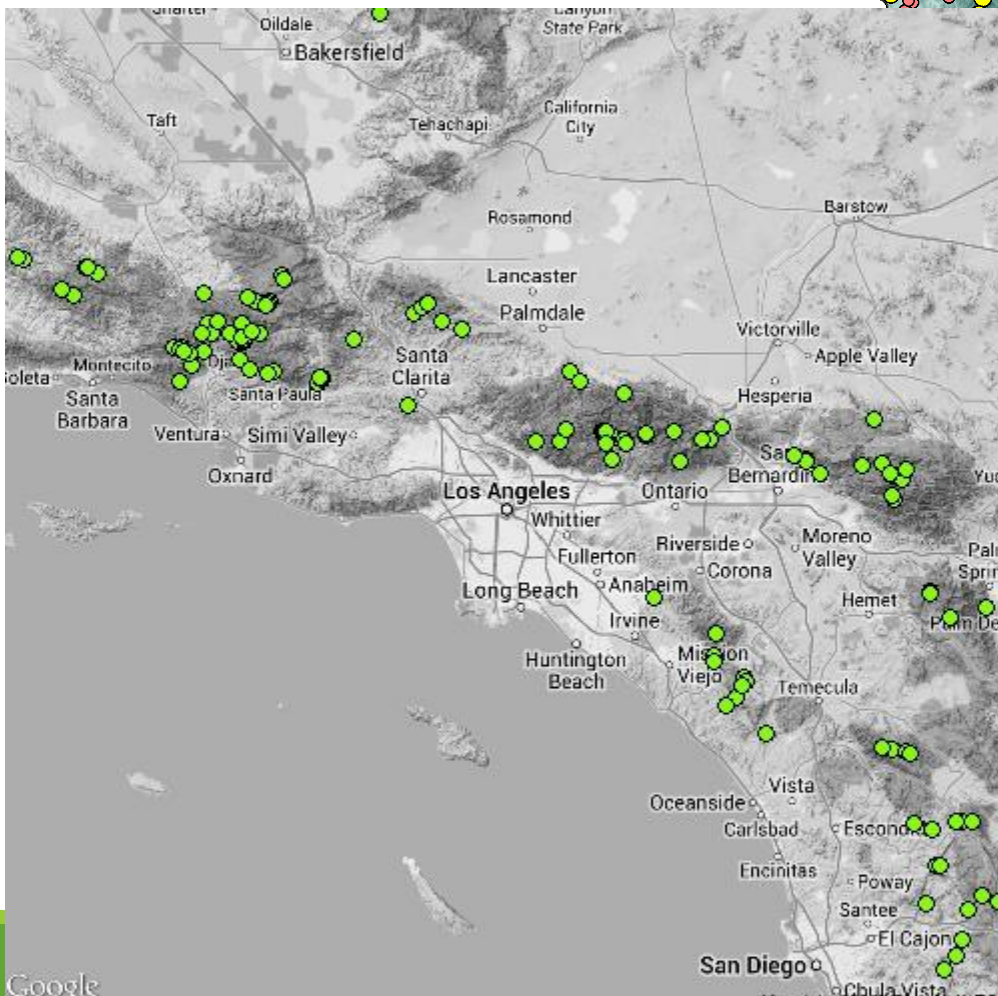
Threshold Sensitivity

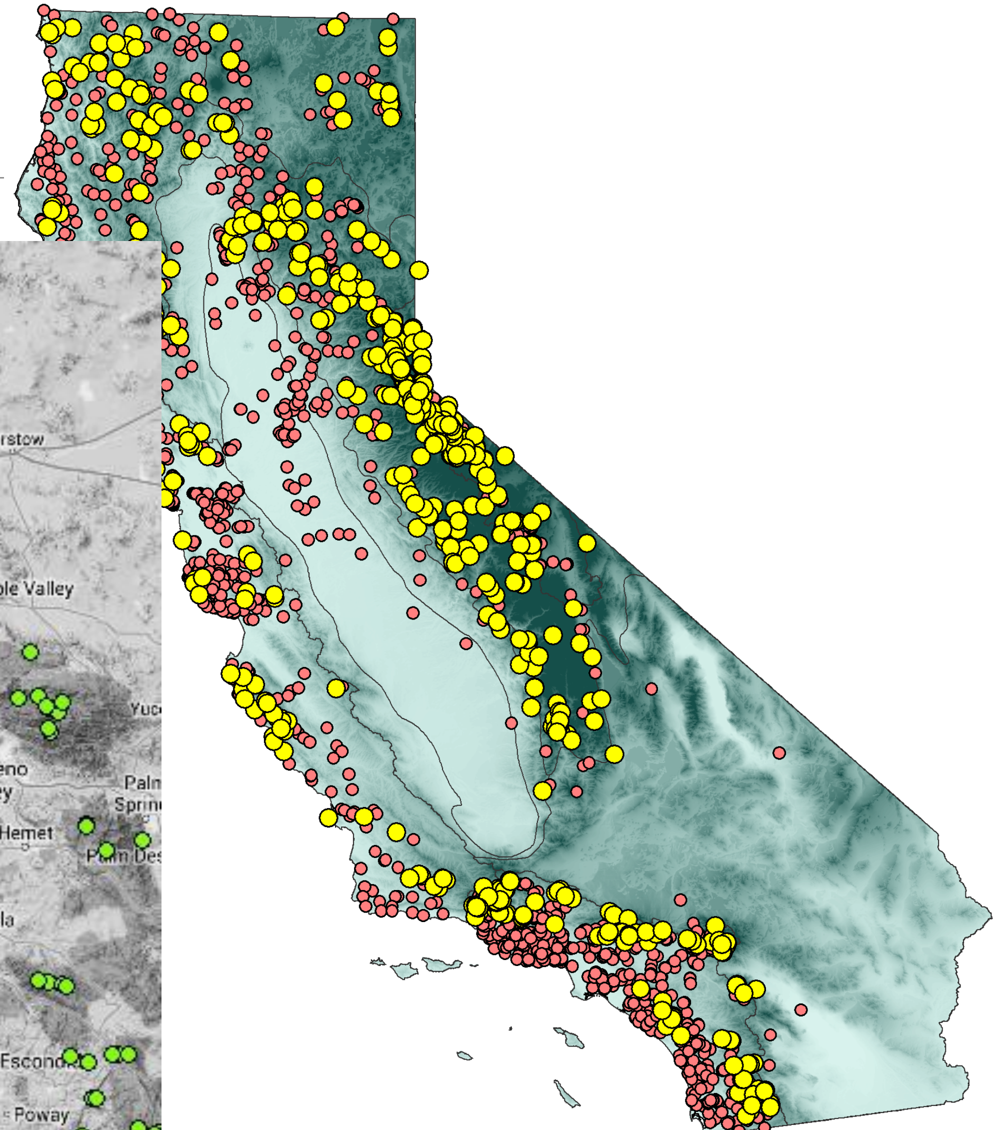


Responsiveness of the Full Range of Reference

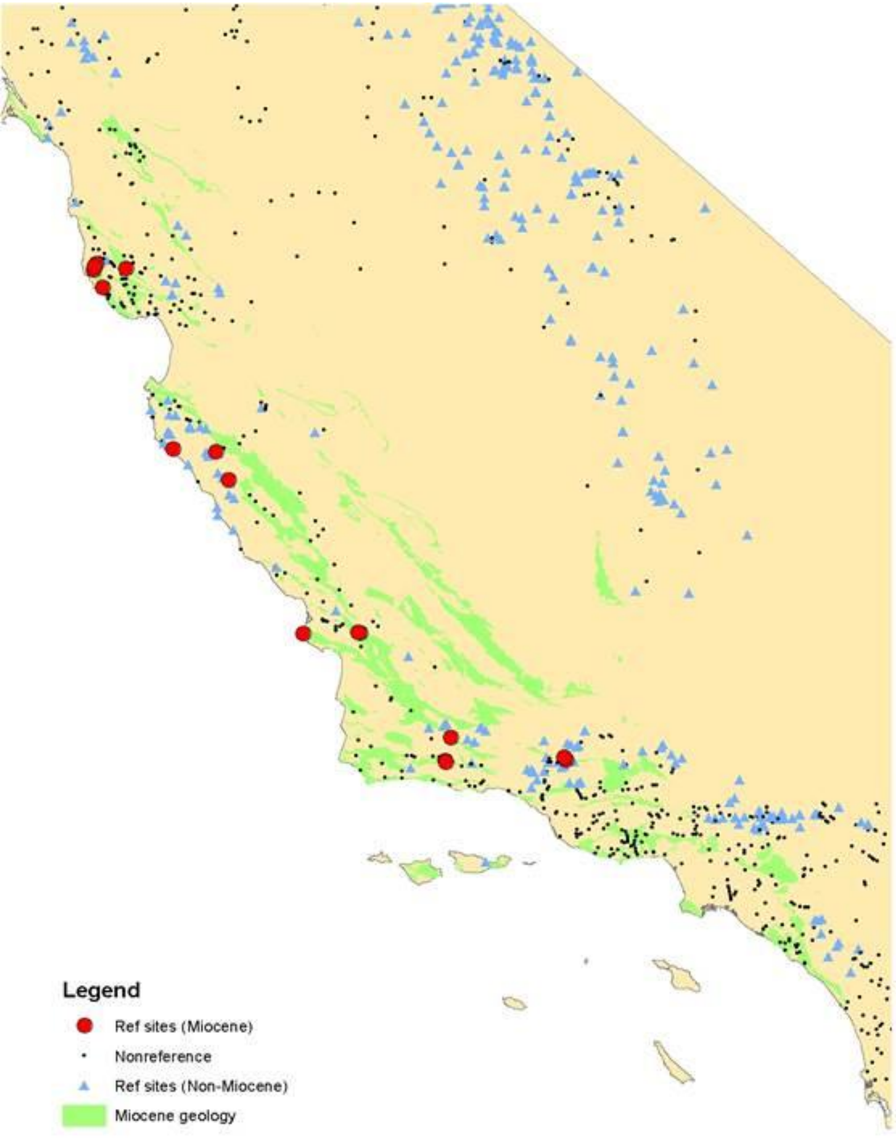


Broad Geographic Coverage





Reference Representation in Challenging Areas



Statewide Distribution of Reference

REGION	n	% of region
North Coast	79	28
Central Valley	1	2
Coastal Chaparral	87	18
Interior Chaparral	30	33
South Coast Mountains	96	68
South Coast Xeric	22	2
Western Sierra	131	50
Central Lahontan	142	74
Deserts + Modoc	27	56
TOTAL	**615**	**-**

Reference Conclusions

- Established a robust reference network that can be used to set biological expectations statewide

- Majority of the state has good representation by reference network

- Reference network must be an ***ongoing effort***

- Some problematic areas remain
  - Areas of relatively poor representation, e.g. Central Valley
  - Areas that are represented, but could use additional sites, e.g. low gradient S. CA
  - Other water body types (e.g. non-perennial streams)

