Putting Biology to Work

SWAMP's Bioassessment Program

Water Quality Monitoring Council - June 1, 2016

- Bioassessment Program's mission and strategy
- Core datasets – PSA, RCMP
- Phase II – Facilitating implementation
- Role of causal assessment

"Society's increased reliance upon technology to maintain our desired standard of environmental quality often results in our overlooking the best possible monitor of environmental quality – life itself."

- W.A. Thomas, G. Goldstein, and W.H. Wilcox
preface to Biological Indicators of Environmental Quality (1973)

Its challenging, but essential that we use ecological information in water quality monitoring

SWAMP Bioassessment Program Vision

Measures of ecological integrity are fully integrated into California's water resource management programs; California makes full use of this information to measure, protect and restore its waterbodies.

- *multiple waterbodies*
- *multiple indicators*
- *multiple programs*

SWAMP Bioassessment Program Strategy

Provide information and tools to assess ecological health and causes of impairment and support the integration of ecological condition indicators in a broad range of regulatory and management programs.

SBP Business Model *invest in three areas:*

i) infrastructure to standardize methods/tools,

ii) core monitoring programs to generate multiuse datasets

iii) communication/collaboration to leverage partnerships to expand body of knowledge and tools for better/faster implementation

Reference Condition Management Plan (RCMP)

"What should the biology look like at a test site?"

Reference Condition Management Plan (Ode et al. 2016, *Freshwater Science*)

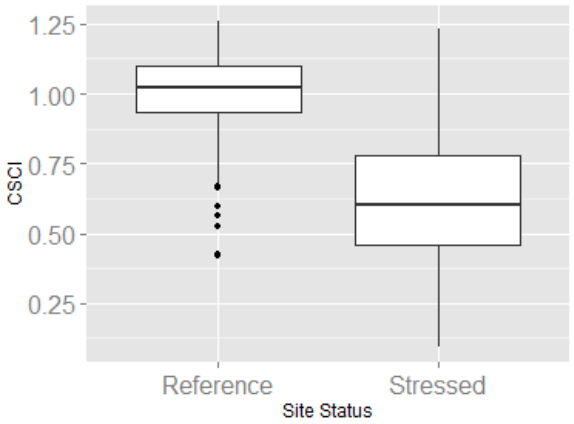
Screened thousands of sites to select a set of sites with low levels of human activity

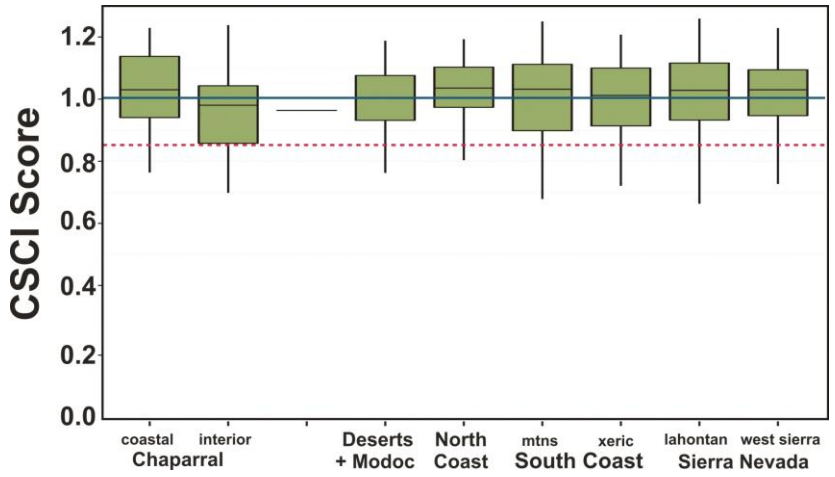
Tested selected sites to ensure that all stream types are well-represented

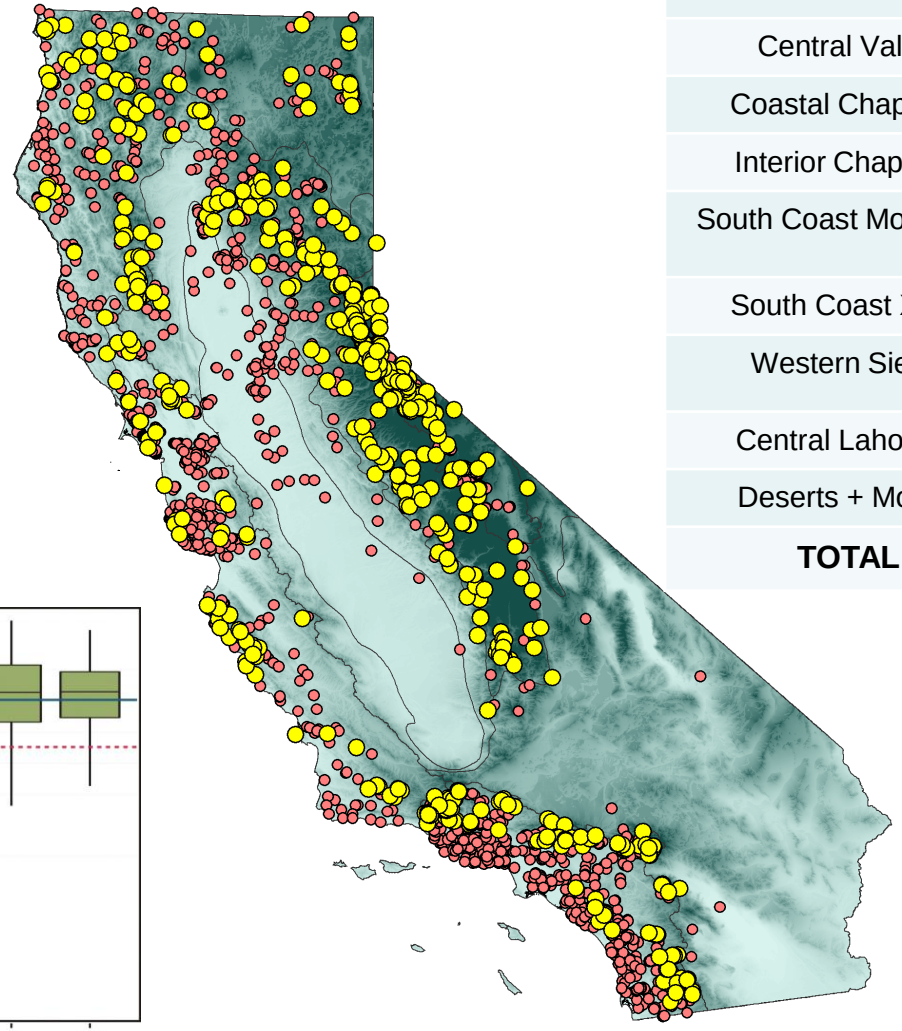
Network of ~700 sites and growing

RCMP is foundation for California Stream Condition Index (CSCI)

