A tool for identifying constraints on stream biointegrity

Presentation to Science Panel

Dec 12, 2018

Background

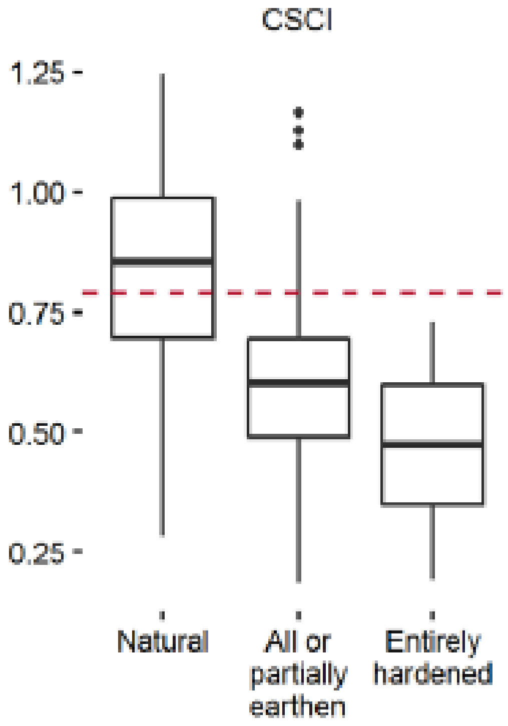
- We created a landscape model that predicts likely ranges of CSCI scores for nearly all stream segments in California
- Local watershed groups have applied models to prioritize management decisions (restoration, protection, monitoring)
  - Interactive, online tools help visualize outcomes of priorities
- We will briefly review the development and validation of this tool

What’s the purpose of the tool?

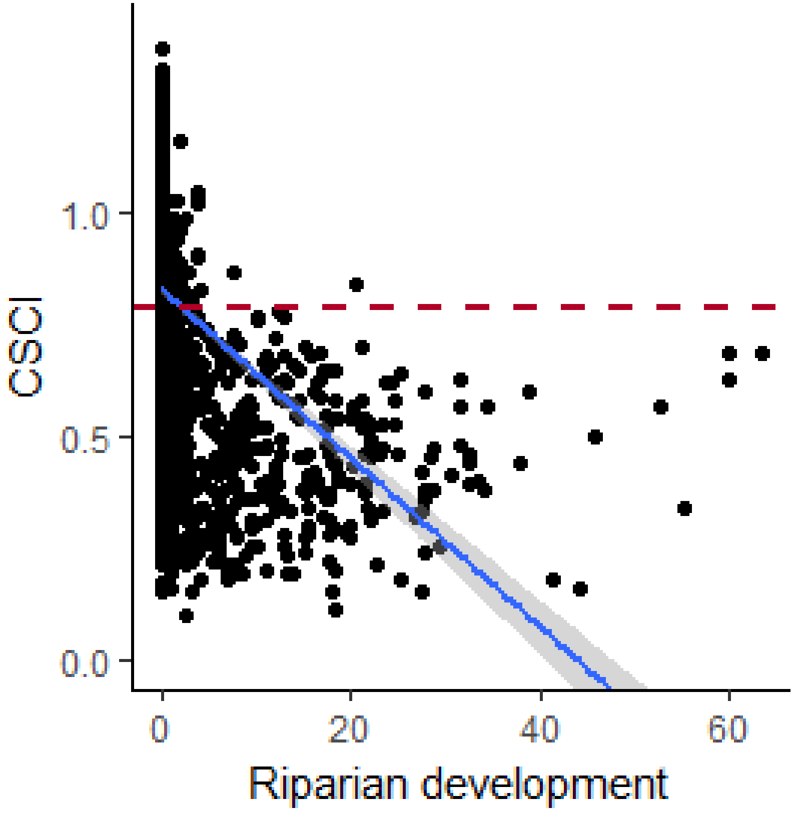
- WB staff wanted a tool to help identify streams where constraints (development, channel modification) create challenges for maintaining bio-integrity
- WB staff is considering whether/how to incorporate tool into biointegrity-biostimulatory policy
- With or without formal incorporation, the tool is intended to help regulated community
  - It provides a technical foundation for discussions with regulators about goals
  - It can support the setting of priorities in watershed plans (e.g., WQIPs, EWMPs), conservation planning

Development can constrain biological integrity

Local habitat



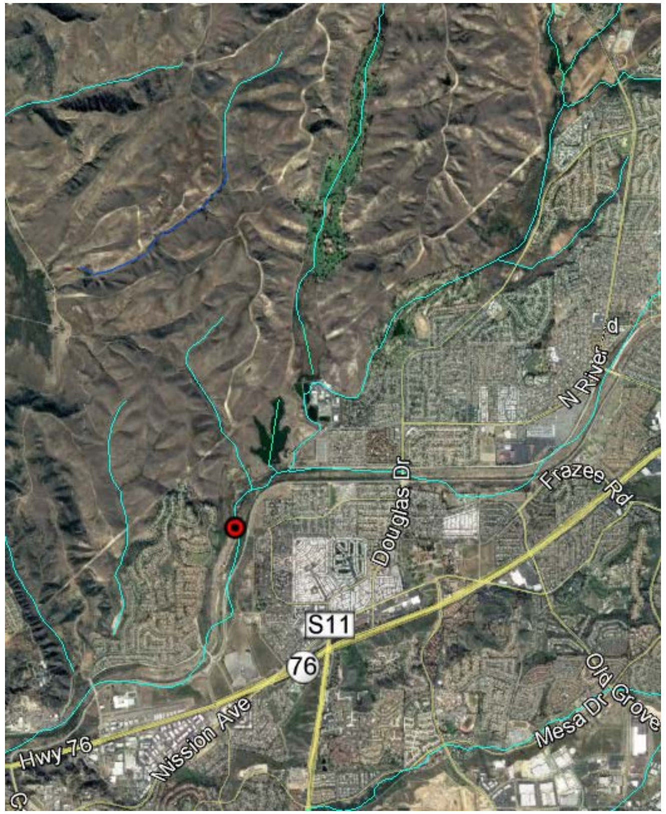
Landscape



High scores (above threshold) rarely, if ever, seen in certain stream types

Two ways to identify constrained streams: Channels vs Landscapes

Modified channel



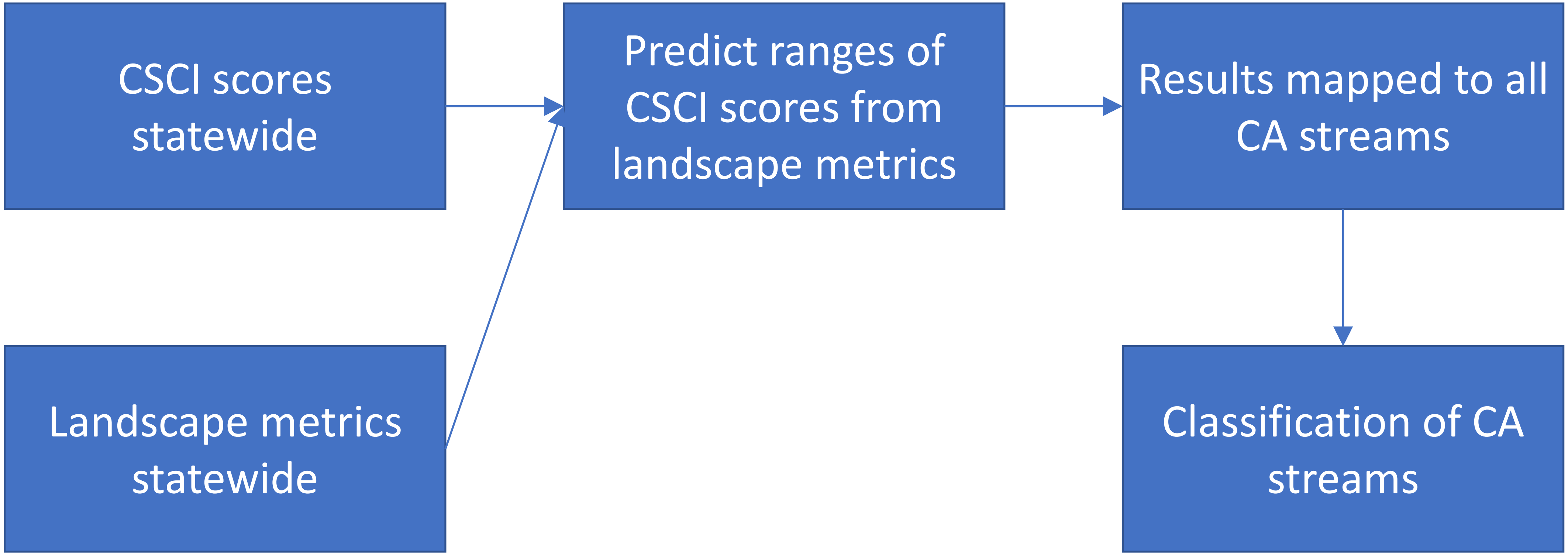
Developed landscape

- Field determination vs. GIS
- Harder to map channel mod
- Channel mod may define the problem too narrowly
- Both approaches have strengths, but landscape approach is better for screening and statewide application

Caveats on purposes and goals

- We set out to create maps and models to provide a ***screening tool*** that starts a conversation, ***not to create a regulatory designation***.
- The maps and models alone are ***not a use attainability analysis (UAA)*** but may help ***prioritize where they may be needed***.
- Analyses are ***associative*** and based on ***observed*** condition, and they can only indirectly inform constraints, restoration potential, or impacts of future management.
- More interest in ***predicting condition,*** not ***explaining mechanisms of impairment***
- We are trying to predict ***biological condition***, not locations where ***channel modification*** has occurred.

