California Stream Nutrient Objectives Stakeholder Meeting

9 December 2014

Southern California Coastal Water Research Project (SCCWRP)

At the Last Stakeholder Meeting and In the Intervening Period..

- Provided funding for independent facilitator to represent stakeholders
  - Brock Bernstein has organized you, with representatives by sector
  - Working with you to get your feedback
- Provided opportunities for comment on the Water Board Nutrient Objective Workplan
  - Revised version now available on the website
- Interacted with you on the process and candidates for Science Panel
  - We’ve chosen the final members, based in part on your feedback

Goals for the Meeting

- Provide an update on program status and schedules
- Present and discuss *Wadeable Streams Science Plan*
- Provide an overview of existing science to supporting numeric guidance in Wadeable Streams

Update on Program Status

- Update up on Science Panel selection
- Provide a draft schedule and approach for interacting with you on:
  - Technical products
  - Science Panel review
  - Policy development

Summary of Phase I Schedule

No.	Task	Targeted Date for Completion
1	Outreach	March 2017
2	Conceptual Approaches to Nutrient Objectives, Water body Definition & Classification	June 2015
3	Conduct and Synthesize Science to Support Numeric Guidance in Wadeable Streams	June 2016
4	Implementation Plan Development	March 2017
5	Implementation Plan Technical Support	Ongoing
6	Rulemaking	2017

Technical Products: Schedule of Activities and Interim Milestones

Product	SAG and RG Review	Science Panel Review	Final Product
Wadeable Streams Science Plan	November 2014	March 2015	June 2015
Conceptual Approach to Nutrient Objectives and Waterbody Classification	April 2015	March 2016, October 2016	June 2016
Wadeable Stream Analyses and Syntheses	January 2016, with interim updates for completed analyses via webinar	March 2016, October 2016	June 2016

Schedule for Science Panel Meetings and Overarching Charge

Spring 2015:	Review of Wadeable Stream Science Plan and other Foundational Science
Spring 2016:	Review of Science Plan Products and Perspectives on Use in Policy Context
Fall 2016:	Review of Revised Products and Perspectives on Use of Science in Policy Context

Confirmed Science Panel Members

R. Jan Stevenson	Stream Ecology/Biogeochemistry	Michigan State Univ.
Ken Reckhow	Modeling	Duke University (Emeritus)
Paul Stacey	Nutrient Management	Great Bay National Estuarine Research Reserve

Need one additional Stream Ecology/Biogeochemistry panelist

Candidates for 2nd Stream Ecology/Biogeochemistry Position

Name	Affiliation	Link to CV
Walter Dodd	Professor Emeritus, Kansas State University	
Barry Biggs	New Zealand National Institute of Water and Atmospheric Research	http://www.niwa.co.nz/people/barry-biggs
Jennifer Tank	University of Notre Dame	http://biology.nd.edu/people/faculty/tank/
Clifford Dahm	University of New Mexico	http://biology.unm.edu/core-faculty/dahm.shtml

Implementation Plan Development Approach & Schedule

January – June 2015:	Focus group meetings with sectors; development of draft implementation plan options
June- Sept 2015:	Discussion of draft implementation plan options with Regulatory Workgroup and Water Board upper management; revise and repeat
Sept –Dec 2015:	As needed, second set of focus group meetings by sectors to discuss revised options
Spring 2016:	Discussion of draft implementation plan with Regulatory Workgroup and Water Board upper management
	Presentation of initial options on implementation to Science Panel
Summer 2016:	Presentation of proposed implementation plan to stakeholders
Fall 2016:	Science Panel feedback on final science products and proposed use in implementation plan

DRAFT Schedule for Rulemaking

Target Date	Action	Duration
January 2017	Release Draft Amendments and Environmental Documentation for Formal Public Comment	45 days
February 2017	Board Workshop	Concurrent with Public Comment Period.
March 2017	Response to Comments and Revise Amendments as needed	60 days
May 2017	Release Revised Amendment and Response to Comments	
June 2017	Water Board Hearing	
July 2017	Water Board Adoption Meeting	
August 2017	Submit Administrative Record to Office of Admin Law (OAL) and EPA for Approval	30 "Working Days" for OAL
October 2017	Nutrient Amendments Effective	

Summary of Schedule

Technical Activities and Review

2015

- Science Panel Review of Science Plan and foundational science
- Conceptual approaches to nutrient objectives
- Wadeable streams analyses and syntheses

2016

- Science Panel interative review of technical products and discussions on implications for policy development

Implementation Plan & Policy Development

2015

- Iterative development and vetting of implementation plan options with stakeholders, regulatory workgroup and Board upper management

2016

- Revision of implementation plan options given final technical products and Science Plan feedback
- Staff report

2017

- Rulemaking and adoption

Questions?

Comments?

Wadeable Streams
Science Plan

Wadeable Streams Science Plan

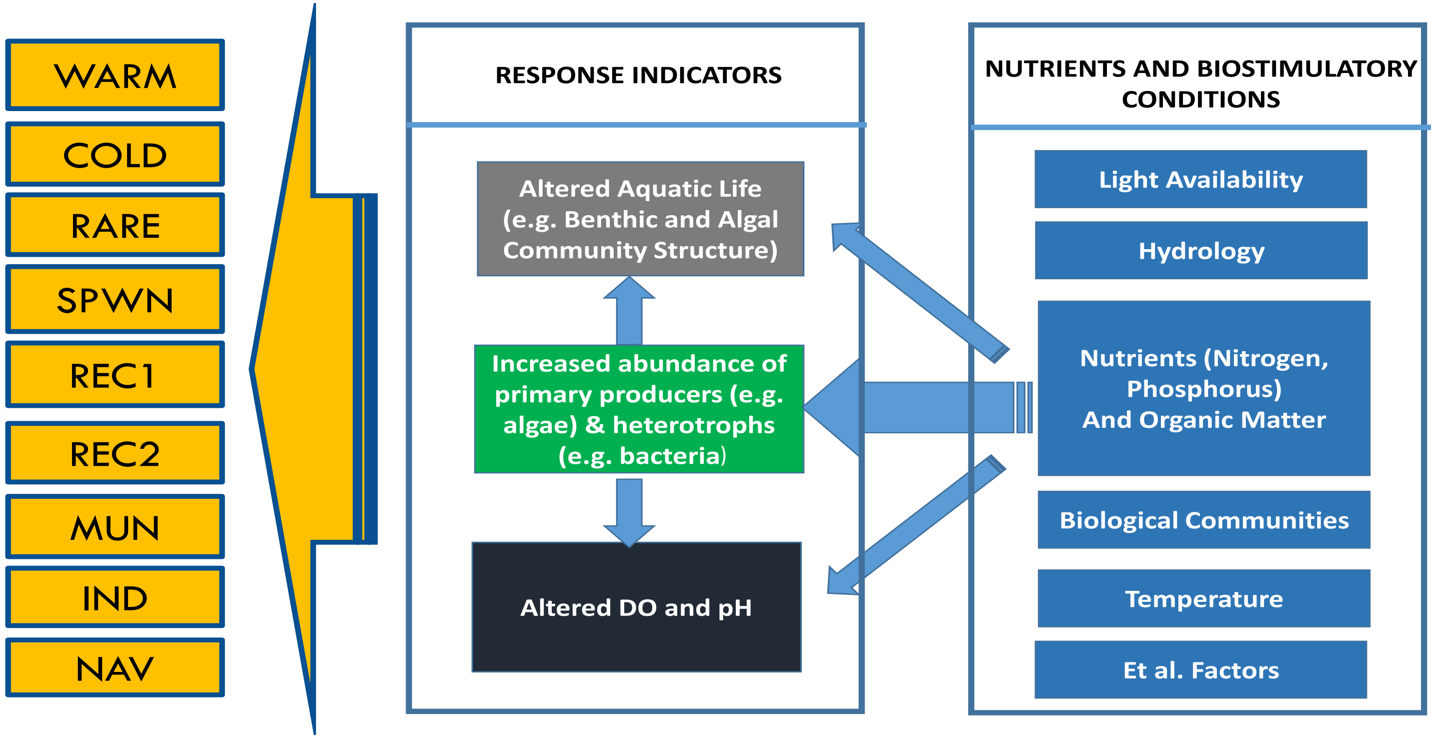
- Regulatory context for technical approach
- Fundamental elements of science supporting nutrient objectives
- Wadeable Streams Science Plan
  - Foundational Science and Monitoring Elements Supporting Plan
  - Proposed Work

Definitions of Nutrient Policy Terms

- ***objectives***: narrative regulatory policy
- ***endpoints***: numeric guidance for response indicators that translate a narrative objective
- ***targets:*** numeric guidance for nutrient concentrations or loads established to protect beneficial uses, as statewide, regional, or sites-specific targets

Water Board Staff Nutrient Objectives Workplan: Two Guiding Principals Frame Technical Approach

- The policy should address nutrient pollution and biostimulatory conditions.
- Numeric guidance should have a strong linkage to beneficial uses.

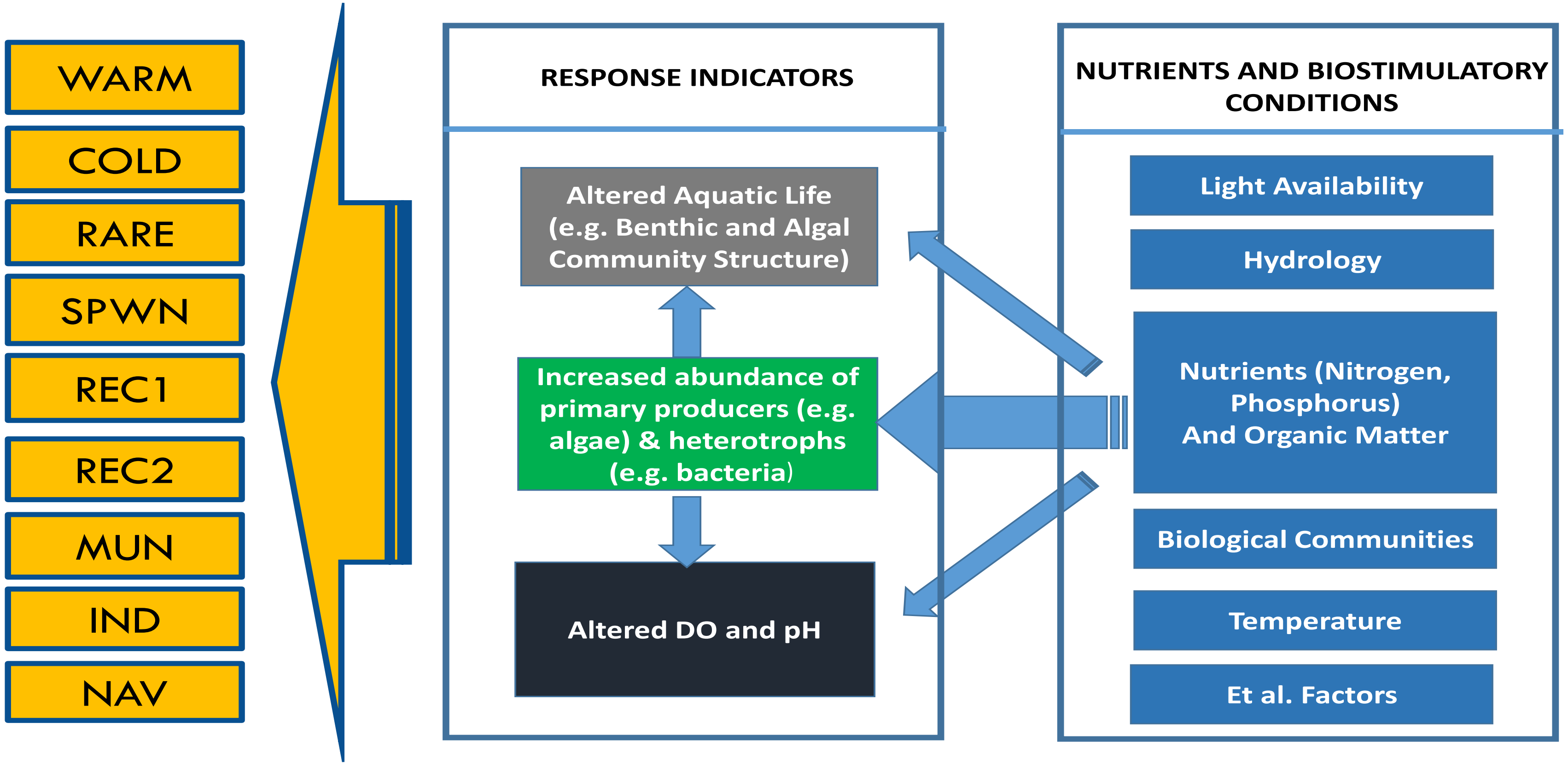


2011 CEQA Scoping: Two Alternatives Considered

- Reference Approach
- Nutrient Numeric Endpoints Approach

Nutrient Numeric Endpoints (NNE) Approach

- Emphasis on response indicators as assessment endpoints
- Use of models to establish linkage to nutrients and biostimulatory conditions

