Setting flow targets to maintain ecological health in the face of flow alteration

PRESENTATION TO WRPI

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Measuring ecological health

Bioassessment: The use of biological organisms (e.g., aquatic insects) to assess the health of a stream

Diverse life histories -> Integrate impacts of all stressors affecting a stream (across time and space)

Directly relevant to management goals

Biological integrity assessment vs. biological resource assessment

Different goals for managing streams

Resource goals:

- Maintenance of productive habitat
- Stable populations of threatened species
- Sustainable fisheries

Bio-integrity goals:

- Natural balance of native species
- Expected levels of diversity
- Maintenance of ecosystem functions

We need to focus on both biological resources and integrity!

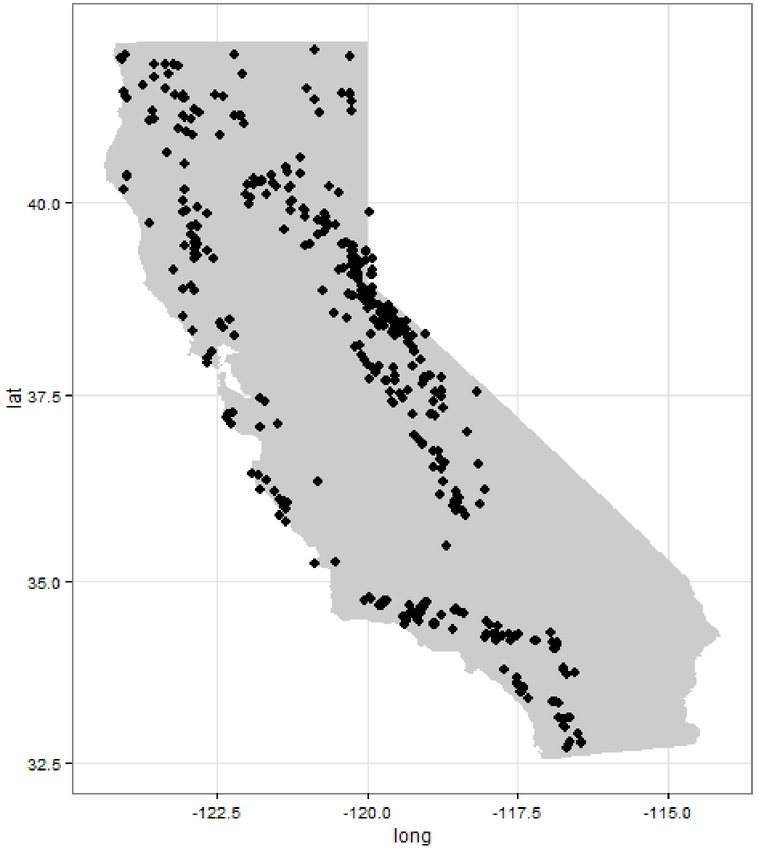
- It provides a more complete picture of ecological health
- It is applicable, even where typical resources are irrelevant
- It is mandated in policy (e.g., Porter-Cologne, Clean Water Act)

- Goals are usually—*but not always*—complementary
- Need to know about tradeoffs

Tools to measure biological integrity

California Stream Condition Index:

A predictive tool that compares observed benthic macroinvertebrate community composition to composition expected at similar undisturbed sites



Taxonomic completeness

- Are all expected taxa present?

Ecological structure

- Are structural measures (e.g., Shannon diversity, predator richness) similar to expectations?

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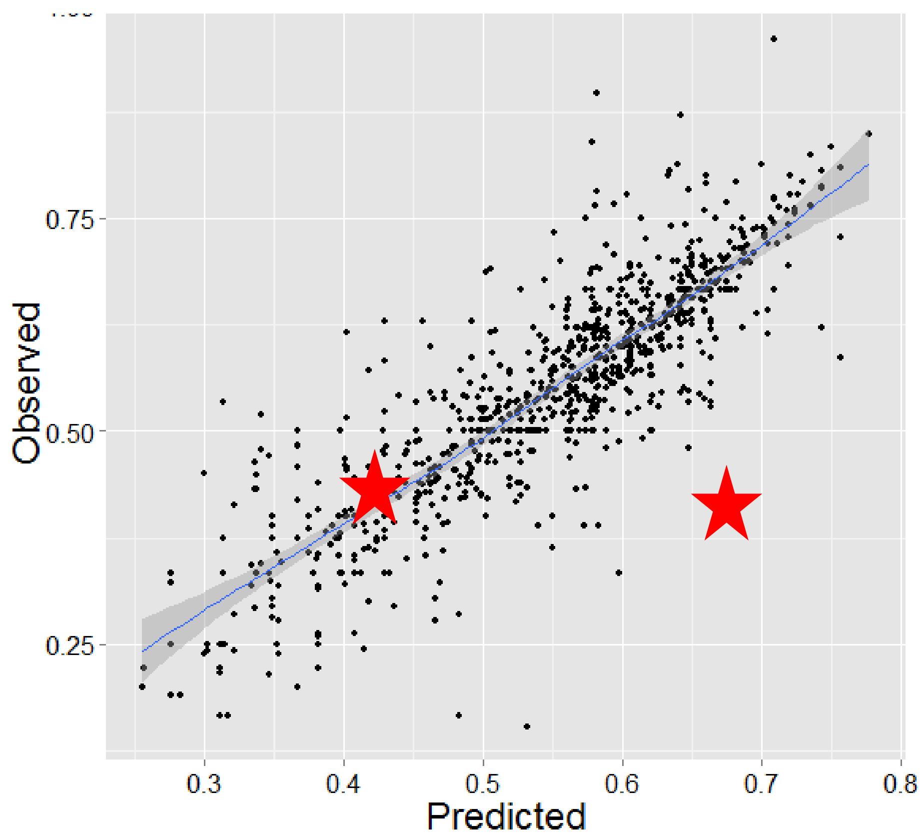


Bioassessment in Southern California

Stormwater Monitoring Coalition:

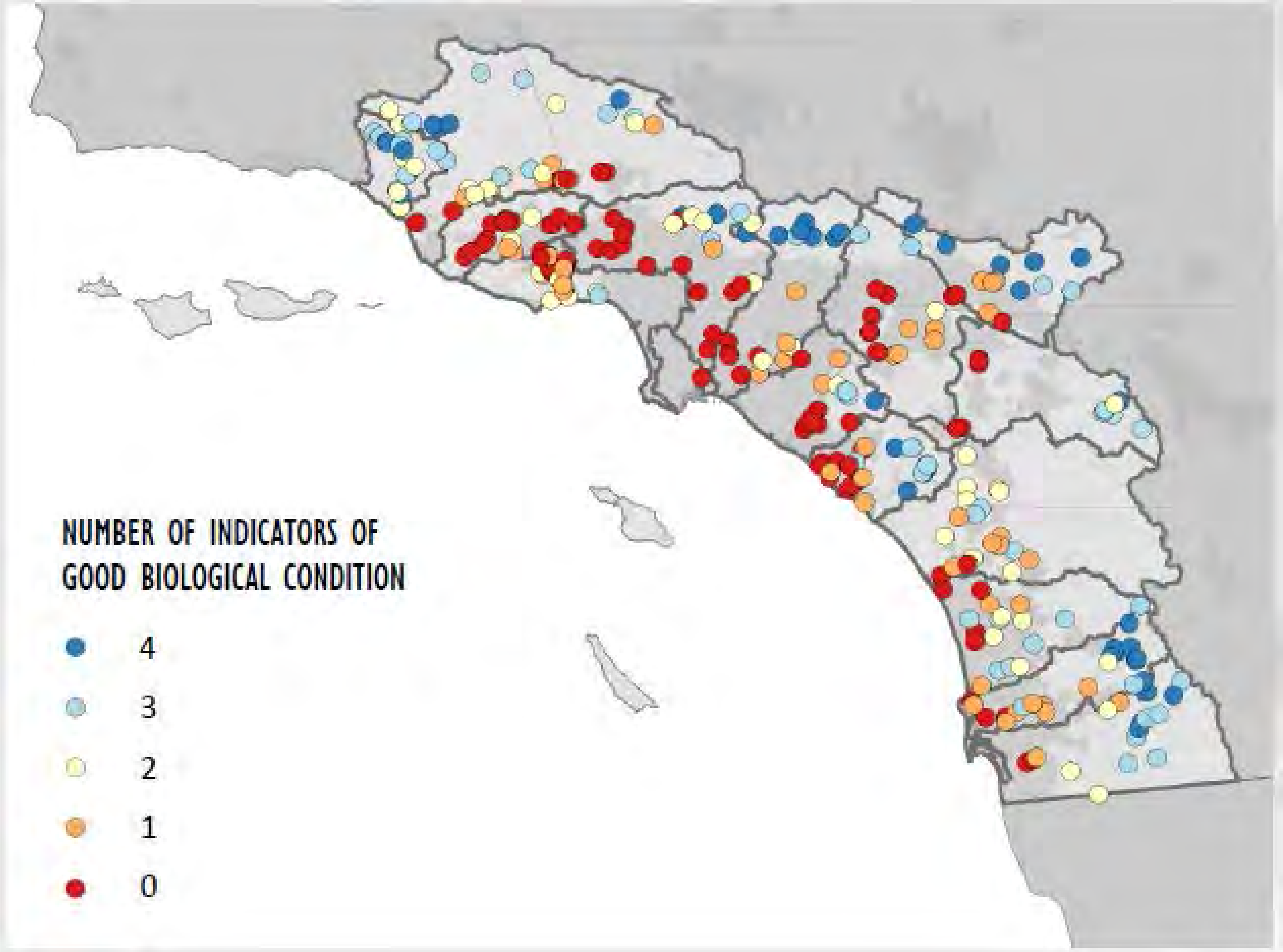
Collaborative monitoring by dischargers and regulators since 2009