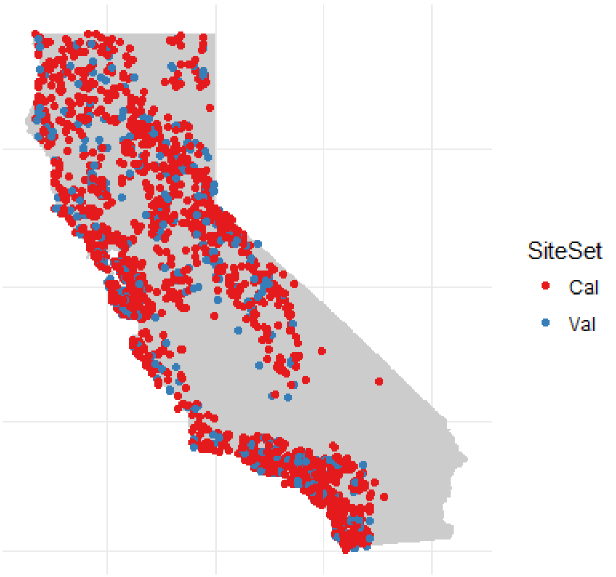
Approach


CSCI scores statewide
Landscape metrics statewide
Predict ranges of CSCI scores from landscape metrics
Results mapped to all CA streams
Classification of CA streams

How models were built

Quantile Random Forest

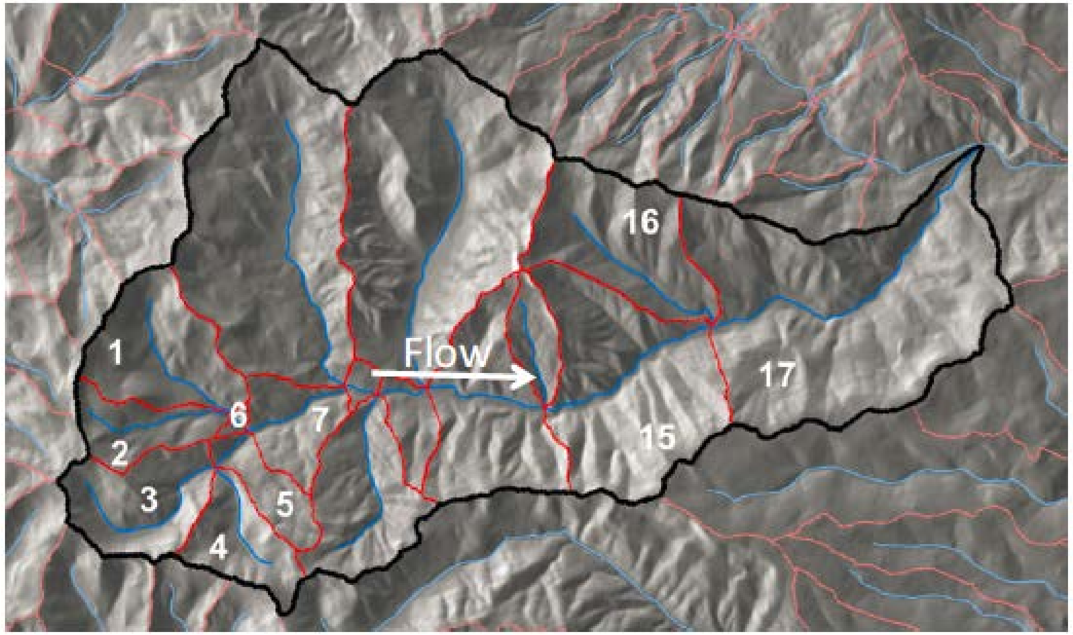
- 3252 sites, split 80% calibration 20% validation
  - Stratified by 6 regions
  - Each region further stratified into thirds by imperviousness
- Where multiple samples are available, only one selected at random for modeling



PSA6	Bottom third	Top third
CH	0.14	2.03
CV	0.55	9.54
DM	0.07	0.17
NC	0.04	0.11
SC	0.29	6.41
SN	0.07	0.22

Predictor data source: STREAMCAT

- Nearly all stream segments from NHD+ (1:100k scale) represented
- Lots of data calculated for each watershed and catchment
  - Metrics also calculated for 100-m riparian buffers
- STREAMCAT makes it easy to explore statewide landscape models on a large scale



We evaluated 117 predictor variables to calibrate models

NATURAL
- Watershed area
- Precipitation
- Temperature
- Geology
- Soils
- Hydrology

ANTHROPOGENIC
- **Landcover & impervious surfaces**
- **Road density & crossings**
- Mines
- Dams
- Atmospheric deposition
- **Canal density**
- Non-native veg cover

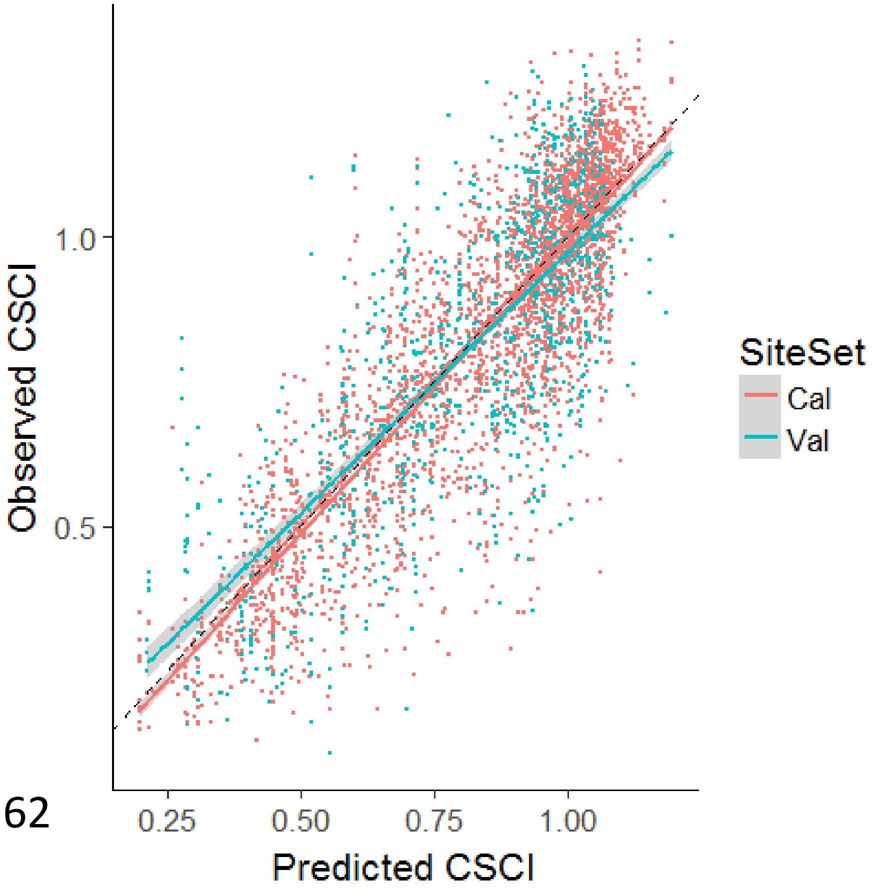
Stressors with long-term impacts

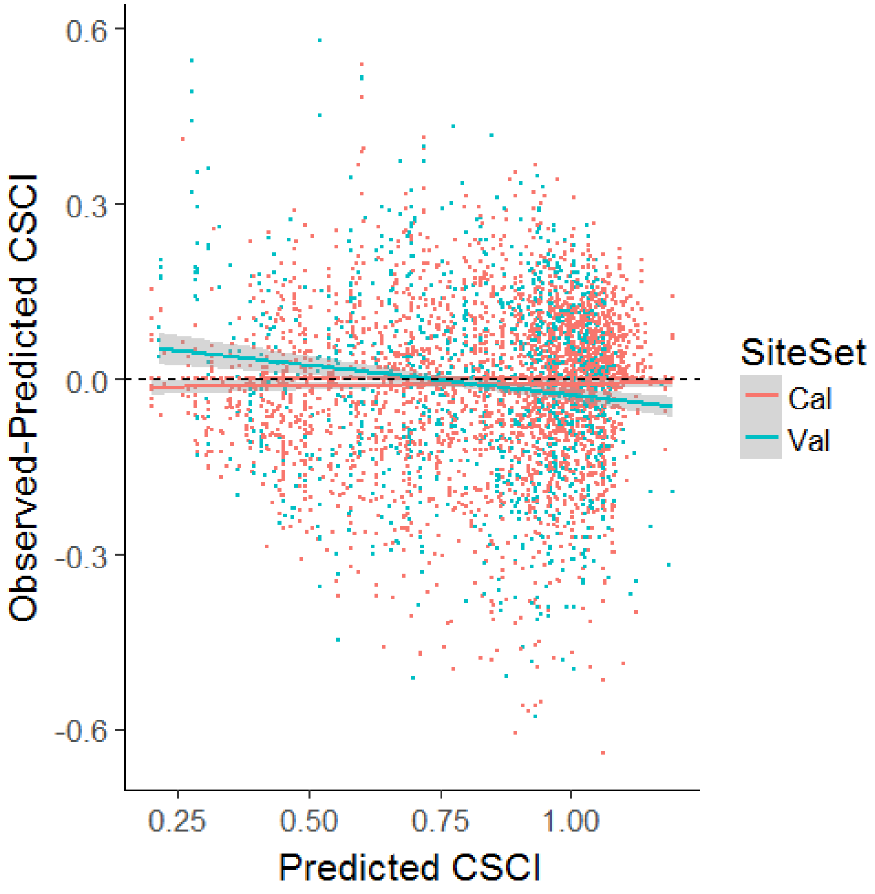
Difficult to manage

Generally outside WB purview

Complex models (dozens of predictors) aren't much better than simpler models (core land use variables)