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**



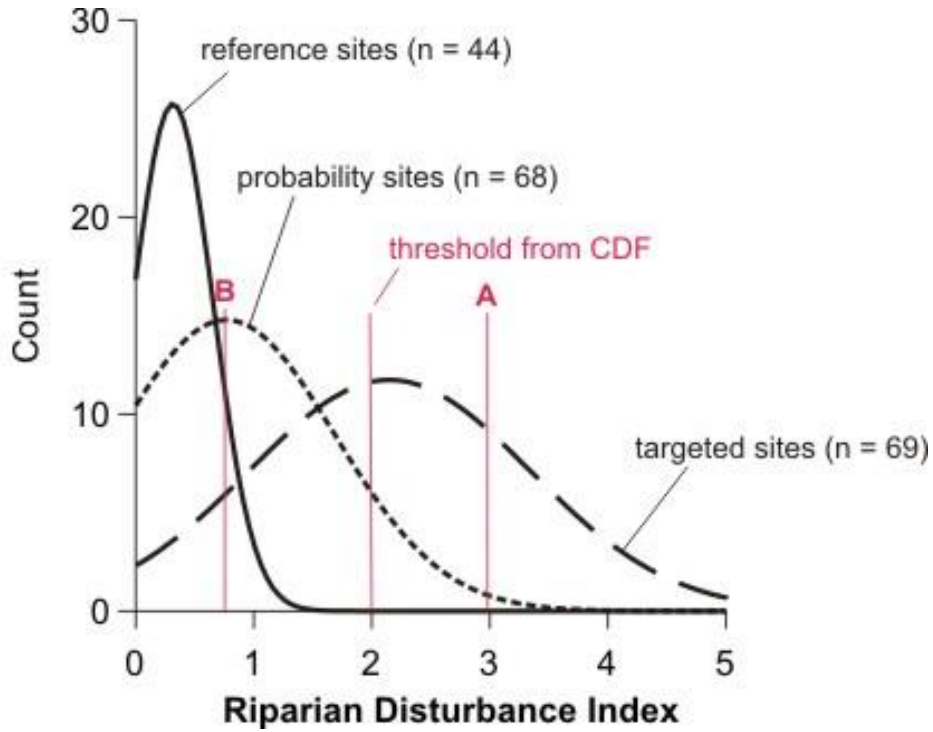




RCMP useful for more than bioassessment

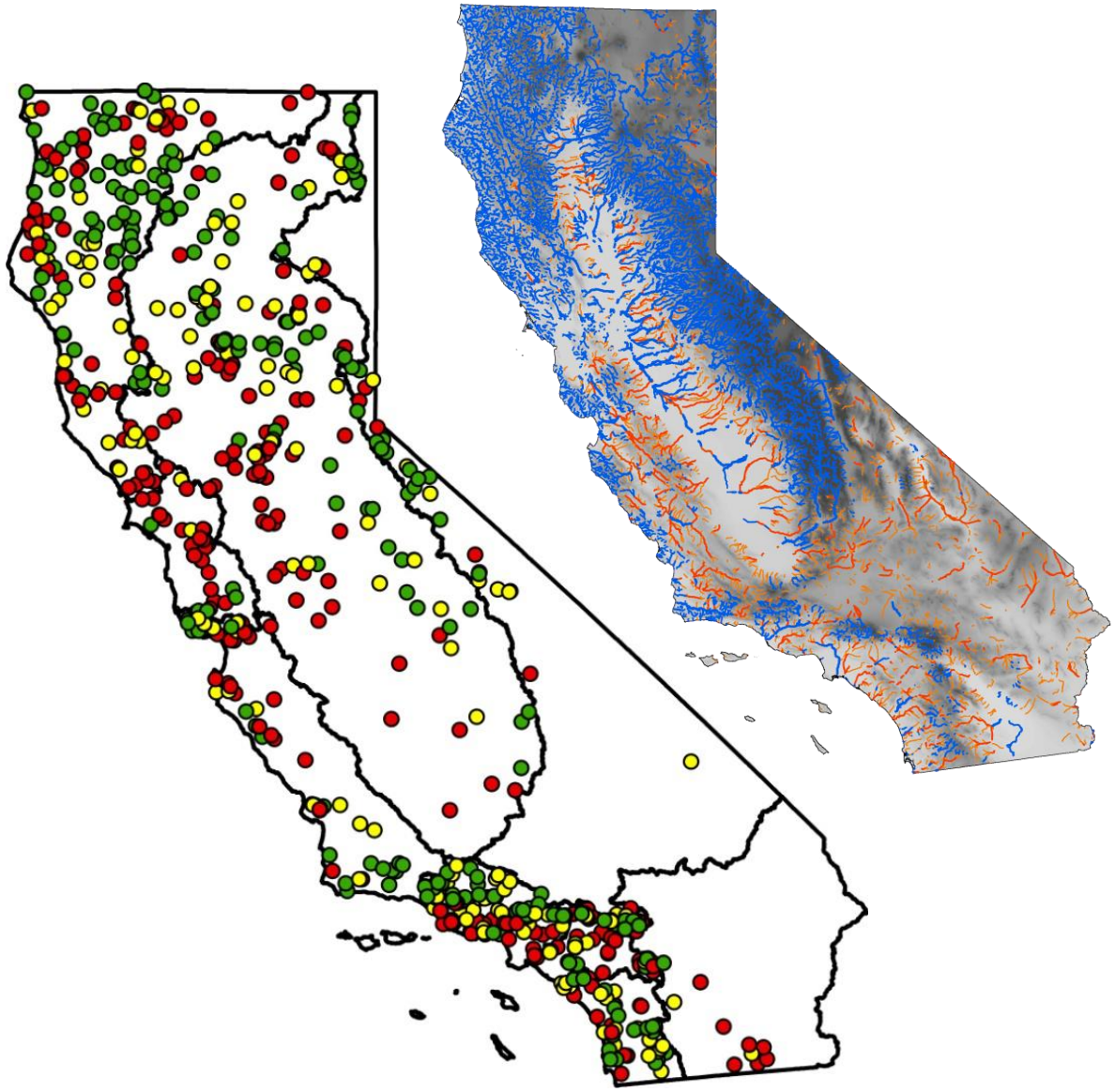
Provides a way to set expectations for variables where expectation is not zero

- biology (bugs, algae)
- nutrients, ions, conductance
- flow characteristics
- fine sediment

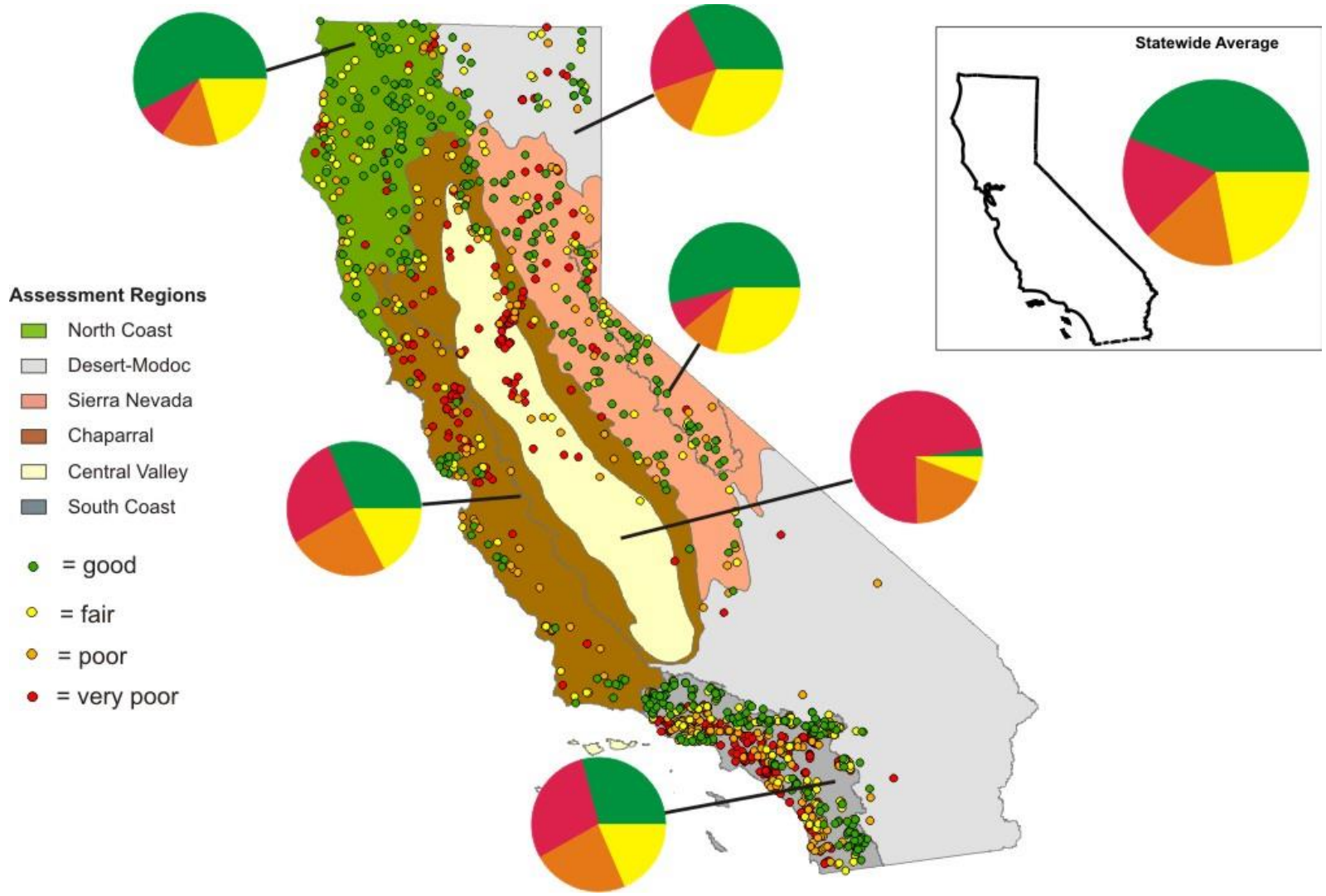


SWAMP's Perennial Streams Assessment (PSA)

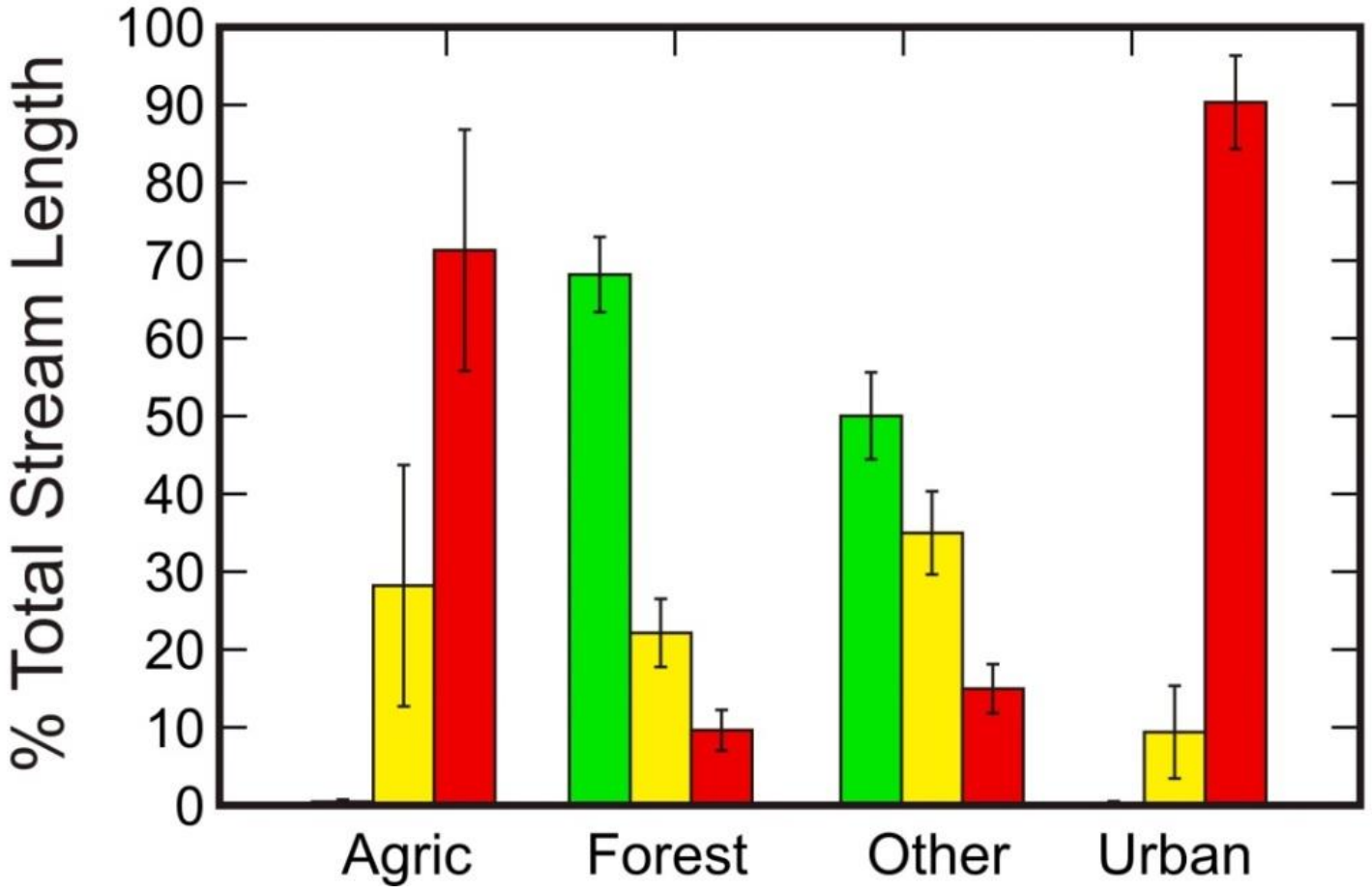
- Probability survey of wadeable, perennial streams in CA (based on EPA's EMAP/ NARS surveys)
- Provides unbiased answers to key management questions
  - What is the condition of the resource?
  - Getting better or worse?
  - What are the major stressors associated with biological impairment?
- Since 2000, ~1400 sites total, 6 (9) regions of the state
- Includes other probability surveys (**SMC**, USFS, private timber, RMC)