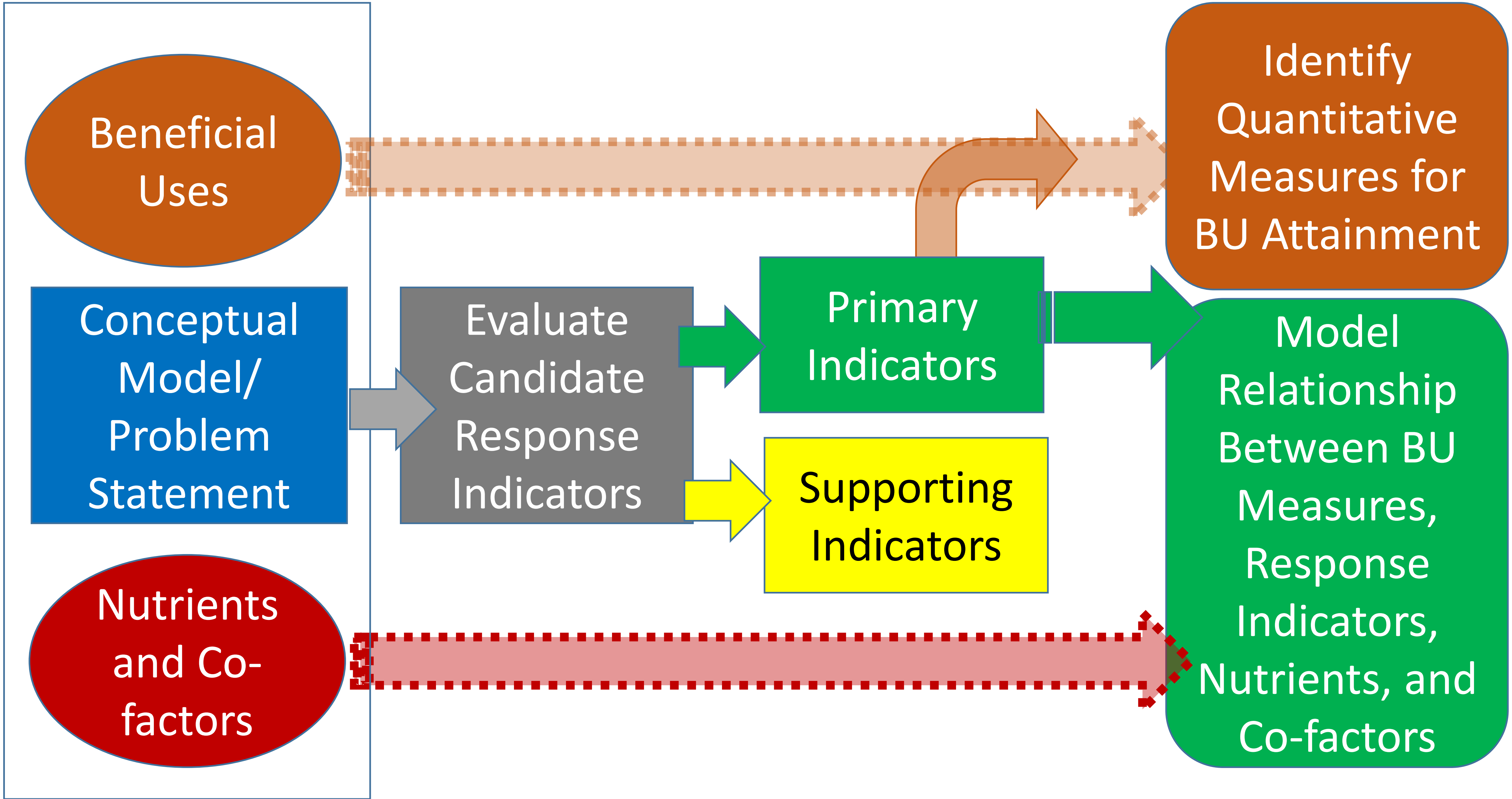


This approach has already been demonstrated in several TMDLs around the State

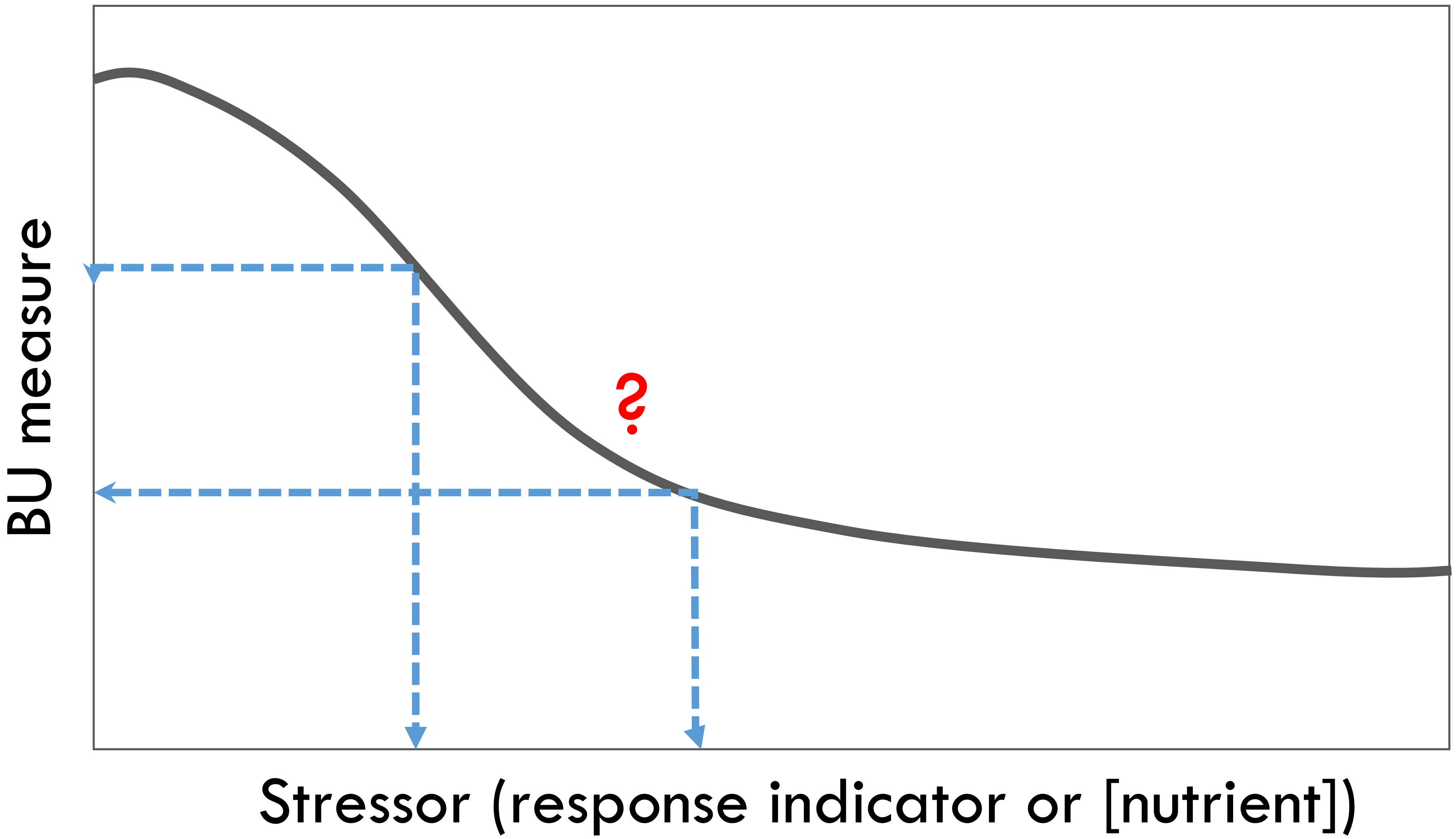
For Nutrient Policy, Water Board Interested in Regional Models to Set "Default" Nutrient Targets

- Accounts for, to the extent possible, landscape- and site-specific factors that control response to nutrients
- Use to establish regional or site-specific "default" targets
  - Flexibility to develop site-specific nutrient targets with more sophisticated models if desired

Building a Scientific Foundation for NNE



Explore How Changes in BU Measure Goal Affects Numeric Response Endpoints or Nutrient Targets



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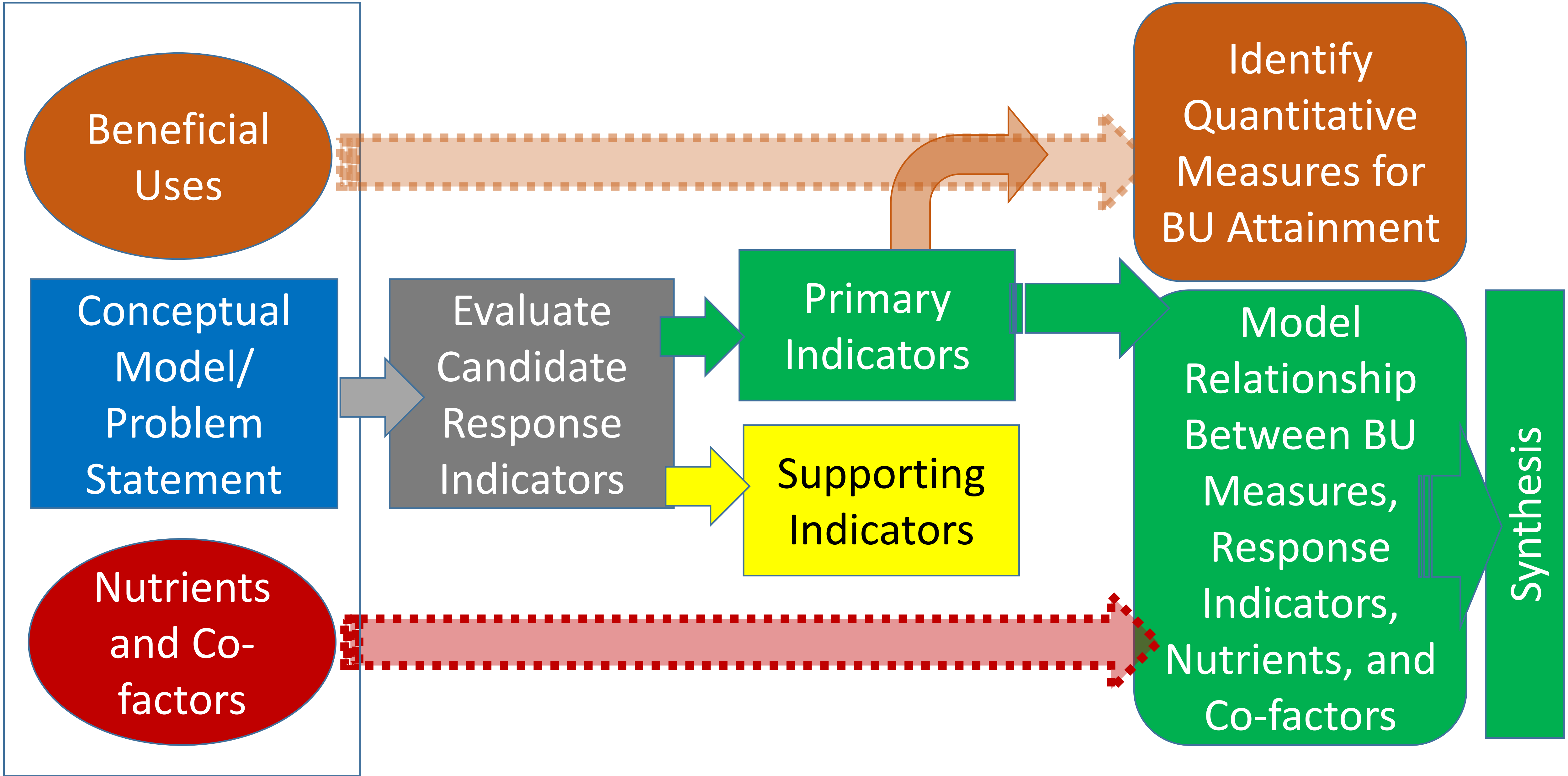

California Technical Team-Streams

Betty Fetscher, SCCWRP

Eric Stein, SCCWRP

Martha Sutula, SCCWRP

Michael Paul, Tetra Tech

Jon Butcher, Tetra Tech

Naomi Detenbeck, EPA/ORD

Elements of the Science Plan

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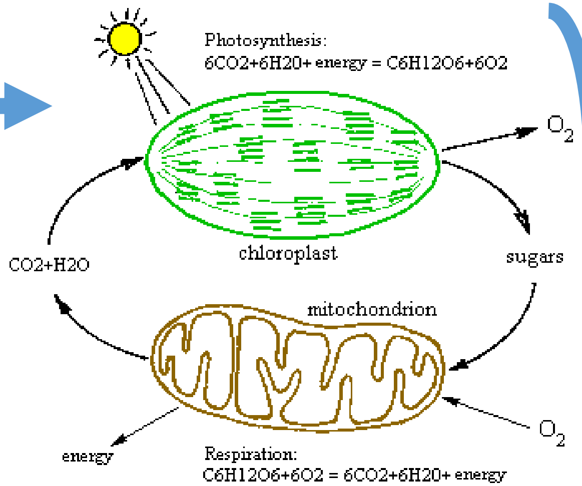
Stream Eutrophication Conceptual Model

