Assessing the potential impact of elevated ionic concentrations on aquatic life in Santa Ana region wadeable streams

Presentation to the Basin Monitoring Task force

SAWPA

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How do you measure support for aquatic life?

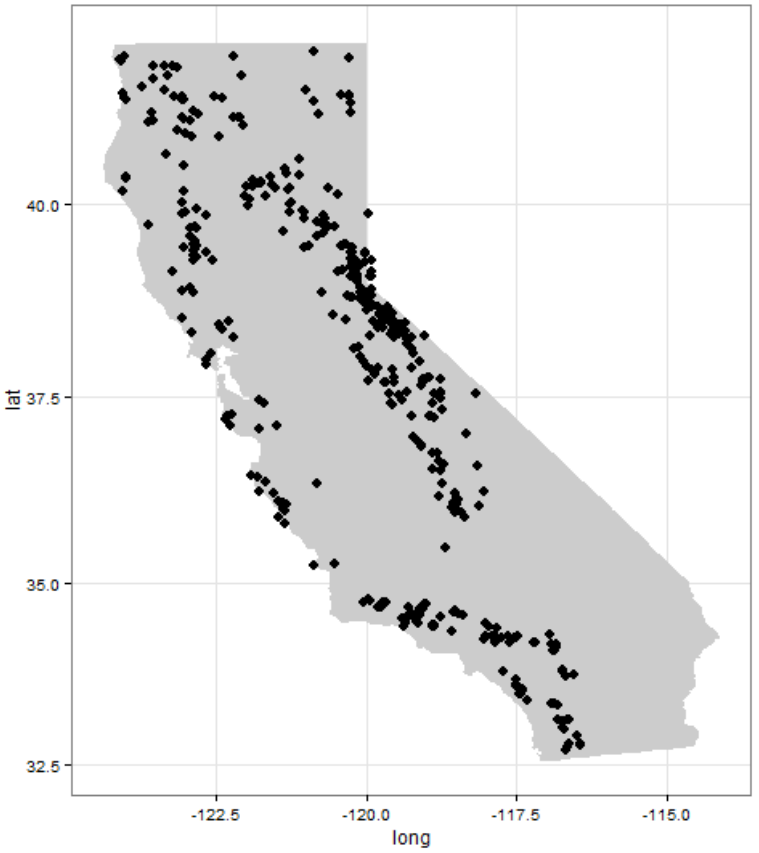
- Bioassessment: The use of biological organisms (e.g., aquatic insects) to assess the health of a stream
- Diverse life histories -> Integrate impacts of all stressors affecting a stream (across time and space)
- Directly relevant to management goals

Tools to measure biological integrity

Predictive indices based on Reference Condition Approach

- California Stream Condition Index (CSCI) for benthic invertebrates
- Algal Stream Condition Index (ASCI)

Predictive indices set the right expectations for different environmental settings.