SWAMP's Perennial Streams Assessment (PSA, 2000-2012)

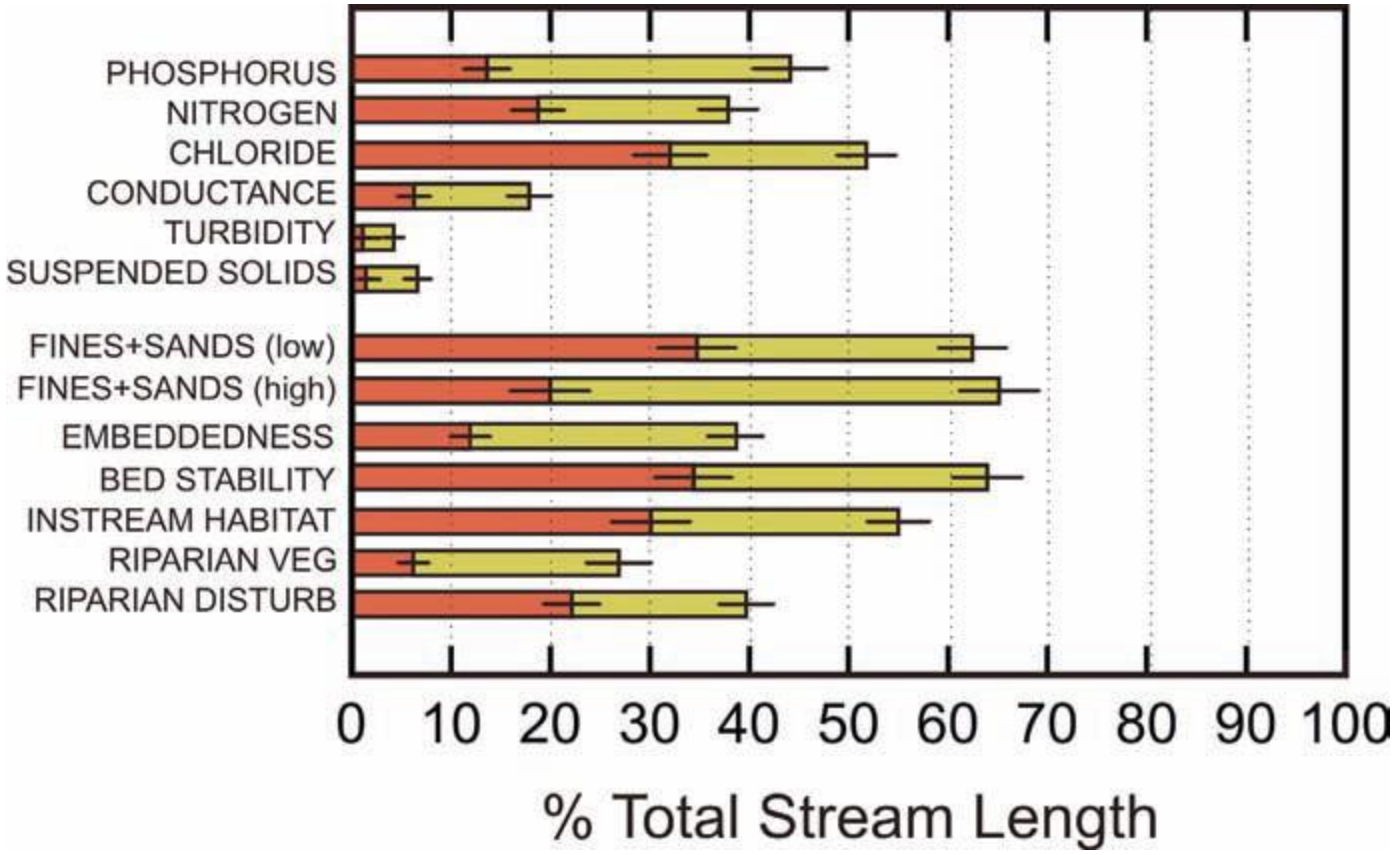


Condition Assessments by Landuse



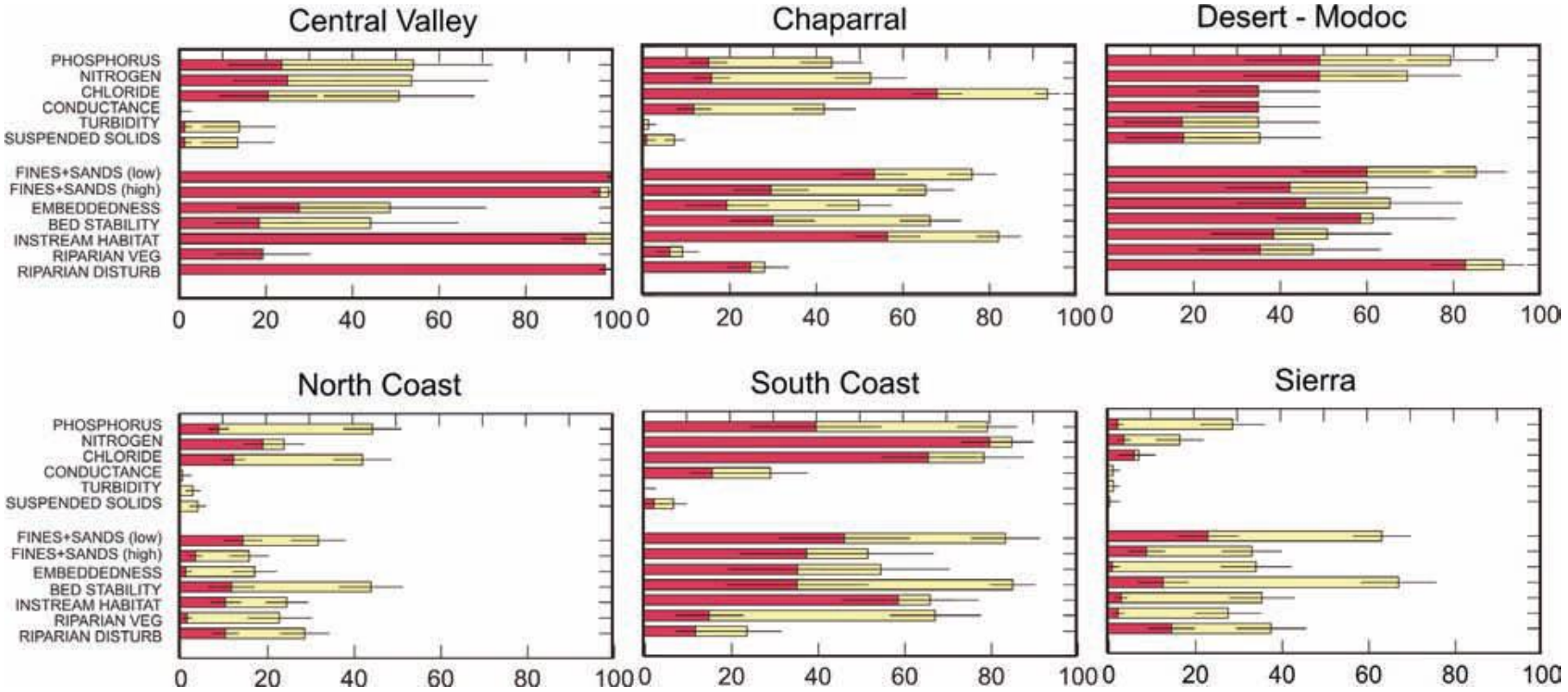
Stressor Extent Estimates:

% of stream length with high (red) or moderate (red + yellow) levels of various stressors



Stressor Extent Estimates by Region:

% of stream length with high (red) or
moderate (red + yellow) levels of various stressors



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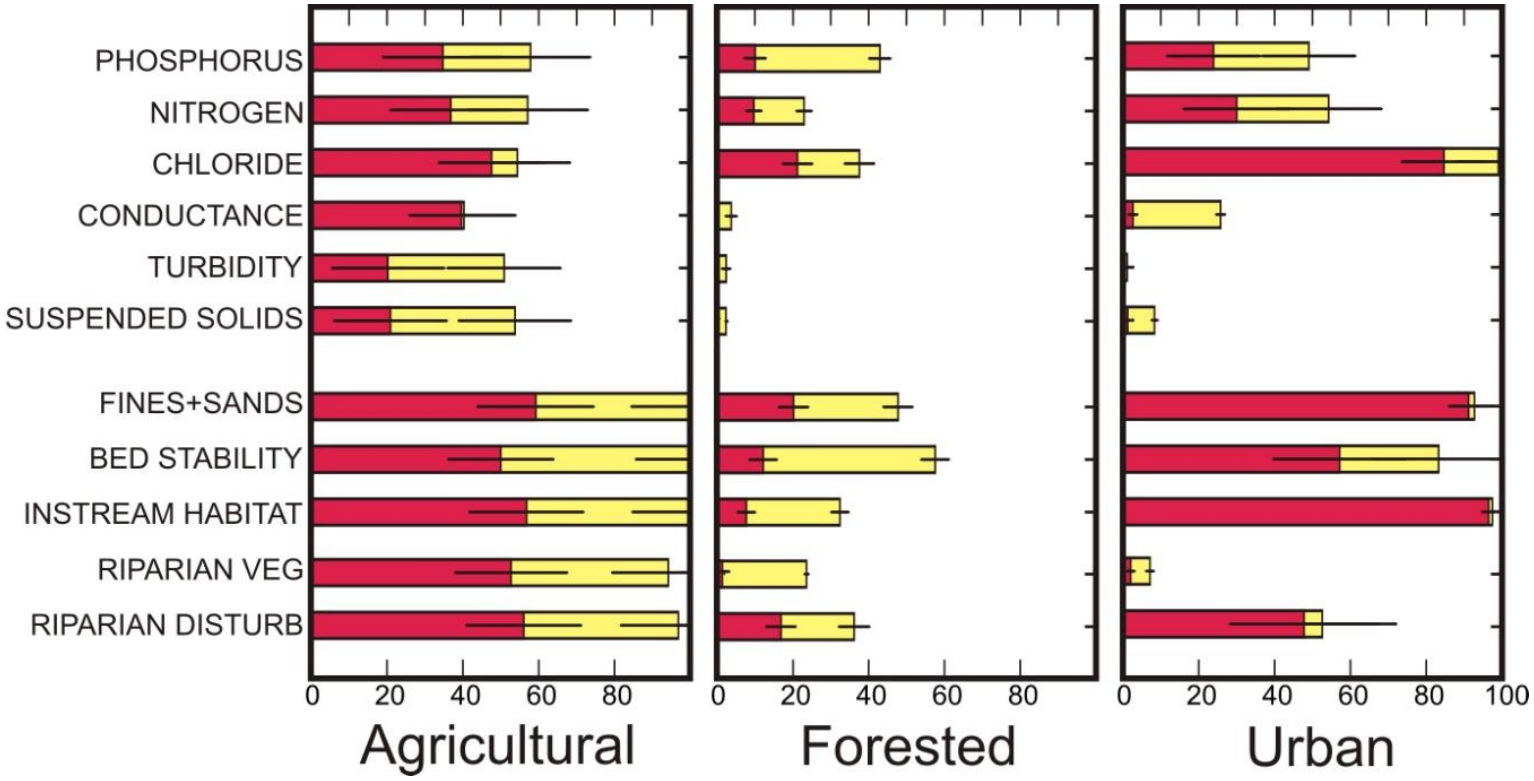