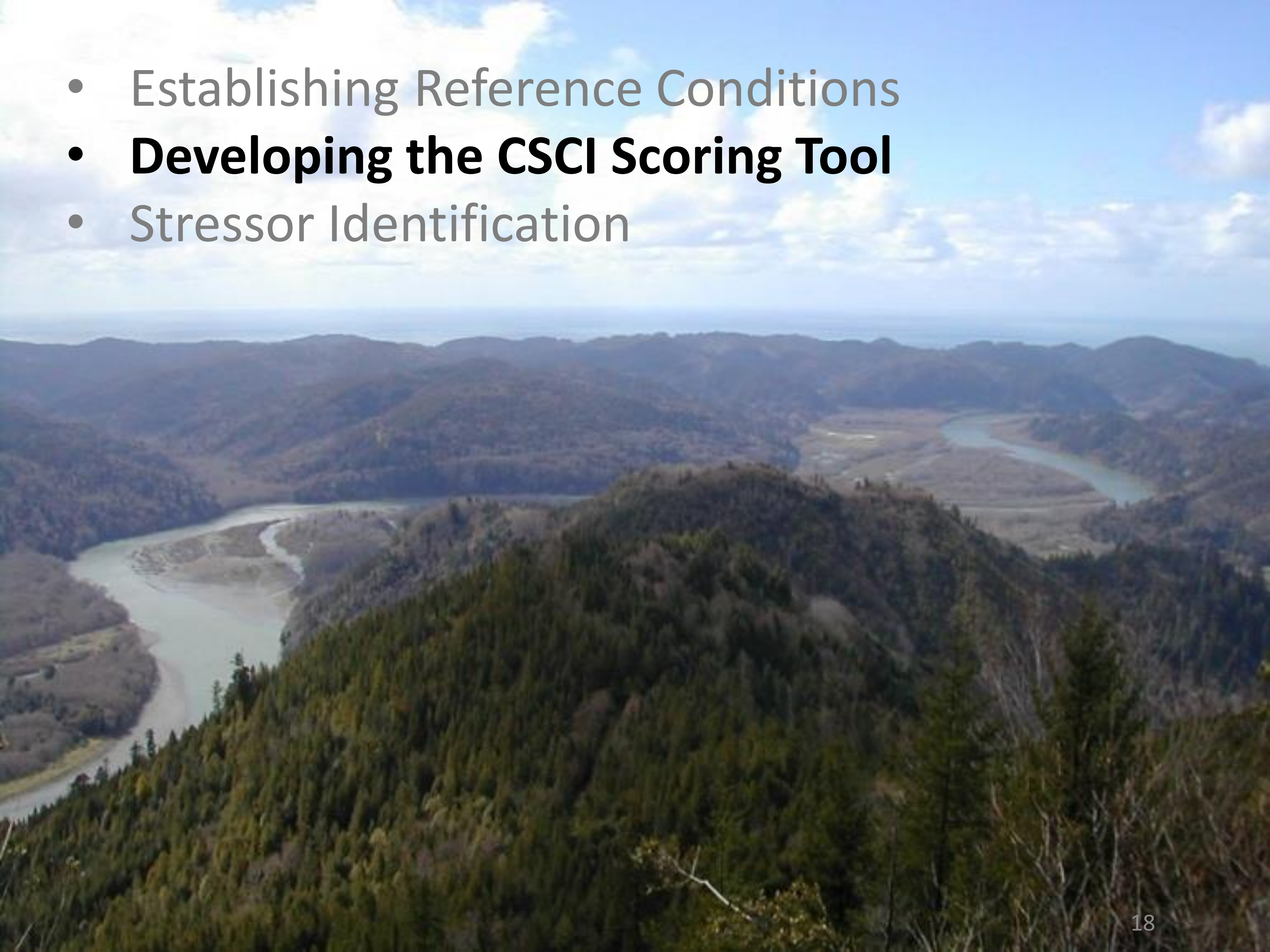
Options for "Problematic" Areas

- Targeted investigations to try and find additional reference sites

- Redefine reference for problematic areas
  - Variable definitions of reference

- Address through adjustments to the scoring tool

- Establishing Reference Conditions
- **Developing the CSCI Scoring Tool**
- Stressor Identification



Why Do We Need A New Tool?

- Different scoring approaches for different regions
- Some parts of the State lack any scoring tools
- Inconsistent definition of reference

A new statewide index is needed

The California Stream Condition Index (CSCI)

- ***Much better reference*** data set
  - Bigger, broader, and more rigorously screened
  - Nearly double sites in S. CA compared to the IBI

- ***Consistent meaning statewide***, without regionalization
  - A specific score means the same thing in all areas
  - Nearly all perennial wadeable streams can be assessed

- ***Site-specific expectations*** means that your site is held to appropriate standards
  - Each site is assessed relative to community that should be there based on site’s physical properties

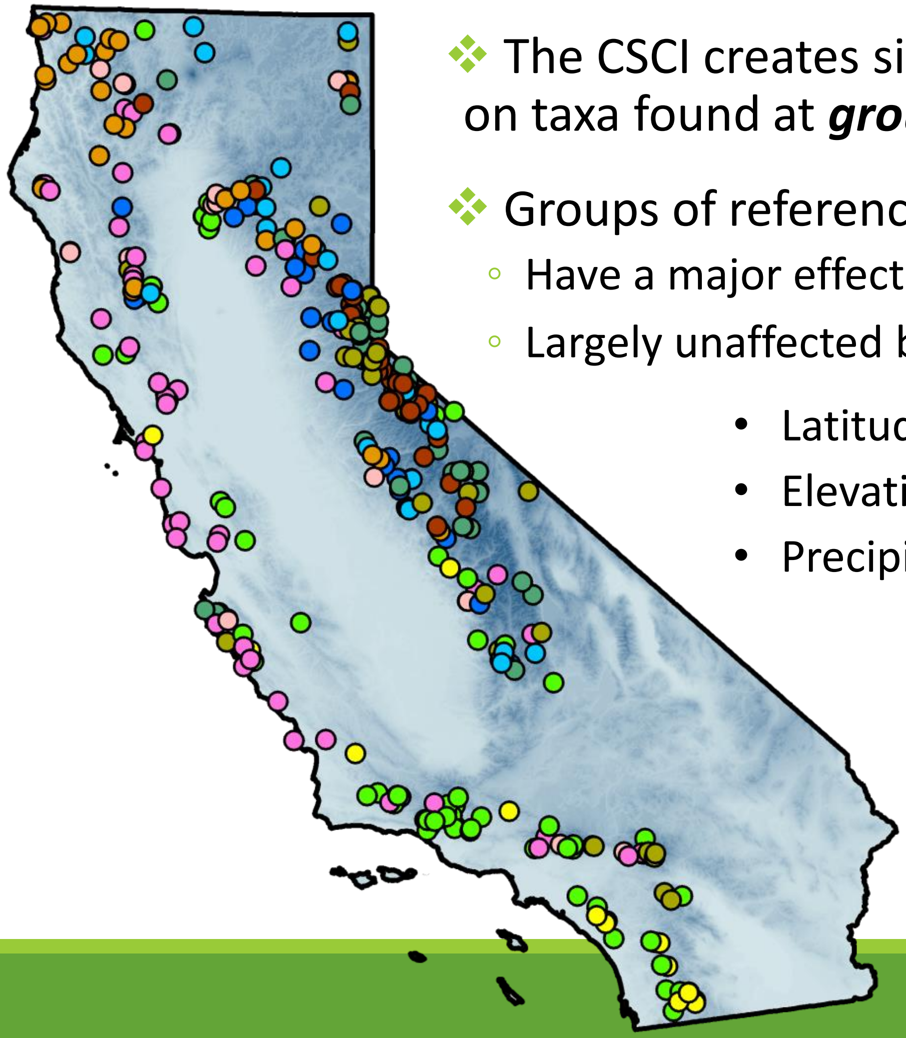
Elements of the CSCI

- **Taxonomic completeness** (O/E)
  - Is a measure of species loss
  - Compares taxa found at similar reference sites

- **Ecological structure** (MMI)
  - Comprised of several metrics that represent community structure
  - Compares metric values observed at similar reference sites.

Multiple elements provide complementary information about biological health

The CSCI Uses a *Predictive* Approach



- The CSCI creates site-specific expectations for each site based on taxa found at ***groups of similar reference sites***
- Groups of reference sites are defined by natural gradients
  - Have a major effect on the invertebrate community
  - Largely unaffected by human activity

- Latitude
- Elevation
- Precipitation
- Temperature
- Watershed area

Expected invertebrate community under unaltered conditions

Scoring Relative to Site-specific Expecations

- Develop expected taxa list based on reference sites located in similar environmental settings → ***Expected***
- Collect Taxa at site being evaluated → ***Observed***
- Compare ***Observed vs. Expected*** taxa list

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

Two Elements of CSCI

Completeness

List of all taxa

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 specie	2
Stonefly species	1
Stonefly species	14
Worm species 1	9
Worm species 2	2