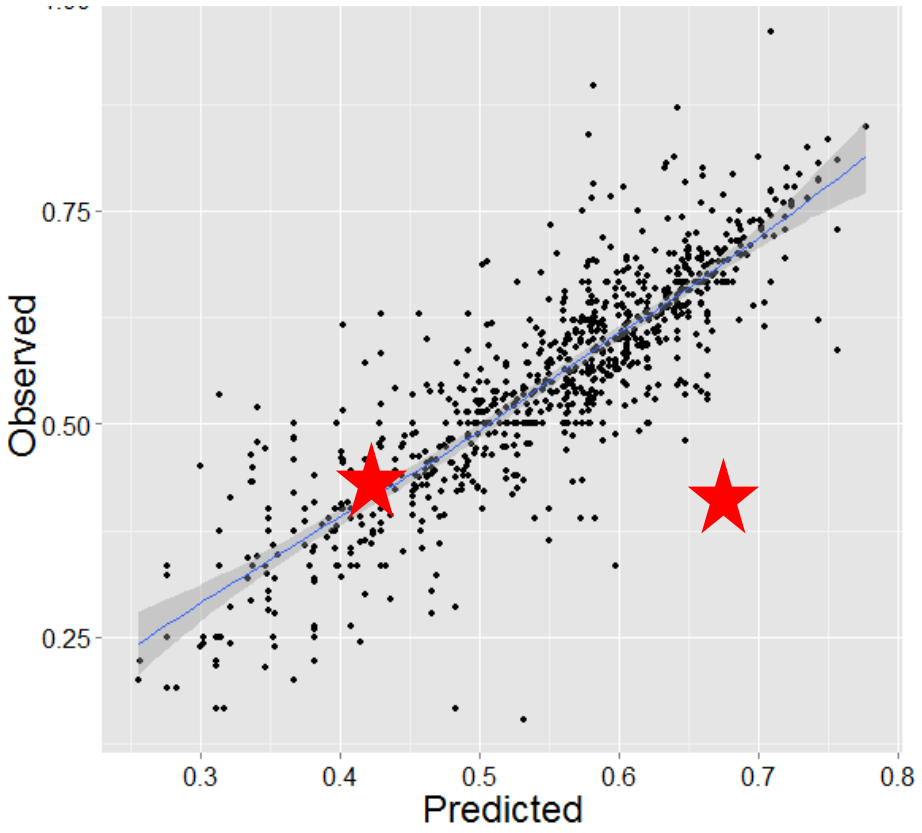


Tools to measure biological integrity

- We use a range of metrics to characterize composition (e.g., diversity, % sensitive taxa, etc.)

- Statistical models compare observed metric values to values expected at environmentally similar reference sites

Example metric:
% sensitive taxa



Objectives for bio-integrity?

- 2018 integrated report included listings based on CSCI
  - Category 5: Impaired aquatic life use due to pollutant (e.g., elevated ions), requires TMDL
- San Diego Regional Board adopted a basin plan amendment
  - Narrative objective with a numeric translator (CSCI with a threshold of 0.79).
    - May eventually include ASCI too
    - Applies to natural and soft-bottom engineered channels
    - Applies to perennial and “seasonal” streams (with 4 weeks continuous flow)
- Other regions considering objectives in their basin plans as well

Why does this matter?

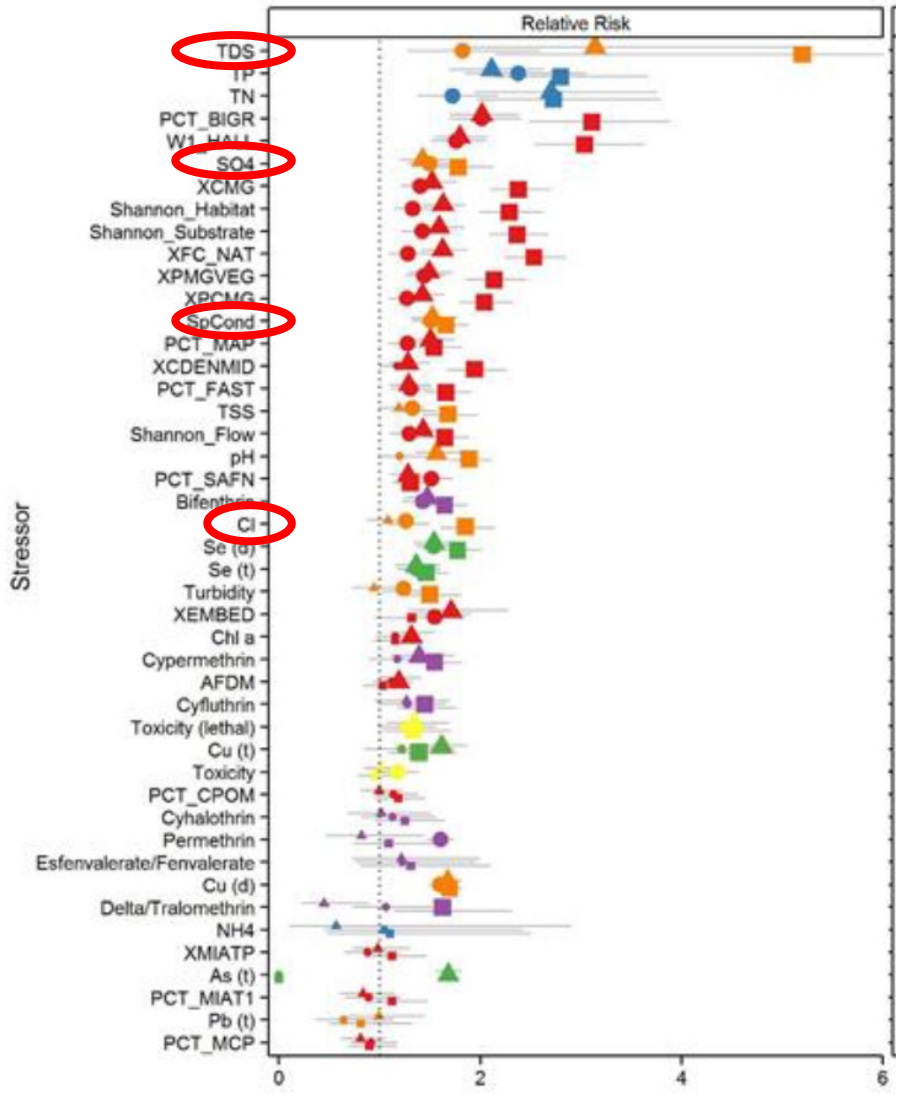
- The Santa Ana basin plan includes objectives for several major ions (Cl, SO_4, Na) and integrated measures (hardness, TDS)
- Per Listing Policy, those objectives are used to assess pollutants associated with poor biological conditions (They are known to be stressors of aquatic life)
- The thresholds were derived for human health, irrigation, and industrial uses.
  - Narratives don't reference aquatic life but don't exclude them either
- Appropriateness for aquatic life protection is unknown.