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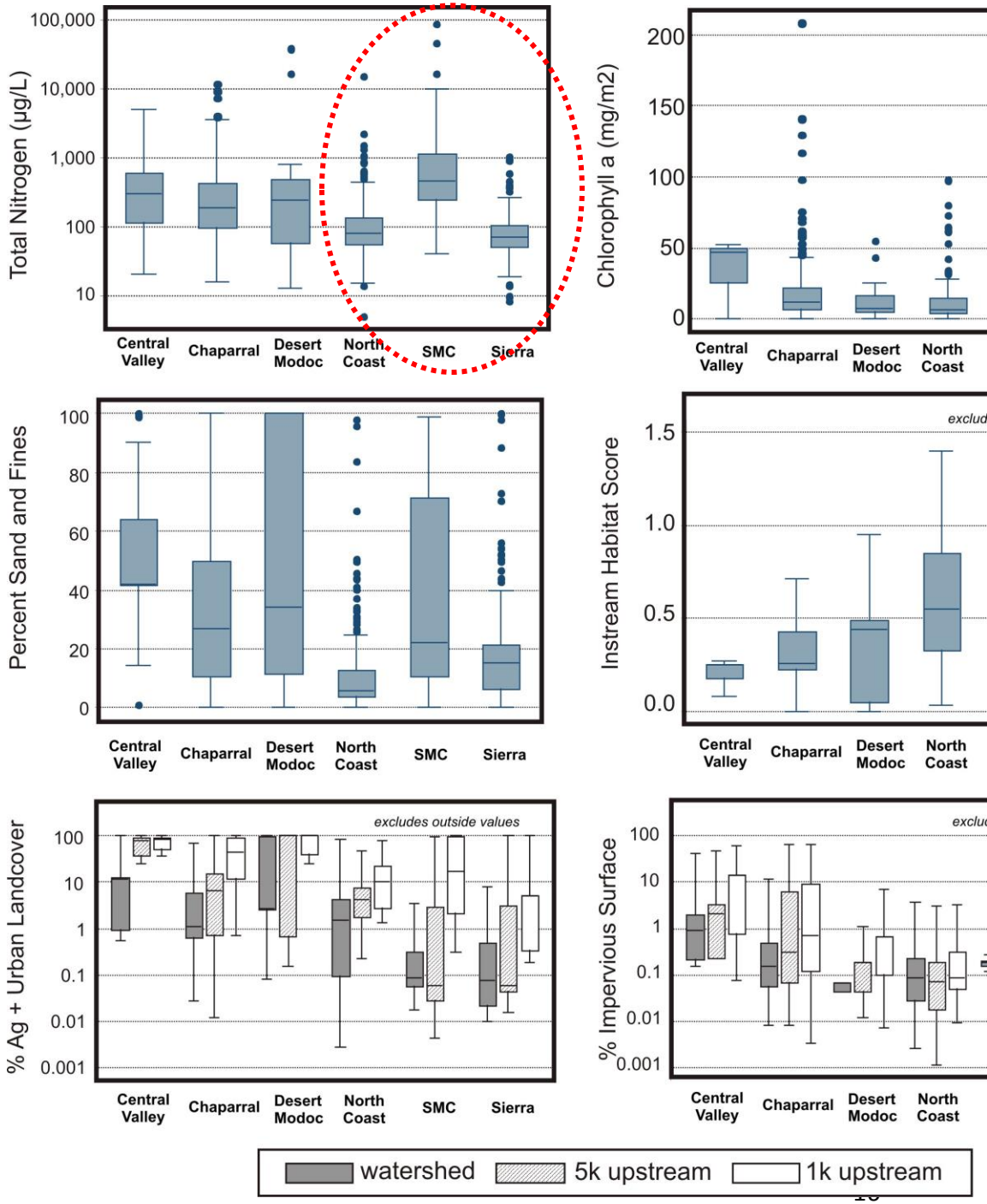
Ranges of stressors in different regions

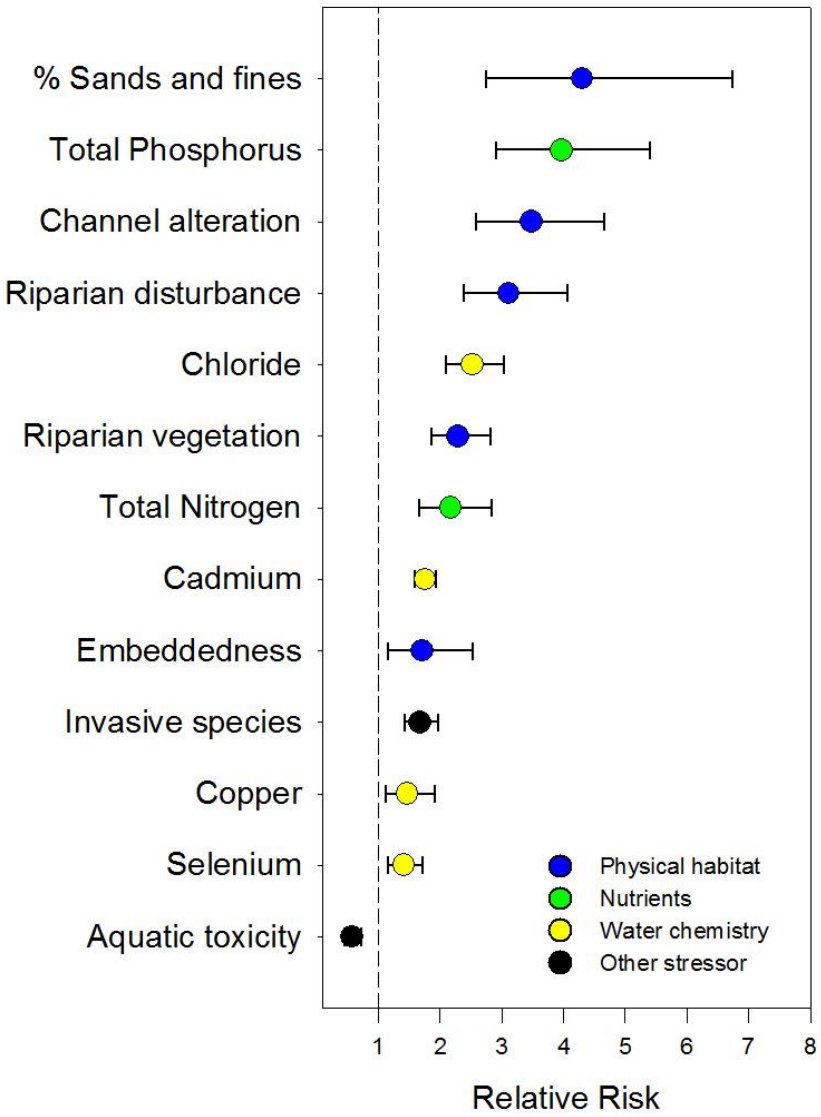
Can also look at influence of spatial scale for GIS variables



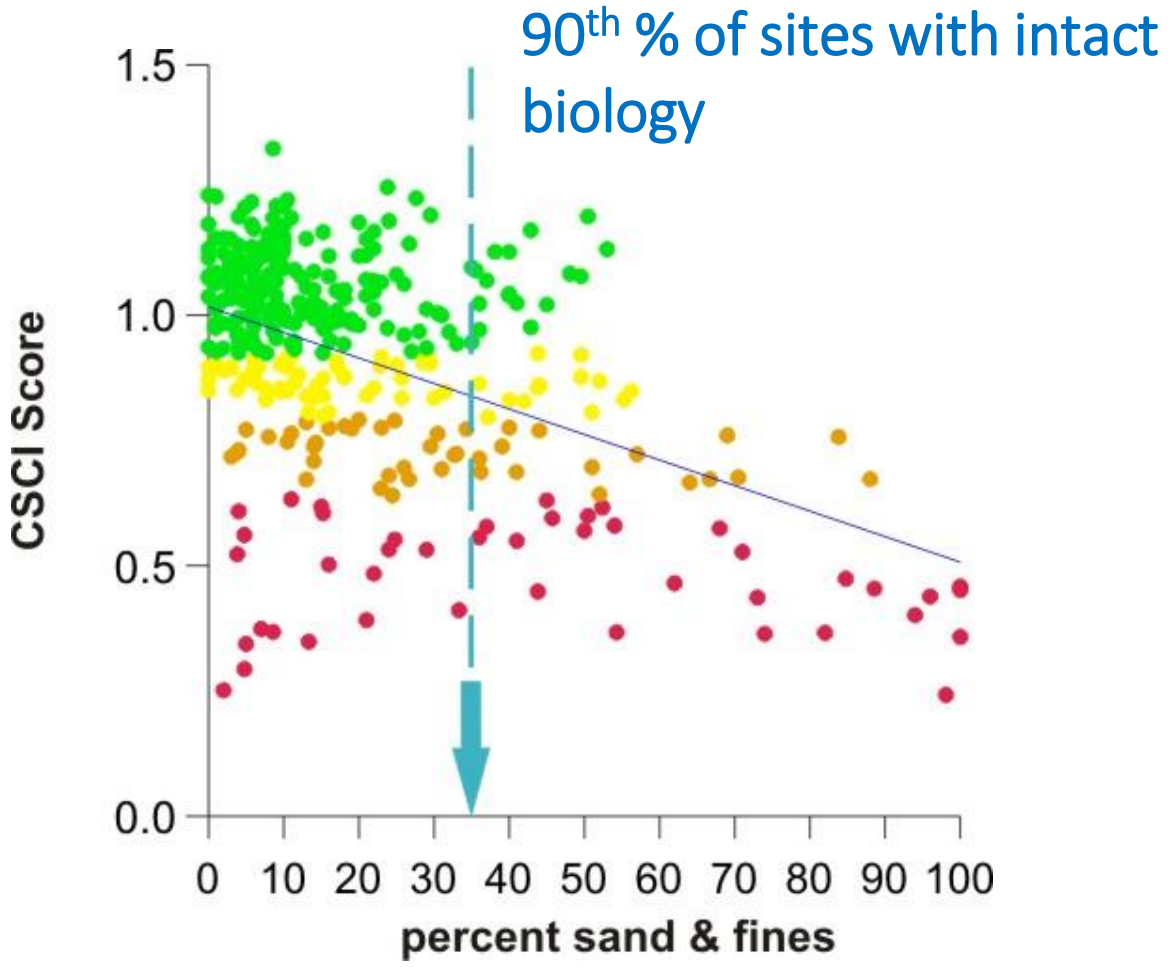
Relative Risk

Increased risk of biological impairment in presence of high stressor levels *(analogous to medical risk advisories – e.g., 10x higher risk of emphysema associated with smoking)*