Ecological structure

% mayfly, stonefly, caddisfly

% beetle taxa

Total number of taxa

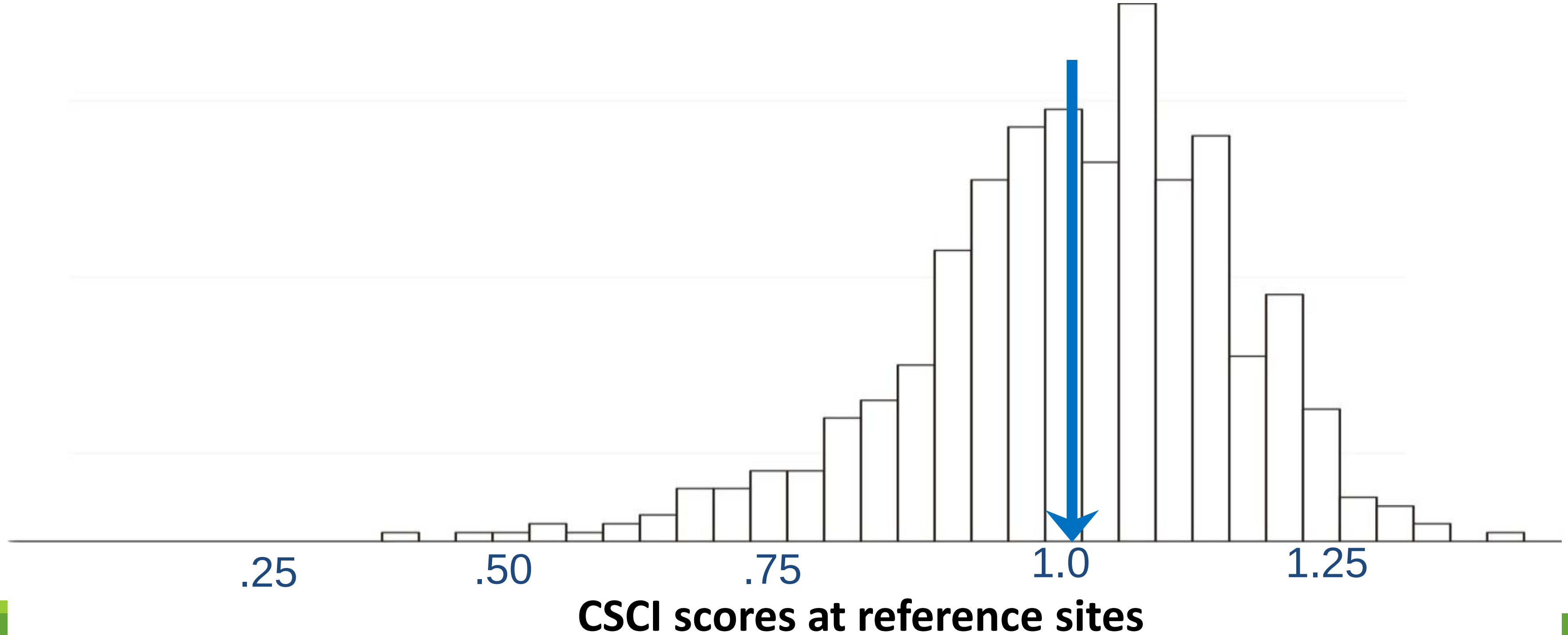
% clinger taxa

shredder taxa

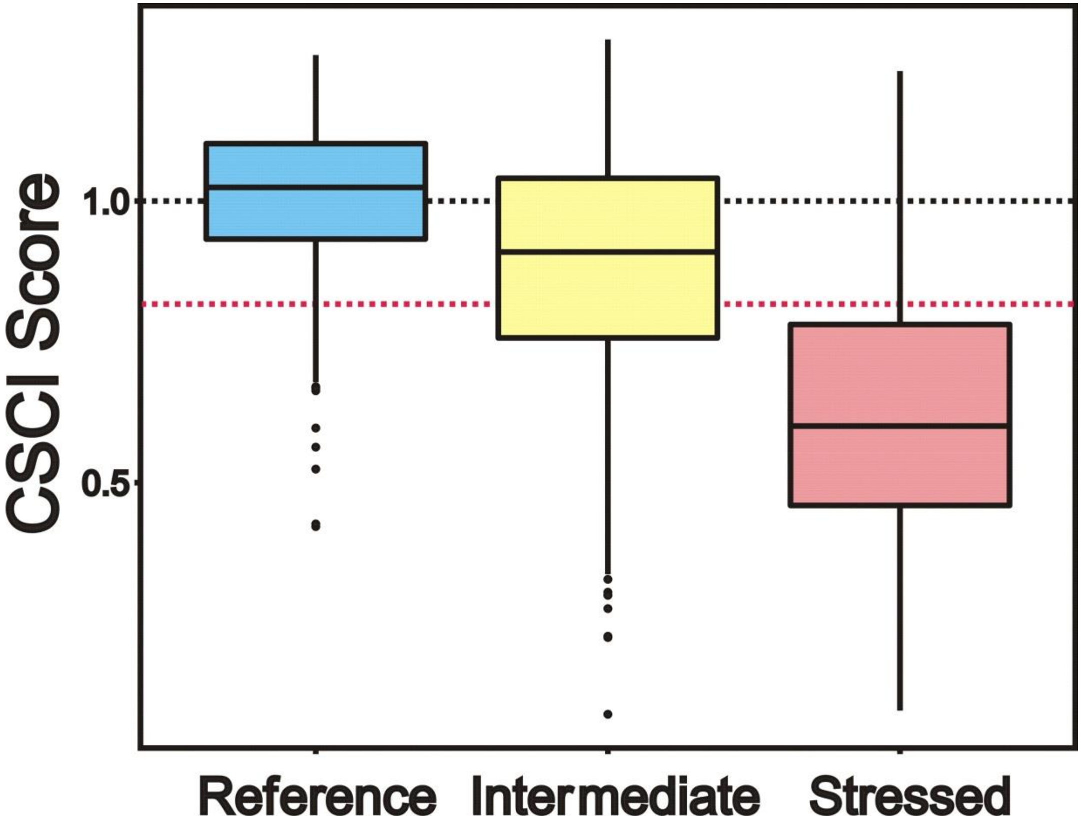
% sensitive individuals

Calculating the CSCI

- CSCI ranges from 0 – 1
- Mean of reference sites = 1.01 ± 0.12 sd

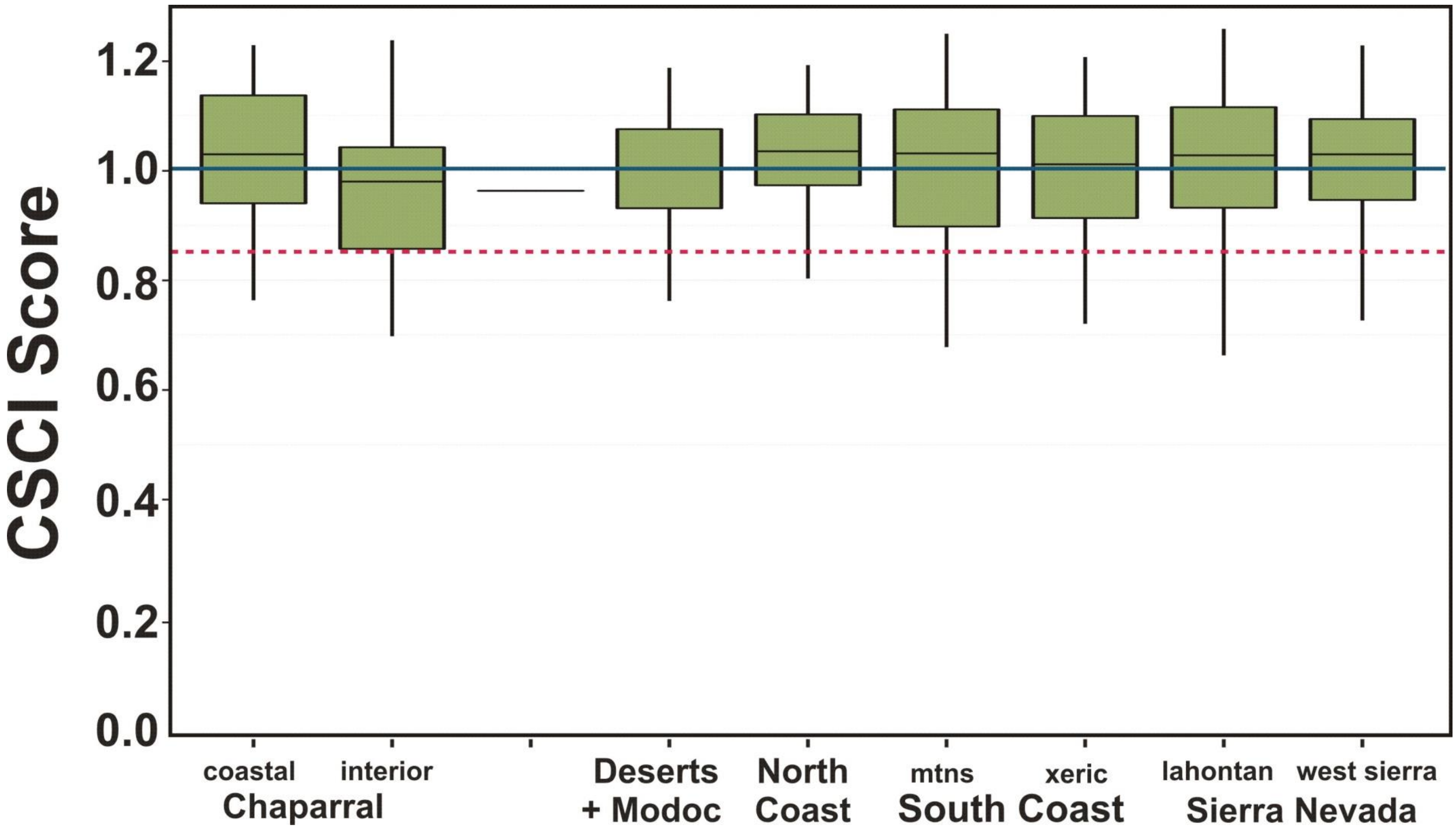


CSCI is responsive to stress



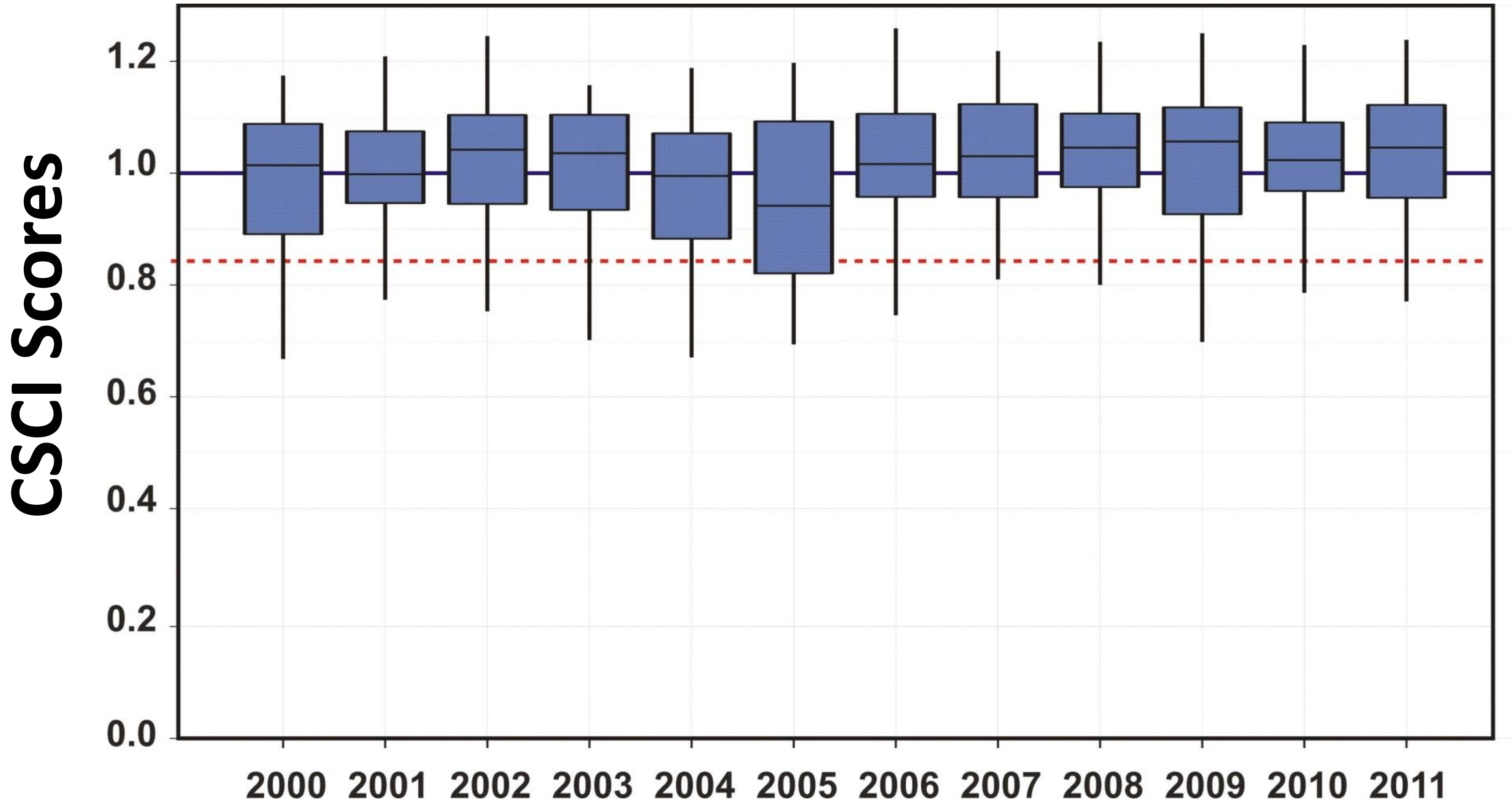
CSCI is consistent in all regions

CSCI scores at reference sites in major CA ecoregions

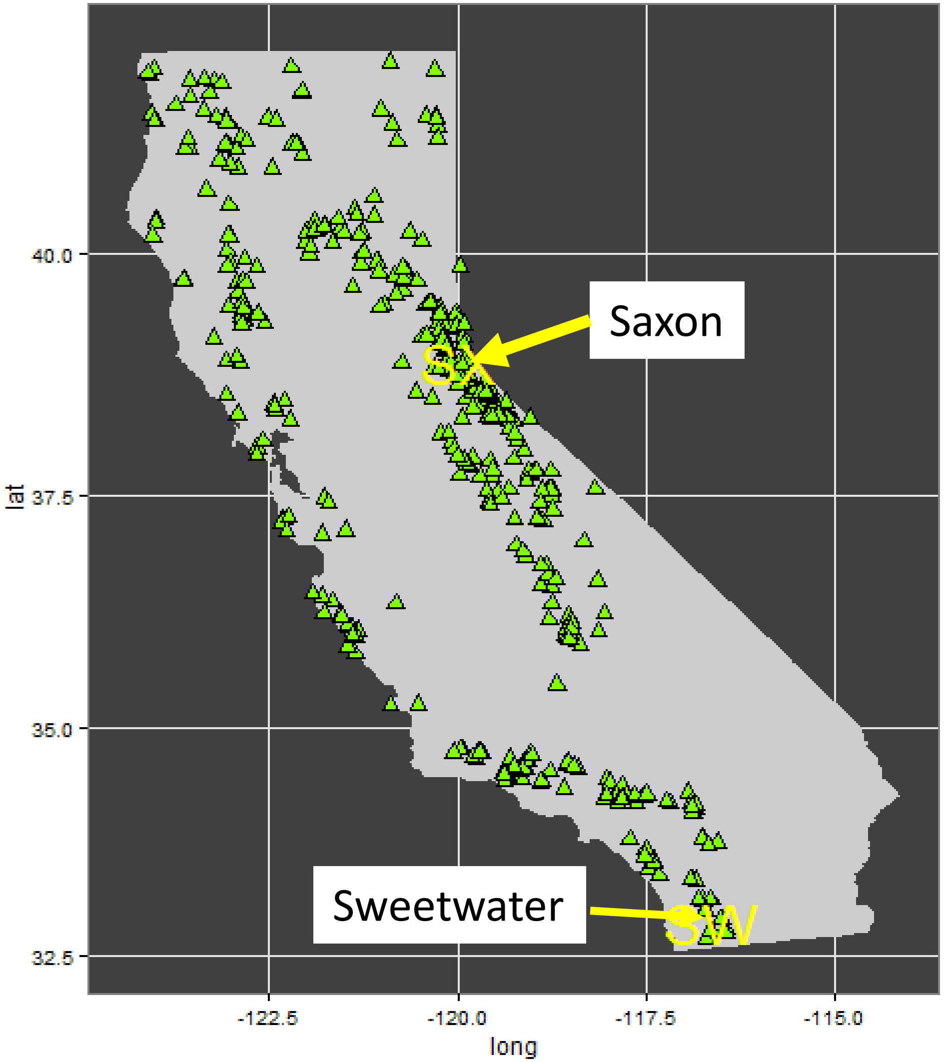


CSCI is consistent over time

CSCI scores at reference sites 2000 - 2011