~60-90 sites per year (800+ so far)

~Broad array of biological indicators, plus habitat and chemistry

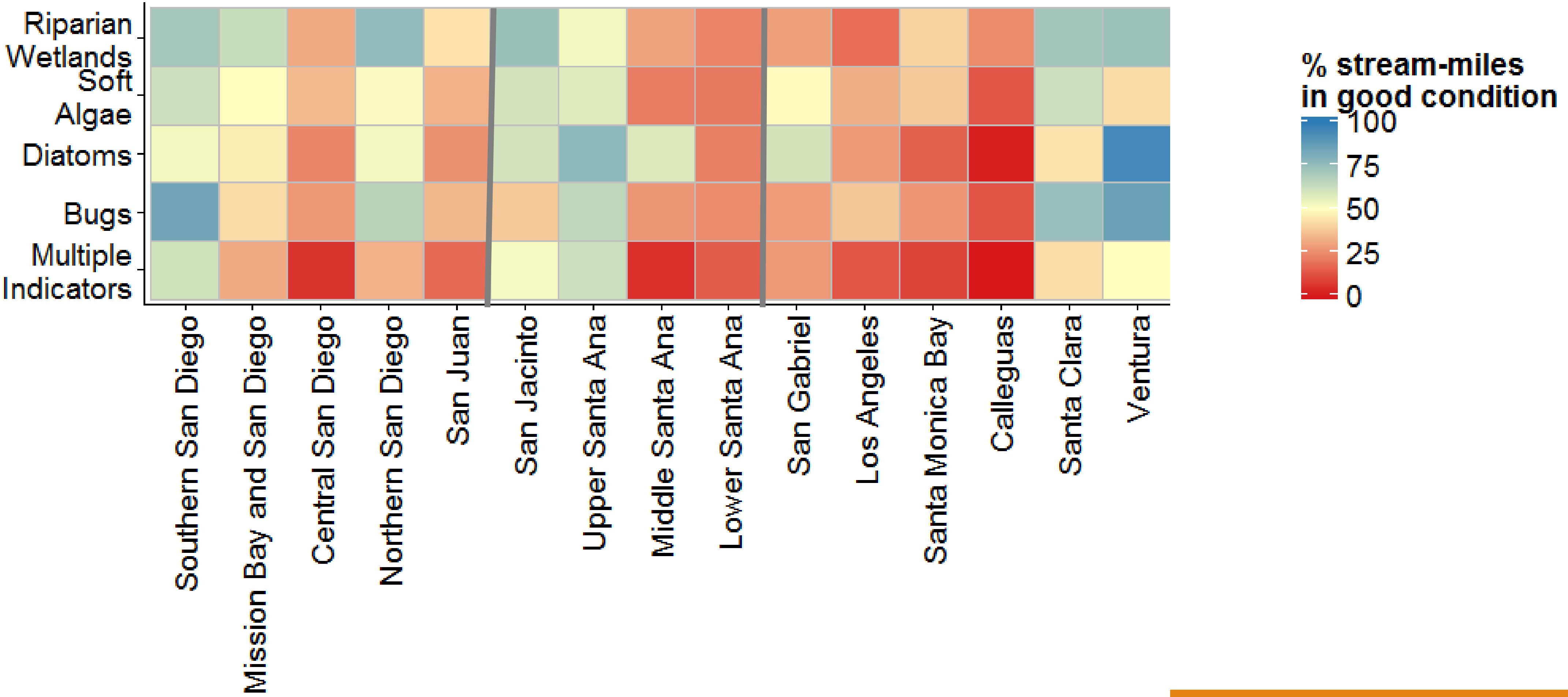
Key questions:

1. What is the extent of healthy streams?
2. What stressors are associated with poor conditions?
3. Are conditions changing over time?



NUMBER OF INDICATORS OF
GOOD BIOLOGICAL CONDITION
4
3
2
1
0

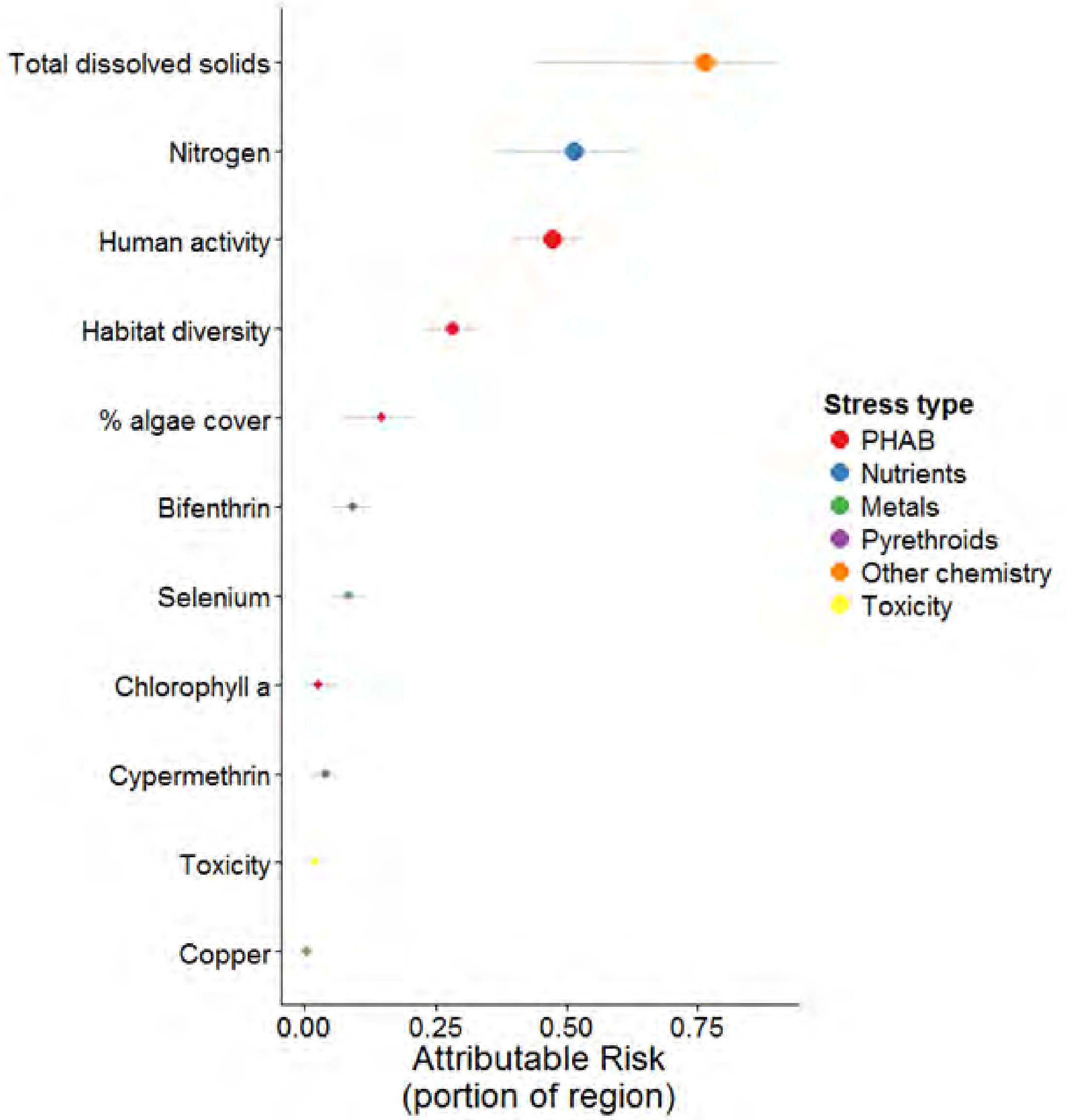
Healthy streams are more extensive in some areas than in others