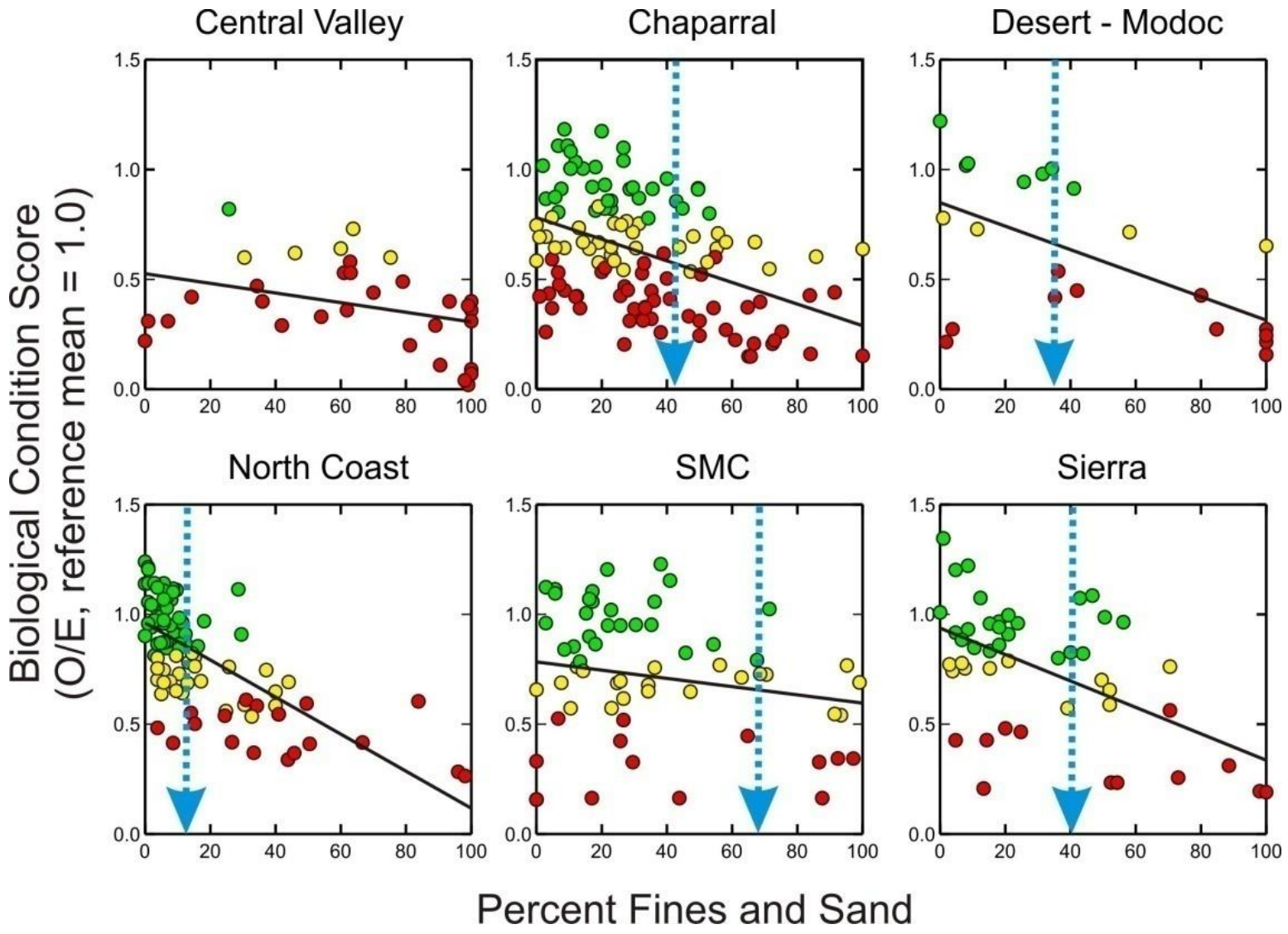
Data from SMC probability survey (Mazor et al. 2011)