The goal of this project is to assess the potential impacts of elevated ionic concentration on aquatic life in streams.

Elevated ionic concentration is one of the most widespread and high-risk stressors for aquatic life in Southern California streams

Top stressors overall:

- Ions
- Nutrients
- Habitat degradation



High risk

Low risk

We will develop the technical foundation that will allow board staff to identify limits likely to protect aquatic life

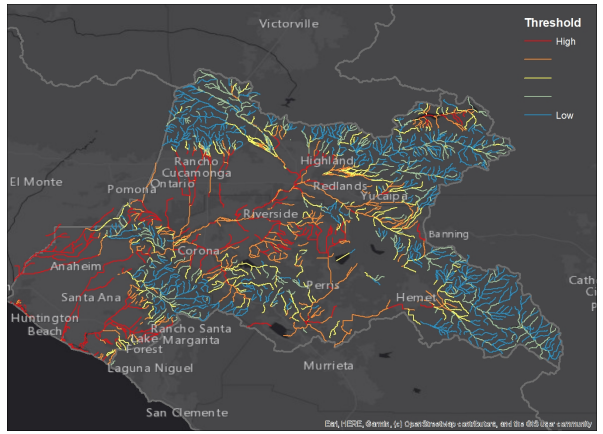
We will identify numbers that correspond to:

- Expected natural levels
- Acceptably low risk of impacts to bioassessment indices
- Acceptably low risk of impacts to biological resources of concern (e.g., priority fish or amphibian species)

Example outputs

Example limits on a parameter (sp. Cond) derived from this study

Reach	Observed reference range	Expected reference range	Limit for CSCI*	Limits for ASCI*	Limit for fish/amphib
Reach A	250 to 1200	300 to 600	900	800	2500
Reach B	250 to 1200	500 to 1200	1500	1400	2500
Reach C	250 to 1200	750 to 1400	1700	1600	2500



*CSCI and ASCI limits may vary by reach (based on predicted reference ranges) or may be constant across all reaches, depending on what the analyses support.

This is a **research project** that has implications for potential policy changes in the future

This is *not* part of the development of a new or amended policy.

This is a good time for stakeholders to weigh in on the science!

Stakeholders can provide feedback about the study

- Are there technical concerns we can address?
- Are there areas we need to pay close attention to during model development or performance evaluation?
- What implications on your operations should board staff keep in mind?