↑ N, P

nutrient enrichment

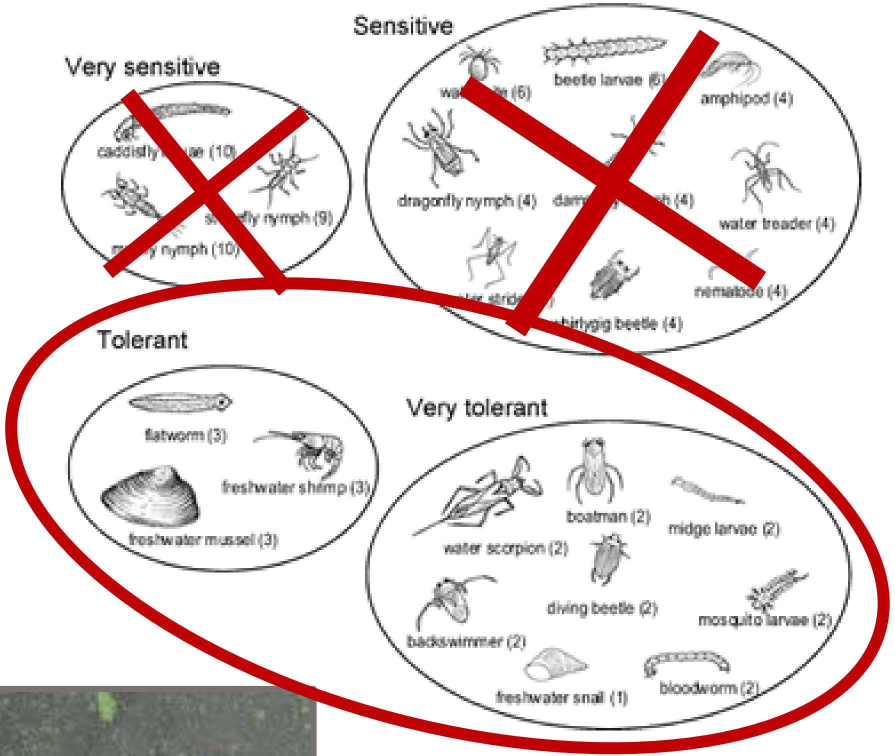
excessive growth of primary producers (algae and/or higher plants)

nighttime algal respiration can deplete oxygen & cause wide pH fluctuations



primary producers eventually die

bacteria consume decaying organic matter, using up dissolved oxygen



from multiple standpoints, eutrophication alters aquatic life

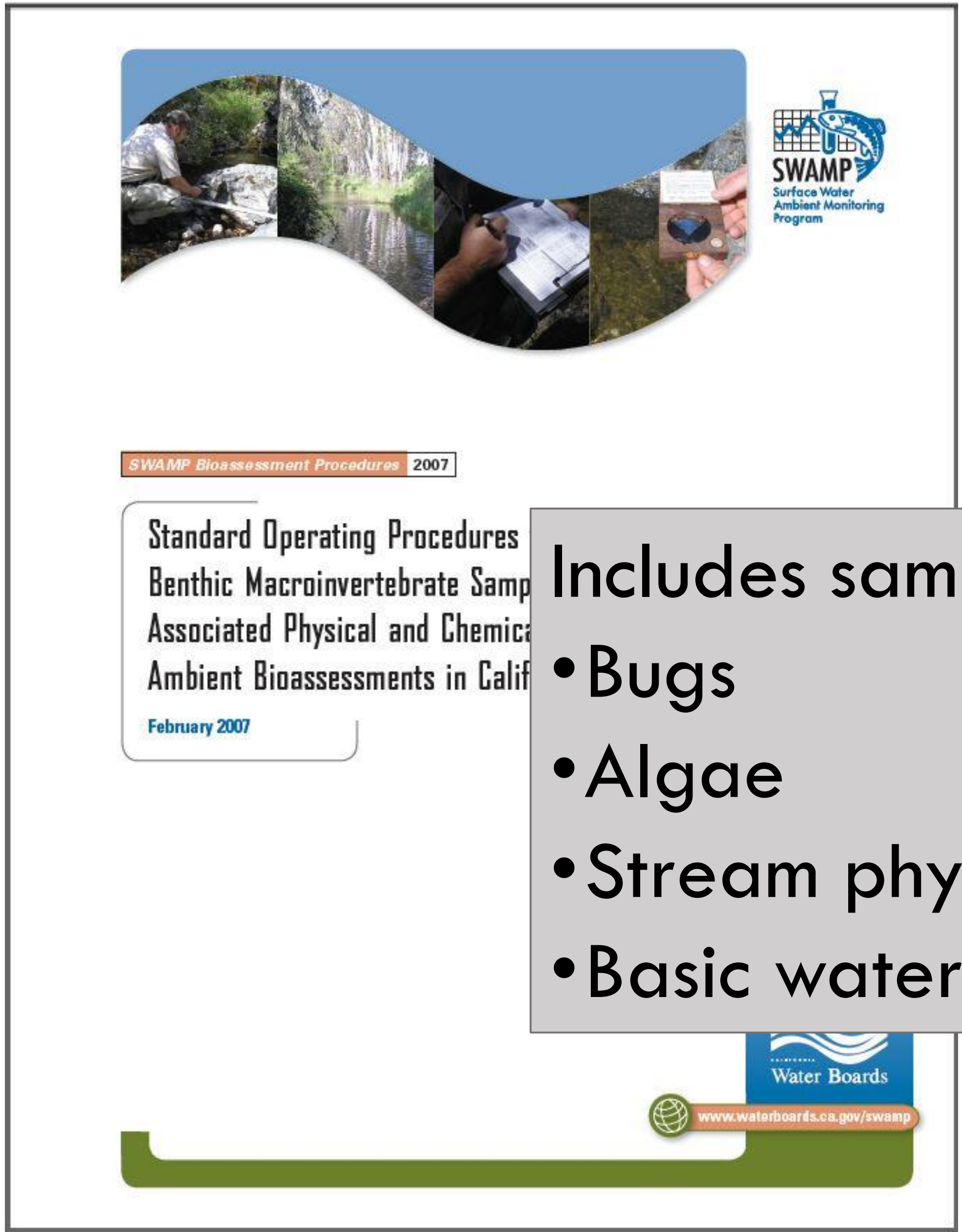
Nutrient Response Pathways: Relationships with **Multiple** Beneficial Use Types

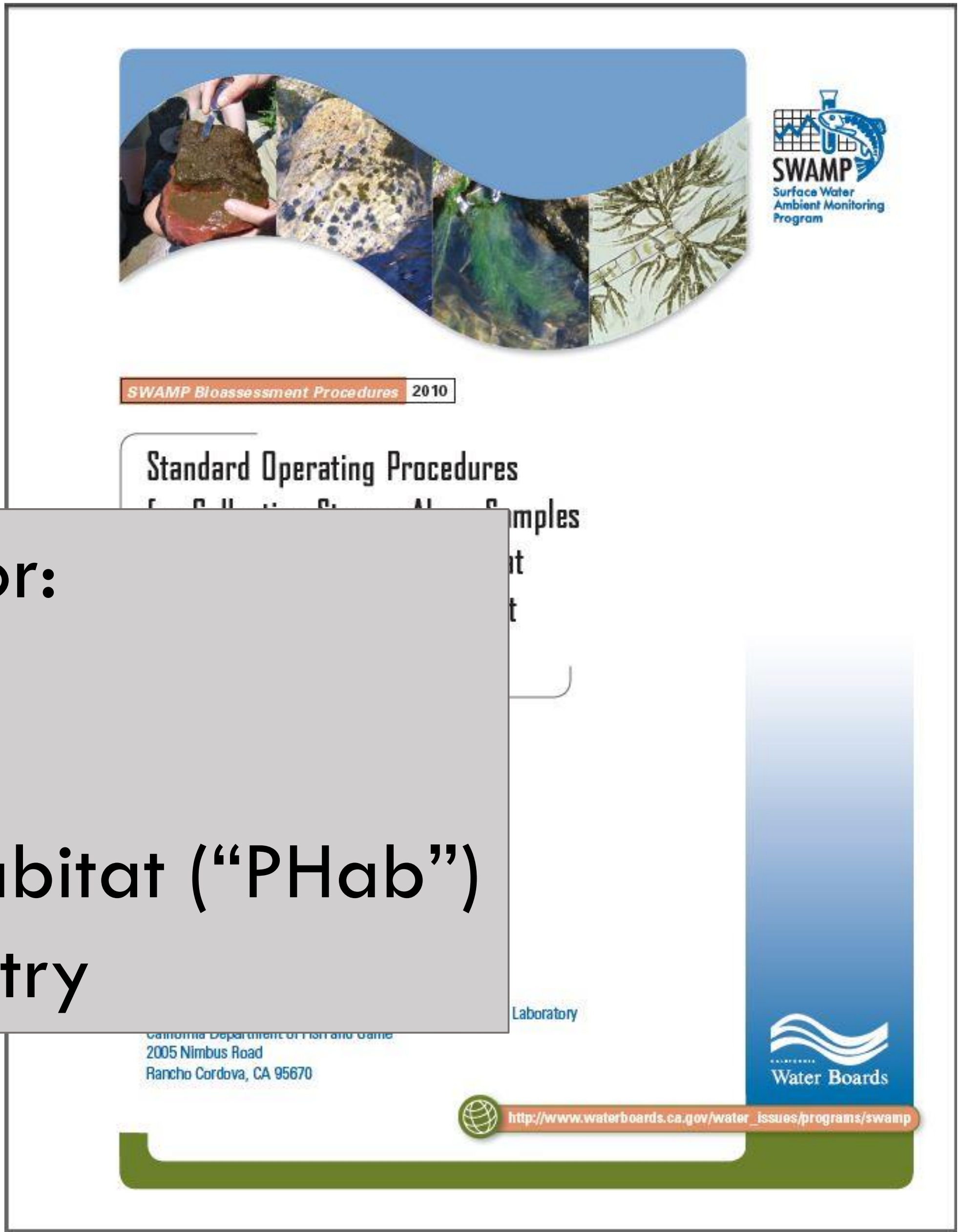
Beneficial Use	Altered Aquatic Life Diversity	Altered Food Web	Unaesthetic Blooms	*Water Quality:* Reduced DO	*Water Quality:* Algal Toxins *et al.* Metabolites	*Water Quality:* Increased Turbidity
COLD	X	X		X	X	X
WARM	X	X		X	X	
SPWN	X	X		X	X	
MIGR	X	X		X	X	
RARE	X	X		X	X	
MUN					X	X
REC-1			X	X	X	X
REC-2			X			X

adapted from Tetra Tech (2006)

Key elements of the eutrophication conceptual model are embedded in the SWAMP wadeable streams program…

Field and laboratory Standard Operating Procedures

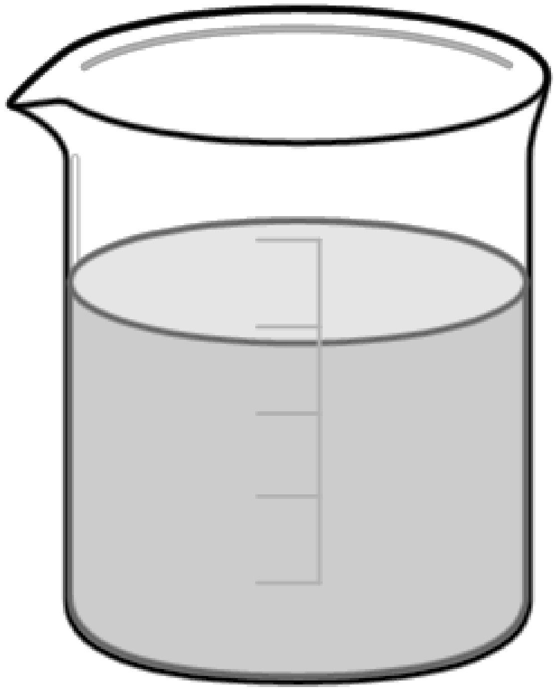


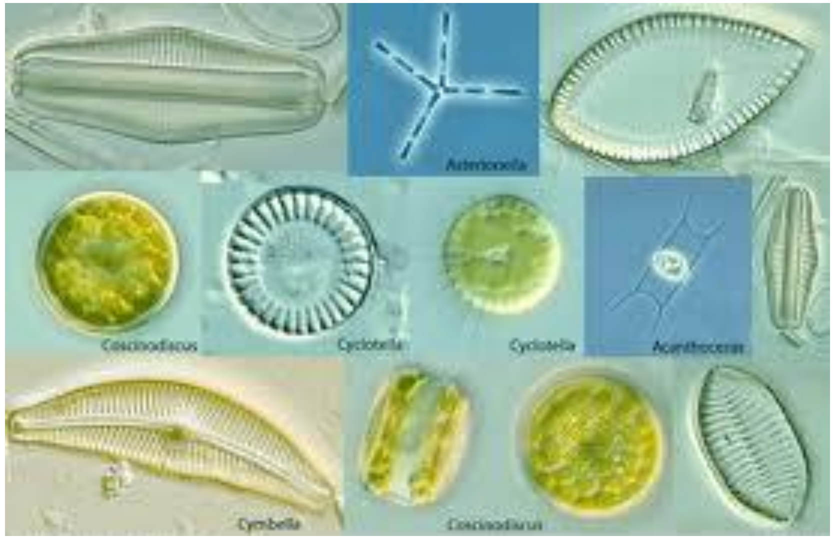


Includes sampling for:

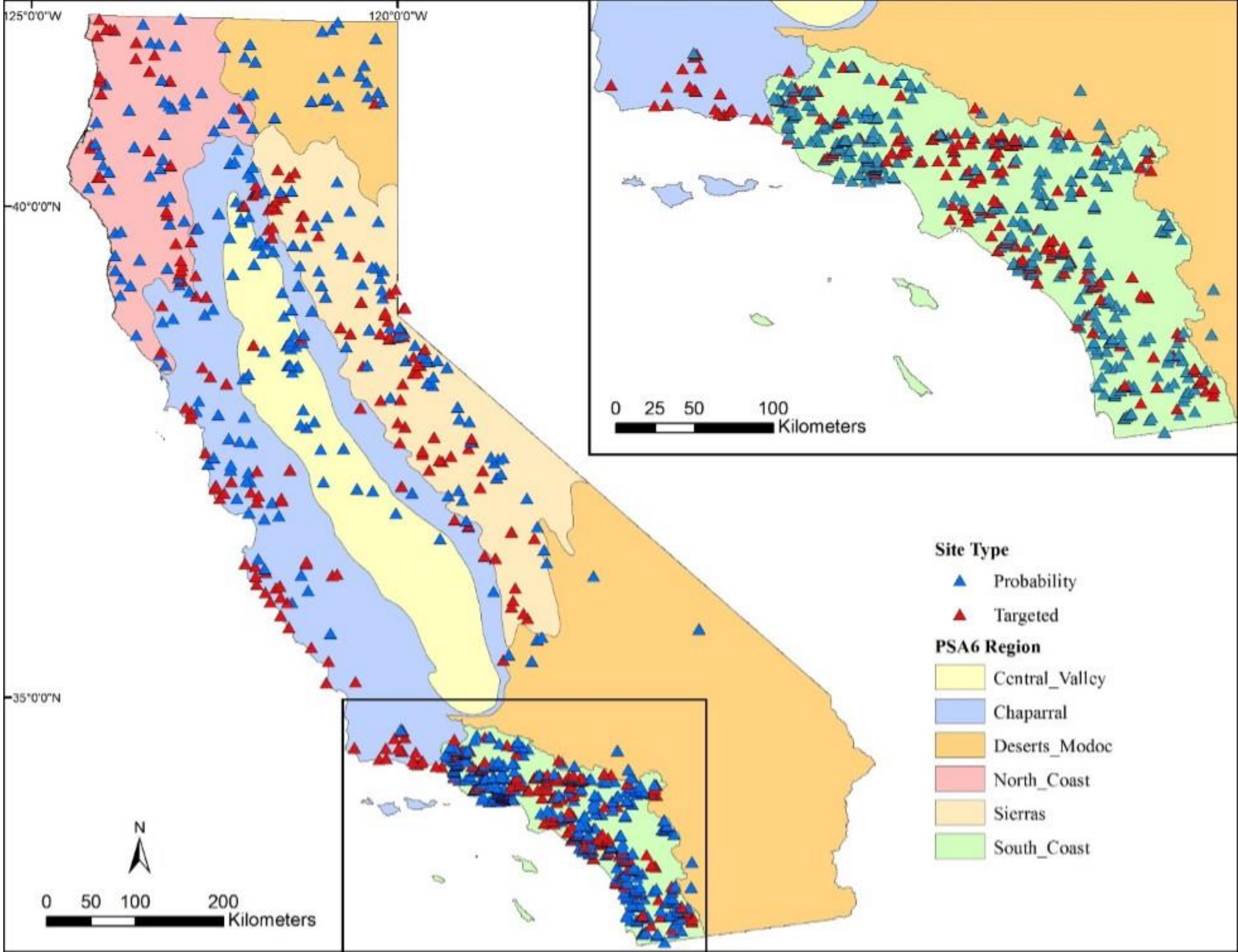
- Bugs
- Algae
- Stream physical habitat ("PHab")
- Basic water chemistry

Ongoing Statewide & Regional Monitoring Efforts → Data Sources





Available data from combined surveys (>1,000 wadeable stream reaches)



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Response Indicators Literature Review

Goal: to evaluate and identify primary and supporting response indicators based on most recent science

Suitability criteria for the indicators:

- clear link to beneficial uses
- has predictive relationship with nutrient concentrations/loads & other factors that regulate eutrophication response
- measurement process is scientifically sound/practical
- shows a *trend* in response to eutrophication with an acceptable signal to noise ratio
- either already routinely collected by State programs, or can be added relatively easily

Examples of Candidate Response Indicators, by Pathway

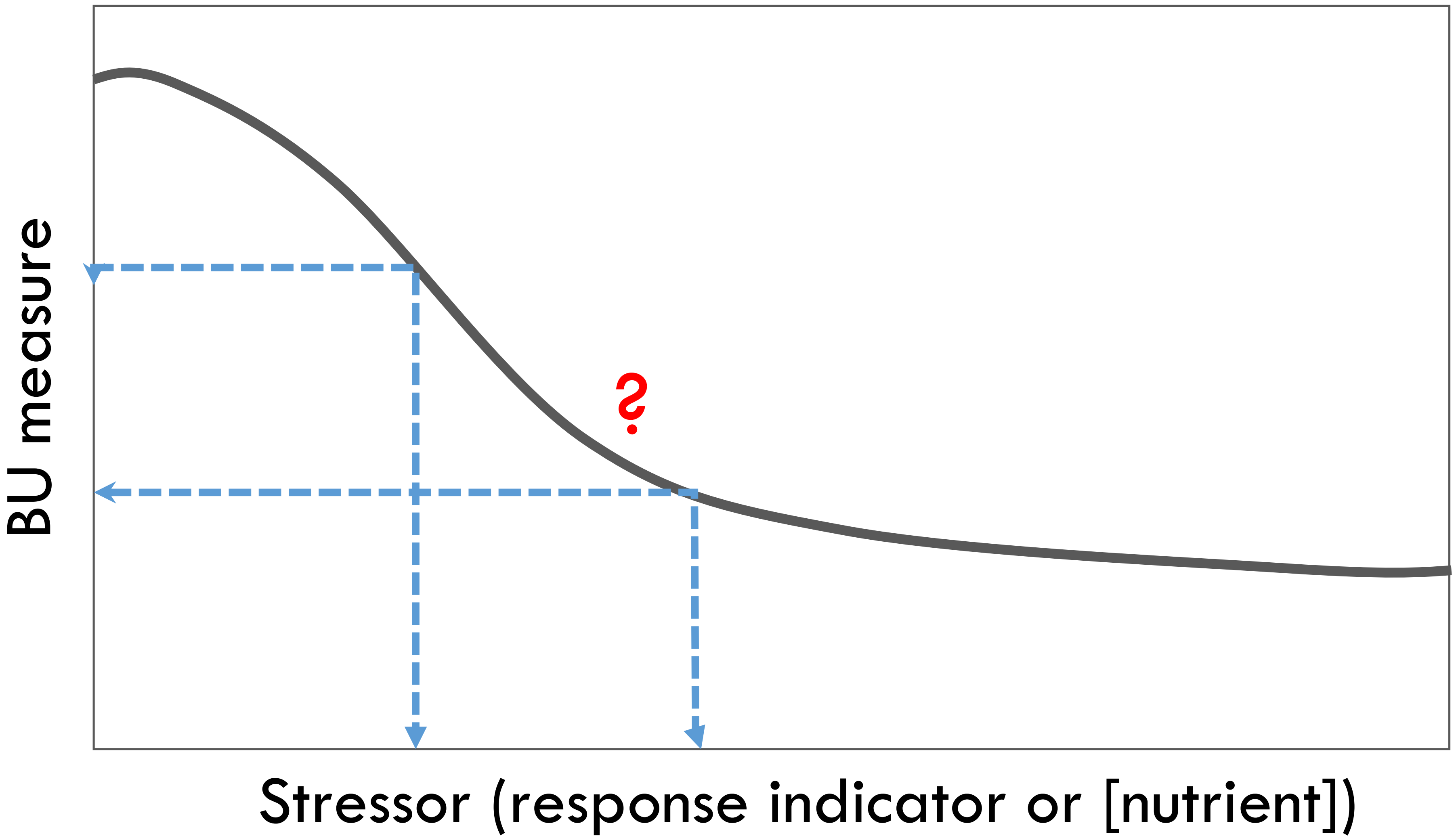
Routinely Monitored

- *Altered Aquatic Diversity, Food Webs, Aesthetics & Water Quality*
  - benthic algal chlorophyll *a*
  - benthic ash-free dry mass (AFDM)
  - algal & macrophyte percent cover
  - benthic diatoms, soft algae & cyanobacteria

Not Routinely Sampled

- *Altered Water Quality*
  - dissolved oxygen; pH
  - algal toxins
  - turbidity
  - trihalomethanes

Explore How Changes in BU Measure Goal Affects Numeric Response Endpoints or Nutrient Targets



Potential Measures of Beneficial Use Attainment

Routinely Monitored

- *Altered Aquatic Diversity and Food Webs*
  - benthic macroinvertebrates (“bugs)
  - benthic diatoms
  - soft algae & cyanobacteria
- *Unaesthetic Blooms*
  - macroalgal & macrophyte percent cover

Not Routinely Sampled

- *Altered Aquatic Diversity*
  - fish
  - amphibians
  - riparian birds
- *Altered Water Quality*
  - dissolved oxygen; pH
  - algal toxins

Most of these measures don’t have established quantitative goals of BU attainment

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Determine the numeric range of stream nutrient and response indicators that correspond to attainment of beneficial uses

Challenge:

The State of California has not adopted quantitative goals for any of the available stream biotic indices (based on bugs and algae).

Determine the numeric range of stream nutrient and response indicators that correspond to attainment of beneficial uses

- Identify nutrient and biomass **thresholds** of effects on aquatic life response indicators
- Estimate levels of algal abundance and nutrient concentrations associated with attainment of a quantitative "goal" based on a **Reference percentile**
- Develop a **Biological Condition Gradient (BCG)** to link nutrients/biomass to stream ecological condition

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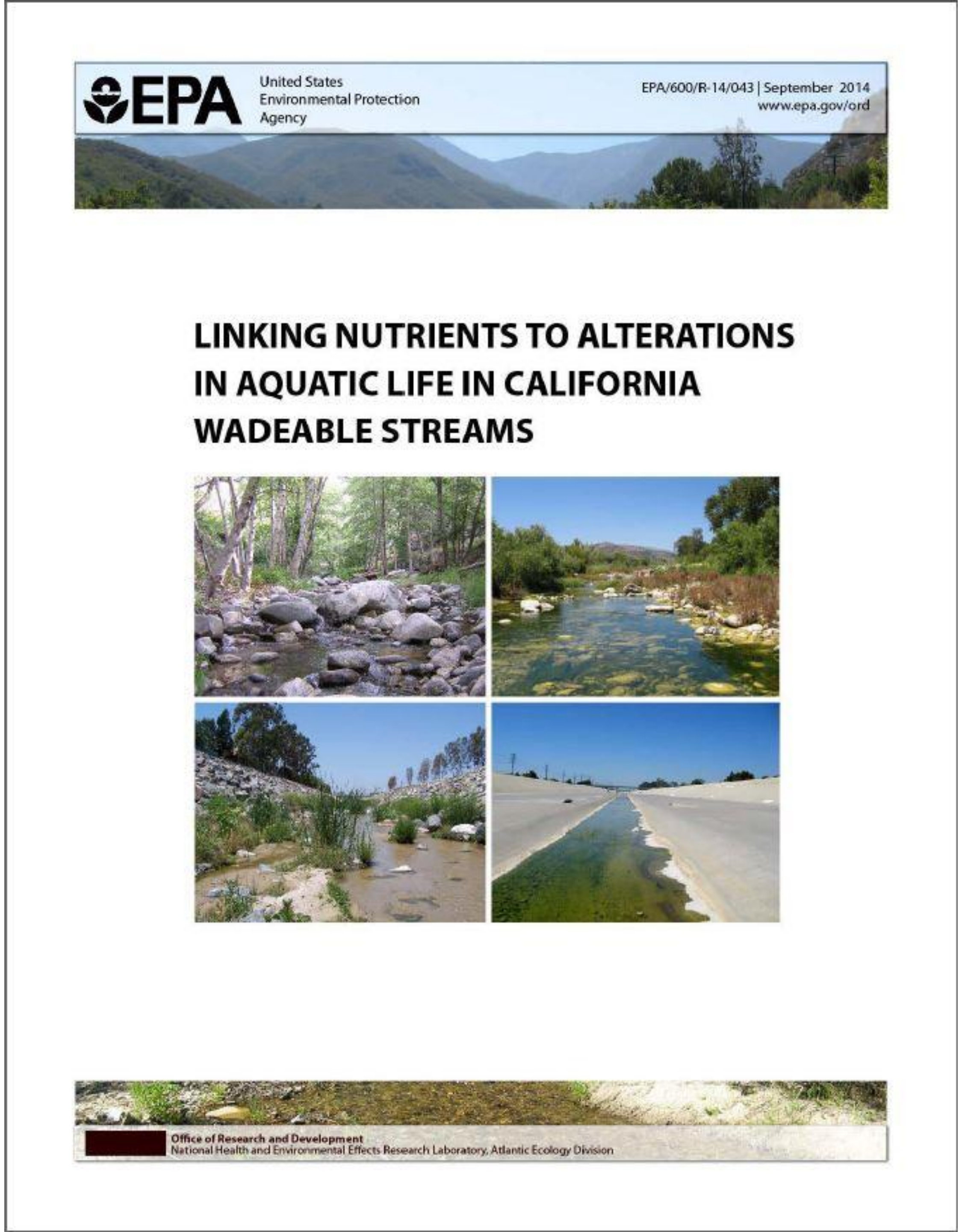
THIS AFTERNOON:

Recently published study with EPA-ORD provides basic research to help inform nutrient policy decisions.