Model predicted CSCI scores well





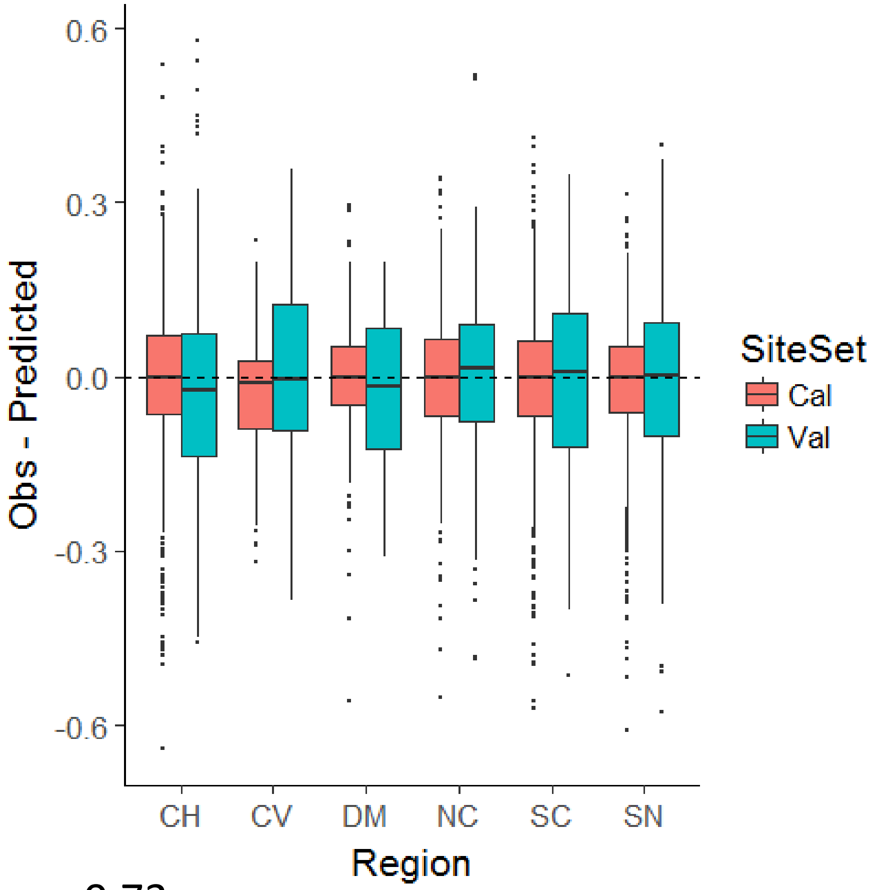
Pseudo r^2: 0.62

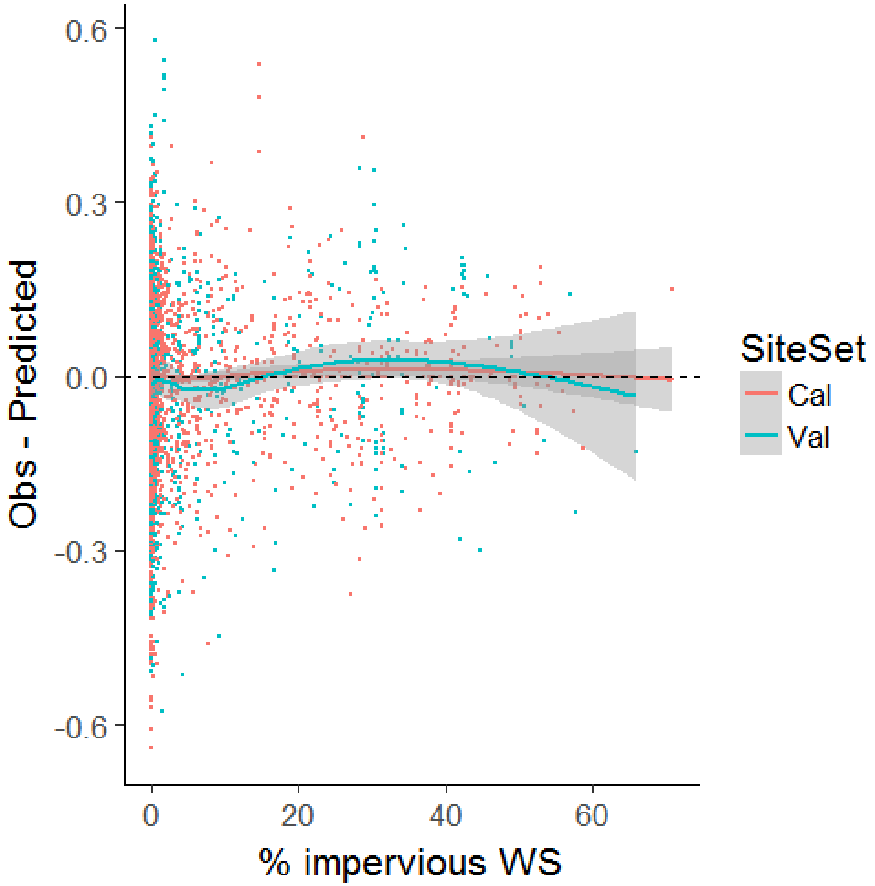
% correct:

Cal: 89%

Val: 81%

Little evidence of bias along natural or anthropogenic gradients



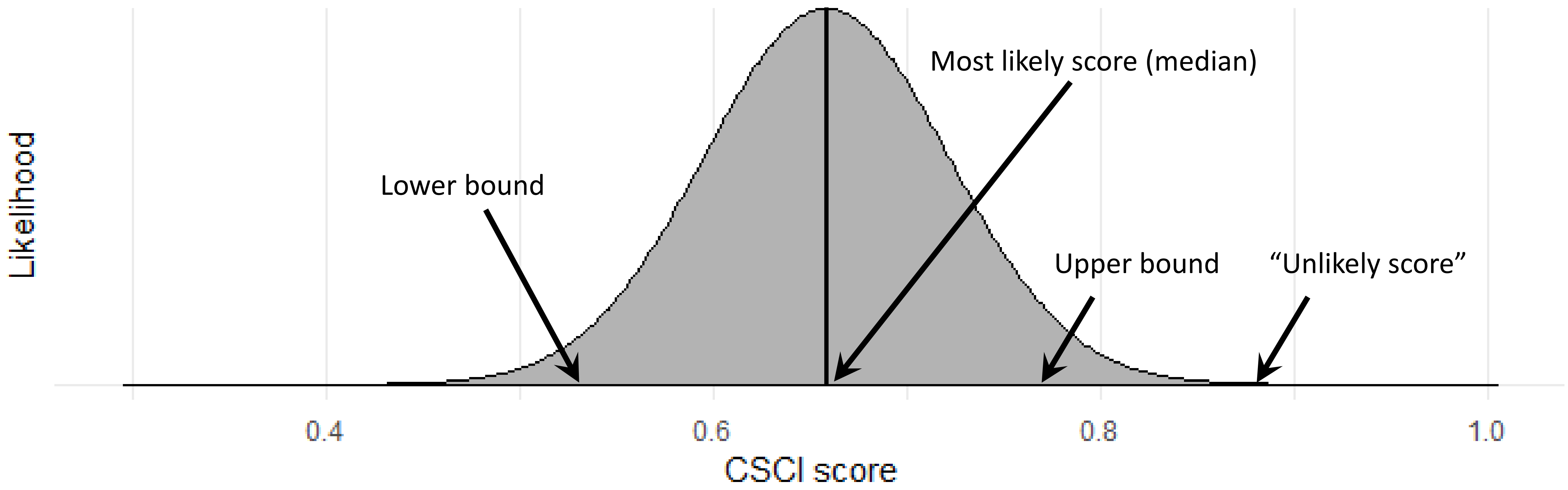


Cal F = 0.56, p = 0.73

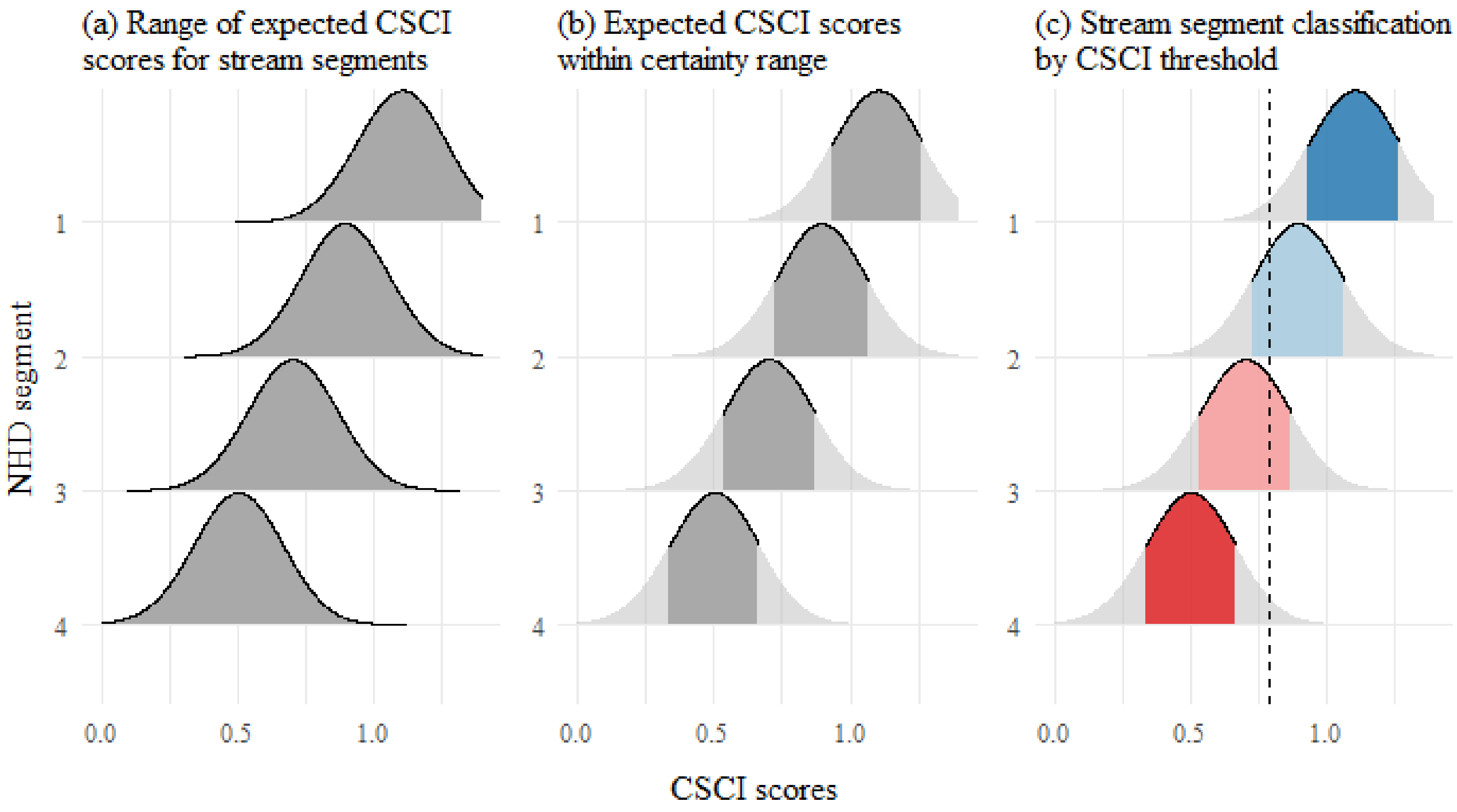
Val F = 0.88, p = 0.49

What we get from the model:

- For each stream reach, a range of modelled biological expectations
- Expectations from distribution of scores at calibration sites with similar levels of disturbance



How are reaches classified using the model?

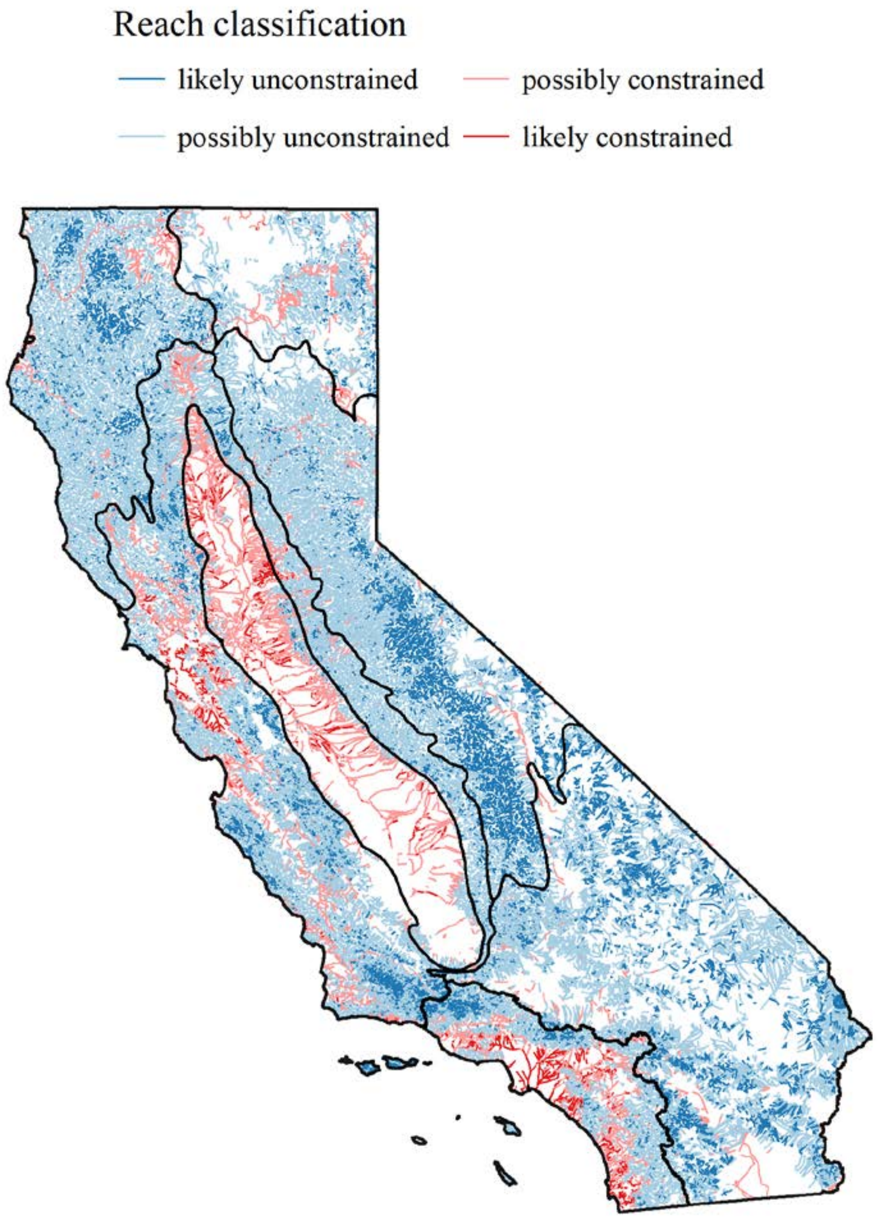


likely unconstrained

possibly unconstrained

possibly constrained

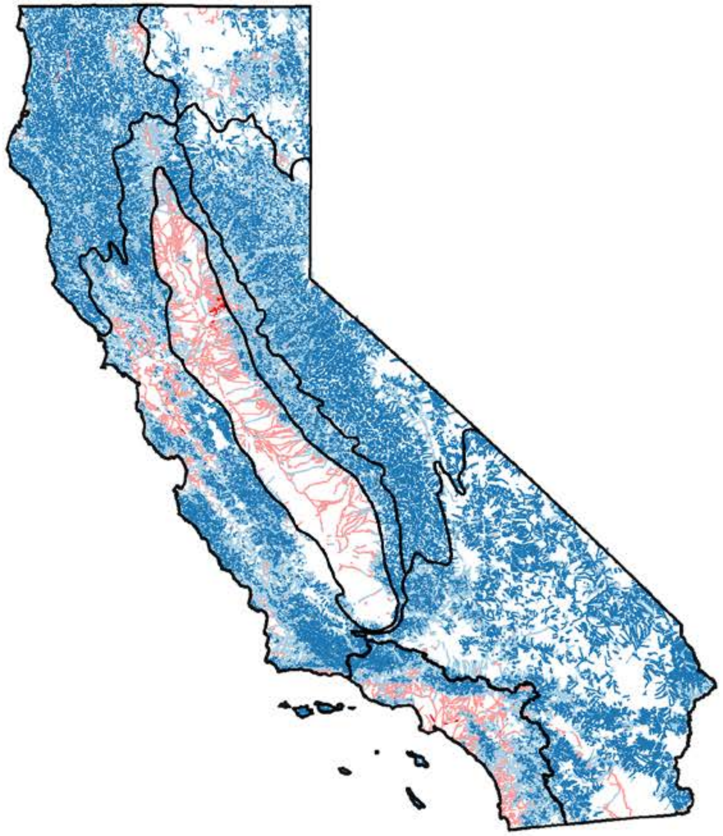
likely constrained



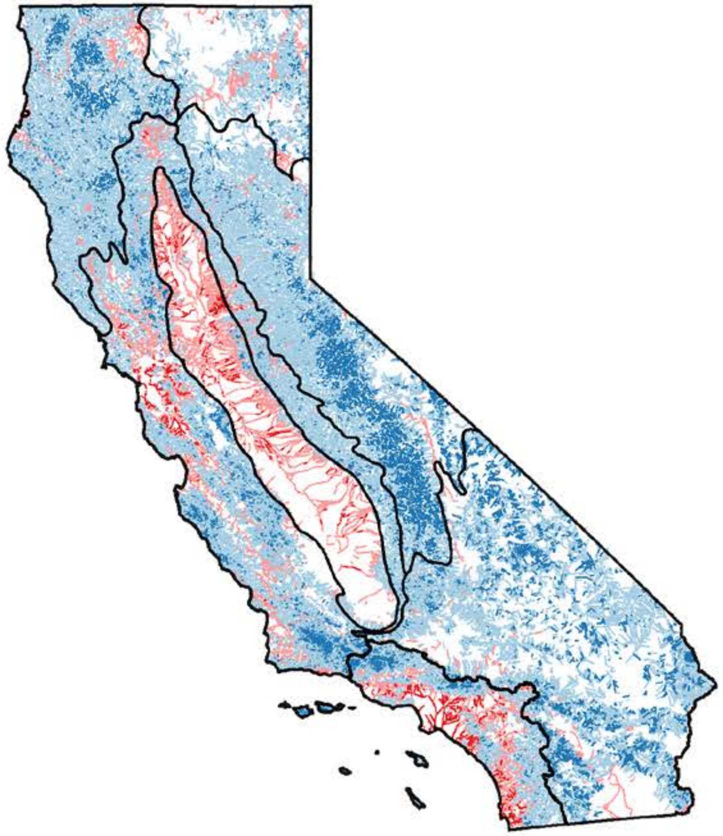
Statewide classifications

- Likely unconstrained: 39%
- Possibly unconstrained: 46%
- Possibly constrained: 11%
- Likely constrained: 4%