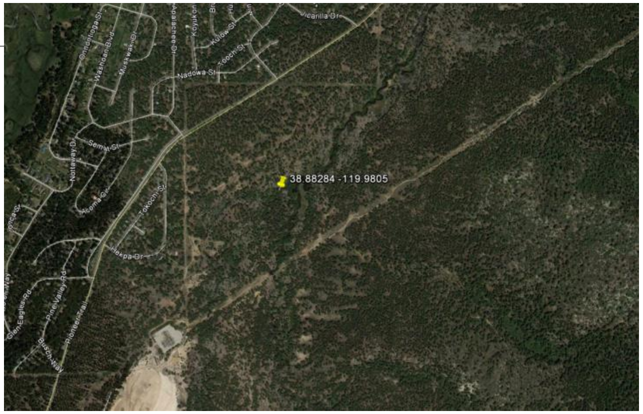


Sample Application of CSCI



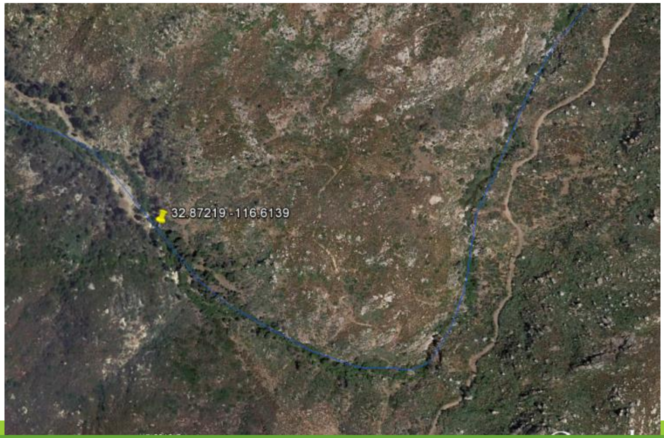
Saxon Creek: Tahoe Basin Urbanized

CSCI = 0.63

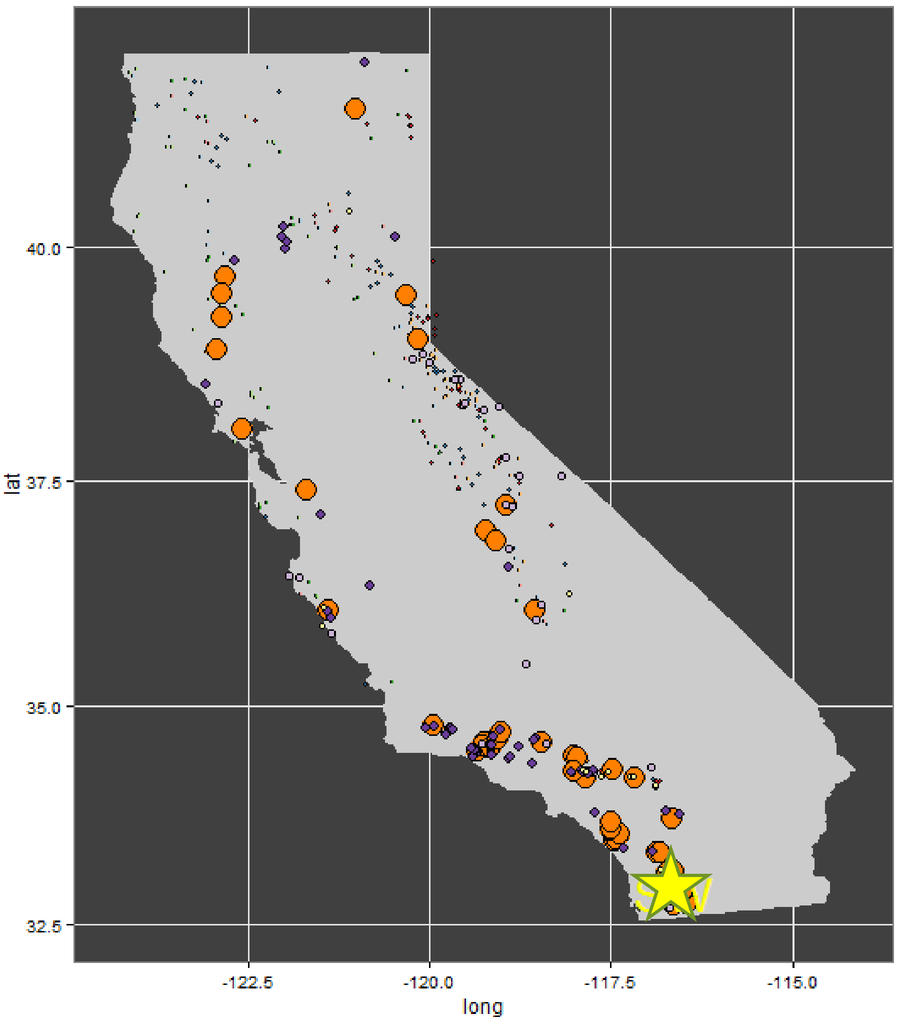


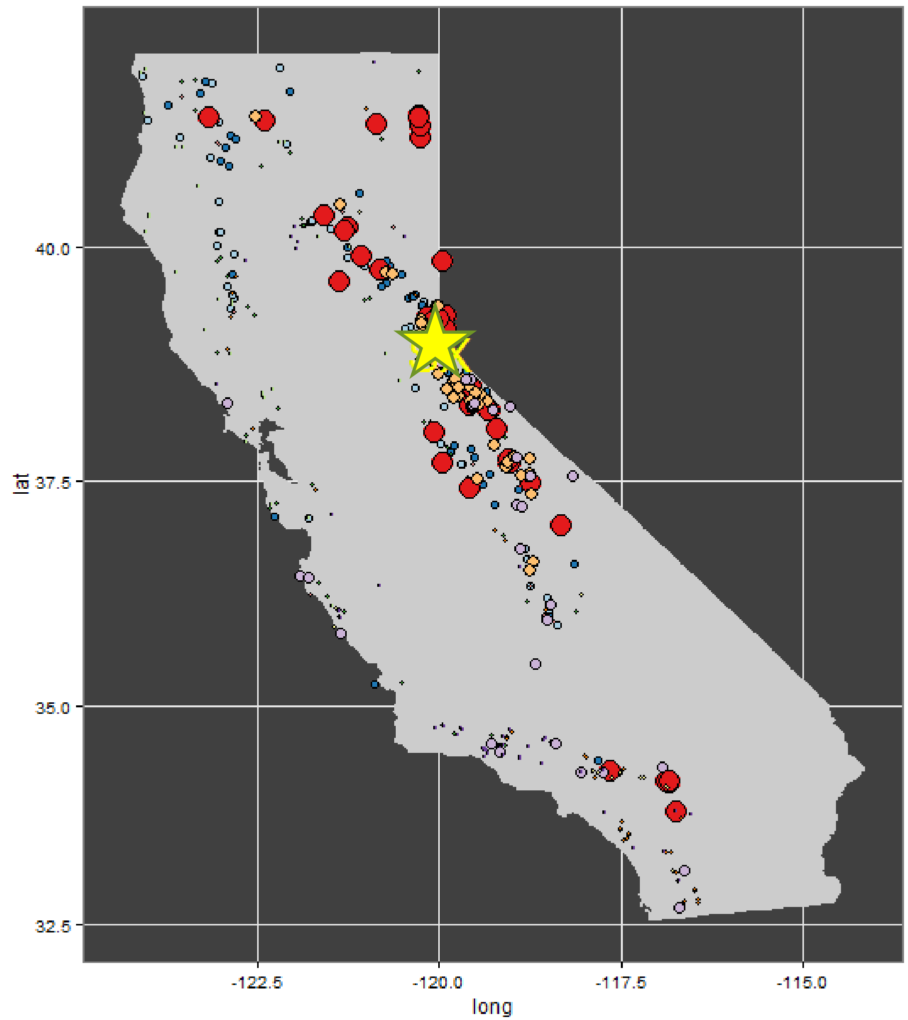
Sweetwater: Socal Xeric Open

CSCI = 1.09



Reference Sites Based on Setting





Taxonomic completeness

Sweetwater

Observed	
Acari	
Baetis	
Chironominae	
Orthocladiinae	
Simulium	
Oligochaeta	
Tanypodinae	

Saxon

Observed	
Acari	
Chironominae	
Cinygmula	
Lepidostoma	
Micrasema	
Orthocladiinae	
Paraleptophlebia	
Simulium	
Sweltsa	
Bezzia	
Oligochaeta	
Tanypodinae	
Zapada	