Fetscher, A.E., M. Sutula, A. Sengupta, and N.E. Detenbeck. Linking nutrients to alterations in aquatic life in California wadeable streams. U.S. Environmental Protection Agency, Washington, DC (NTIS EPA/600/R-14/043), 2014.


EPA United States Environmental Protection Agency

EPA/600/R-14/043 | September 2014
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LINKING NUTRIENTS TO ALTERATIONS IN AQUATIC LIFE IN CALIFORNIA WADEABLE STREAMS

Office of Research and Development
National Health and Environmental Effects Research Laboratory, Atlantic Ecology Division

Determine the numeric range of stream nutrient and response indicators that correspond to attainment of beneficial uses

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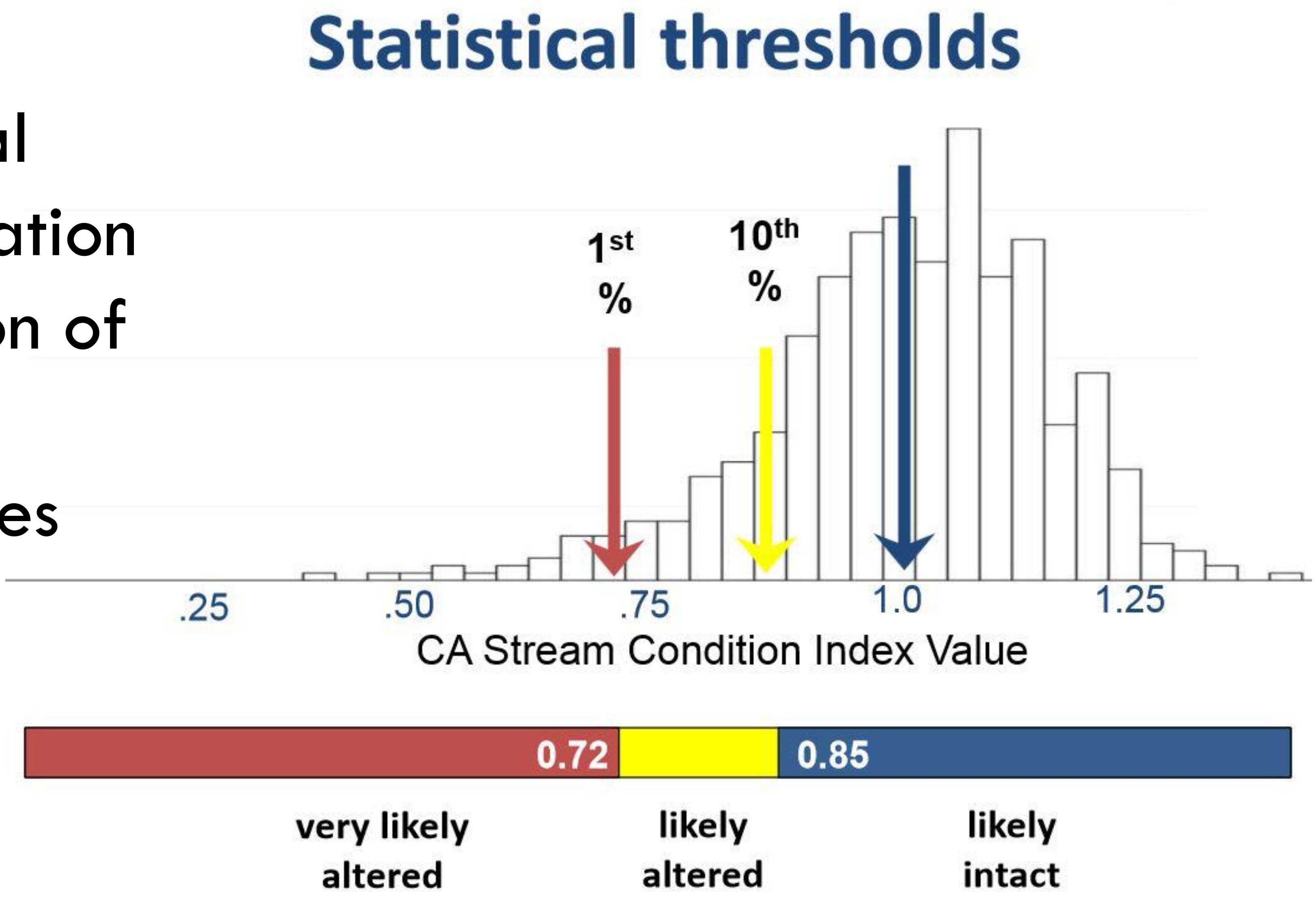
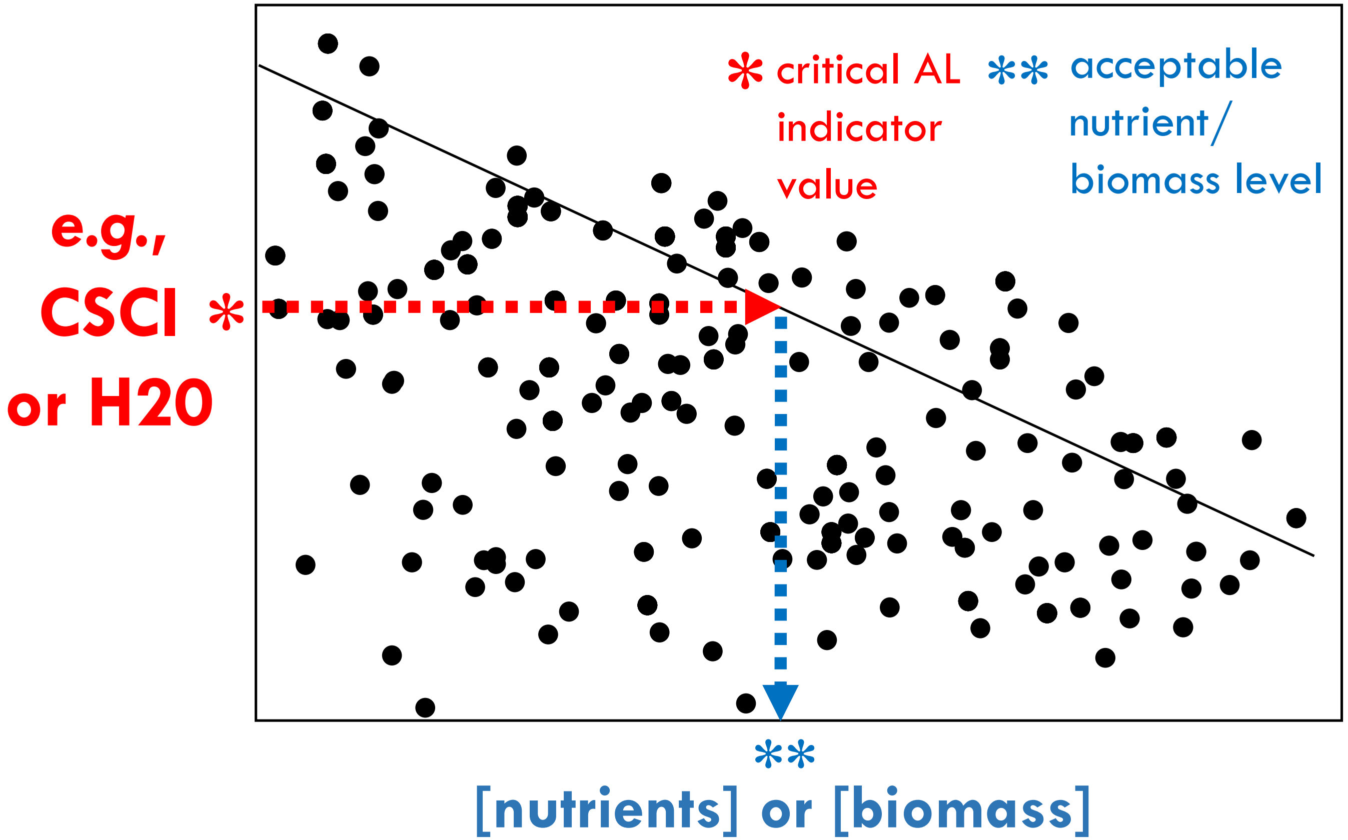
Reference Approach

Establish BU attainment goal based on deviation from distribution of scores among "Reference" sites



Apply Regional Percentile of Reference Condition to Regression Models

The goal for a stream biotic index (based on deviation from Reference) can then be interpolated to a nutrient or algal abundance level



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Develop a BCG

Motivation for this task:

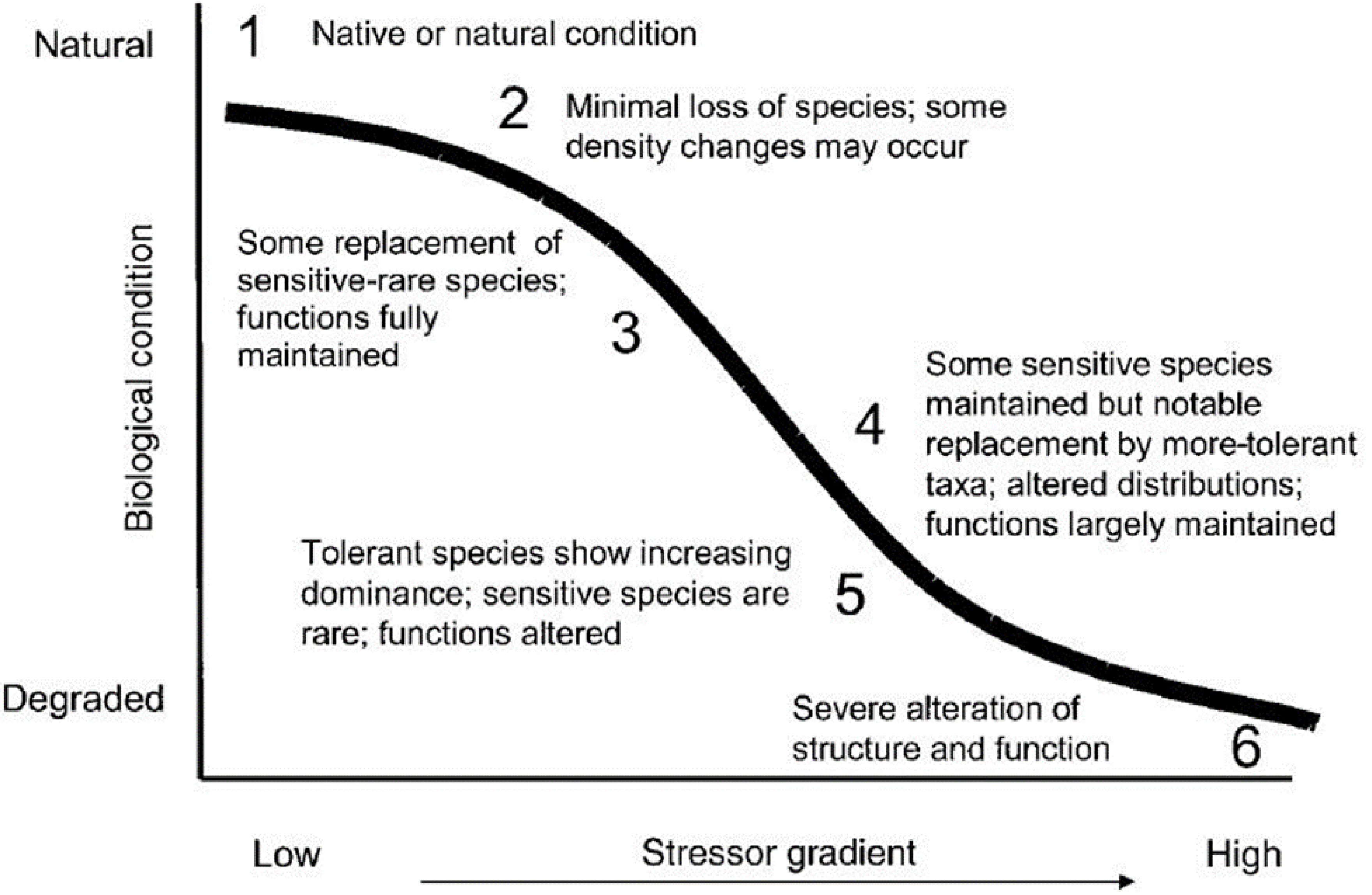
Previous work (Fetscher et al. 2014) revealed thresholds* of response of aquatic communities (bugs & algae) to stream nutrient & biomass concentrations, *but their connection to ecological health of the stream (beneficial uses) is unclear*

***same critique applicable to "Reference percentile" approach**

Develop a BCG

The Biological Condition Gradient:

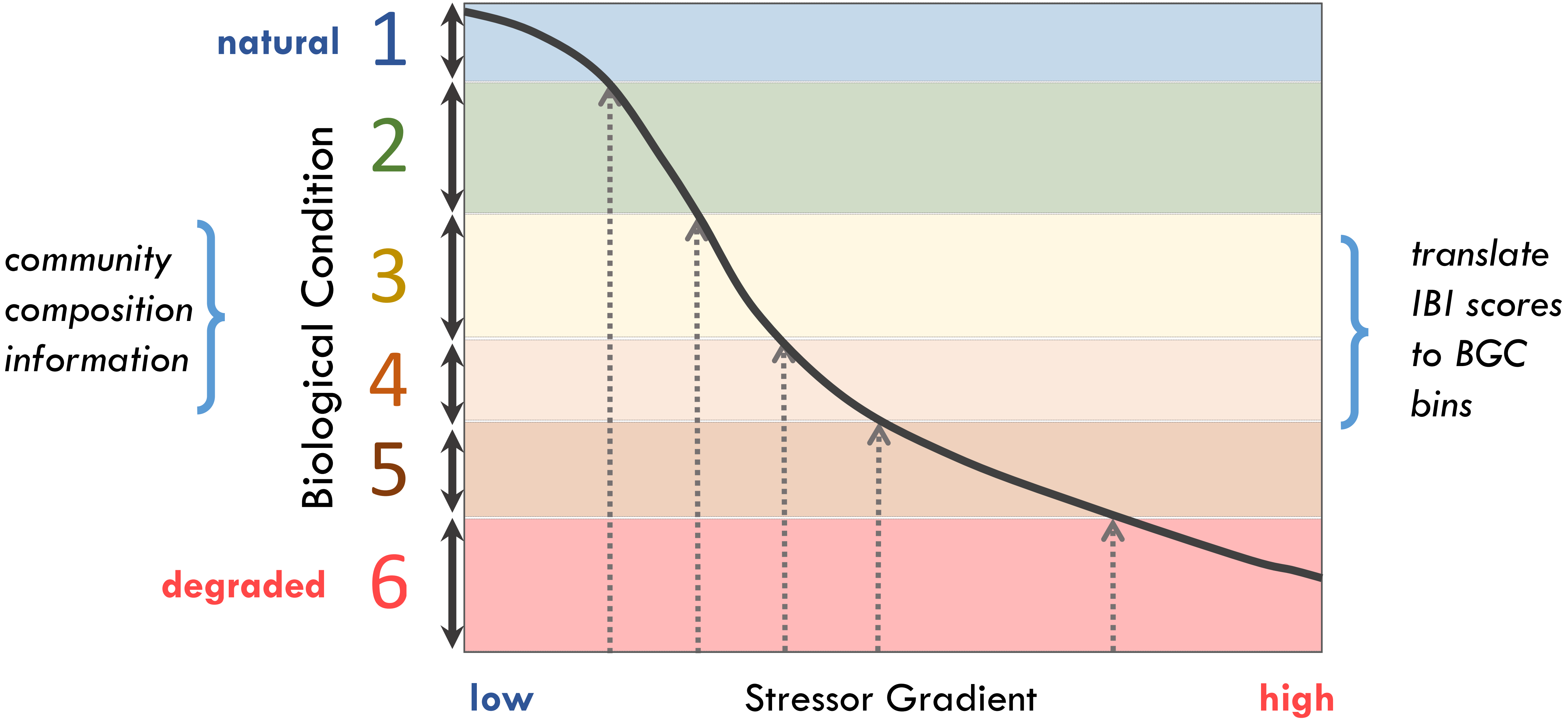
- *as stress increases, community composition changes in predictable ways (e.g., disappearance of rare-sensitive species; replacement with tolerant subset)*
- *experts work to reach consensus on the ecological meaningfulness of community shifts, by assigning bins*



Davies and Jackson (2006)

BCG Development Process

Currently only being done for algae



BCG Development Steps

1. select 6-10 experts in stream algal ecology
2. *in workshop #1*: agree upon methodology to use
3. experts score sites (independently)
4. *in workshop(s) #2+*: reconcile differences & achieve consensus on BCG bins

BCG Development Steps (cont'd)

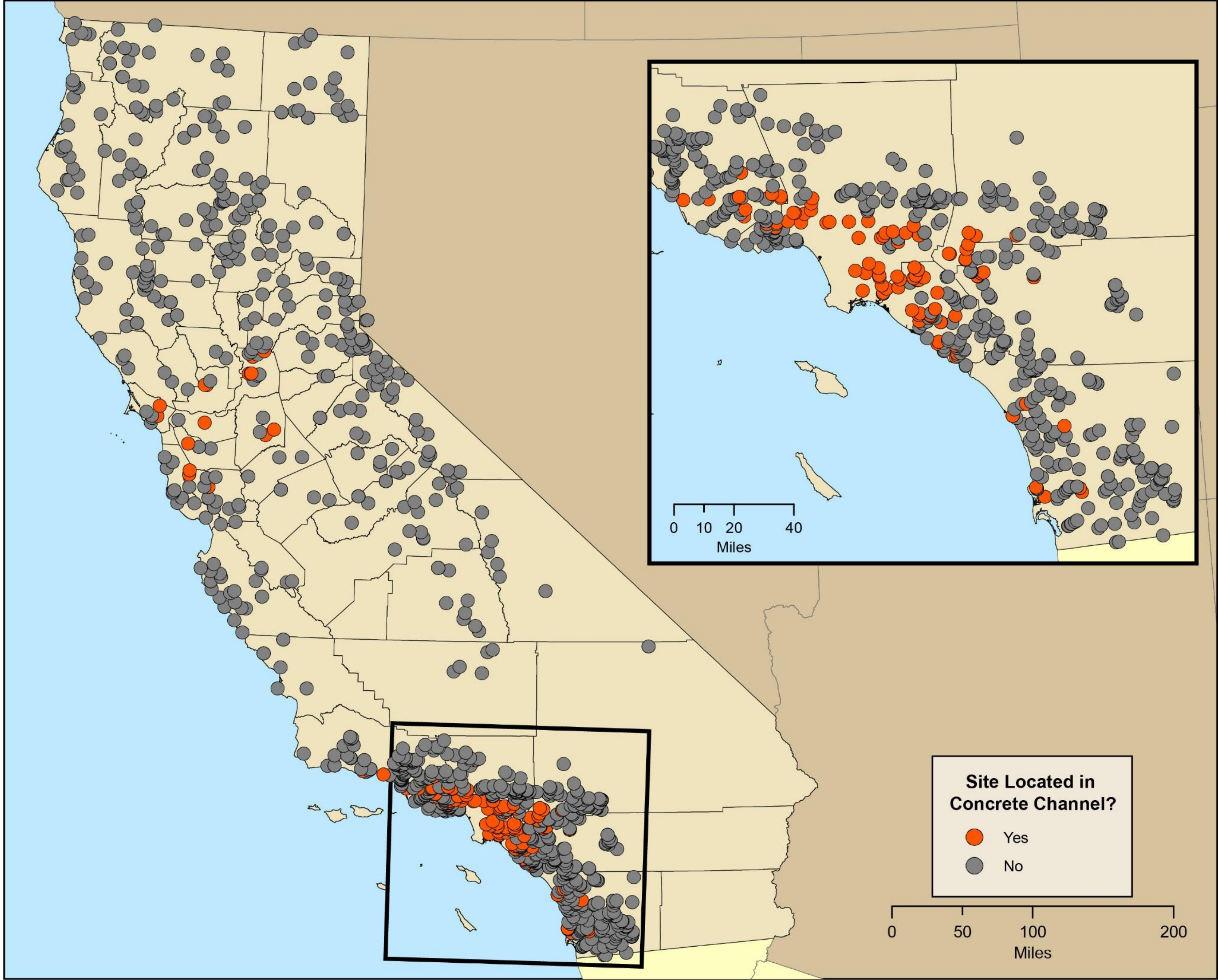
4. use BCG bins to map back to ranges of nutrient & algal concentrations
   – forms basis for discussion between Water Board & stakeholders on BCG bins associated with BU attainment

5. compare BCG nutrient targets to thresholds (EPA-ORD) and reference-based targets to complete synthesis

BCG Synthesis Facilitates Conversations about Modified Channels

- Identify stream subtypes of concern
- Assess the status of existing data
- Use the data to explore environmental gradients & relationship to BU measures

Sites Located in Concrete Channels



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Rationale for Statistical Models

- Element 1.3 already produces default nutrient targets… *so why do we need to do this?*

- Element 1.3 doesn’t explicitly account for site-specific factors (biostimulatory) affecting biomass response to nutrients

- Alternative modeling approach provides regulatory flexibility to establish site-specific (as opposed to regional default) nutrient targets linked to algal abundance endpoints

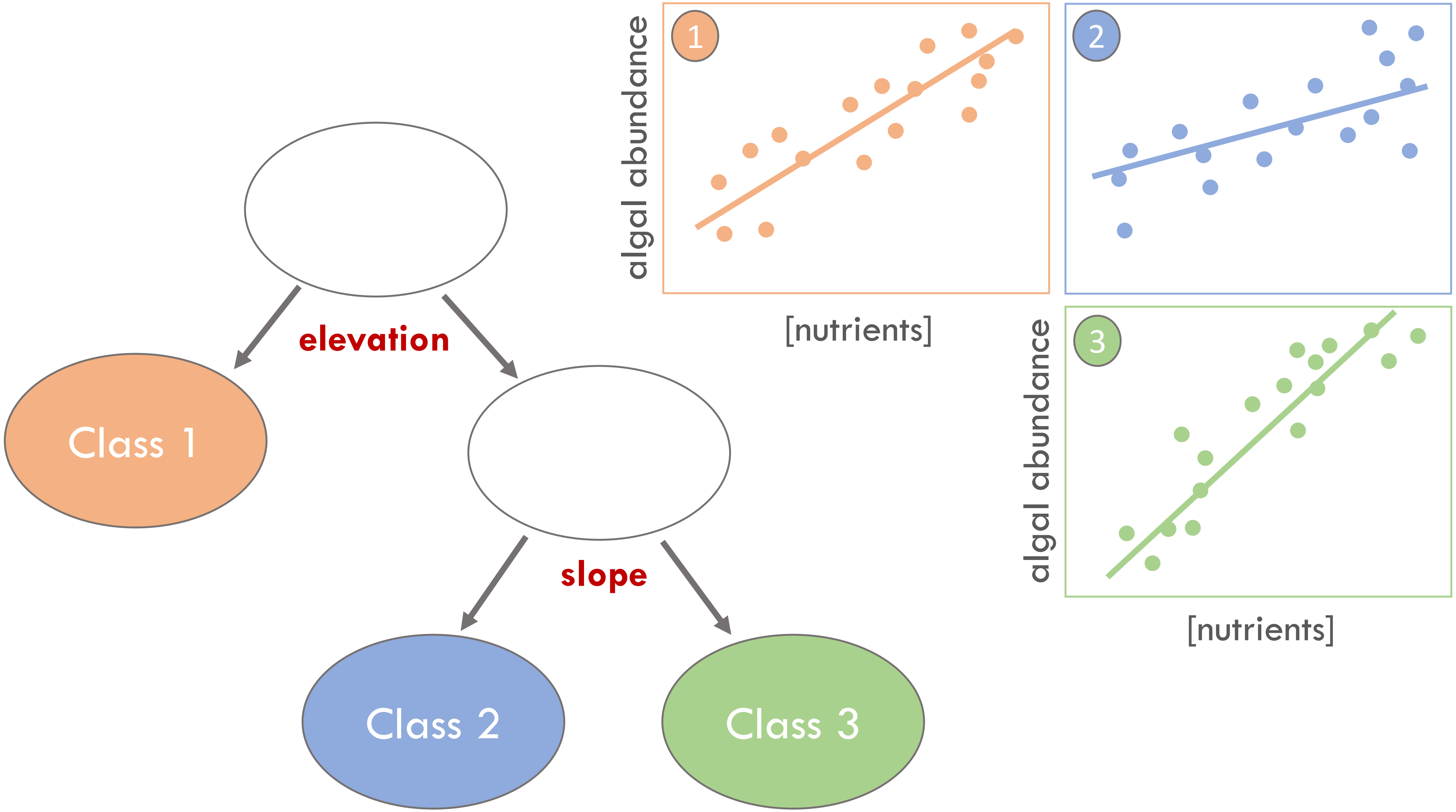
Approach: Bayesian Classification and Regression Trees (B-CART)

- Models primary producer abundance response to nutrients
  - **chlorophyll *a***
  - **AFDM**
  - **macroalgal % cover**

- Uses site-specific factors (natural gradients) to assign sites to classes

- Yields simplified set of regression models to predict algal biomass by site "class", along with a set of rules to define the classes

B-CART End Result



Models predicting biomass from nutrients, customized for site classes defined by natural gradients

→ facilitates derivation of site-specific nutrient targets

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Implementation Plan Technical Support

Goal: identify technical elements needed to support the implementation of nutrient objectives in wadeable streams

- Technical guidance to facilitate
  - method standardization
  - data transfer formats
  - documentation and education
- Technical information to guide site-specific decisions on nutrient management (i.e. cost-effectiveness of point and non-point source treatment technologies)
- Science and/or data and/or "guidance documents" for statistical statewide/regional or site-specific models

Not currently funded

Science Plan

Group Discussion

Existing Studies Supporting Science Plan: EPA-ORD Ecological Threshold Analyses

Determine the numeric range of stream nutrient and response indicators that correspond to attainment of beneficial uses