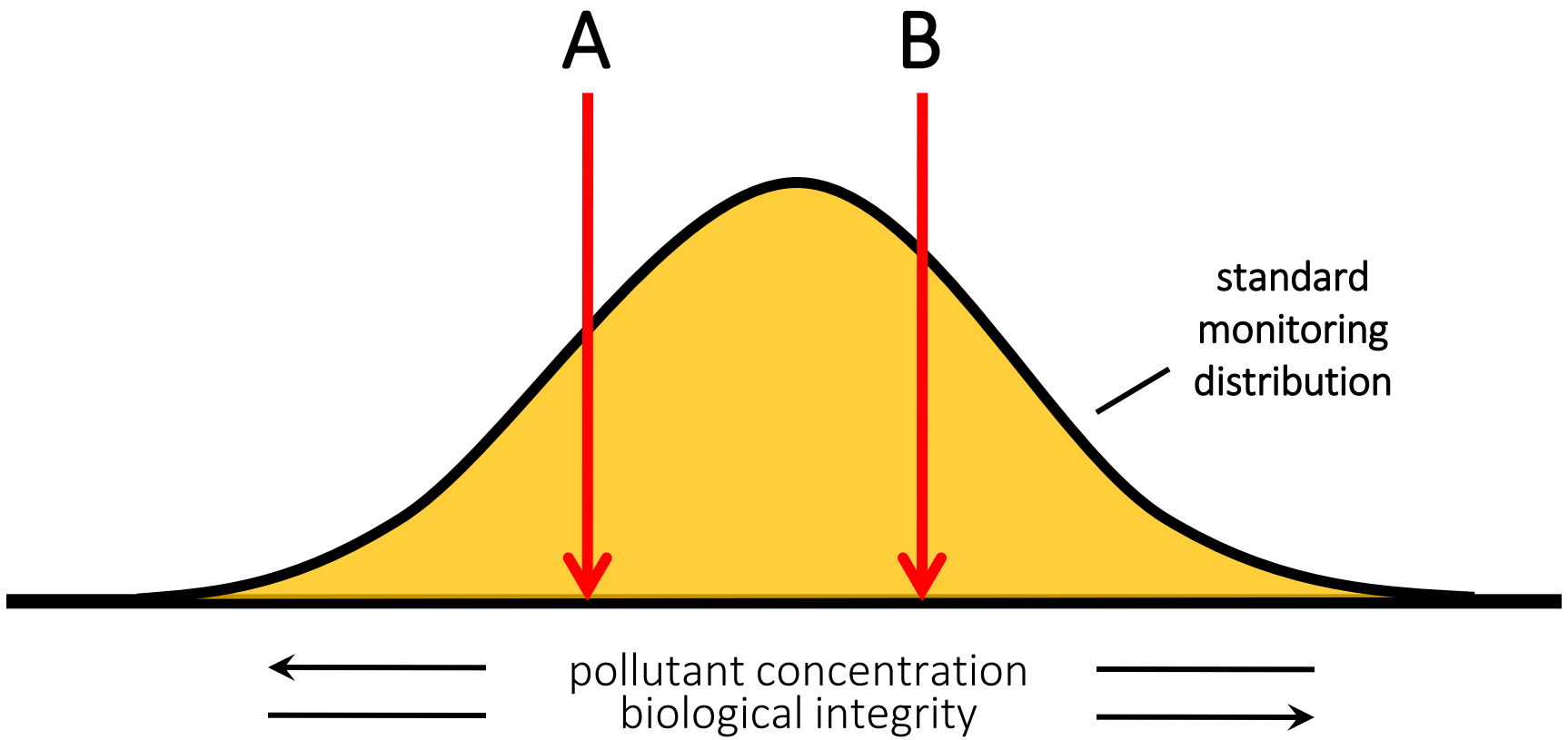
Biology based stressor thresholds

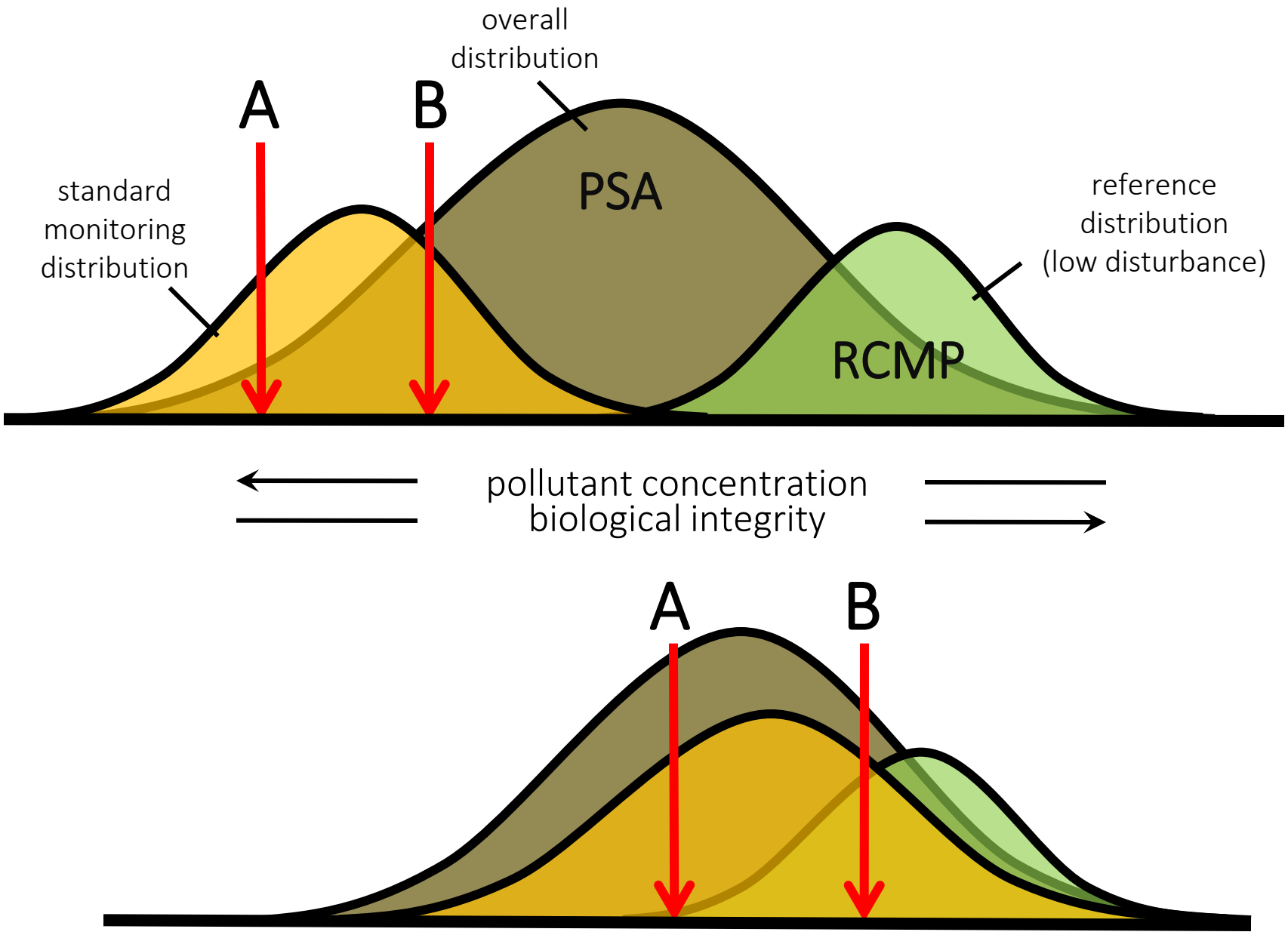


Regionally relevant thresholds



Probability and reference surveys provide context for interpreting targeted data




overall
distribution
A
B
PSA
standard
monitoring
distribution
reference
distribution
(low disturbance)
RCMP
pollutant concentration
biological integrity
A
B

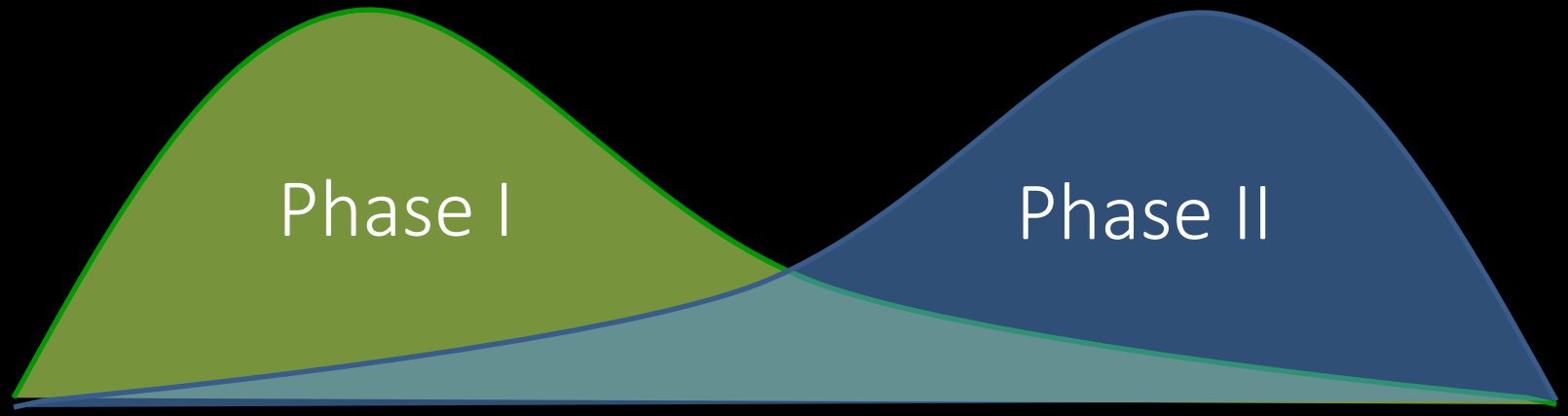
PSA/RCMP Indicators (local variables)

Category	Indicator	EMAP	CMAP	PSA
Physical Habitat	Instream habitat condition	**x**	**x**	**x**
	Riparian vegetative condition	**x**	**x**	**x**
	Human activities within reach	**x**	**x**	**x**
Biological Indicators	Benthic macroinvertebrates	**x**	**x**	**x**
	Algae	**x**	**x**	**x**
	Fish	**x**	-	-
	CRAM Wetland Condition	-	-	**x**
Chemical Indicators/ Stressors	SSC/TSS, turbidity, pH, conductance, DO	**x**	**x**	**x**
	Major ions (Cl^-, SO_4)	**x**	**x**	**x**
	Nutrients (N, P, Si)	**x**	**x**	**x**
	DOC	**x**	**x**	**x**

Moving from Phase I to Phase II

Phase I - *developing the capacity to conduct reliable ecological assessments (emphasis on BMIs in wadeable streams)*

Phase II - *expanding the universe of scope and tools and fostering implementation in Waterboard programs and elsewhere*



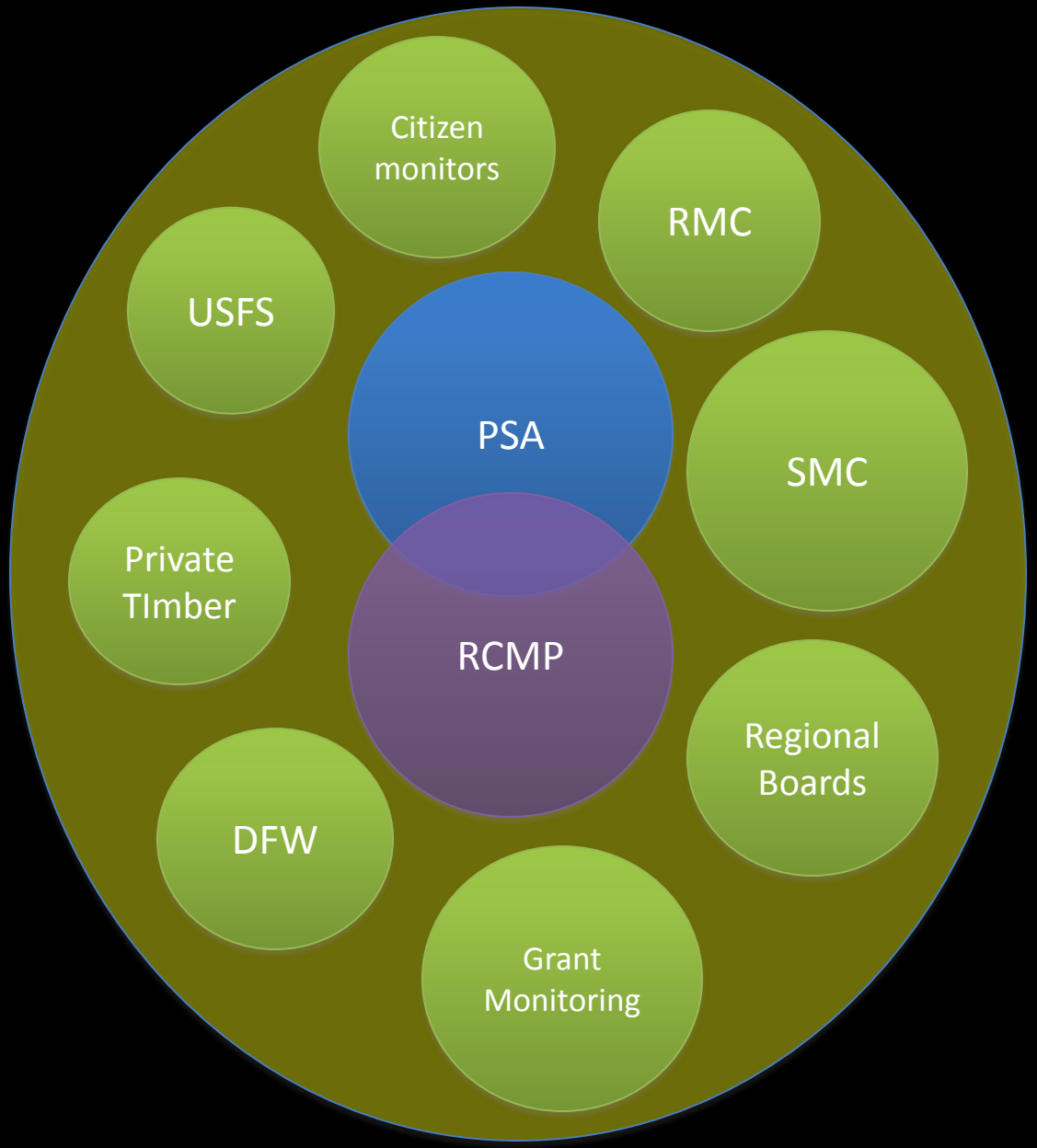
Infrastructure Development – *Develop standard methods and tools for collecting, evaluating, managing, interpreting and reporting biological data*

Phase I – Infrastructure (mostly) in place for BMIs/wadeable streams, limited program resources used to maintain and support new features, external investments (e.g., 205j)