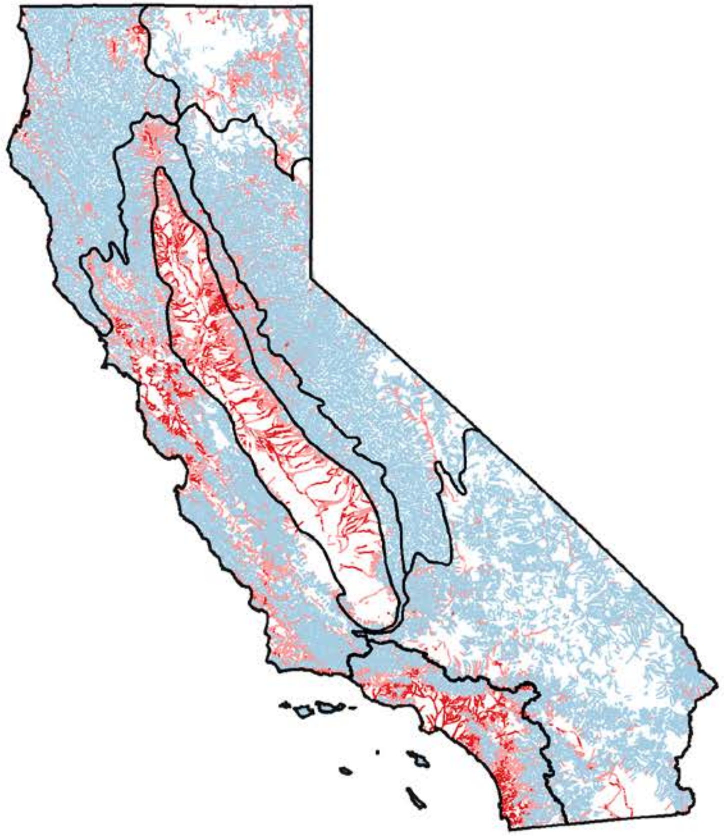
Explore how decision-points affects outcomes



Streams constrained below CSCI 0.63

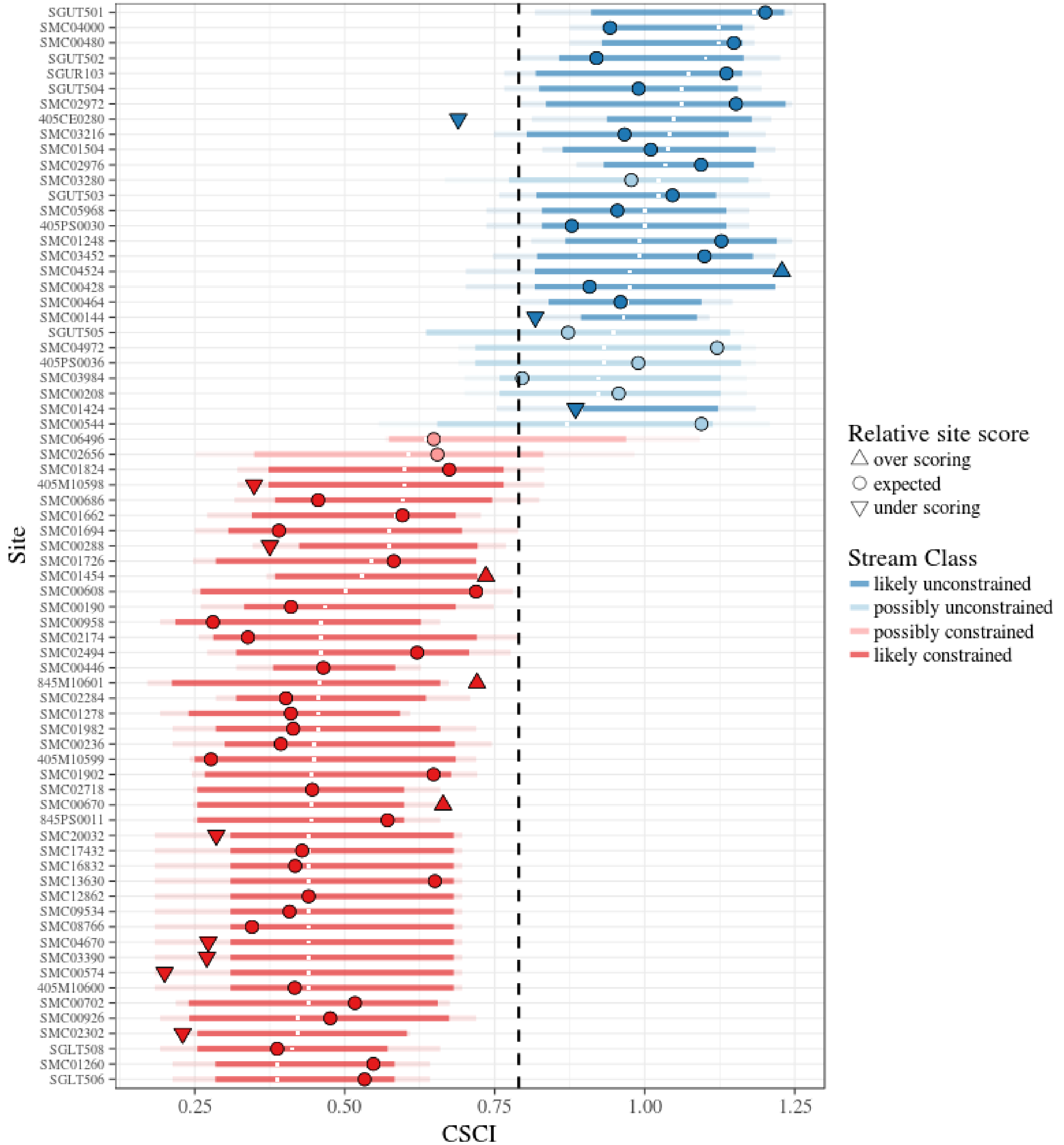


Streams constrained below CSCI 0.79

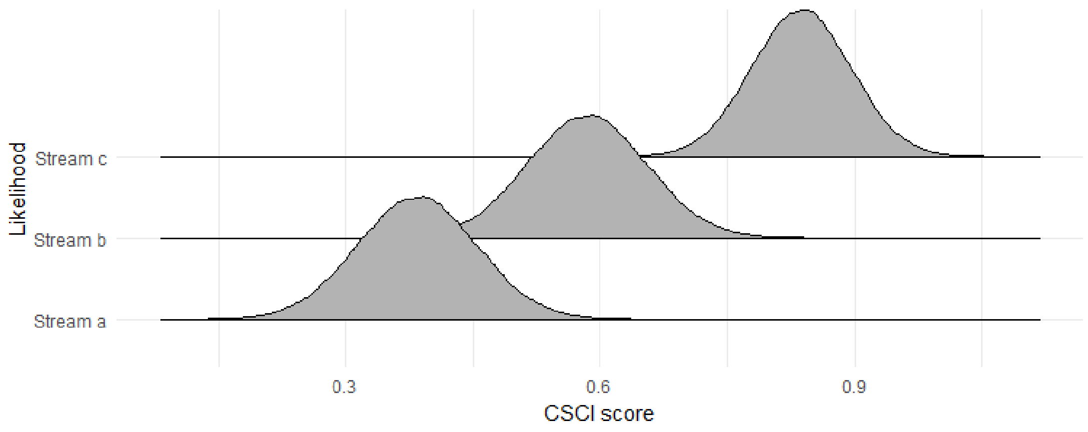


Streams constrained below CSCI 0.92

Models provide context to help set priorities



- Lots of sampling
- Many low-scoring sites
- Which ones to fix?