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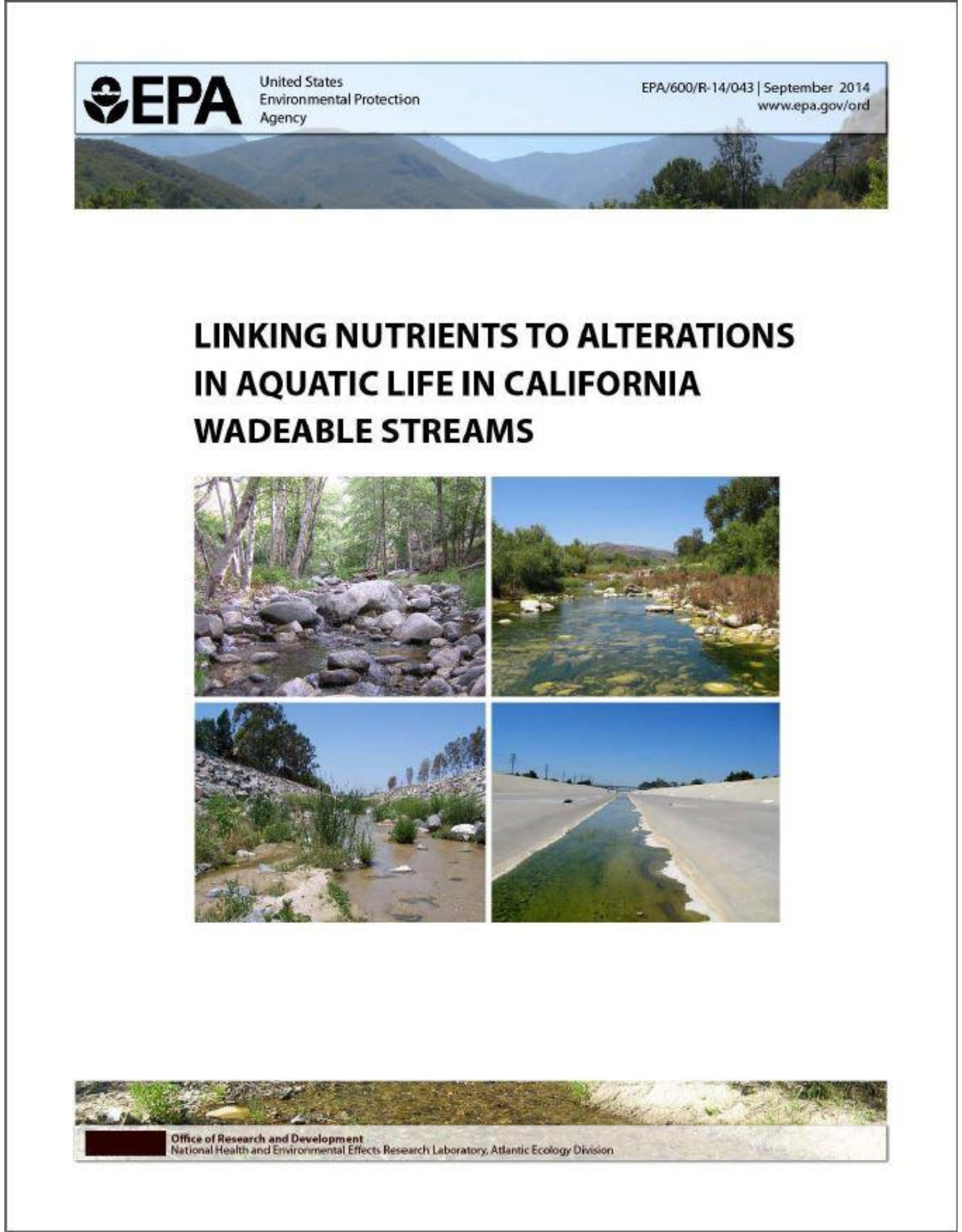
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Office of Research and Development
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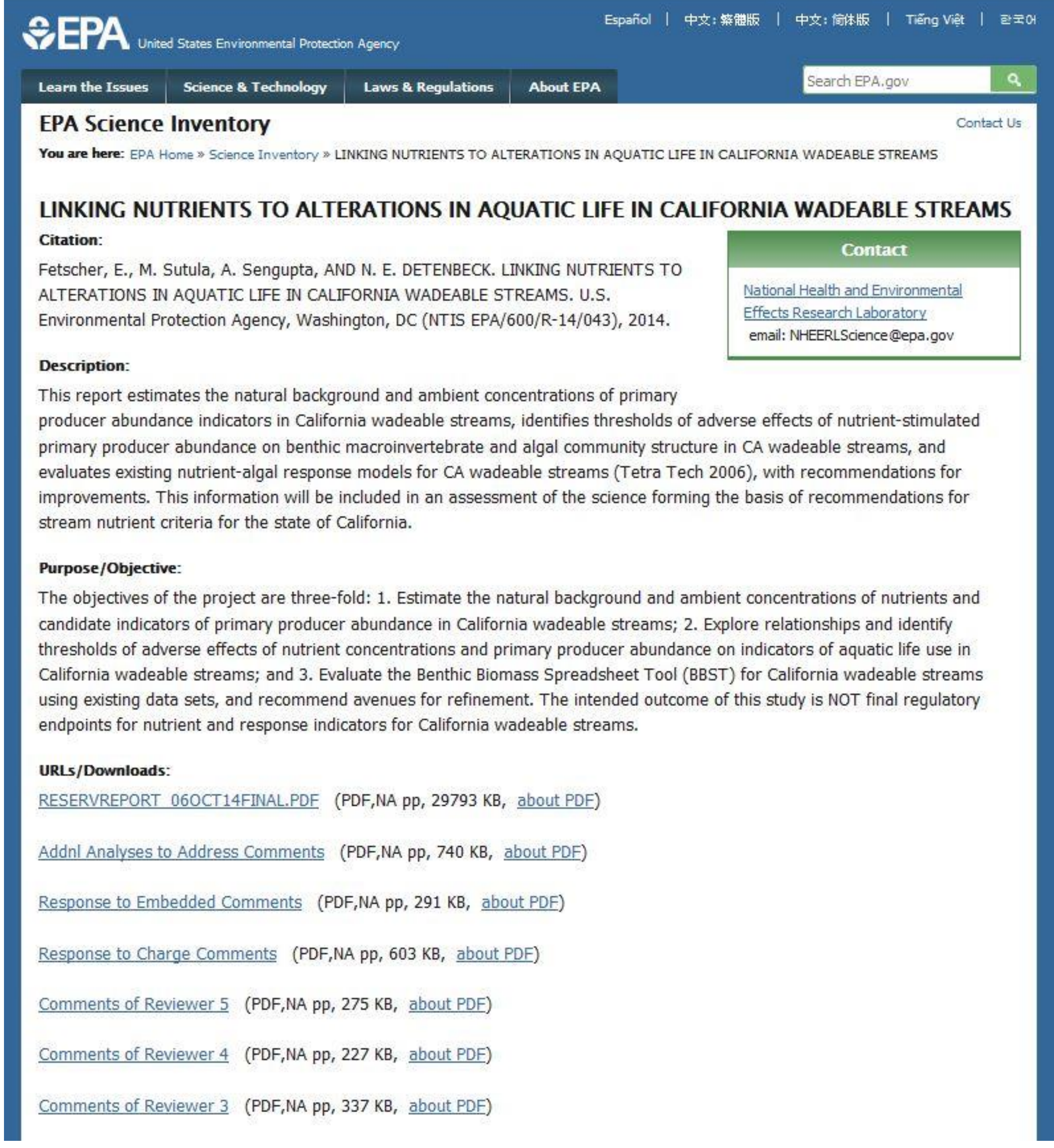
http://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=274010&simpleSearch=1&searchAll=LINKING+NUTRIENTS+TO+ALTERATIONS



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LINKING NUTRIENTS TO ALTERATIONS IN AQUATIC LIFE IN CALIFORNIA WADEABLE STREAMS

Citation:

Fetscher, E., M. Sutula, A. Sengupta, AND N. E. DETENBECK. LINKING NUTRIENTS TO ALTERATIONS IN AQUATIC LIFE IN CALIFORNIA WADEABLE STREAMS. U.S. Environmental Protection Agency, Washington, DC (NTIS EPA/600/R-14/043), 2014.

Contact

National Health and Environmental Effects Research Laboratory
email: NHEERLScience@epa.gov

Description:

This report estimates the natural background and ambient concentrations of primary producer abundance indicators in California wadeable streams, identifies thresholds of adverse effects of nutrient-stimulated primary producer abundance on benthic macroinvertebrate and algal community structure in CA wadeable streams, and evaluates existing nutrient-algal response models for CA wadeable streams (Tetra Tech 2006), with recommendations for improvements. This information will be included in an assessment of the science forming the basis of recommendations for stream nutrient criteria for the state of California.

Purpose/Objective:

The objectives of the project are three-fold: 1. Estimate the natural background and ambient concentrations of nutrients and candidate indicators of primary producer abundance in California wadeable streams; 2. Explore relationships and identify thresholds of adverse effects of nutrient concentrations and primary producer abundance on indicators of aquatic life use in California wadeable streams; and 3. Evaluate the Benthic Biomass Spreadsheet Tool (BBST) for California wadeable streams using existing data sets, and recommend avenues for refinement. The intended outcome of this study is NOT final regulatory endpoints for nutrient and response indicators for California wadeable streams.

URLs/Downloads:

RESERVREPORT_06OCT14FINAL.PDF (PDF,NA pp, 29793 KB, about PDF)

Addnl Analyses to Address Comments (PDF,NA pp, 740 KB, about PDF)

Response to Embedded Comments (PDF,NA pp, 291 KB, about PDF)

Response to Charge Comments (PDF,NA pp, 603 KB, about PDF)

Comments of Reviewer 5 (PDF,NA pp, 275 KB, about PDF)

Comments of Reviewer 4 (PDF,NA pp, 227 KB, about PDF)

Comments of Reviewer 3 (PDF,NA pp, 337 KB, about PDF)

Goals of the Report

1. Identify (statistical methods) **thresholds of adverse effects of primary producer abundance and nutrients** on bug and algal community structure in California wadeable streams

2. **Estimate the natural background and ambient concentrations of candidate primary producer abundance and nutrient indicators** in California wadeable streams

3. **Evaluate the Tetra Tech (2006) nutrient-algal response models** (i.e., the Benthic Biomass Spreadsheet Tool, BBST) for California wadeable streams using existing data sets, and recommend avenues for refinement

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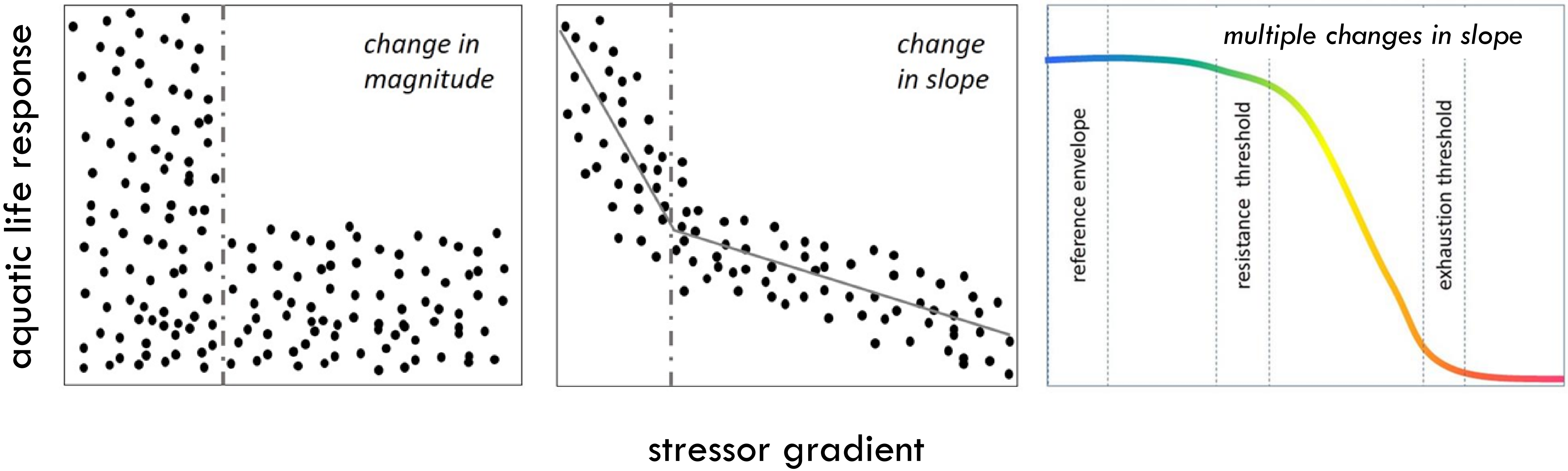
Value in using a variety of approaches to identify thresholds