Research questions

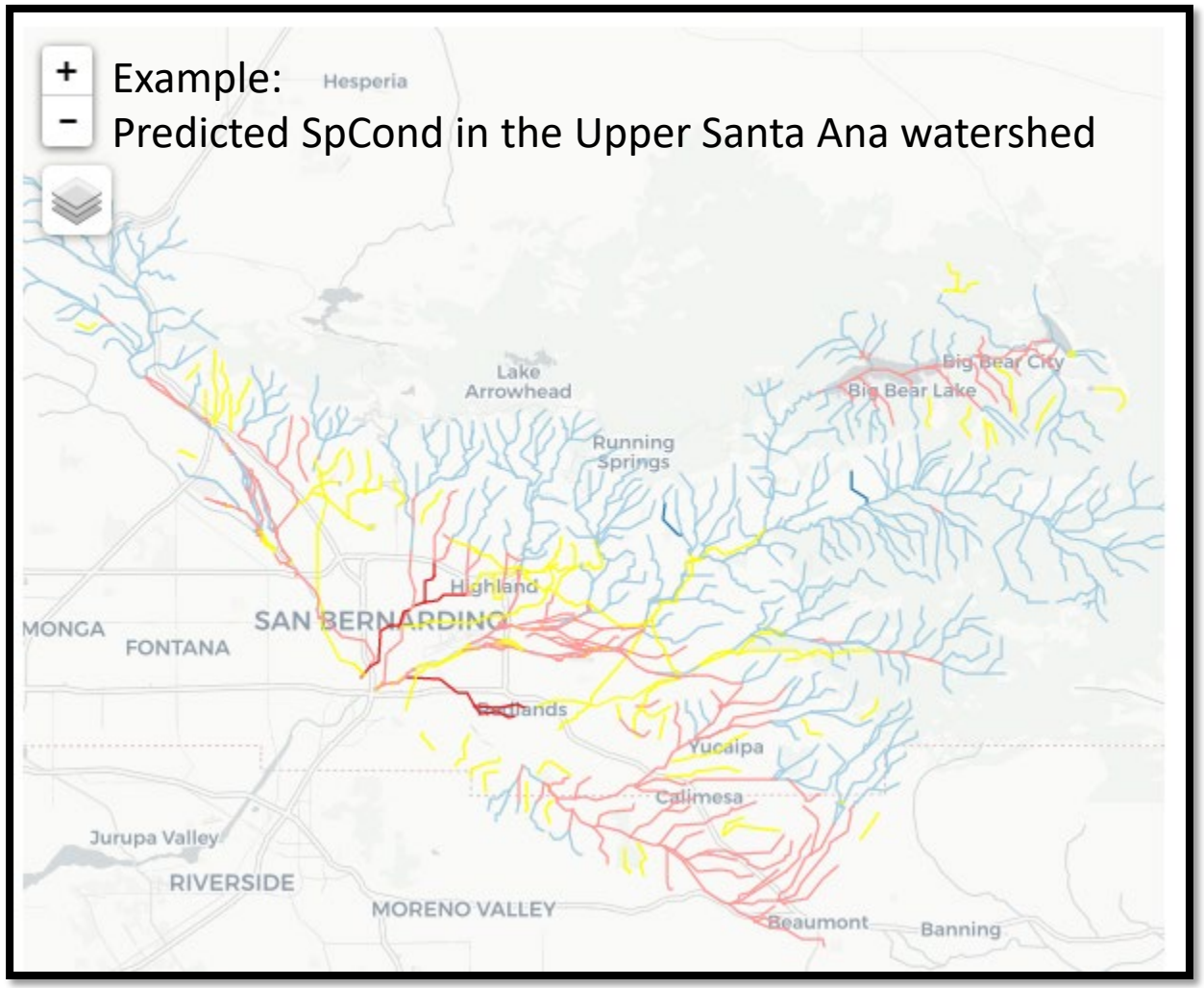
1. What are expected (natural) reference levels of major ions in the Santa Ana watershed?
2. How does elevated ionic concentration affect biological endpoints?
3. Can integrated measures (e.g., TDS, conductivity) be used as a surrogate for measuring specific ions?

First two questions can be improved with SAWPA input!