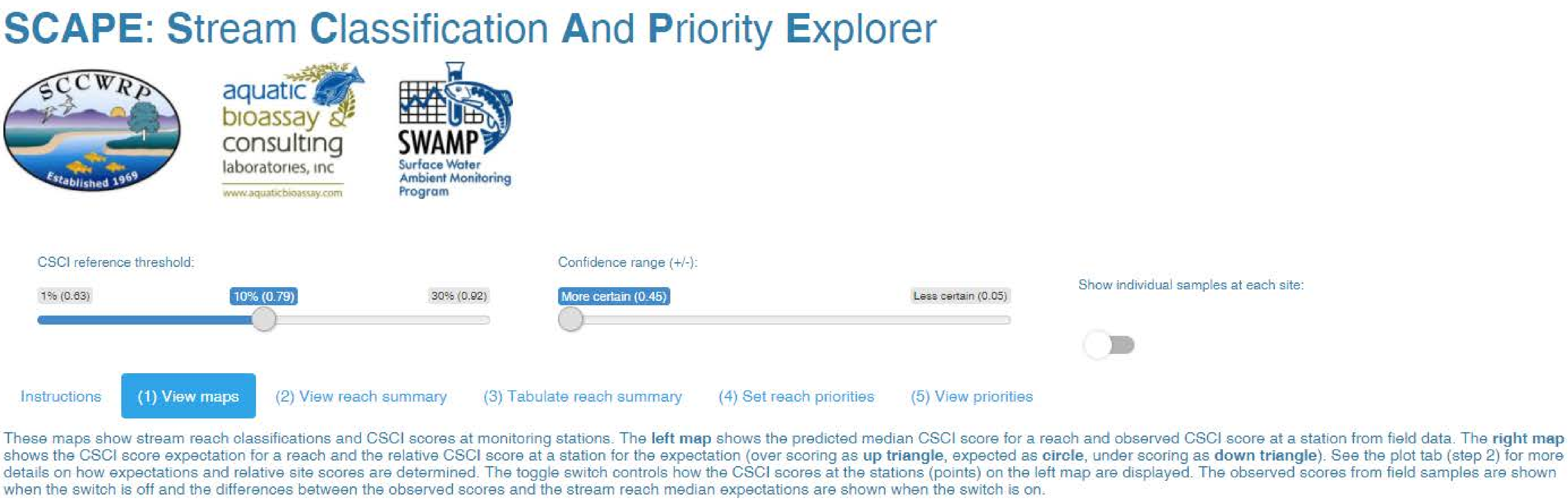
Prioritizing actions based on observed scores and landscape context

An applied example from the San Gabriel watershed

Action	Example activity	Example high- priority site	Example low-priority site
Investigate	Higher frequency of sampling. Evaluate additional data (e.g., habitat).	Sites scoring outside prediction interval	Sites scoring as expected
Protect	Extra scrutiny for proposed impacts.	Unconstrained sites	Constrained sites
Restore	Make funding recommendations. Conduct causal assessment. Prioritize TMDL development.	Low-scoring unconstrained sites.	Low-scoring constrained sites. (high priority for UAA?)

What are the impacts and outcomes of key decisions?

- Developed an online application for selected watersheds – transparent and exploratory



http://shiny.sccwrp.org/scape/

Current status

- Manuscript completed EPA internal review, and has been submitted to *Freshwater Science*
- Review by advisory groups requested concurrently with journal review

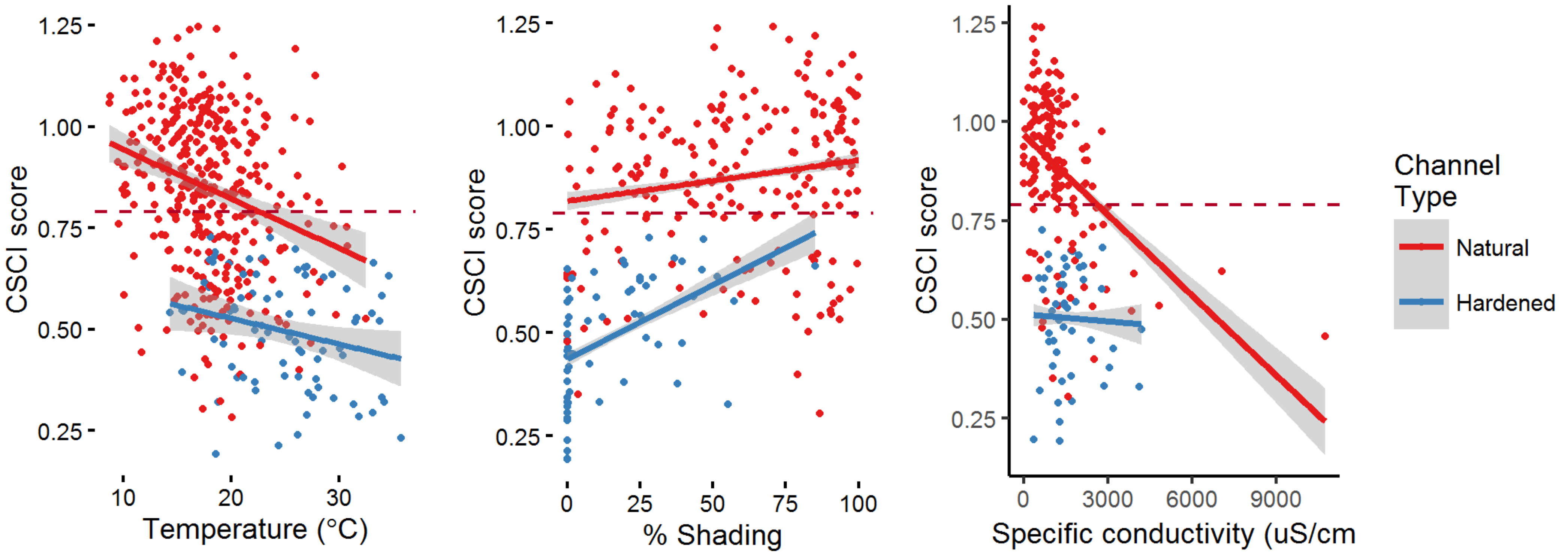
Charge Questions

- Comment on the adequacy of the data set, the analytical approaches to predict ranges of biointegrity scores associated with landscape development, the evaluation of performance and findings of the Channels in Developed Landscape Tool.

- Are there technical ways to address stakeholder concerns?

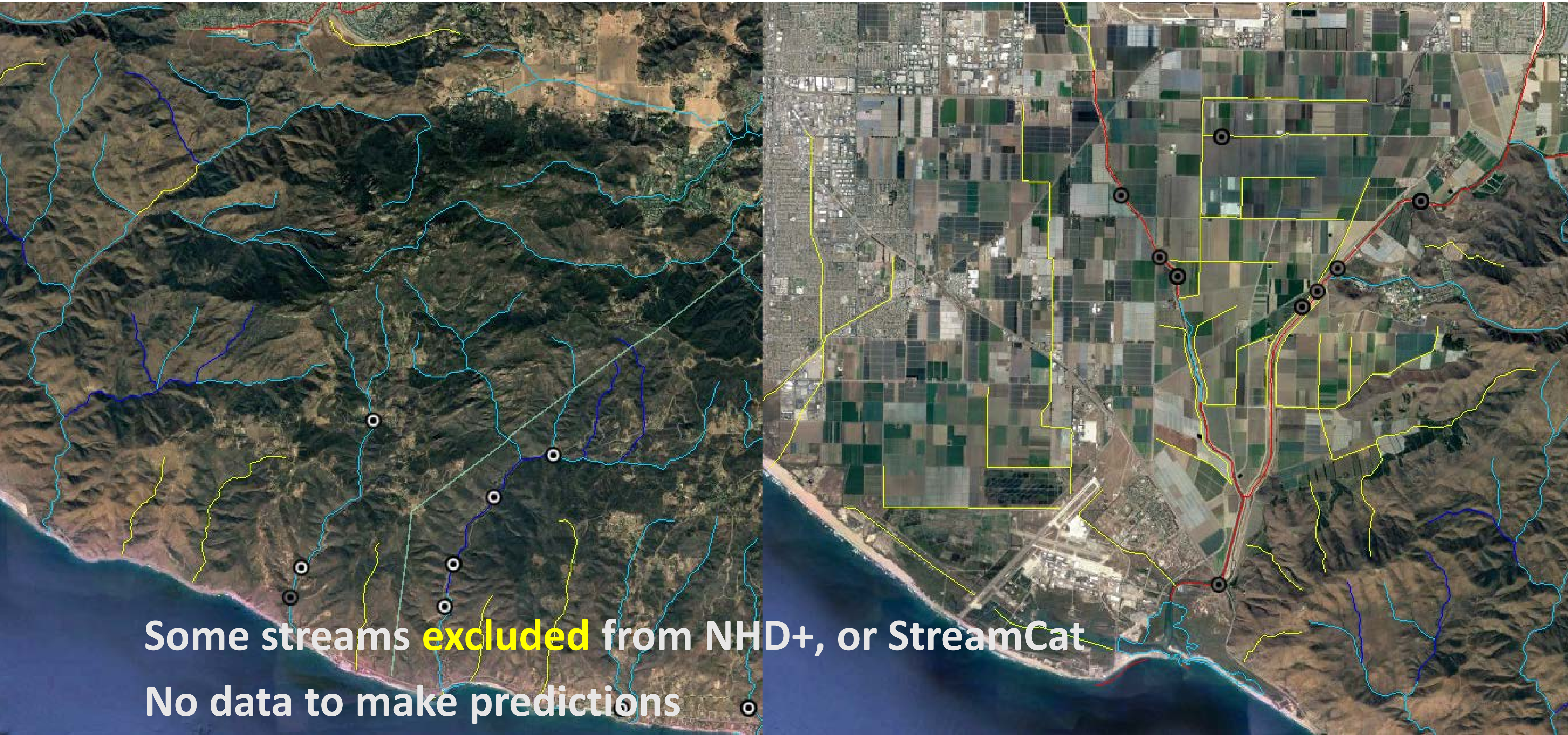
Questions?

Dampened response to WQ gradients



Improving WQ may not protect bio-integrity

Model can't be applied to *every* stream….