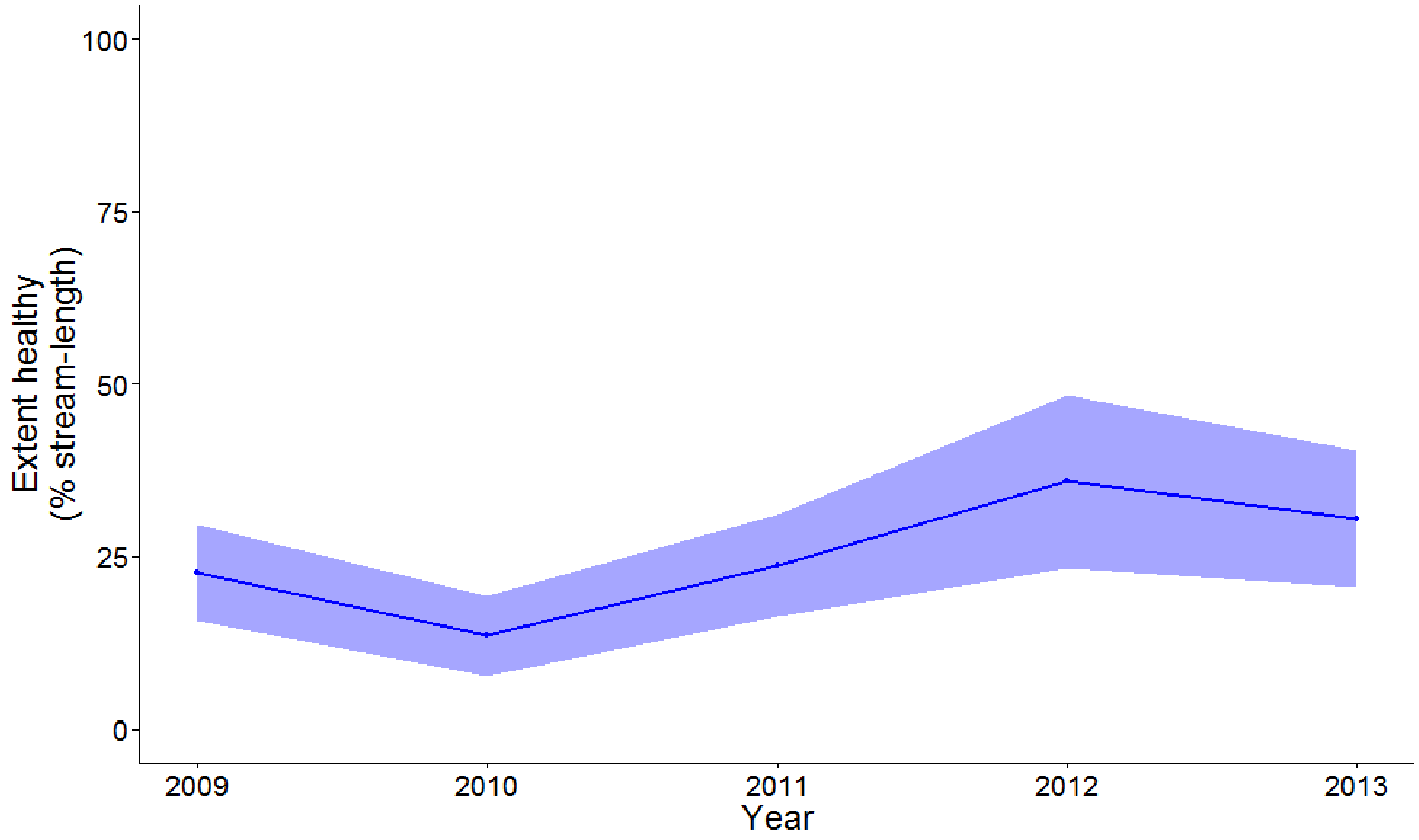
Prioritizing stressors

- Nutrients
- Major ions
- Degraded habit

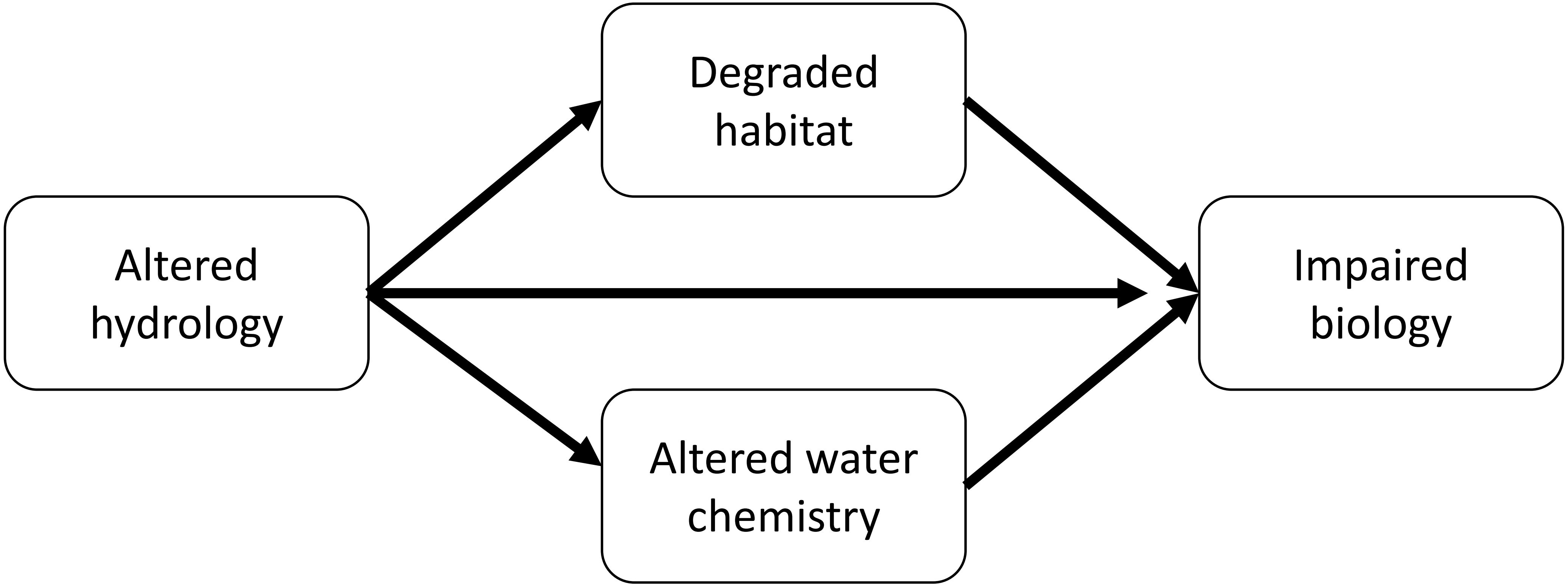
Metals, toxicity, pyrethroids were limited, or weakly associated with biological condition.



No obvious trends over time



Hydrology is an integrative driver



How can you set targets for flow?

Relate biological alteration (ΔB) to hydrologic alteration (ΔH)

We have tools to measure ΔB

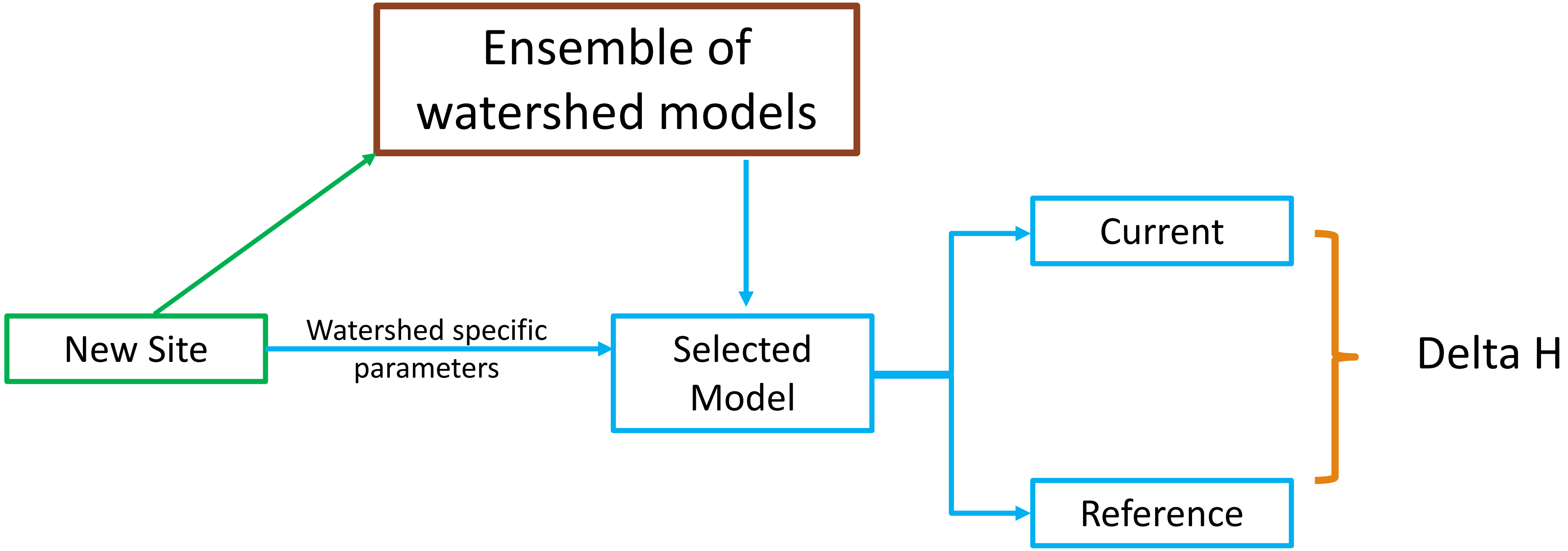
- California Stream Condition Index (CSCI) and its components express ΔB as difference between observed and expected (i.e., reference) biology
- Future expansion to algae indices, other bug metrics