Assessing reference levels

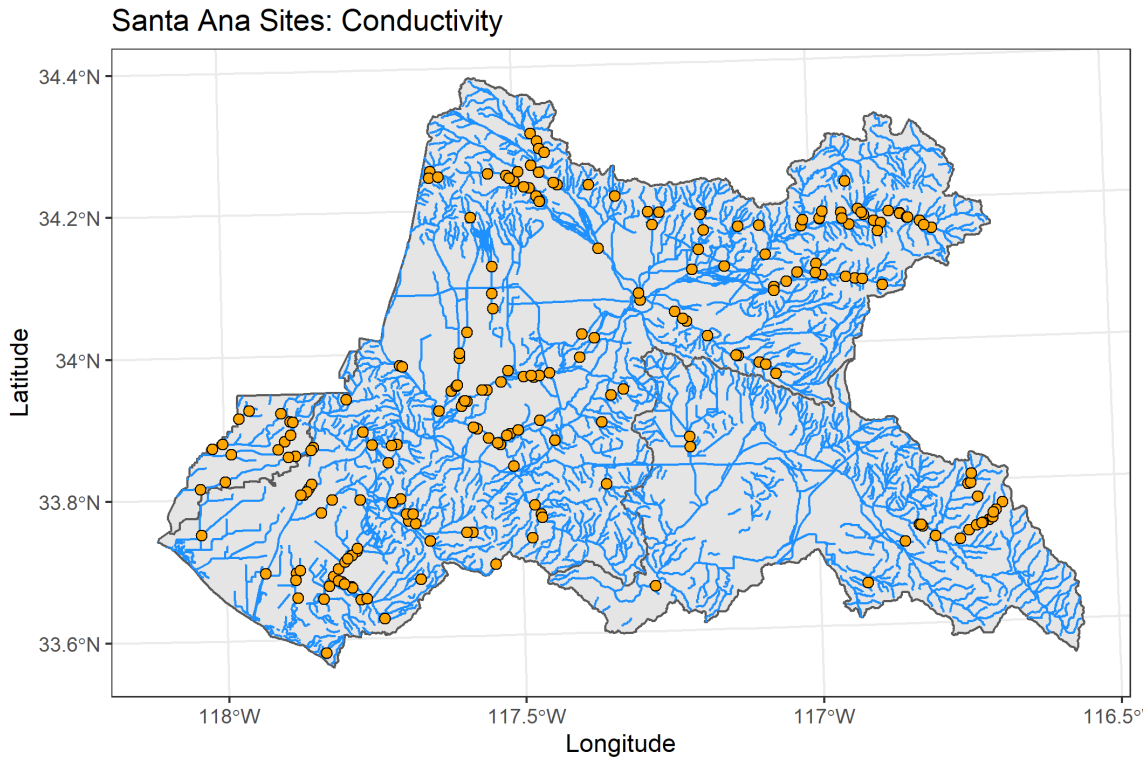
Expected range:
- Up to 450 uS/cm
- Up to 600 uS/cm
- Up to 1200 uS/cm
- Up to 2500 uS/cm

- We will follow Olson and Hawkins' 2012 study
- Build statistical models of ionic parameters at natural (reference) sites.
  - Models will have a *continental* scope, but extra focus on validating within our region.
  - Models will produce a *range* of expected levels.
  - Predictors based on soils, lithology,, climate, watershed size (natural factors only).
  - Models may incorporate seasonal variability, antecedent climate.
- Models will allow us to make maps with reach-specific predictions of natural levels



Assessing reference levels

- Our data sets include:
  - Olsen & Hawkins original data (Western US)
  - SMC (SoCal)
  - SWAMP/CEDEN (California)
  - EPA/NRSA (USA)
  - USGS/NAQWA (USA)
- Are there other data sets you have that we should consider?



Evaluating reference model performance

- Multiple aspects of performance
  - Precision (e.g., high pseudo-R2)
  - Accuracy (e.g., high % accurate predictions at validation reference sites)
- Multiple spatial scales
  - Global performance
  - Performance in Santa Ana watershed
  - Sub-regions of Santa Ana, if appropriate

Where should we focus on validating performance?

E.g., are there reaches of particular interest?

What would help you have confidence in these models?

Biological response to elevated ionic concentration

With those models, we can quantify *increases* in ionic concentration from natural levels!

- We can model response to *differences* between observed and expected levels.

Although our bioassessment indices were already designed to minimize the influence of natural factors (e.g., geology), these water chemistry models improve our ability to avoid conflating impacts of natural vs. anthropogenic sources of ions.