Far more taxa at Saxon Creek, but…

Taxonomic completeness

Sweetwater

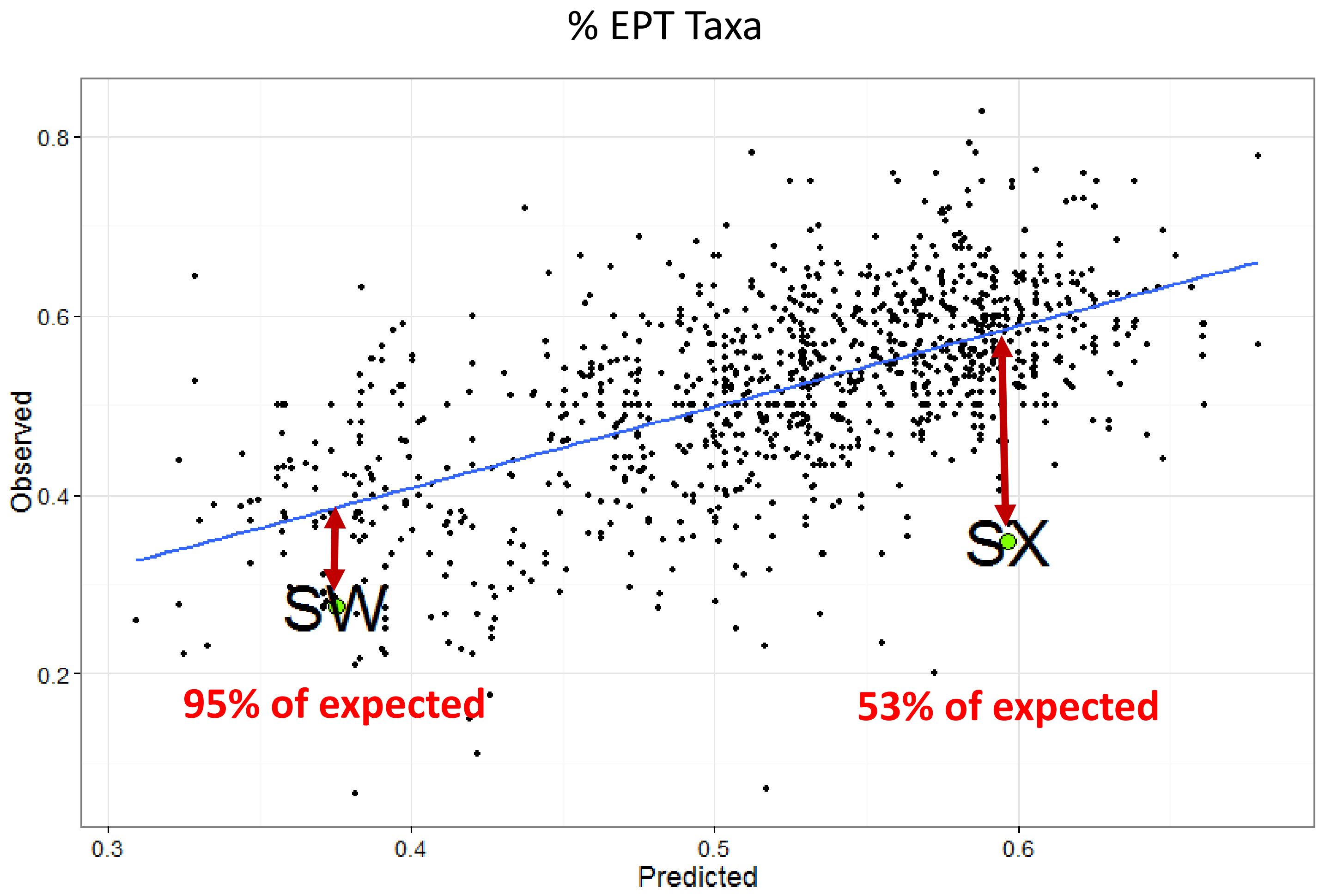
Observed	Missing
Acari	Bezzia
Baetis	
Chironominae	
Orthocladiinae	
Simulium	
Oligochaeta	
Tanypodinae	

Saxon

Observed	Missing
Acari	Baetis
Chironominae	Drunella
Cinygmula	Malenka
Lepidostoma	Rhyacophila
Micrasema	Turbellaria
Orthocladiinae	Yoraperla
Paraleptophlebia	Epeorus
Simulium	
Sweltsa	
Bezzia	
Oligochaeta	
Tanypodinae	
Zapada	

Lots of taxa missing at Saxon creek

Ecological structure



Most metrics "better" at Saxon Creek, but much further from expectations

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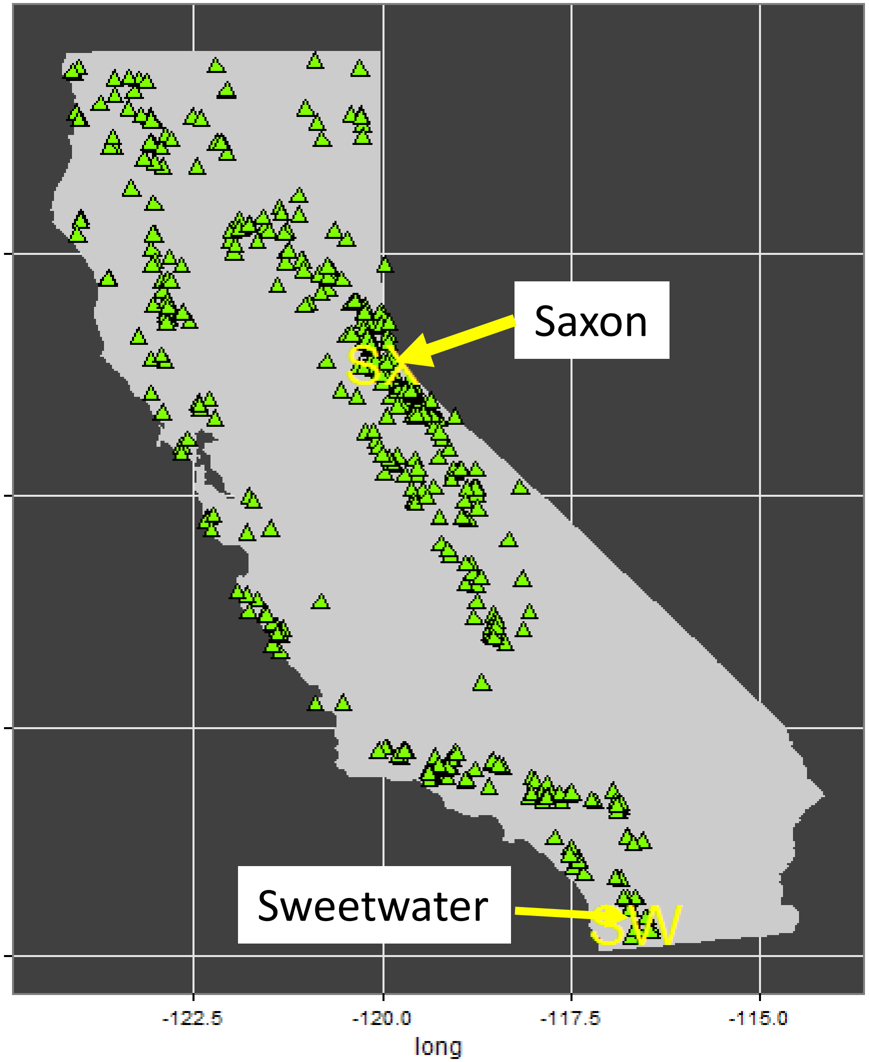
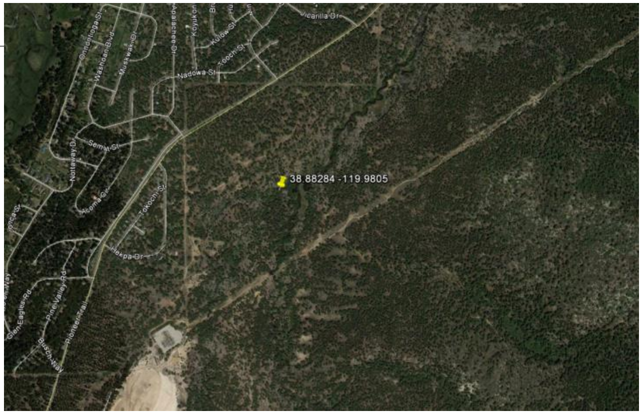