Harder to measure ΔH, especially at ungauged sites

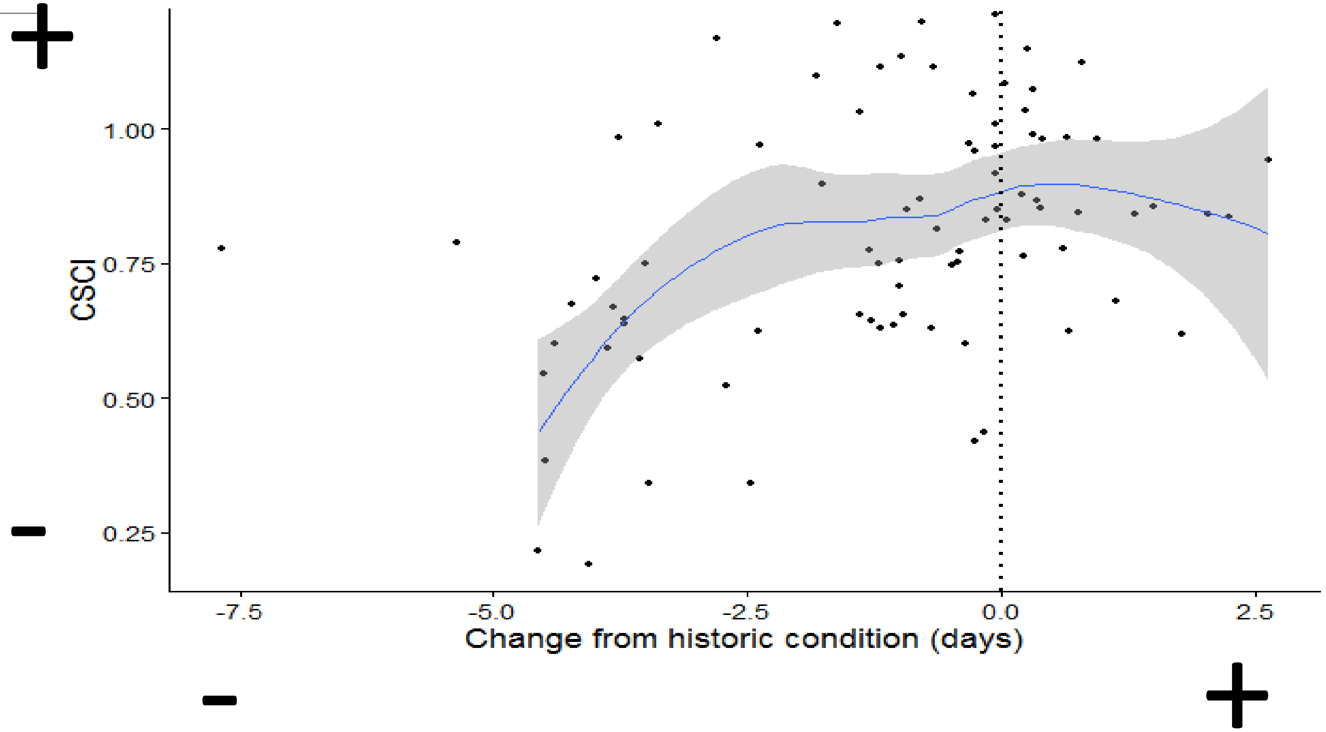
- How do you know current hydrology?
- How do you know reference hydrology?
- How do you characterize biologically relevant aspects of the hydrograph?

Predicting flows and alteration at ungaged locations

Assumption: Certain catchment and hydrologic parameters can transfer to other catchments given adequate similarities.



Relating hydrology to biology



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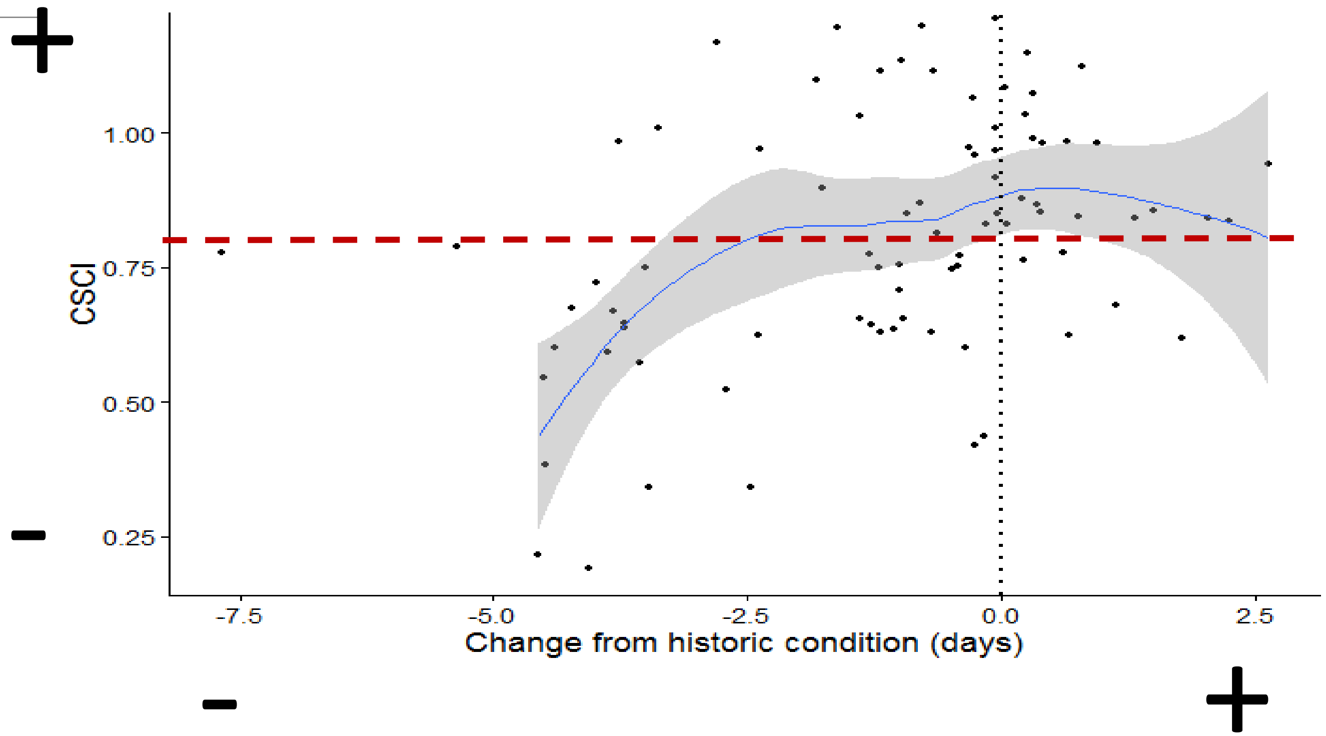