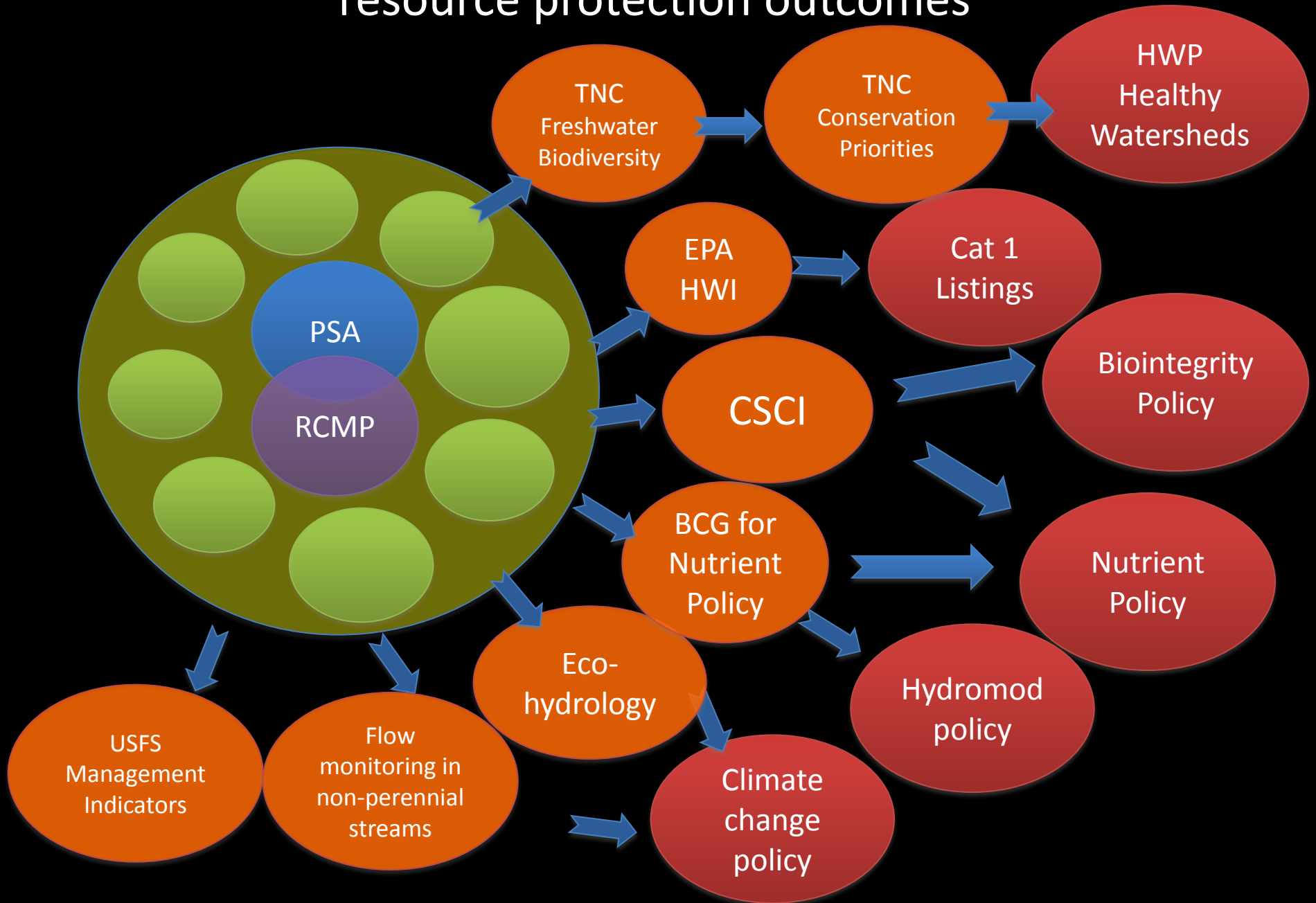
Phase II – **Expanding capacity/capabilitites (a few examples/recommendations)**

- Algae – much infrastructure now in place (field and lab methods), investing in statewide indices, taxonomic standards, quality assurance, molecular tools?
- Nonperennial streams – testing methods, improving maps, modeling flow-ecology relationships (mostly funded by grants)
- Climate/Drought impacts – key to environmental flows
- Nutrient impacts – BCG, NNE, nutrient policy
- Depressional wetlands – pilot testing in R2 and SoCal
- Causal assessment tools – SCCWRP pilots

core investments spur others



Core monitoring datasets ultimately leverage better resource protection outcomes



Phase II – Through the Lens of Causal Assessment

Causal Assessment – what to do when you have impaired biology?

Developing the toolbox for finding patterns, associations and probable cause in a multivariate world

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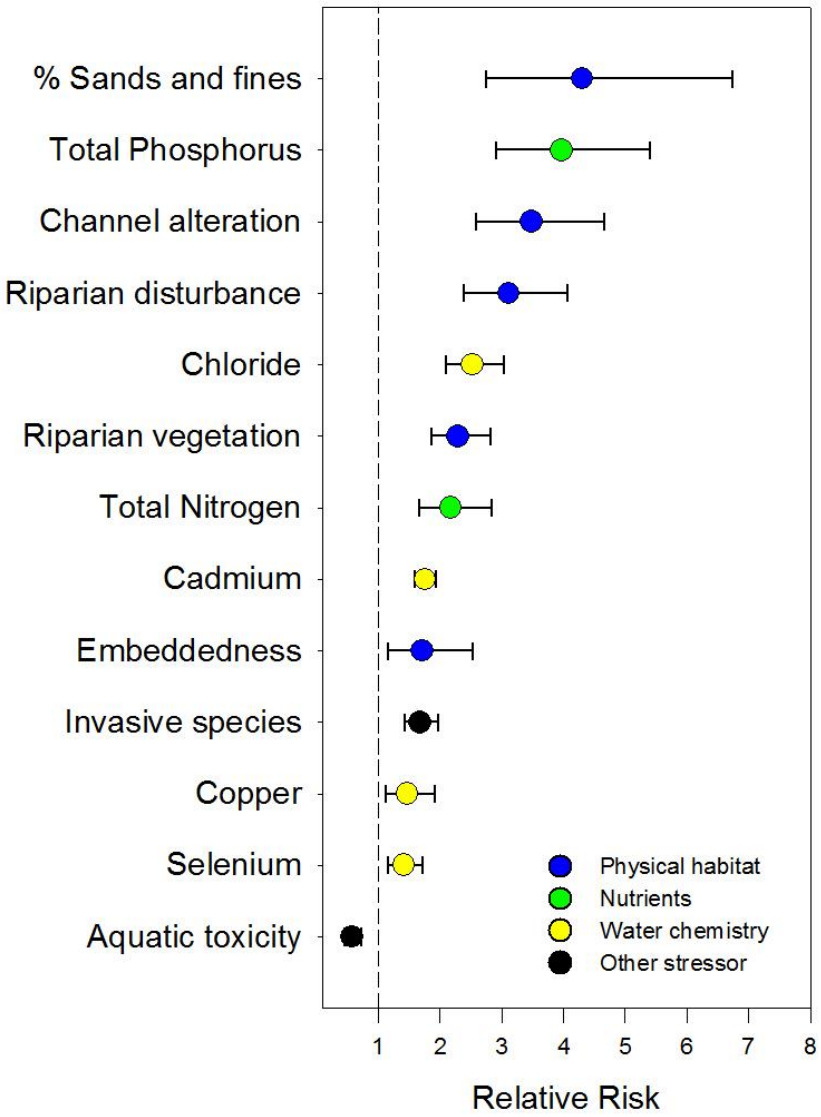
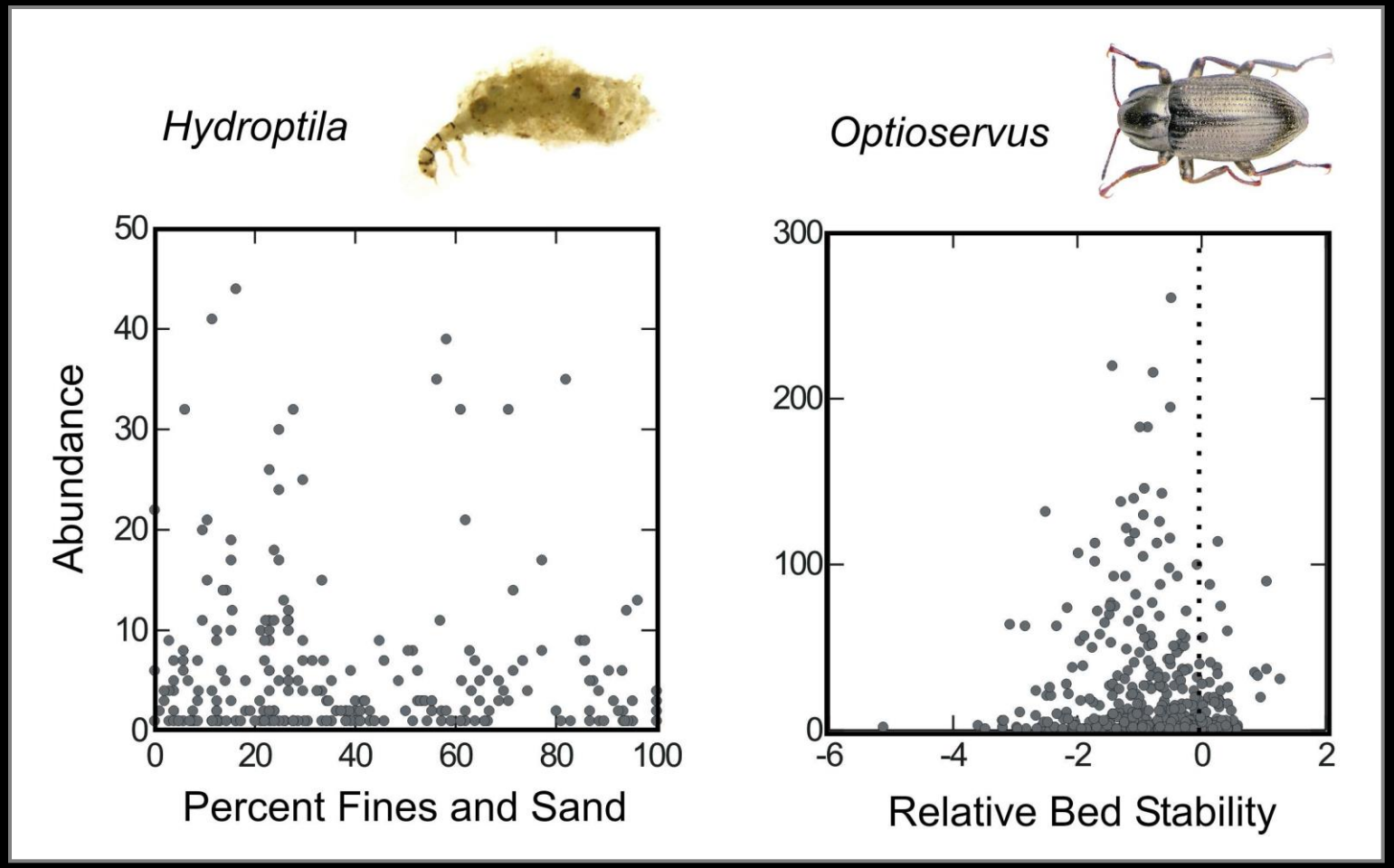
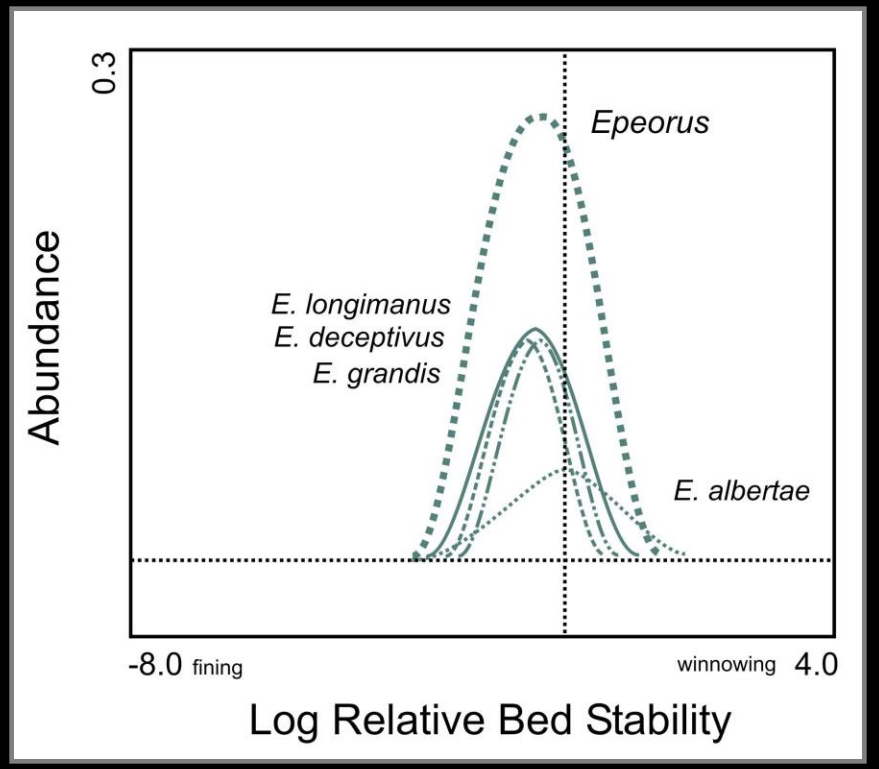