Saxon Creek: Tahoe Basin Urbanized

CSCI = 0.63



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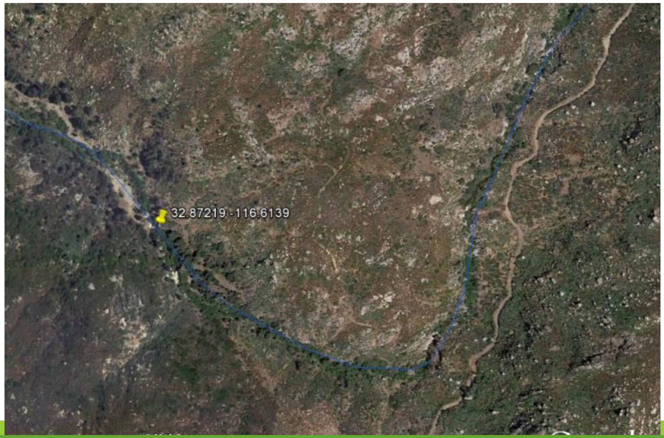
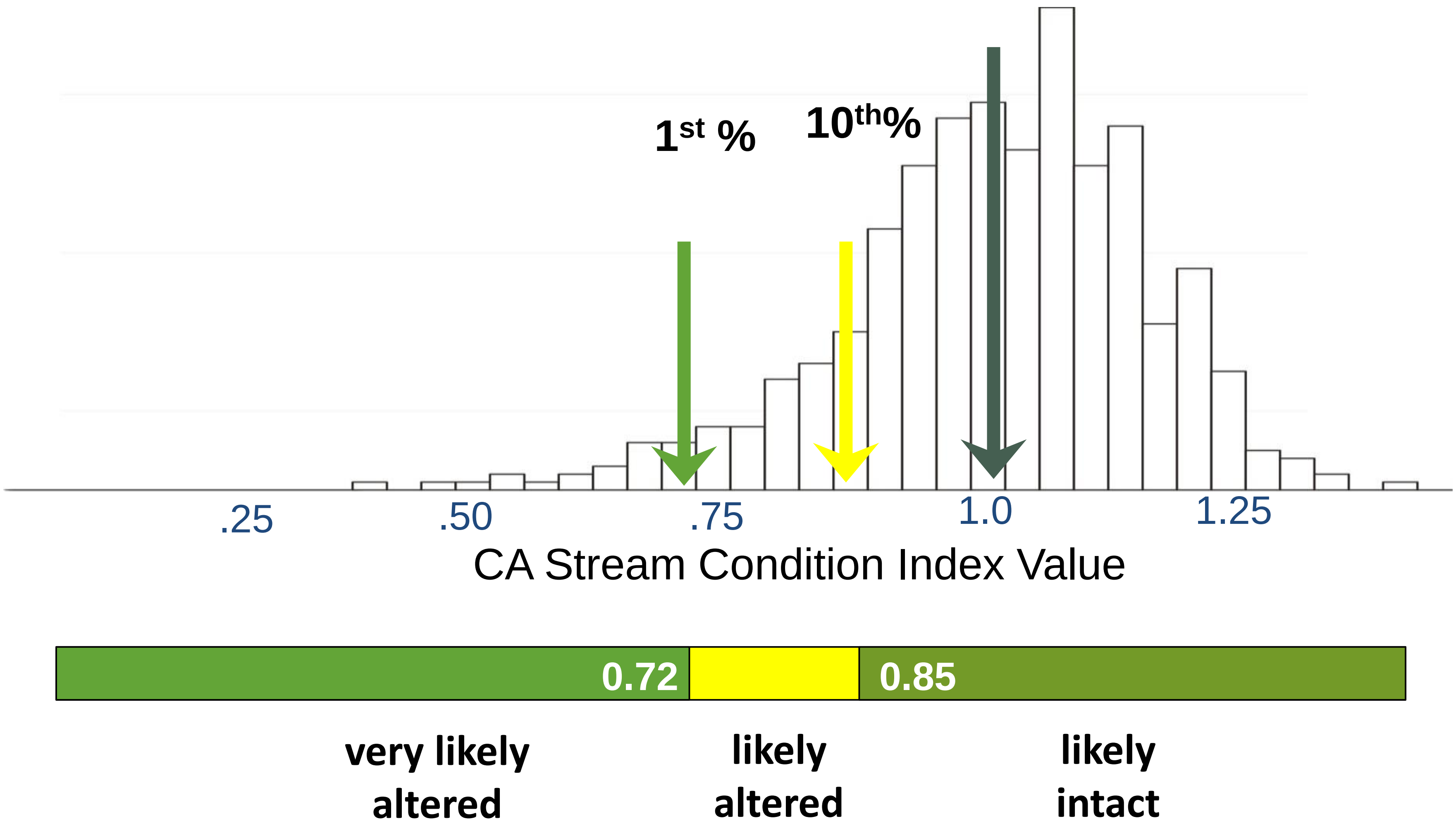
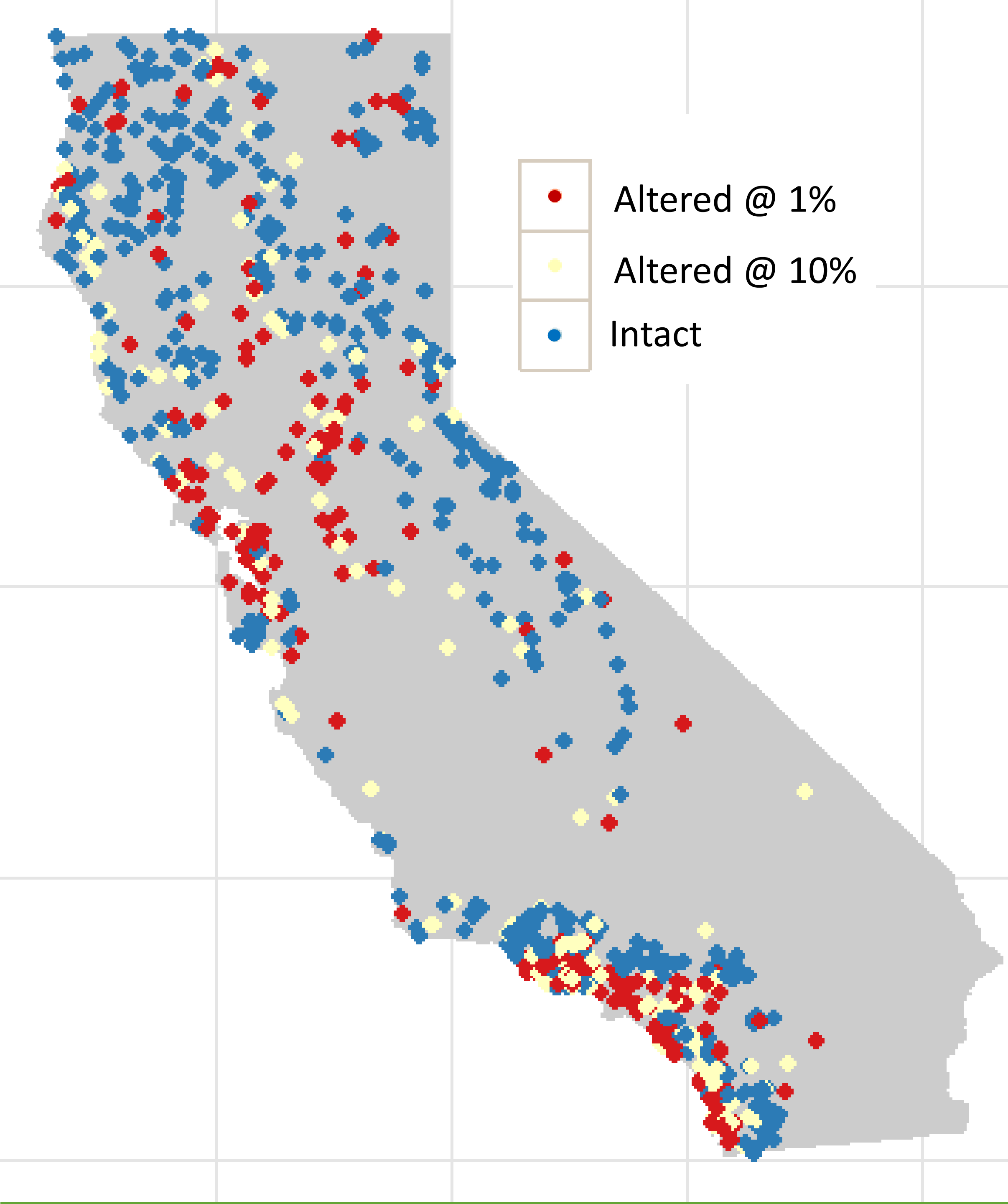
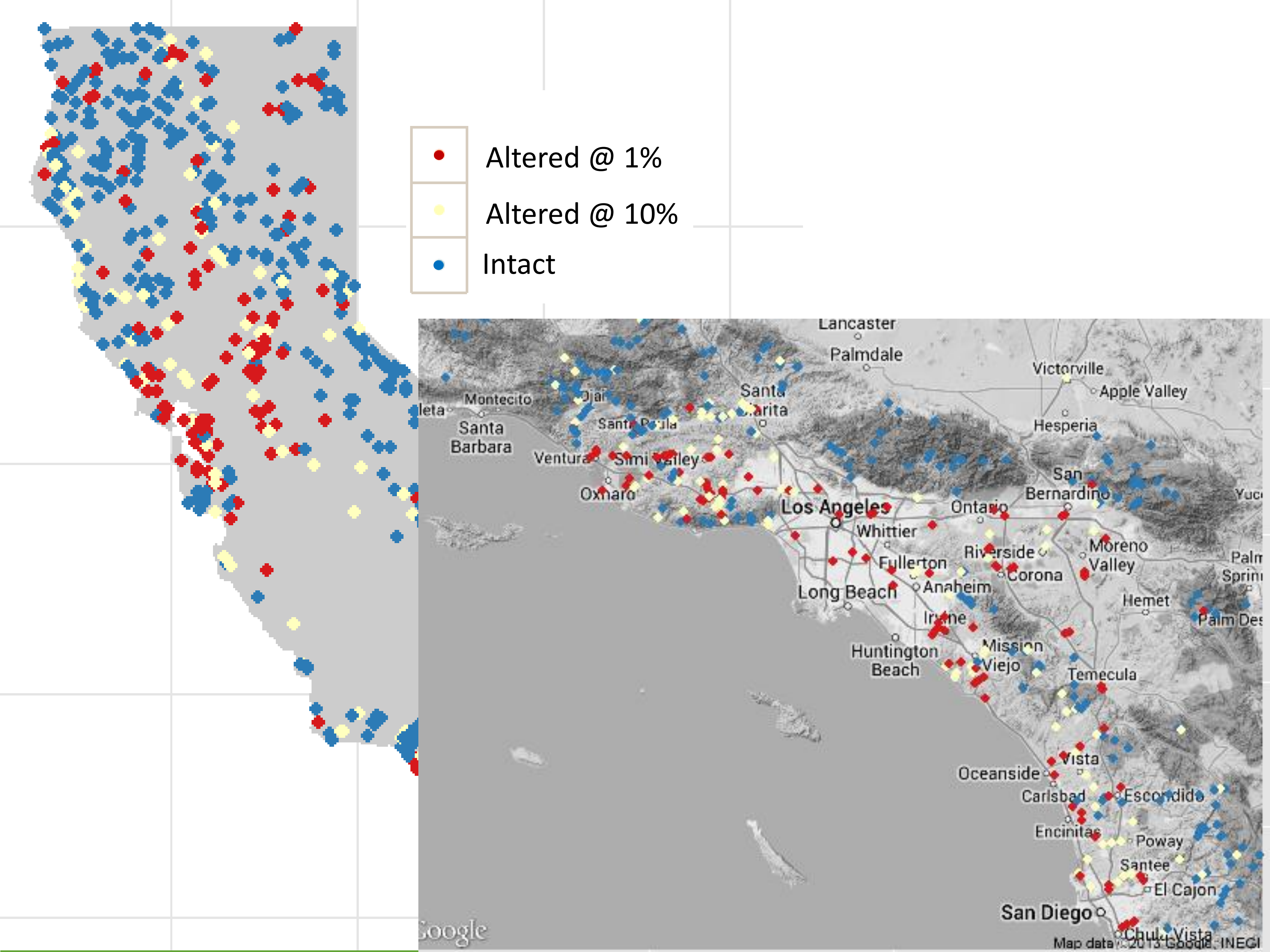


Setting Thresholds




Altered @ 1%
Altered @ 10%
Intact



Altered @ 1%
Altered @ 10%
Intact
Lancaster
Palmdale
Victorville
Apple Valley
Hesperia
Montecito
Santa Barbara
Ventura
Oxnard
Simi Valley
Santa Paula
Los Angeles
Whittier
Ontario
San Bernardino
Riverside
Moreno Valley
Corona
Fullerton
Anaheim
Long Beach
Irvine
Hemet
Huntington Beach
Mission Viejo
Temecula
Vista
Oceanside
Carlsbad
Escondido
Encinitas
Poway
Santee
El Cajon
San Diego
Google

What About Channelized Streams?

Scoring Tool Conclusions and Future Efforts

- State has a new scoring tool for use in implementing bio-objectives
  - Predictive approach allows sites to be judged against site-specific expectations
  - Can be applied with a consistent interpretation statewide

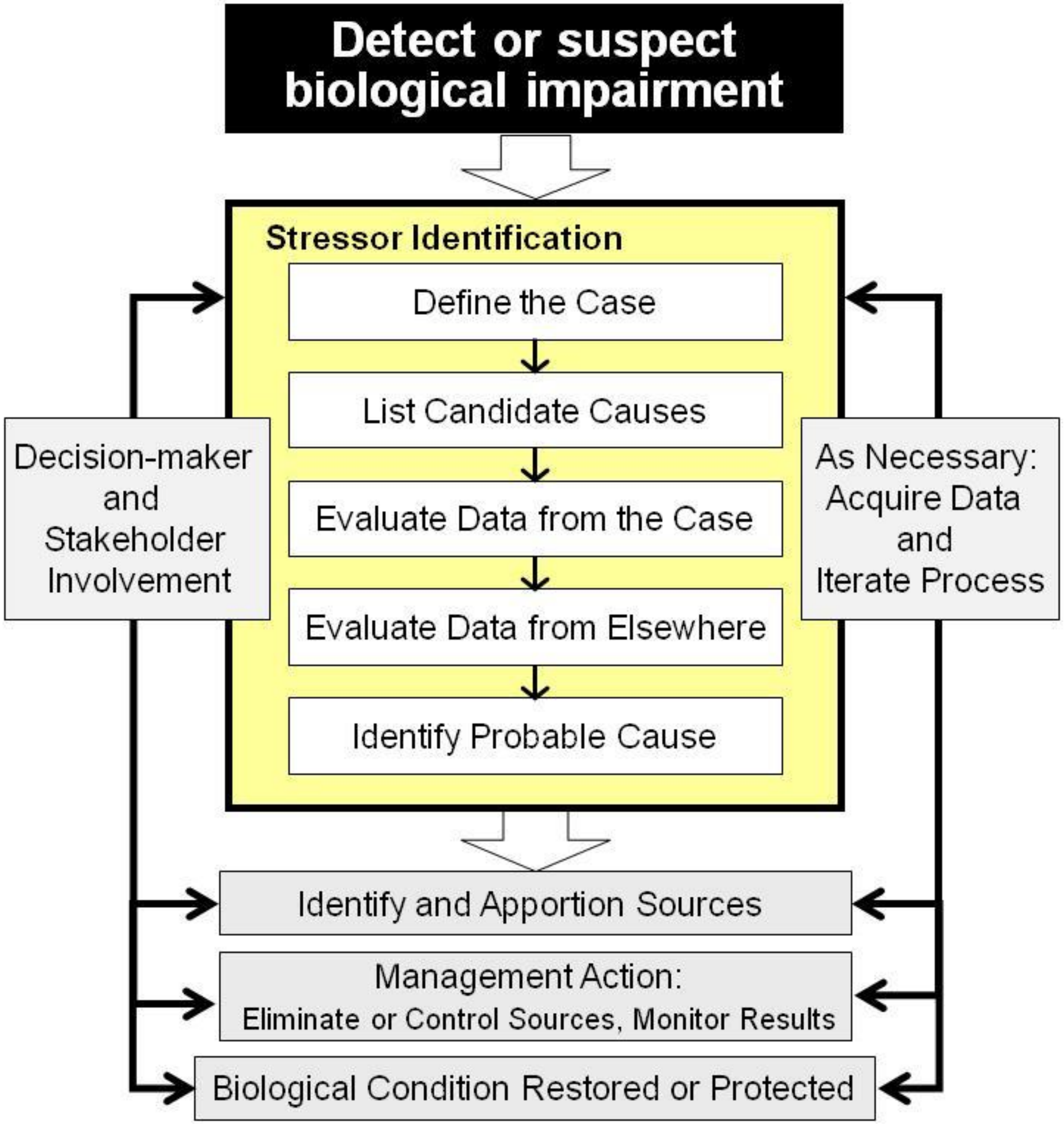
- Through policy development, additional issues need to be addressed:
  - Setting thresholds
  - How to deal with special class streams
    - *Streams with few appropriate ref sites (e.g., Central Valley floor streams)*
    - *Streams unlikely to achieve reference condition (e.g., permanently channelized streams)*