Biological response to elevated ionic concentration

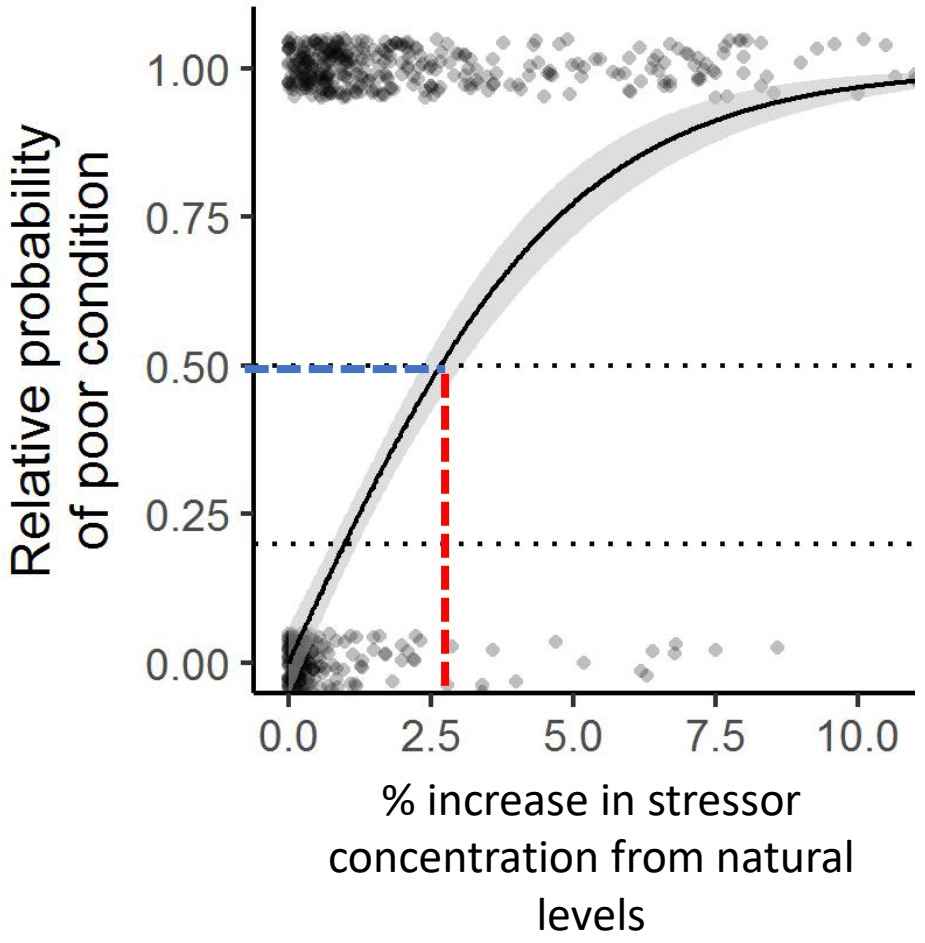
We can focus on two kinds of responses:

- Standard bioassessment indices (CSCI, ASCI)
- One or more species of aquatic vertebrate of management concern (e.g., Santa Ana sucker, arroyo chub, yellow-legged frog, California newt et.c)

The two response-types require slightly different approaches

Determine assessment threshold concentrations to maintain high index scores:

1. Calibrate response models (e.g., logistic regressions) to predict likelihood of poor index scores
2. Identify concentrations associated with "acceptably low" likelihood