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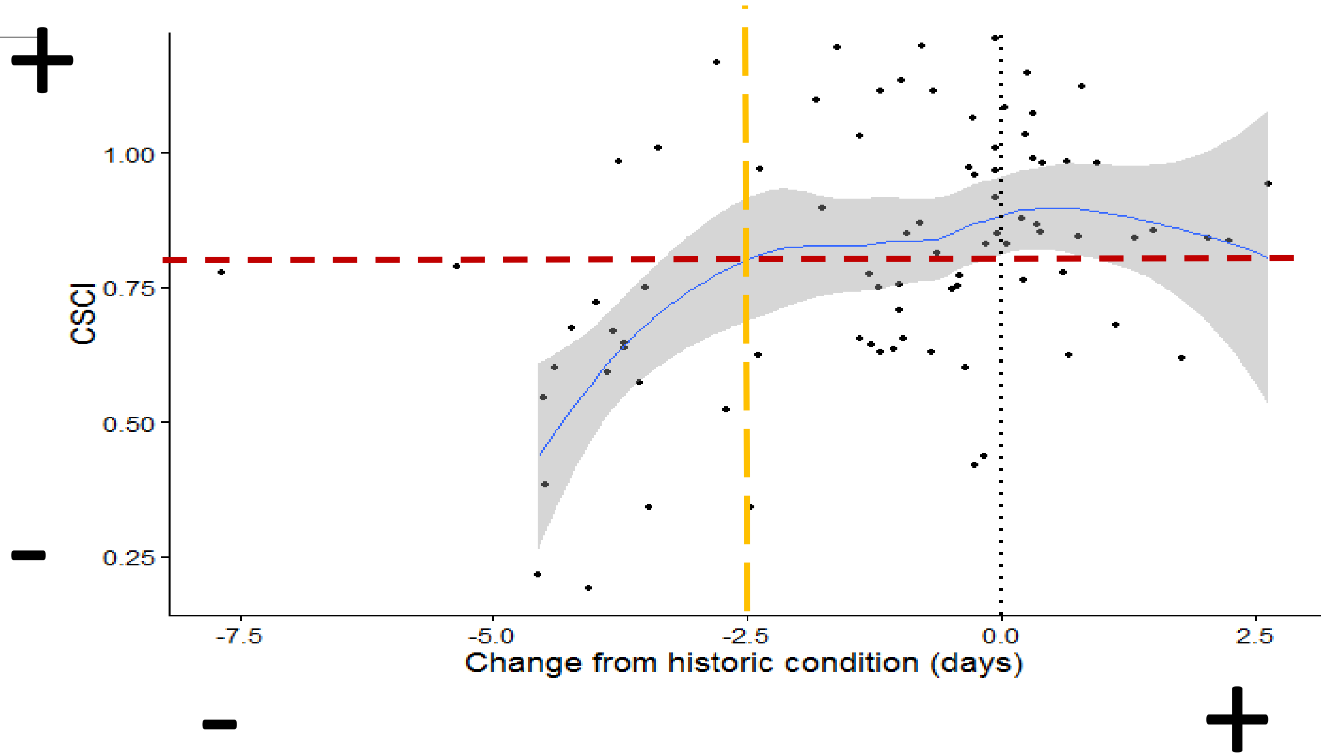
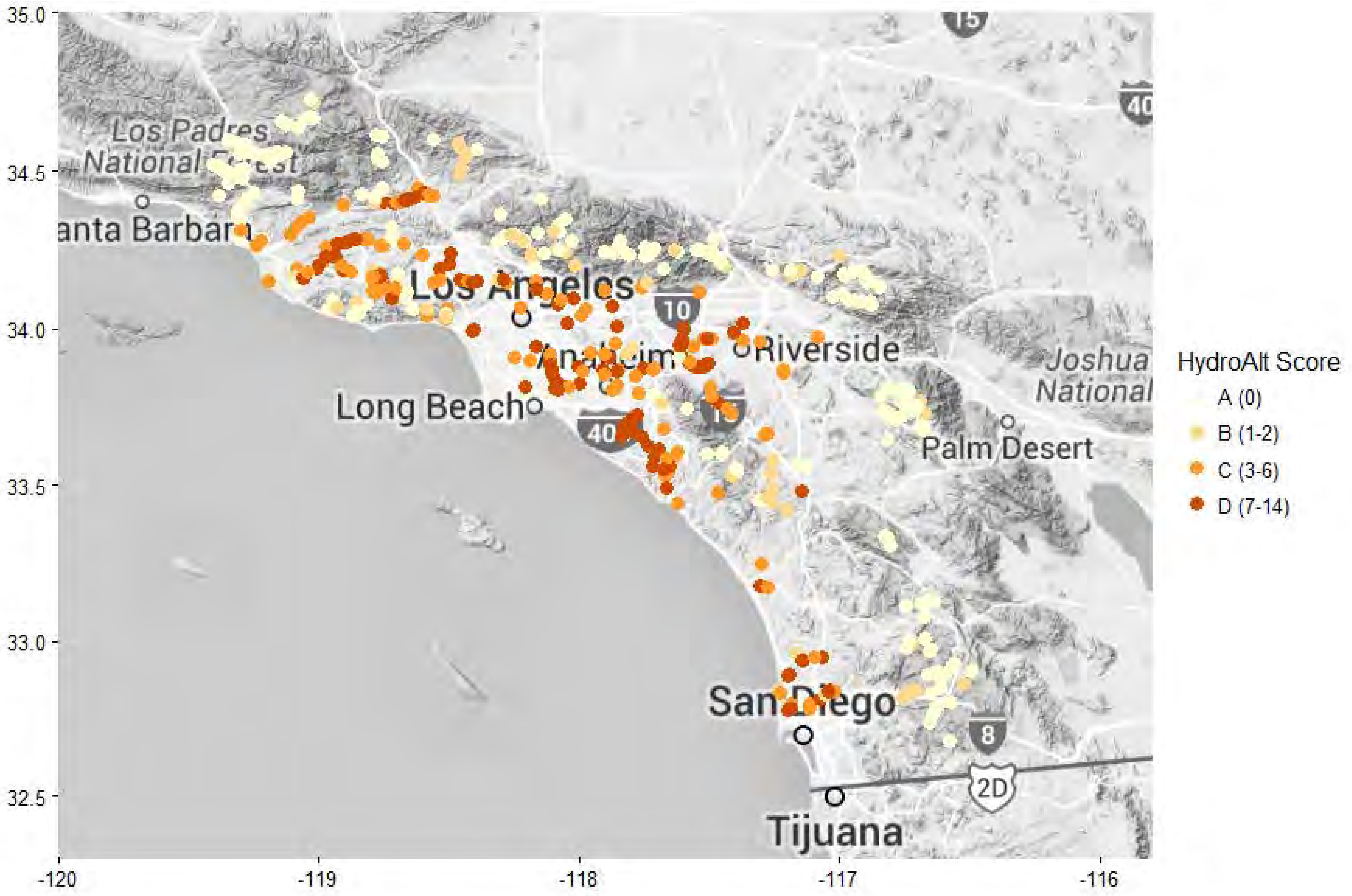
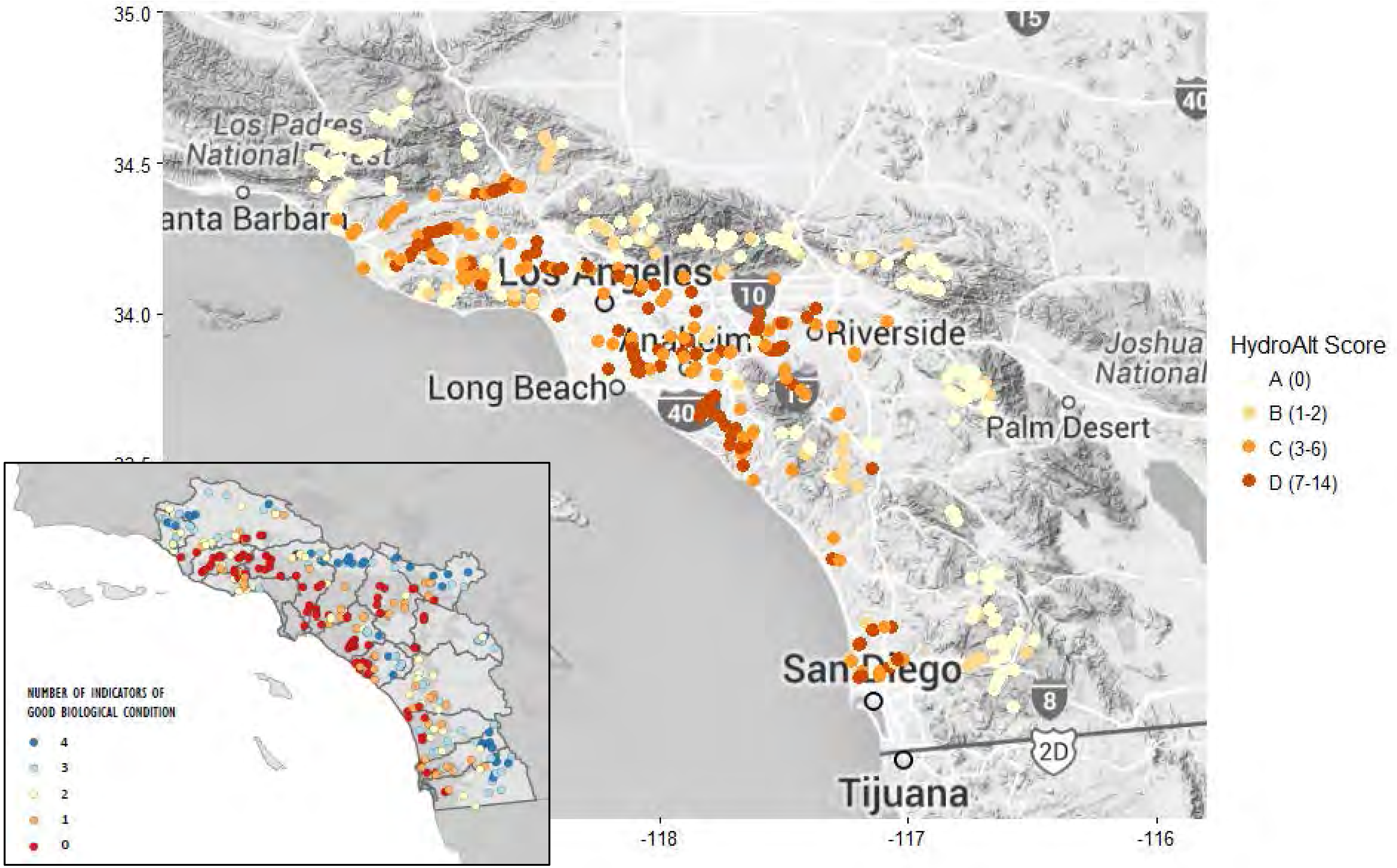


Hydrologic alteration index

- Pick metrics based on importance in BRT models to predict biological response (passing/failing CSCI score)
- Select no more than 2 metrics in each class
- Simple scoring: 0: Meets target. 1: Fails target. 2: Fails target by twice the amount.
- Sum of scores:
    A. 0 points. Unaltered
    B. 1 to 2. Mild alteration
    C. 3 to 6. Moderate alteration
    D. 7 to 14. Severe alteration



HydroAlt Score
A (0)
B (1-2)
C (3-6)
D (7-14)
35.0
34.5
34.0
33.5
33.0
32.5
-120
-119
-118
-117
-116
Los Padres National Forest
anta Barbara
Los Angeles
Anaheim
Riverside
Long Beach
Palm Desert
Joshua National
San Diego
Tijuana