- Need to develop support tools to ease/automate calculation of CSCI

- Establishing Reference Conditions
- Developing the CSCI Scoring Tool
- **Stressor Identification**

Stressor Identification

- What's causing my site to be out of compliance?
- US EPA has a framework developed for stressor identification
  - www.epa.gov/CADDIS
  - Not vetted in California
- Our goal was to test CADDIS in four California case studies
  - Write an Evaluation and Guidance Manual



Causal
Assessment
Diagnostic
Decision
Information
System

The Five Steps

- Define the case
- List candidate causes
- Evaluate data from the case
- Evaluate data from outside the case
- Identify probable causes
  - Refute causes

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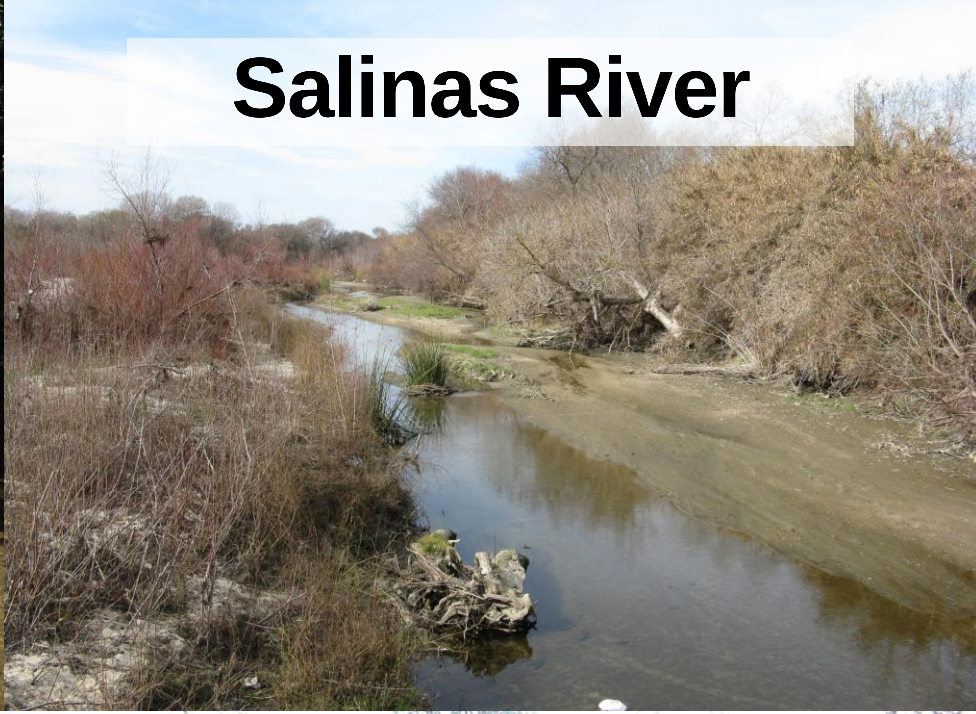
Garcia River

Salinas River

Santa Clara River

San Diego River

The Five Steps

- Define the case
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- Evaluate data from outside the case
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CUMULATIVE LIST OF CANDIDATE CAUSES

- Flow alteration
- Physical habitat loss or alteration
- Temperature
- Dissolved oxygen
- Conductivity, TDS
- Sediment
- Nutrients
- Trace metals
- Pesticides
- PAHs
- Invasive species

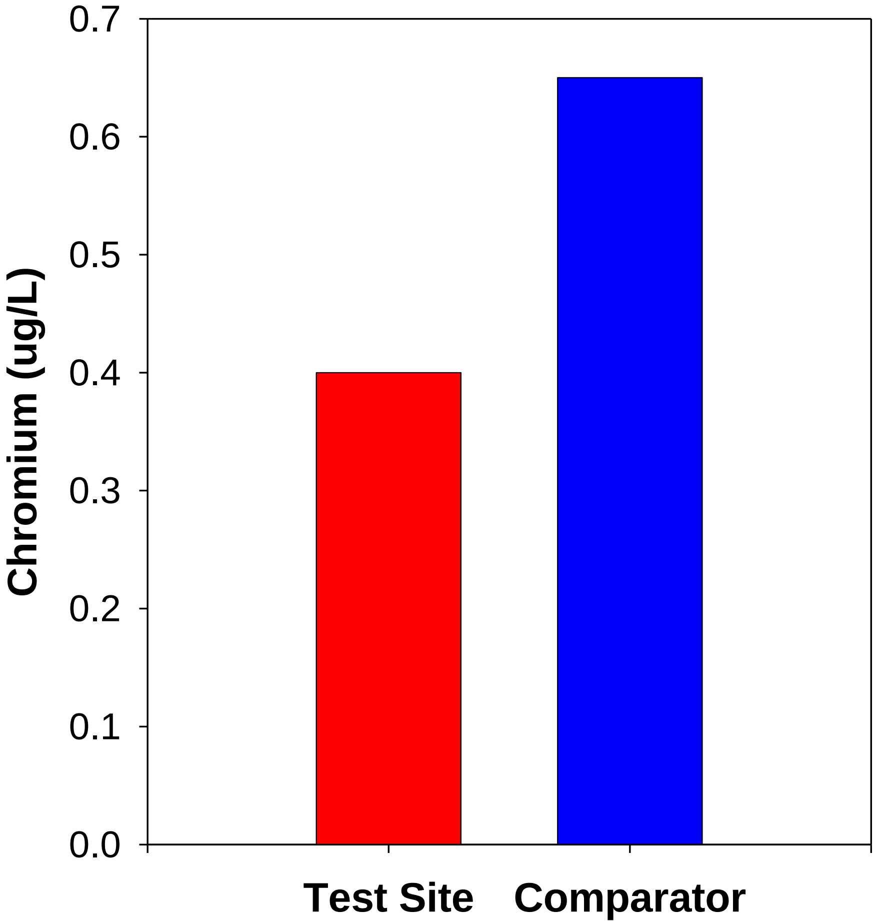
The Five Steps

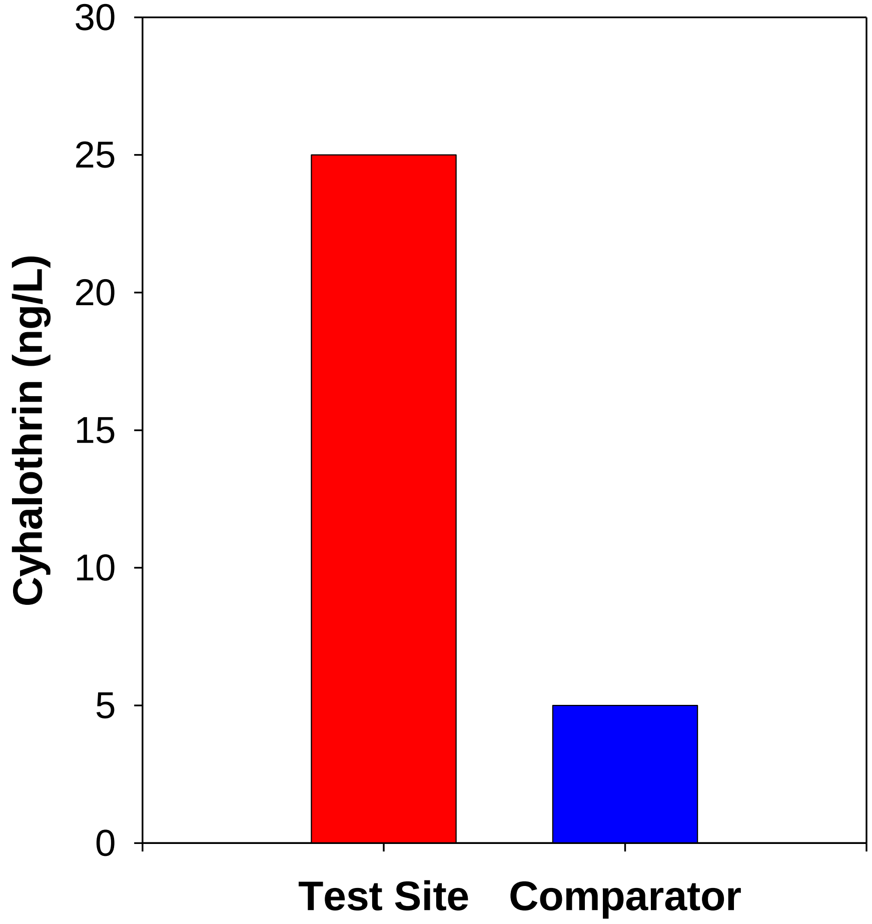
- Define the case
- List candidate causes
- **Evaluate data from the case**
- Evaluate data from outside the case
- Identify probable causes
  - Refute causes