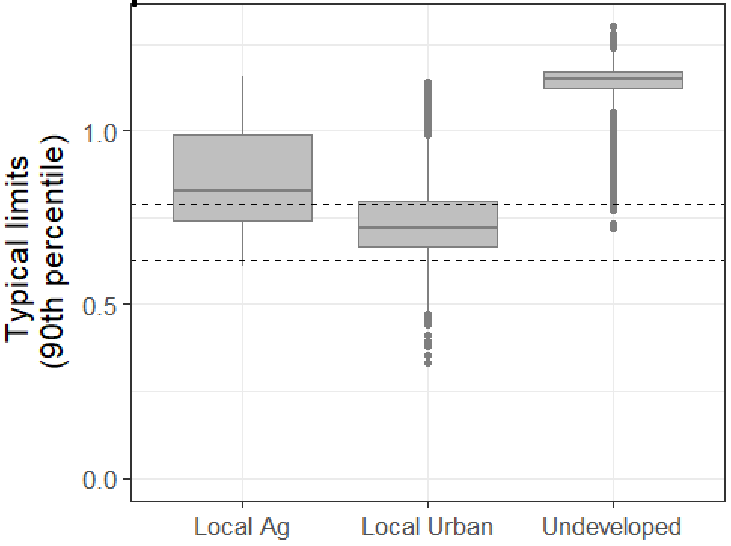


Can we characterize ranges here too?

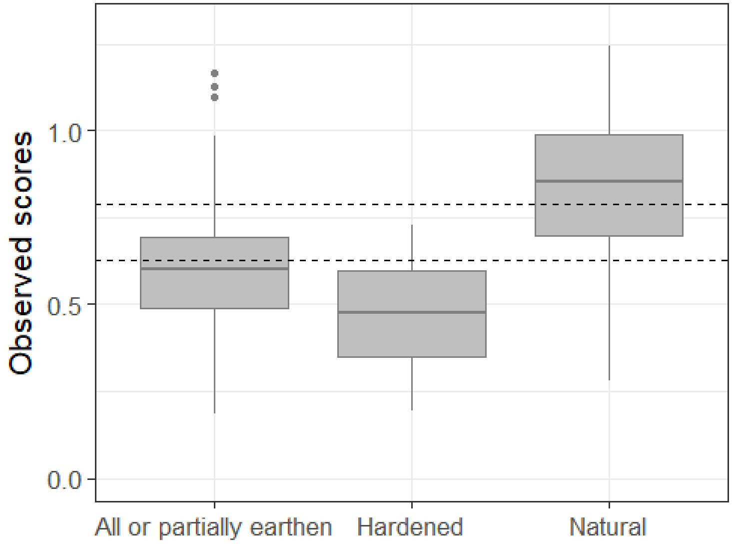
Options:

- Derive ranges for "typical" ag/urban site from model
- Derive ranges observed at SoCal engineered channels

Generalize from model predictions elsewhere



Ranges observed in modified channels



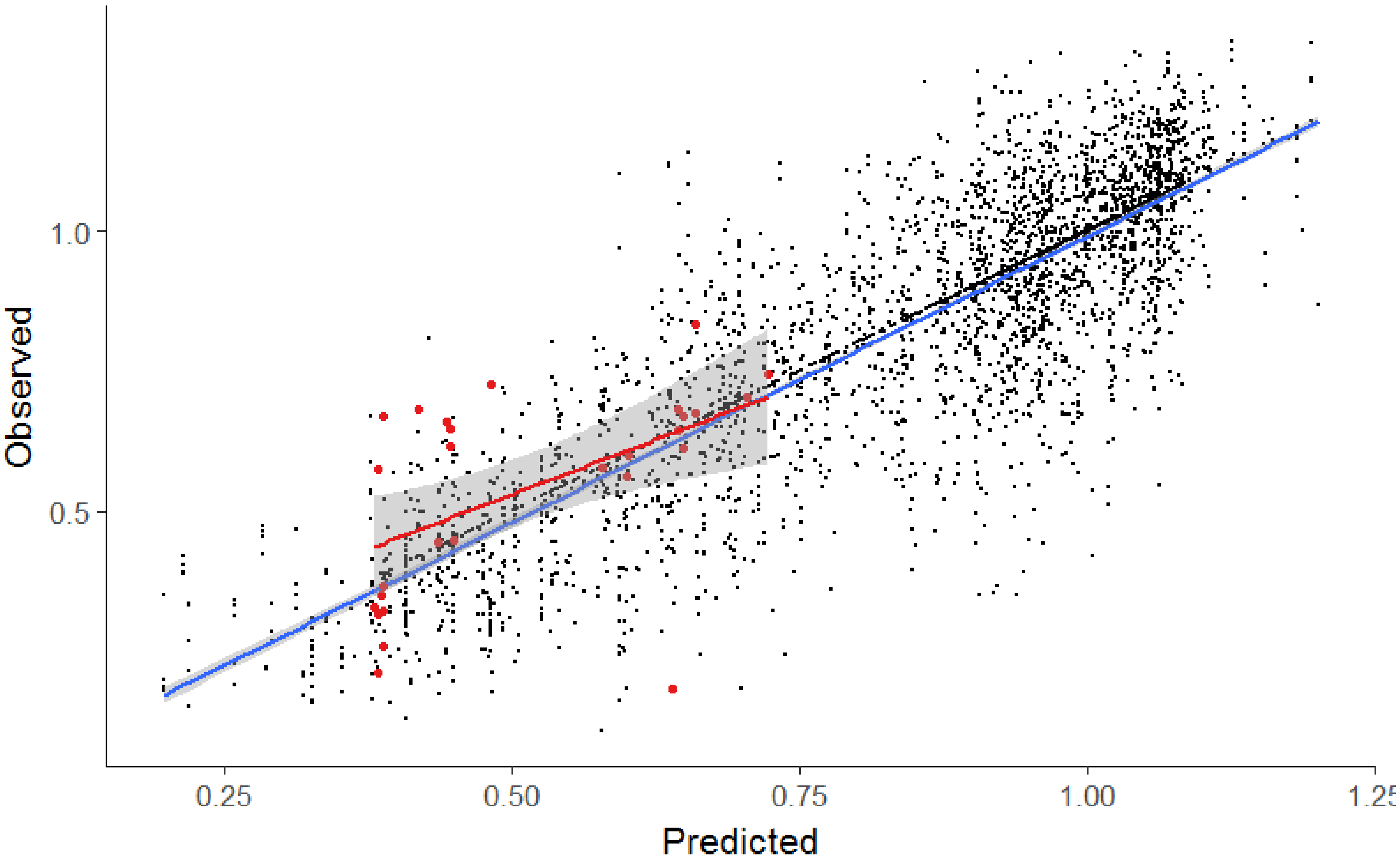
Can Sci. Panel comment on options for characterizing index score ranges at these sites?

Feedback: Unmodelled factors may be important!

- We developed a simple and complex model
  - Both performed similarly (based on accuracy, as well as user feedback)
  - Excluded factors were redundant

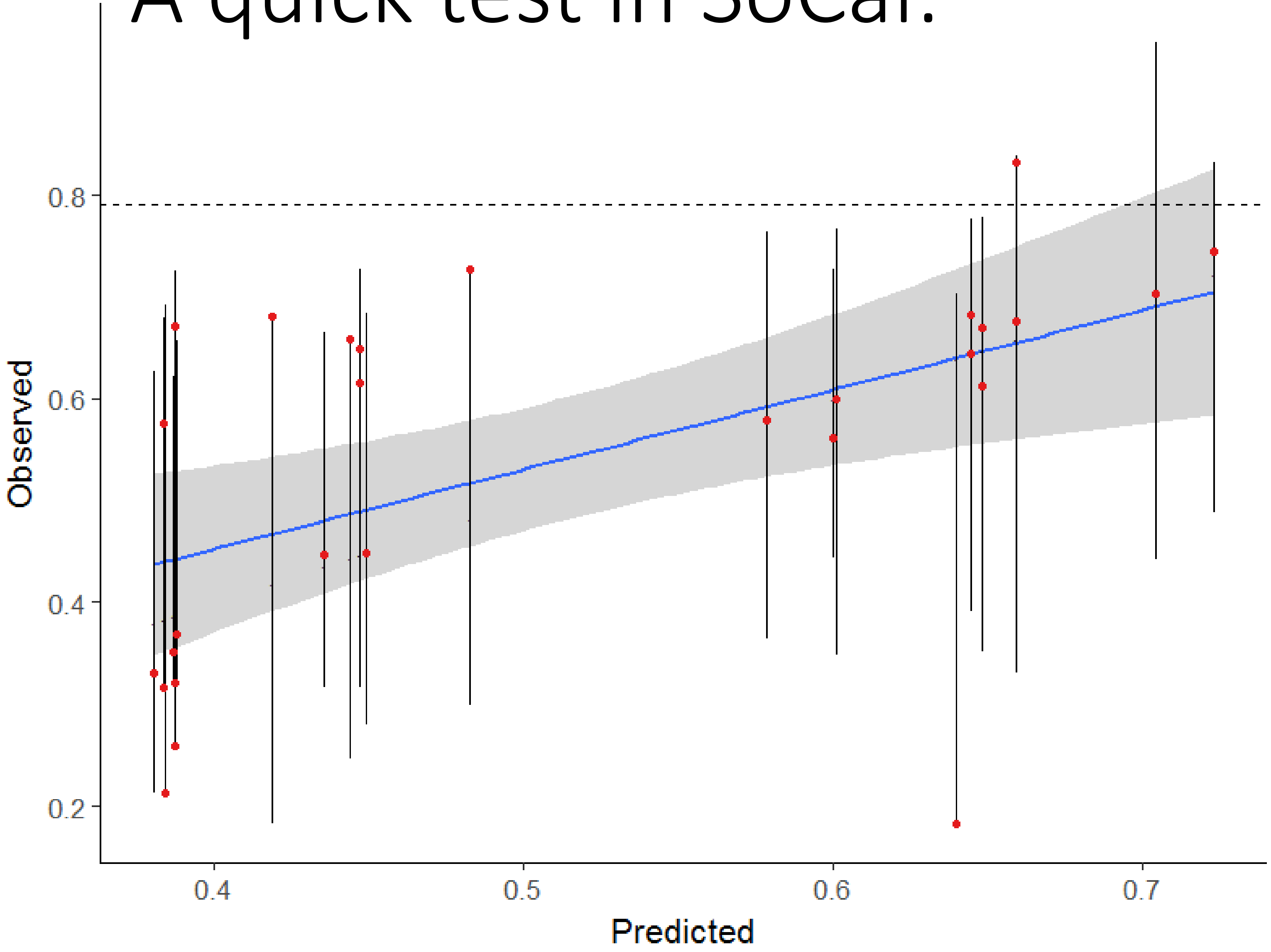
- But constraints can be caused by other factors besides urban/ag
  - E.g., Hydromodification, silviculture/timber harvesting, cannabis cultivation
  - Unfeasible for statewide application and/or data unavailable – invest in stressor data acquisition!
- *Landscape models are one approach for evaluating constraints, best suited for screening-level application on a statewide scale*