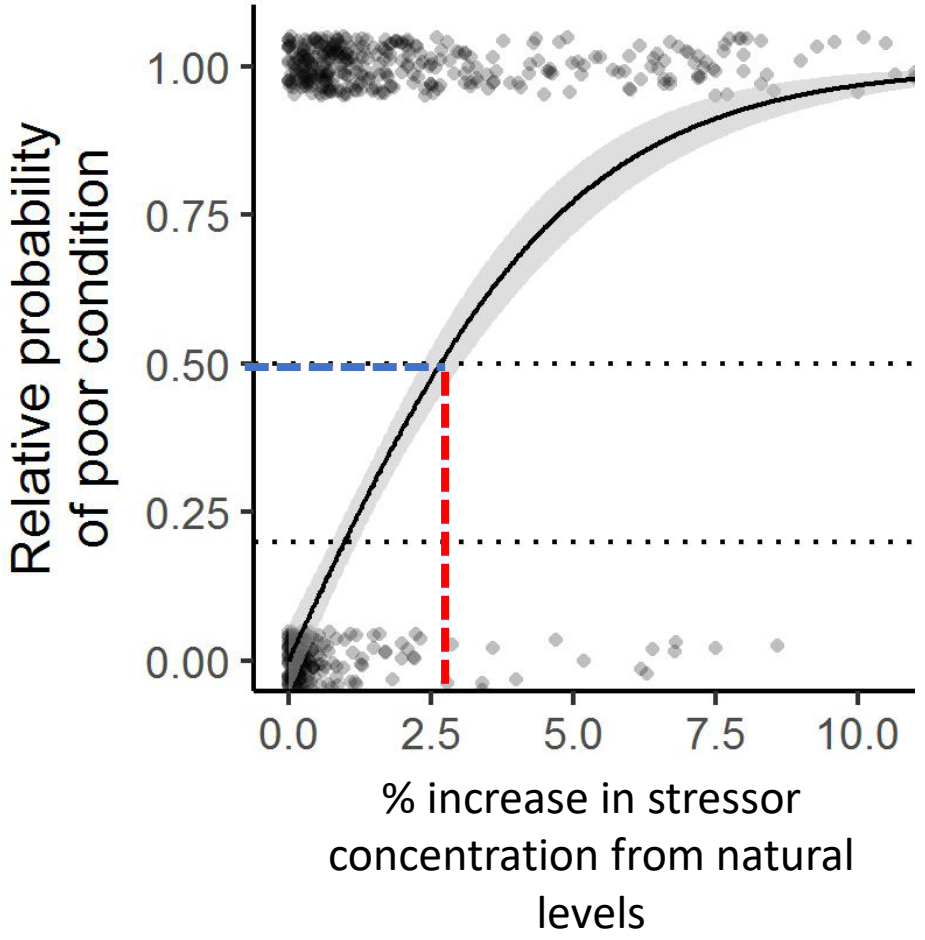


Determine assessment threshold concentrations to maintain high index scores:

Acceptably low

- A *non-technical* decision made by WB staff based on risk tolerance
- We will evaluate several options

SAWPA can examine these curves and share their views on risk with the Regional Board.



Determine assessment threshold concentrations to support aquatic species of management concern:

1. Consult with regional experts, WB staff, and stakeholders to identify priority species of fish and/or amphibians.
2. Review technical literature for preferred and tolerated concentrations.

How do we pick a species to focus on?

- Native vs non-native?
- Life history factors (e.g., longevity)?
- Conservation status (protected, HCP, stocked etc.)?
- Known sensitivity to ionic concentration?
- Widespread or narrow distribution?

Group	Species	Comments
Fish	Santa Ana sucker	Protected, limited range
	Speckled dace	Protected, limited range
	Arroyo chub	Protected, limited range
	Rainbow trout/steelhead	Re-introduction target, protected, limited range
	Brown trout	Stocked, limited range
Amphibs	Arroyo toad	Protected, limited range
	Yellow-legged frog	Protected, limited range
	Newt	Native, moderately widespread
	Treefrogs	Native, very widespread

How should we select a species to focus on?
Do you know of specific studies that may help us?

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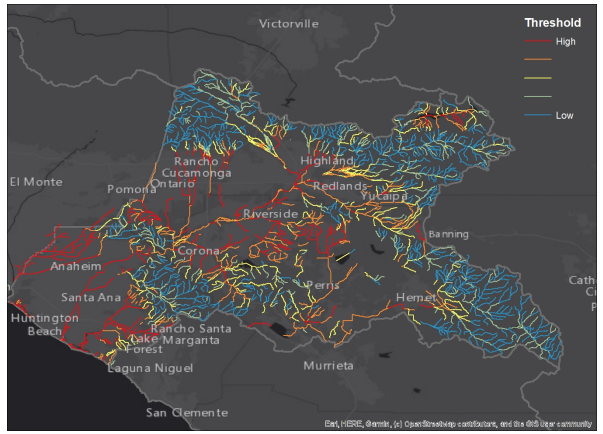

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Questions for you now

- Any comments or thoughts on our general approach and research goals?
- What should we pay attention to when evaluating model performance?
- What aquatic vertebrate species would you like us to focus on?

How can SAWPA agencies get involved?

- Share data we can use to develop or validate models
- Provide feedback at future meetings
- Review technical products