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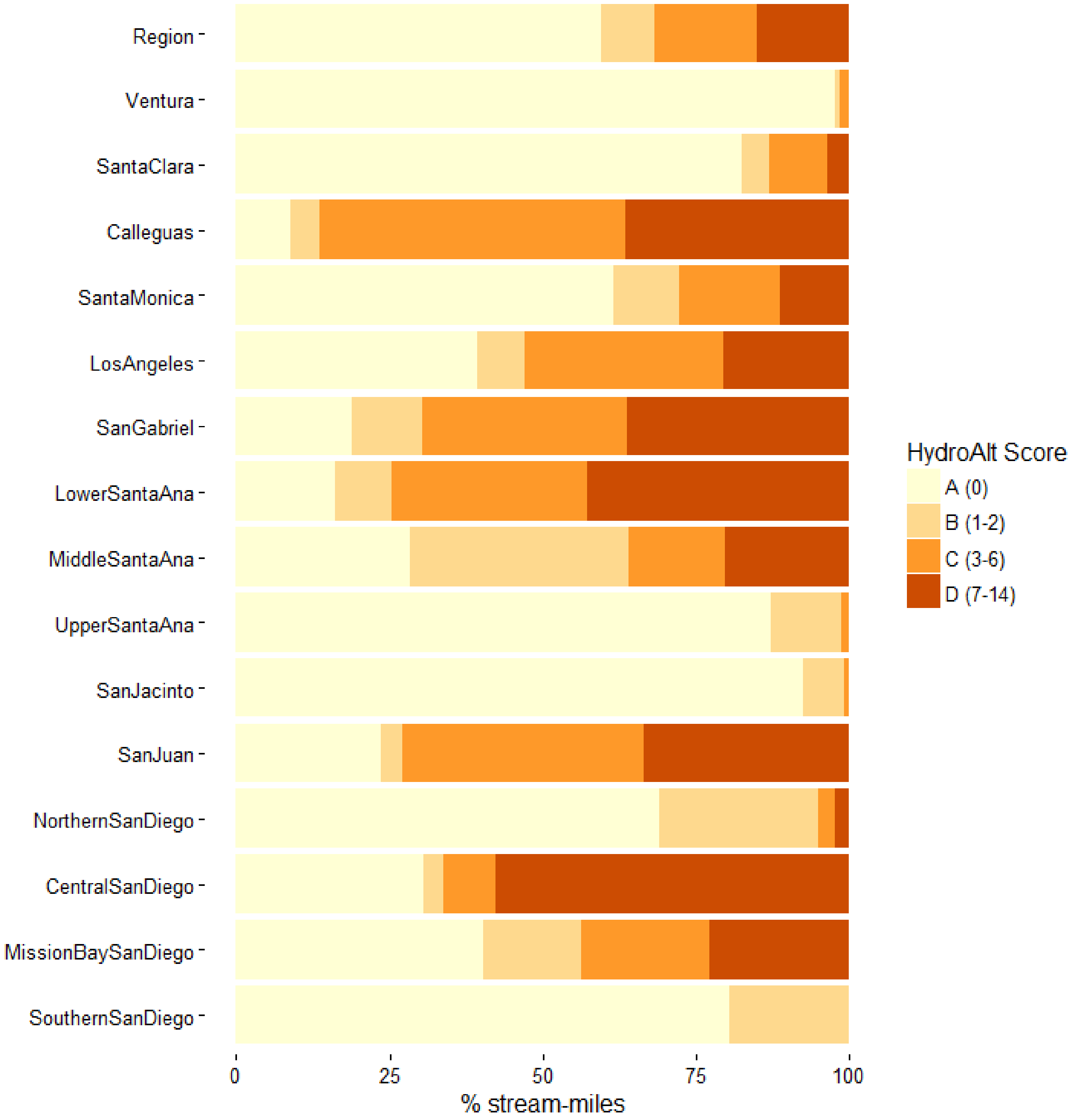
Where are unaltered streams extensive?

Land Use	% Class A
Ag	20
Open	82
Urban	6



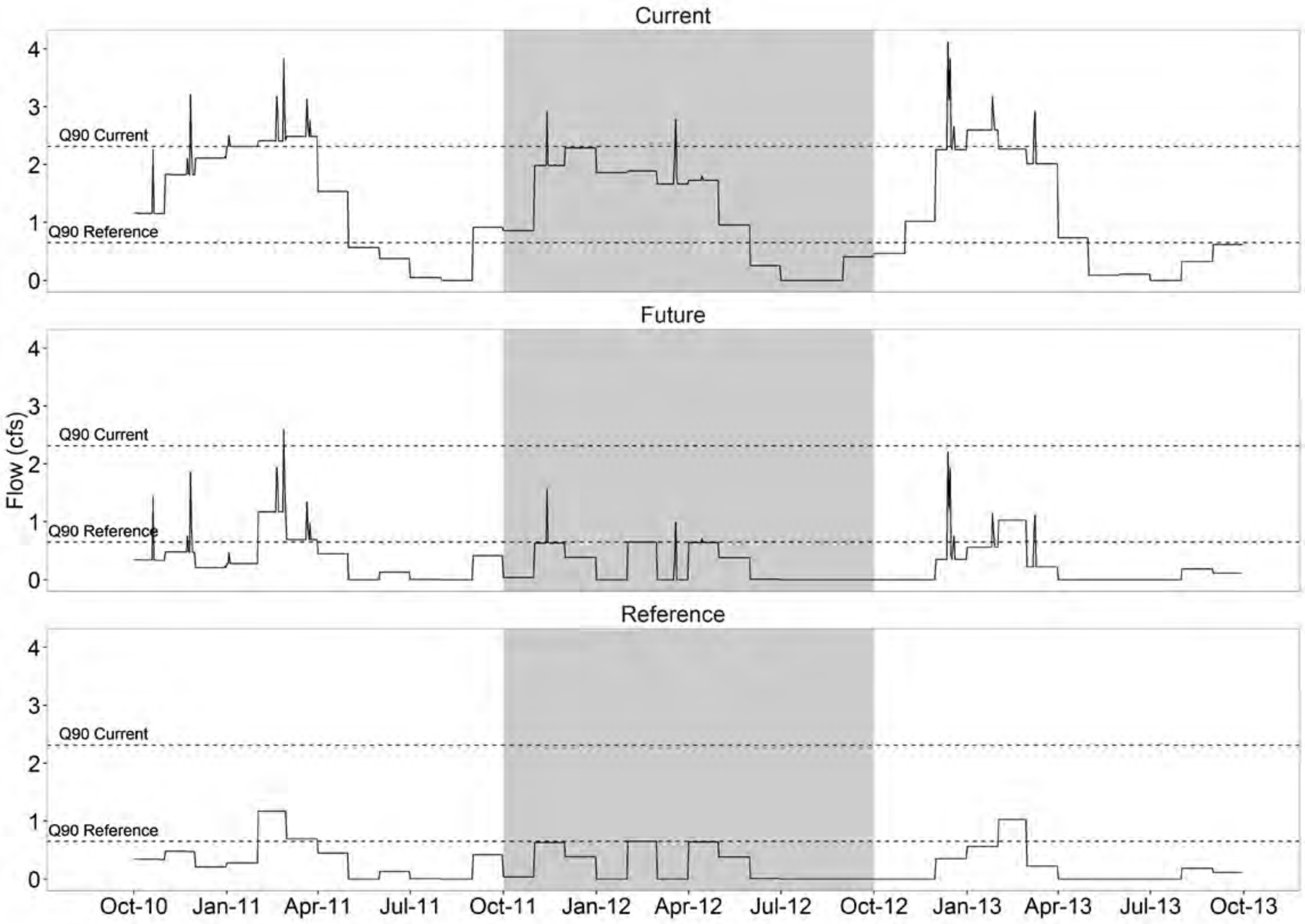
How can this help stream management?

A few examples from San Diego River case study

- Assess impacts of increased water reuse/decreased discharge from Santee Lakes
- Determine required flows to improve the health of Alvarado Creek
- Forecasting impacts of increased imperviousness
- Rapid causal assessment screenings

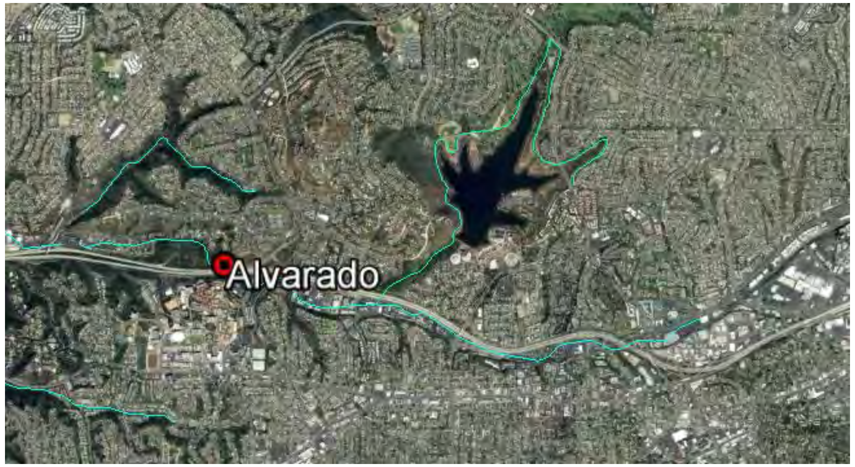
Reducing discharge from Santee restores a more natural hydrograph

Scenario	HighNum (mean #/y)	HighDur (median d/y)
Reference	1.7	28
Current	1.3	212
Future	1.7	28