Example: Effluent-dominated streams



Red: Effluent-dominated sites in 3 SoCal rivers (Los Angeles, San Gabriel, Santa Ana)

How about effluent-dominated streams? A quick test in SoCal:



24 of 28 are constrained
27 of 28 are low-scoring

Although we couldn’t include this as a model predictor, we still can tell that most are constrained.

Comment: “Constrained” does not mean “unfixable”

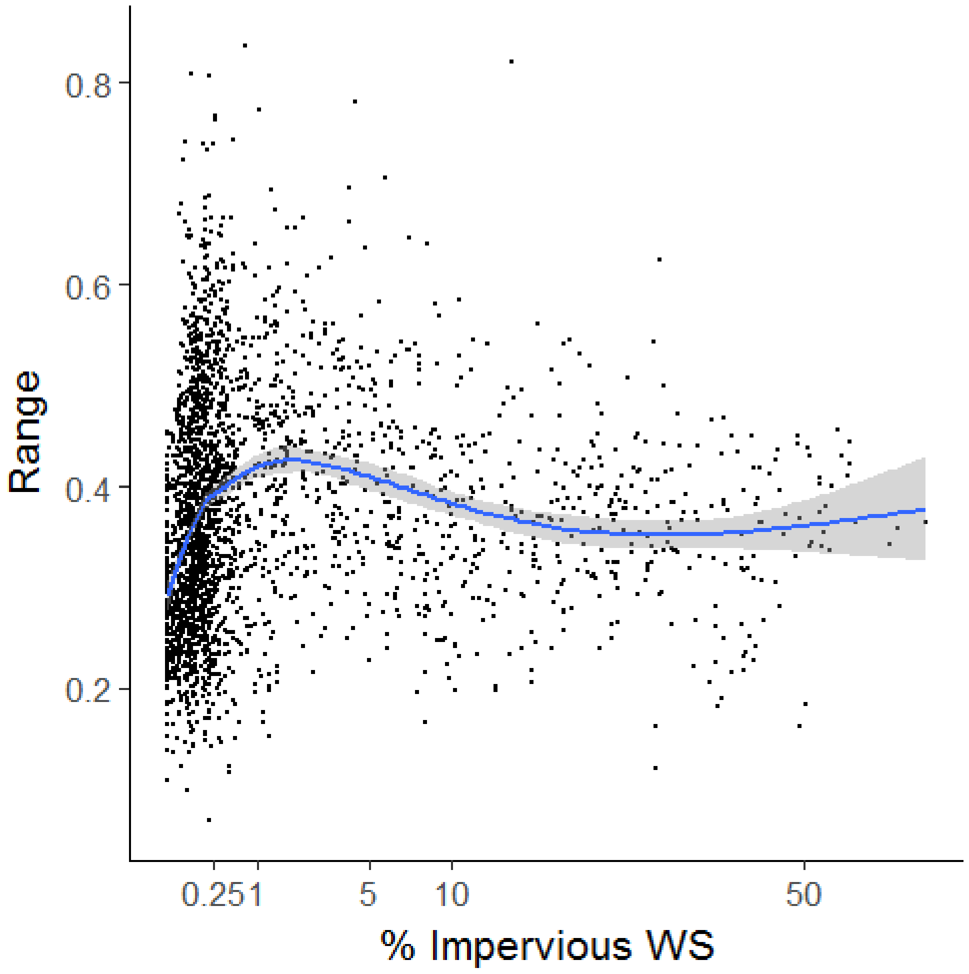
We agree

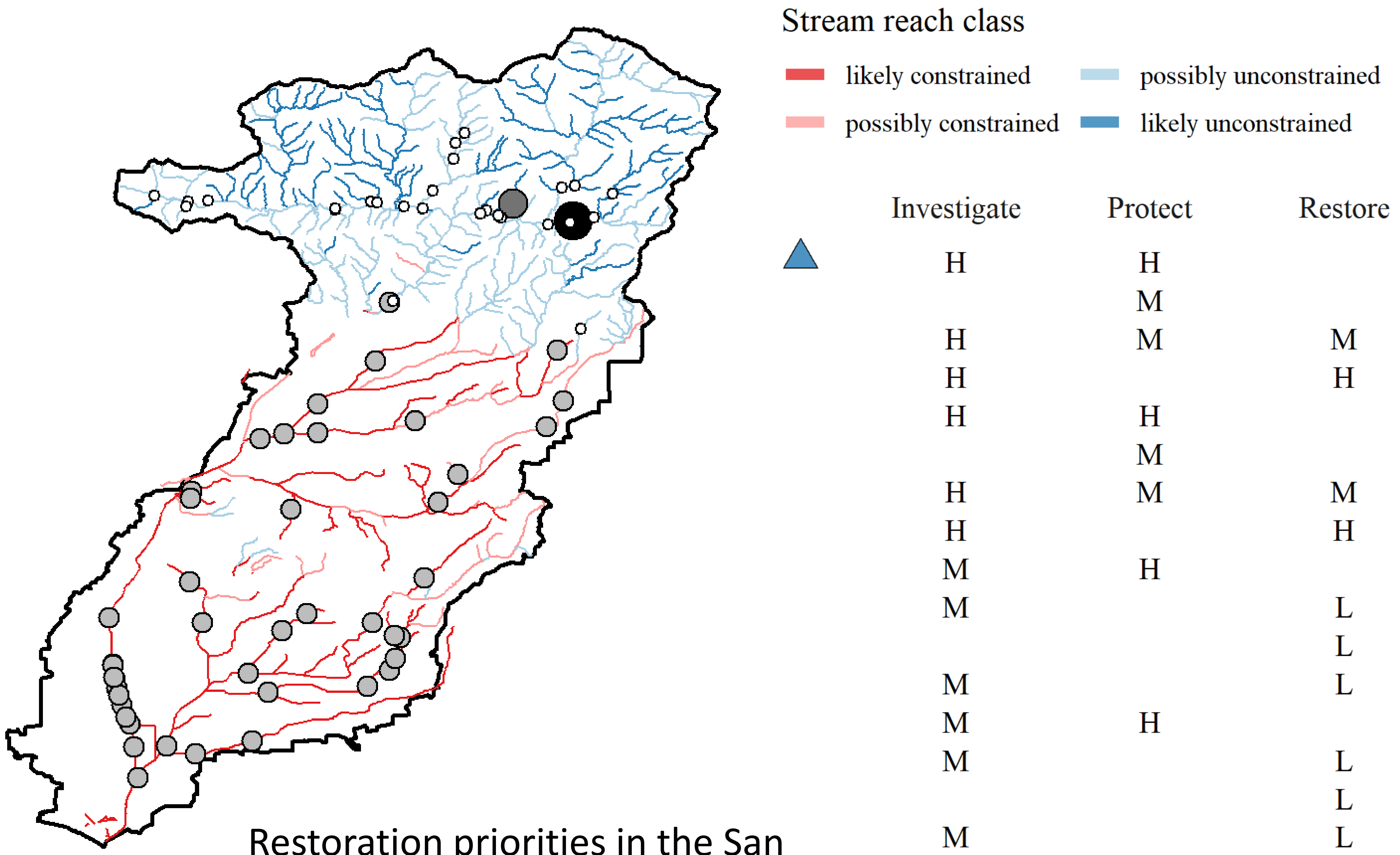
- Model is based only on association between landscape pressures and biological response
  - Does not identify mechanism
  - Causal assessment for **manageable stressors** is logical follow-up

- Model is based on CSCI
  - Other biological endpoints may exhibit different constraints

How narrow is the *range* of predicted scores?

- Narrow range: More confidence in classifications!
- Range = 90th percentile minus 10th percentile
- Narrowest range (~0.3) at very low impervious
- Widest range at Desert/Modoc, and high-impervious North Coast.





Restoration priorities in the San Gabriel Watershed