TYPES OF EVIDENCE

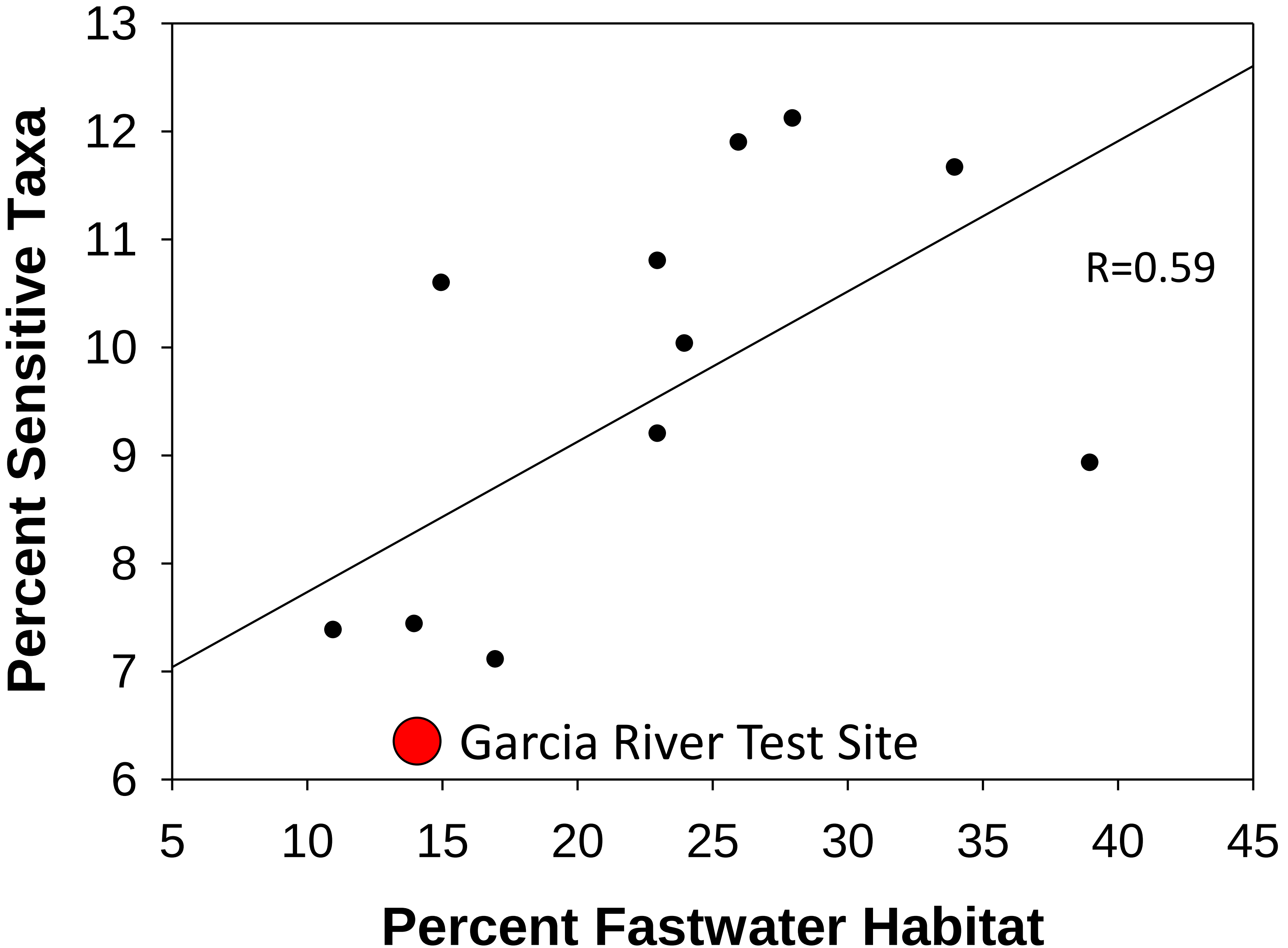
- Spatial/temporal co-occurrence
- Exposure
- Biological mechanism
- Field based stress-response relationship
- Casual pathway
- Manipulation of exposure
- Laboratory tests of site media
- Temporal sequence
- Verified predictions
- Symptoms

Spatial-Temporal Co-Occurrence: San Diego River





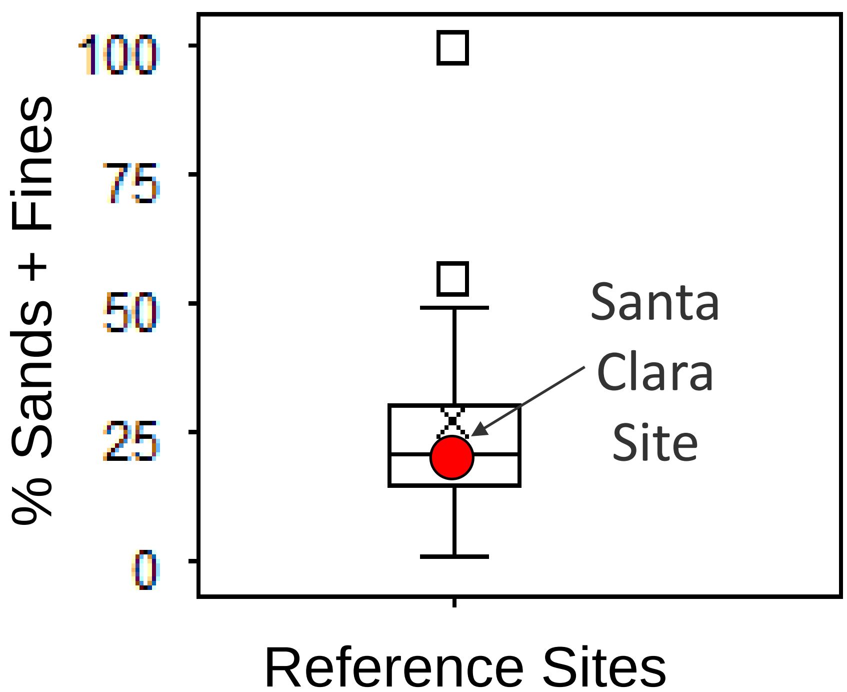
Stressor-Response from the Field: Garcia River

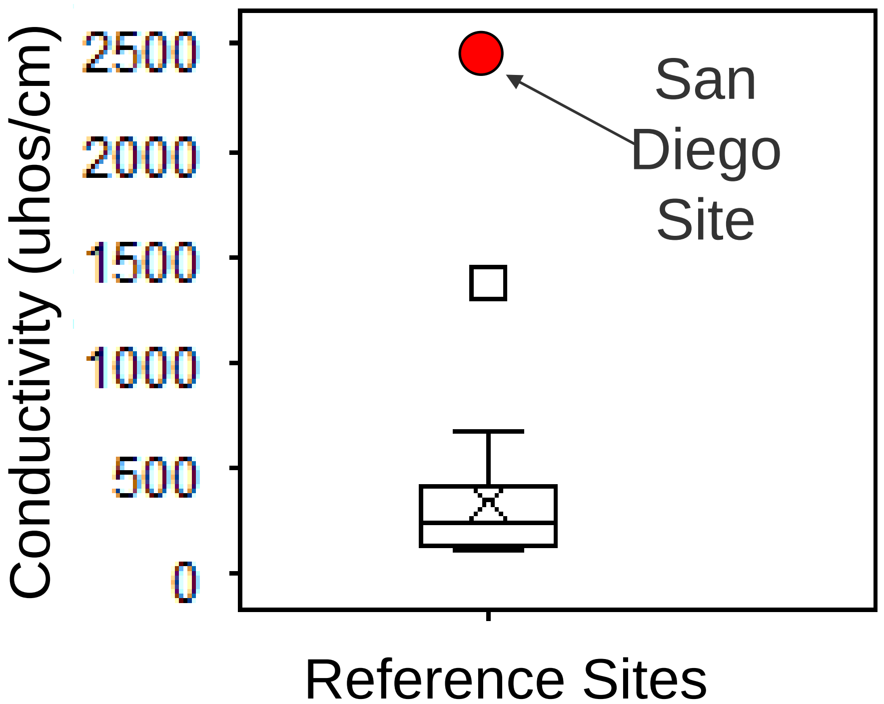


The Five Steps

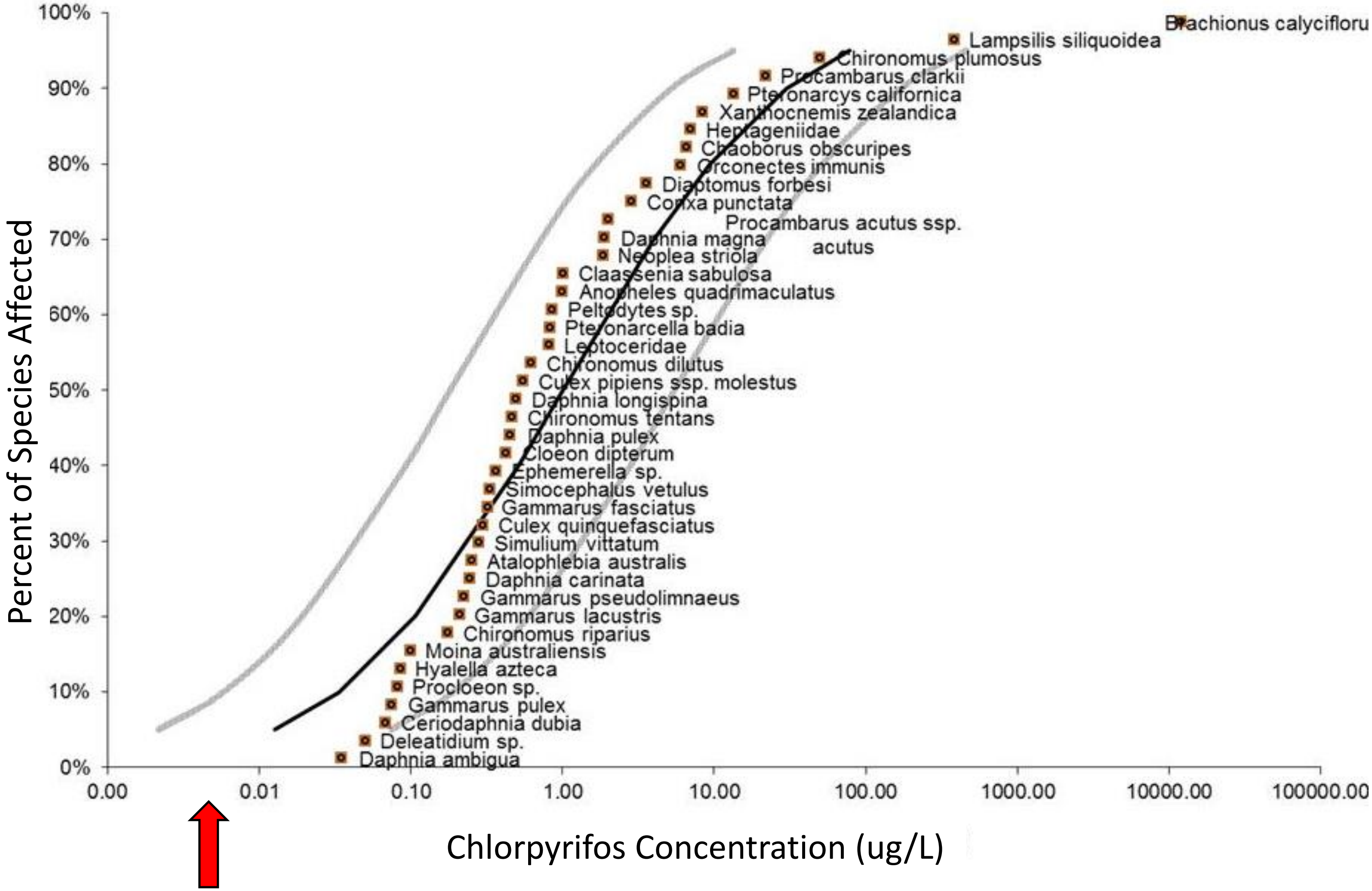
- Define the case
- List candidate causes
- Evaluate data from the case
- Evaluate data from outside the case
- Identify probable causes
  - Refute causes

Co-Occurrence from Outside the Case: Santa Clara and San Diego Rivers





Species Sensitivity Distributions



Max Concentration at Salinas River Test Site

CADDIS Works, but It Isn't Perfect

- CADDIS strengths
  - Already built and documented
  - Adept at ruling out causes
  - Wonderful communication tool

- CADDIS weaknesses
  - Nonpoint, cumulative stressors are difficult to diagnose
  - Challenges to find appropriate comparator sites
  - Uncertainty is problematic for decision making

- Because of California's unique issues, implementing recommendations will be important

Guidance Manual Recommendations

- Take advantage of our large statewide data set for comparator site selection
  - Can be automated

- Reduce uncertainty by creating new data analysis tools
  - Will streamline analysis increasing speed and decreasing cost

- Post-identification steps need similar guidance

Questions