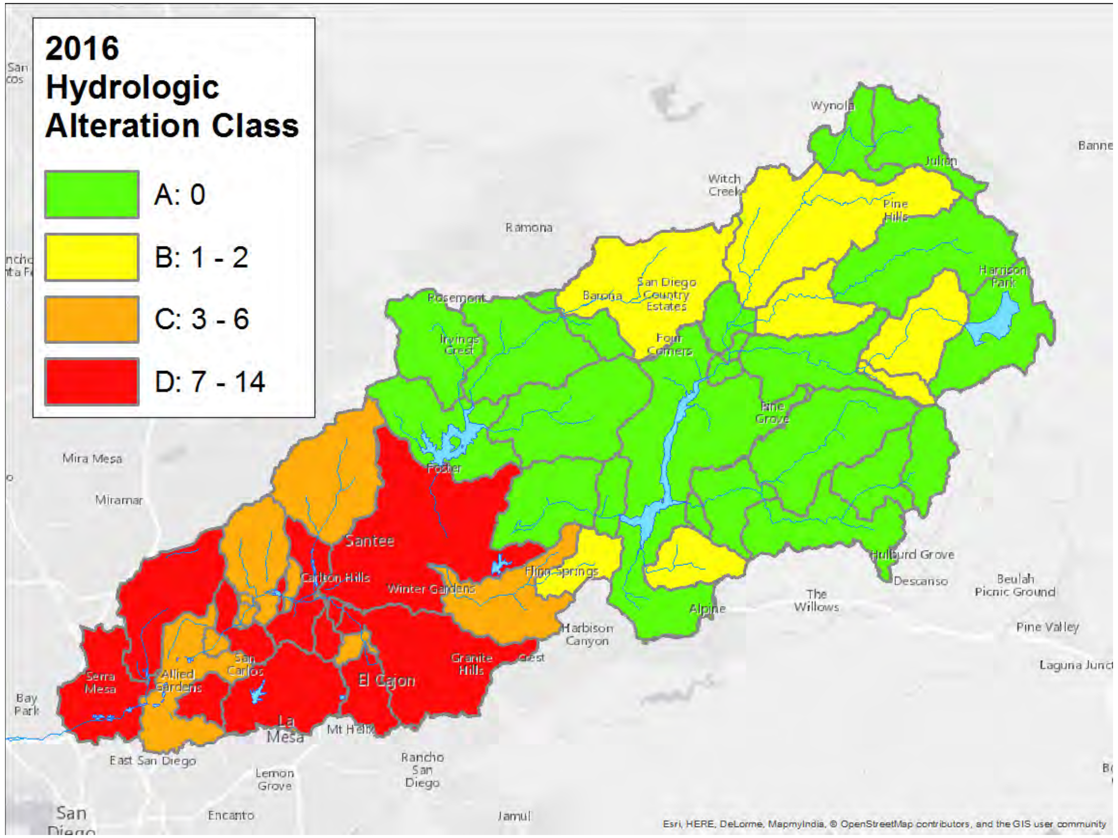
Runoff capture is more effective than reducing impervious cover at restoring healthy flows

Restoration scenarios at Alvarado Creek

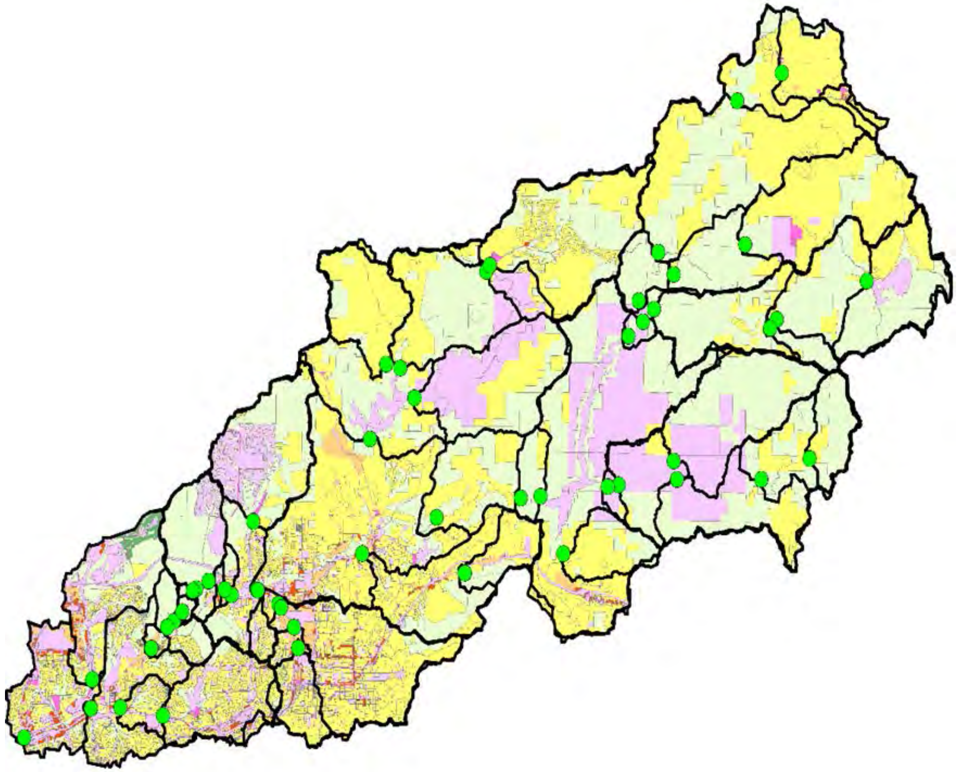


Metric	Current (50% impervious)	25% impervious	10% impervious	Runoff capture (85% of 24-hour storm)	Target
Q99	142	71	69	3	70
Qmean	5.62	2.81	1.12	0.10	0.20