Stressor-specific tolerance values

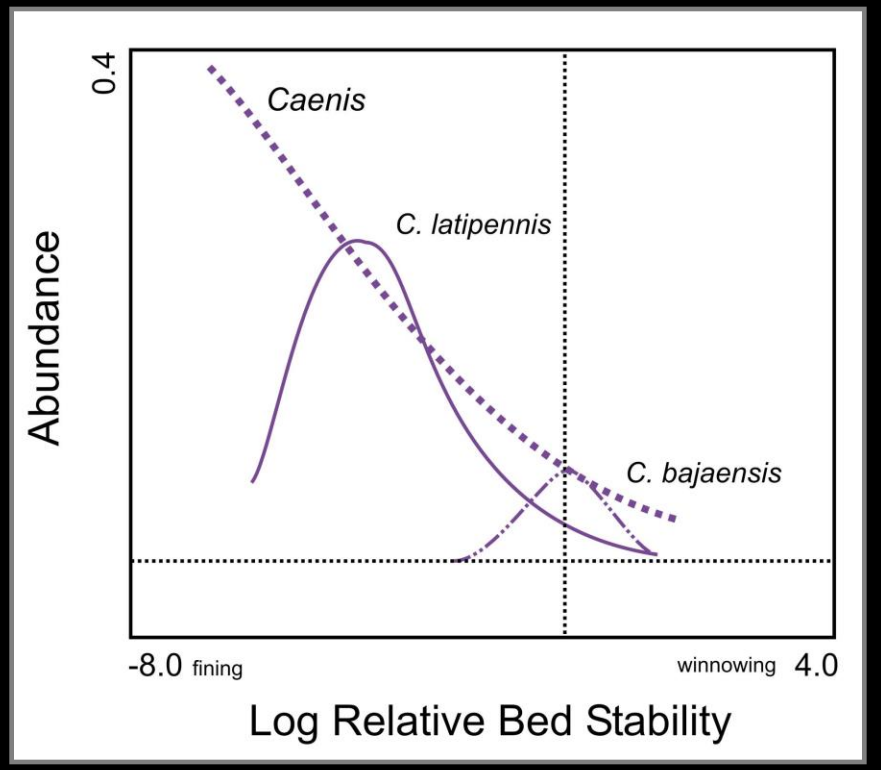


Sediment intolerant vs. sediment tolerant

Epeorus



Caenis



Tolerance values for pesticides – SPEAR (SPEcies At Risk)

• Developed in Germany in 2005 for use in European streams (Matthias Liess and colleagues)

• SPEAR metric = relative abundance of species in a sample that are sensitive to pesticide toxicity

• Sensitivity is based on specific traits:
  - physiological sensitivity to pesticides
  - generation time
  - presence of aquatic stages
  - ability to migrate and recolonize

• Species level IDs are preferable, but some taxa are aggregated at higher taxonomic levels to accommodate typical monitoring data

Adapting SPEAR to California taxa

(Andy Rehn and Marco Sigala, Lisa Hunt, Bryn Phillips and Brian Anderson)

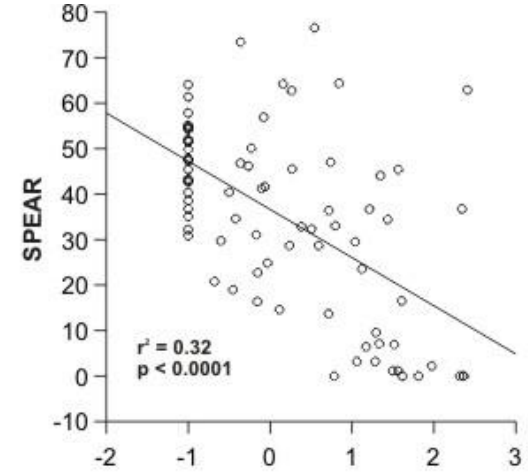
SPEAR sensitivity traits from Europe applied to CA taxa (when it made sense)

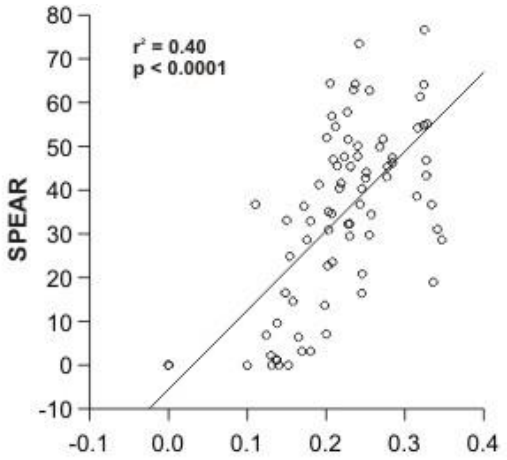
- good taxonomic overlap
- sensitivity consistent within a taxon

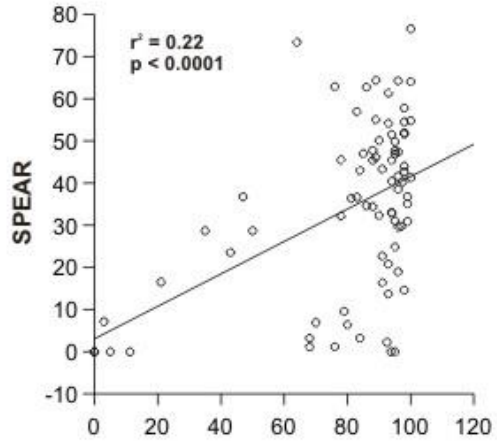
Created a testing dataset (78 samples from 61 sites) with overlapping bioassessment, sediment pesticide and sediment toxicity data

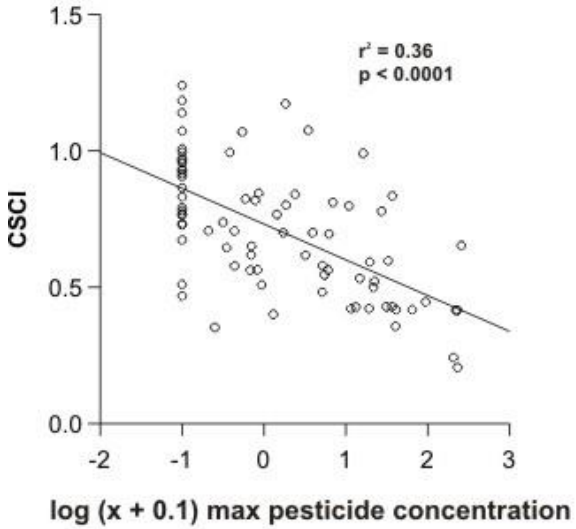
- 12 sites from SPoT with a bioassessment site w/in 500m
- 49 sites from the SMC program; all data collected at same site/ same day

Comparisons of SPEAR index and the CSCI responses

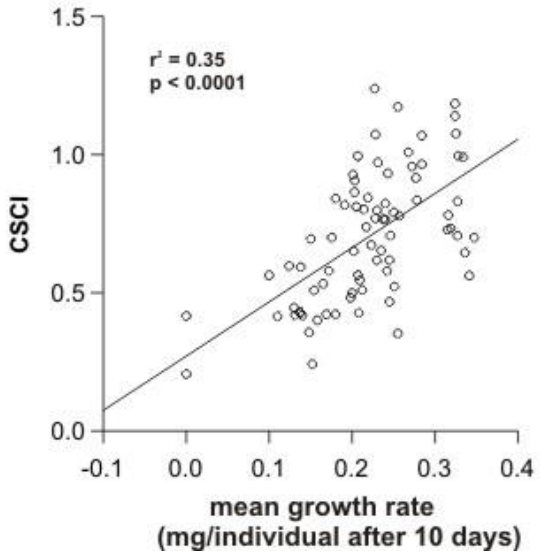




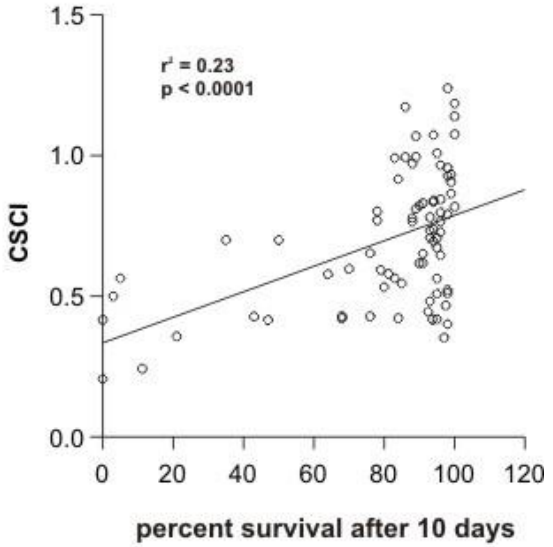




maximum single pesticide concentration observed



mean growth rate of *Hyalella* in the lab



% 10 day survival rate of *Hyalella* in the lab