Impacts of planned development

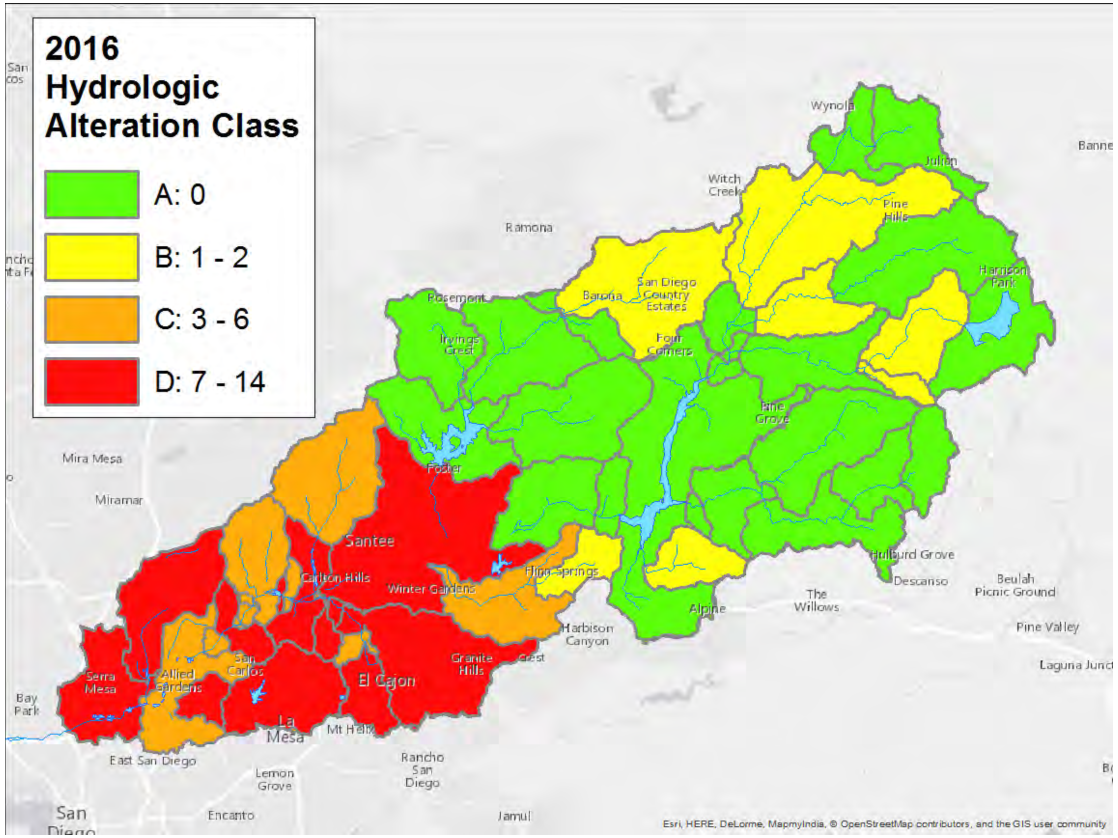


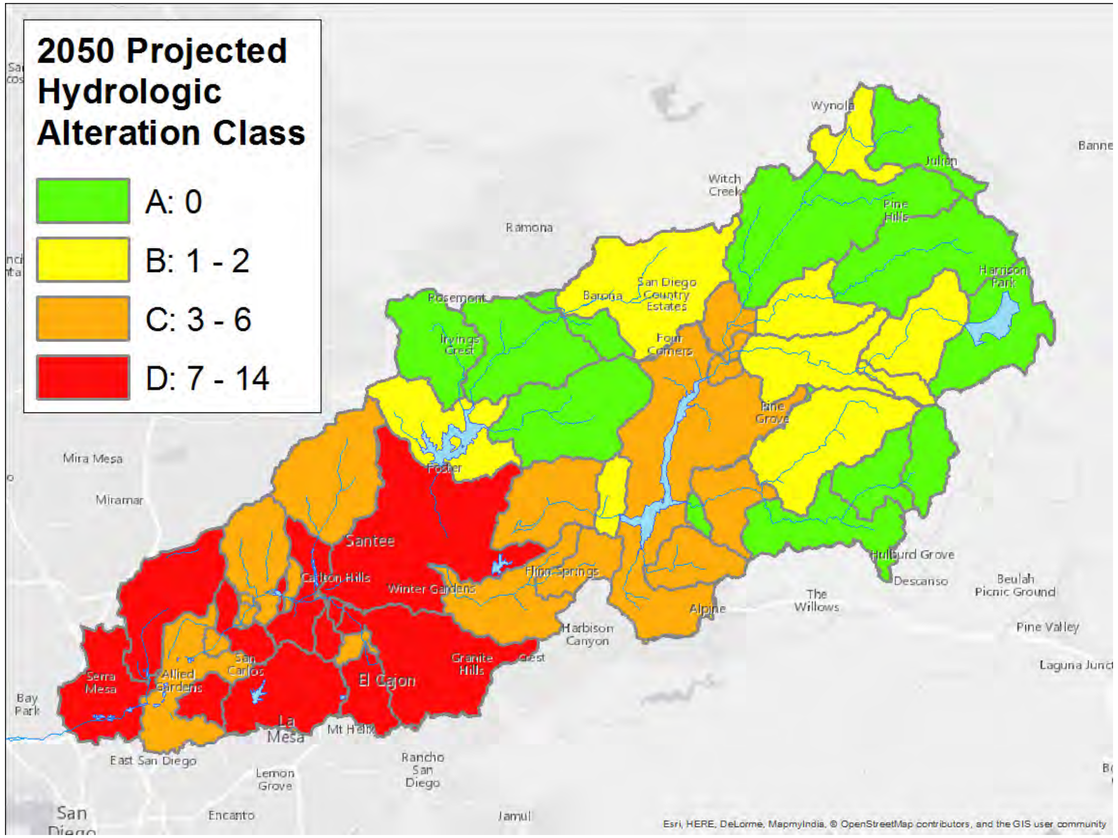
Current



2050

Impacts of planned development



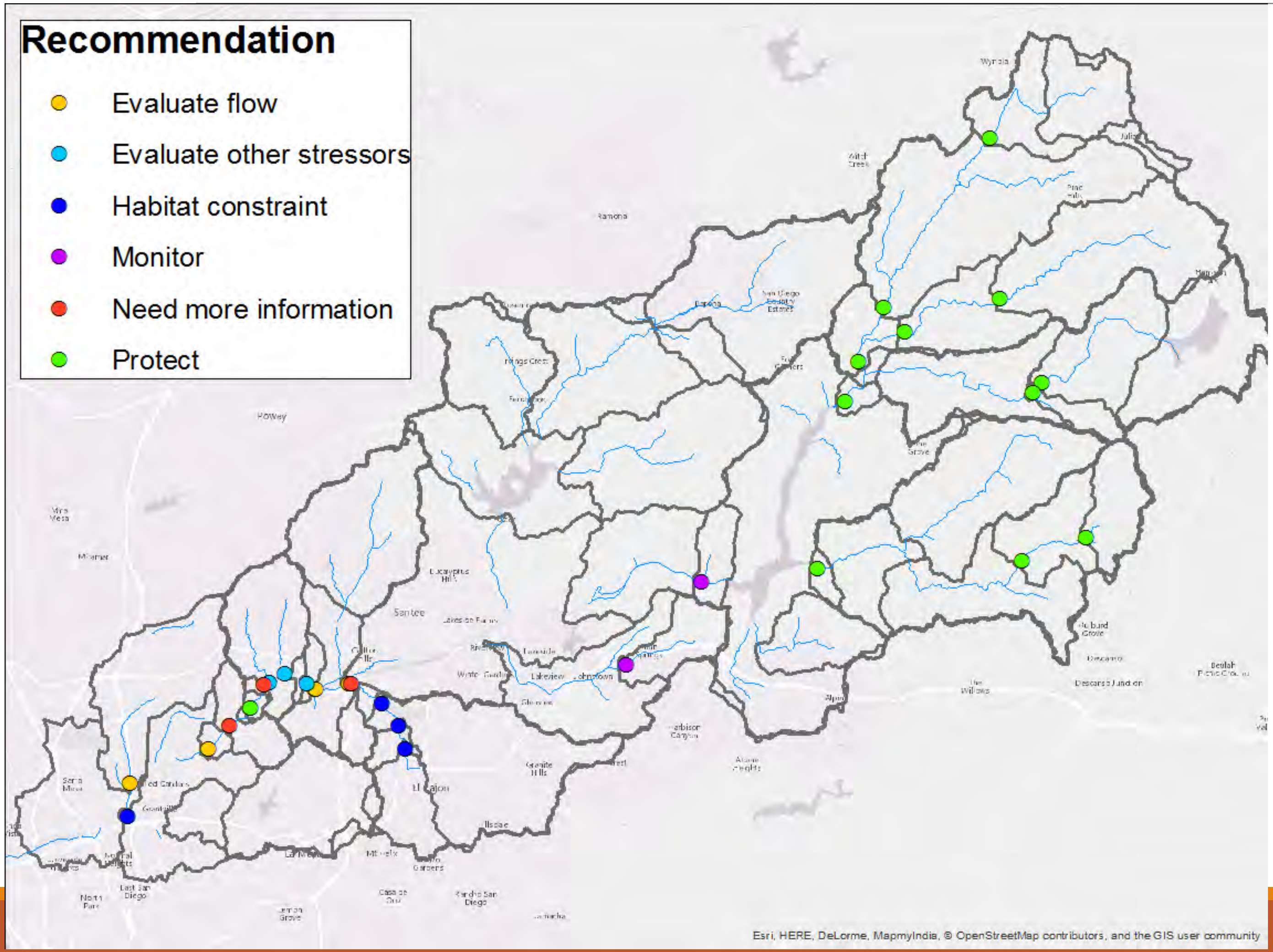


Current

2050

Prioritize vulnerable catchments to protect source waters

Rapid causal assessment screening

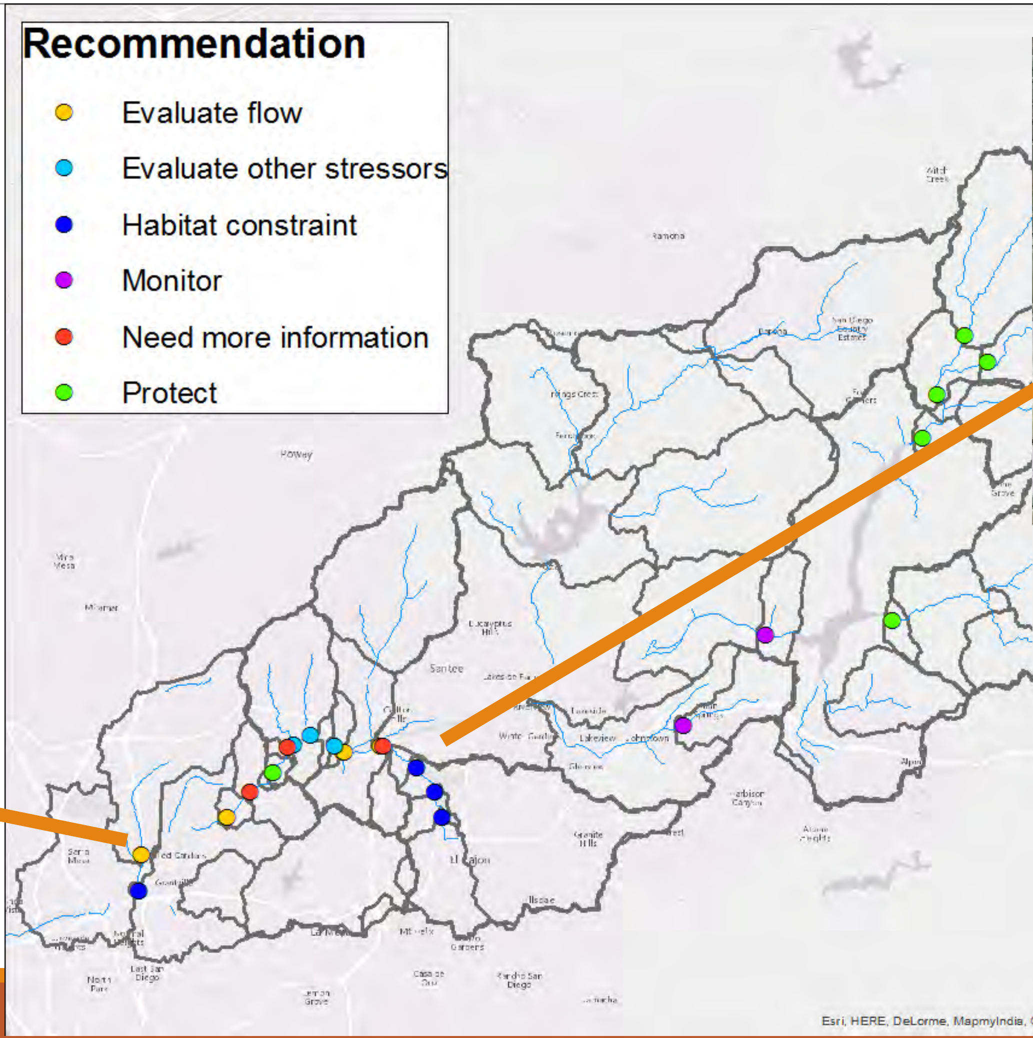


For the "Evaluate flow" sites, will flow management help?

Where do habitat constraints limit options?

Different recommendations for “altered + unhealthy” sites

Flow management could work here



Channel won’t respond much to improved flows

Where is the science needed?

Better flow models that handle complexity while maintaining simplicity

Broaden links between hydrologic alteration and other responses:

- Other biological communities (algae, fish, riparian plants, etc.)
- Habitat and physical responses
- Processes, like eutrophication, cyanotoxin production

Improved causal screening, better recommendations for management actions

- Disentangling impacts of water chemistry and physical responses
- Biological diagnosis

Thank you!