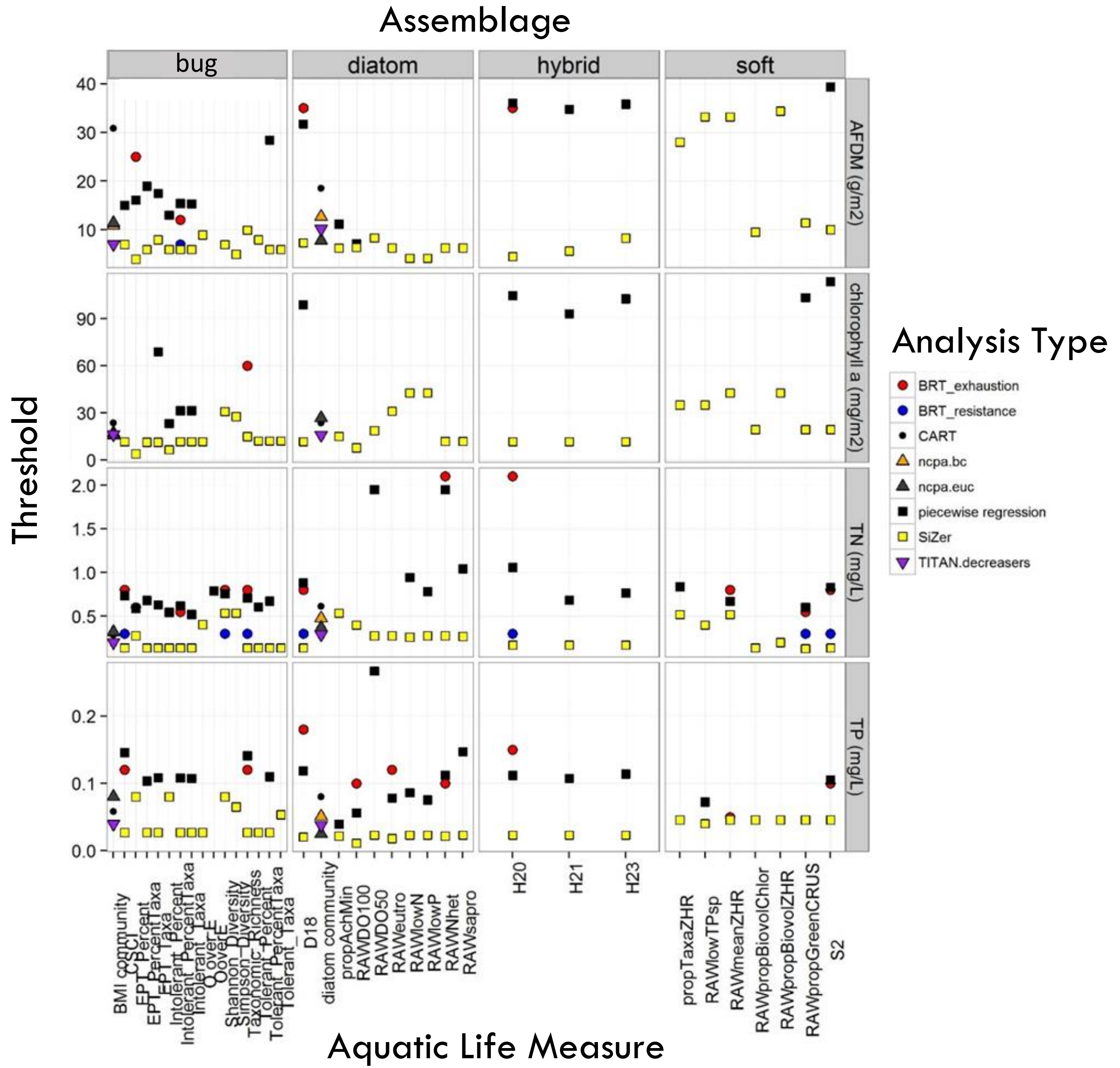
- different analytical methods lend themselves to detecting magnitude *vs.* slope thresholds
- different sets of tradeoffs associated with each method
- increased confidence when results agree

Analytical Technique	Strengths	Limitations	Type of Threshold (refer to Figure 3.1.)
CART	Number of thresholds does not have to be established a priori but can be manually limited by user. Least absolute deviation method can be used to reduce sensitivity to outliers. Can handle multiple potential predictors of thresholds.	This technique can overfit classification and regression trees. Bootstrapping is desirable to determine robustness and level of confidence associated with solutions.	magnitude
TITAN	Provides separate change points for taxa to allow user to assess a community-level change point (if it exists); multiple assessment measures are available for determining confidence in change points	Some degree of interpretation is involved in determining what constitutes a "community-level change point"	magnitude
Piecewise Regression	Intuitive, conceptually easy for non-experts to grasp; provides several measures of uncertainty for determining confidence in the breakpoint	User must specify number of breakpoints *a priori*; this technique will "find a breakpoint" whether a true threshold exists or not; sensitive to outliers	slope
SiZer	No requirement for *a priori* determination of the number of break points	SiZer maps can be difficult to interpret; output does not include a numeric threshold (only visual, subject to interpretation); no measure of uncertainty	slope
BRT	Insensitive to data distributions as well as the presence of outliers, can fit both linear and nonlinear relationships, and automatically handles interaction effects between pairs of predictors	Partial effects plots are created using the mean of other predictor variables so care must be taken in interpretation if interactions exist.	slope (thresholds identified from partial dependence plots); magnitude thresholds can be determined through subsequent CART analysis

Types of Ecological Thresholds



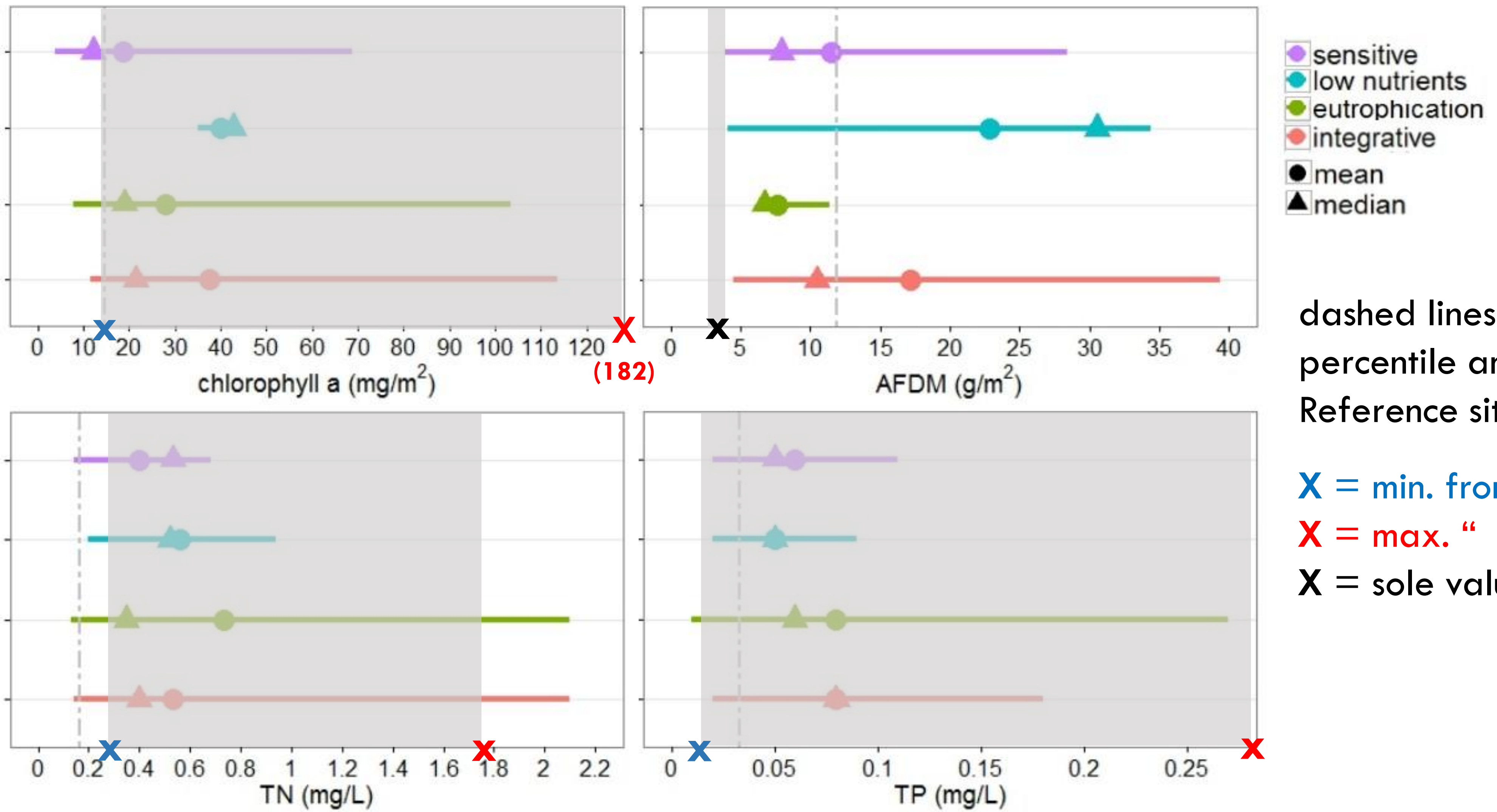
Summary of thresholds across all analyses, for selected algal abundance indicator and nutrient gradients



“Aquatic Life (AL) categories” for grouping metric/indices

- sensitive: metrics based on “sensitive” taxa, i.e., those that are known, based on the literature, to be highly responsive to relatively low levels of generalized stress.
- low-nutrients: metrics based on taxa that have been associated with low-nutrient conditions by previous studies in the literature
- eutrophication: metrics based on taxa that are tolerant to various aspects of eutrophication, according to the literature
- integrative: indices that provide an integrative measure of community composition to provide inference into overall water-body condition

Ranges of Thresholds of Aquatic Life Response by "AL Category"



dashed lines = 75th percentile among Reference sites statewide

X = min. from the literature

X = max. "

X = sole value "

Summary of Thresholds

- **Benthic chlorophyll *a* (live biomass)**
  - Mean thresholds 20-40 mg m^{-2}
- **Ash free dry mass (all organic matter)**
  - Mean thresholds 8-23 g m^{-2}
- **Total nitrogen and phosphorus**
  - Mean thresholds of 0.05-0.08 mg L^{-1} TP and 0.4-0.8 mg L^{-1} TN
- No thresholds found for percent cover—though this indicator still has utility for REC-2

Comparing Regional to Statewide Results

Gradient	South Coast Ecoregion mean threshold (range); count	Statewide mean threshold (range); count
chlorophyll *a* (mg/m^2)	**45** (13 - 111); 35	**31** (4 - 113); 52
AFDM (g/m^2)	**30** (4 - 180); 39	**15** (4 - 39); 61
TN (mg/L)	**0.55** (0.15 - 2.0); 65	**0.53** (0.13 - 2.1); 84
TP (mg/L)	**0.071** (0.019 - 0.300); 55	**0.070** (0.011 - 0.267); 71

South Coast values somewhat higher, but mostly similar

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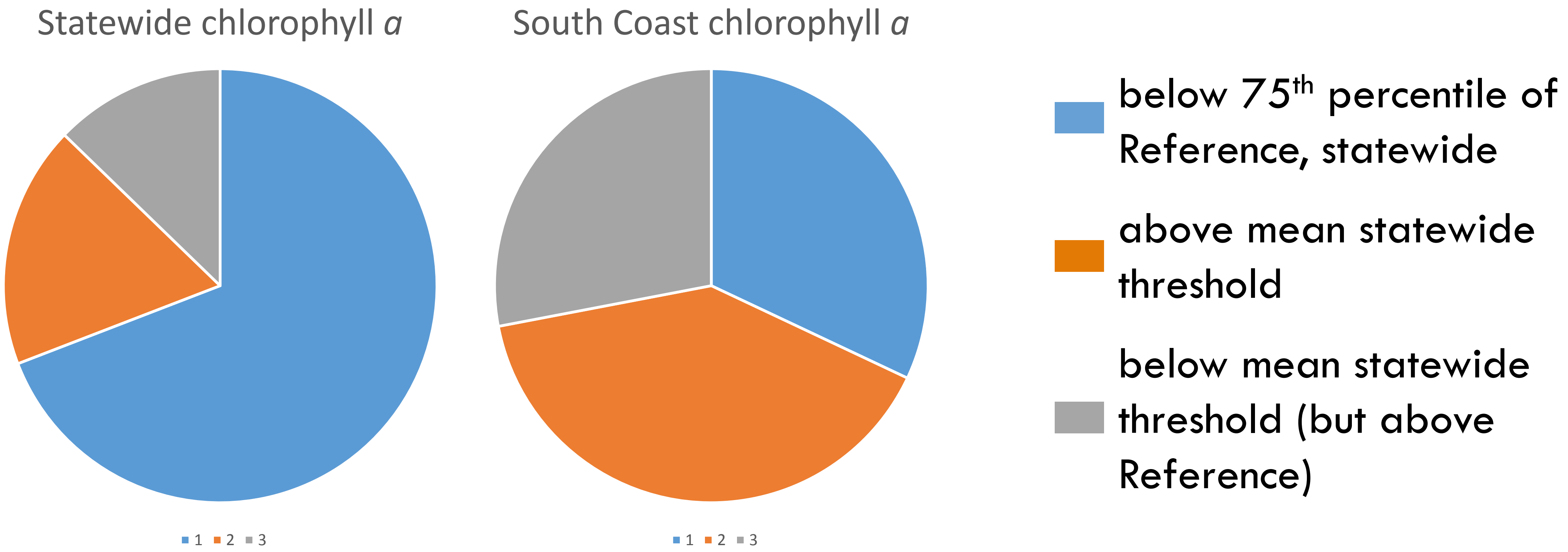
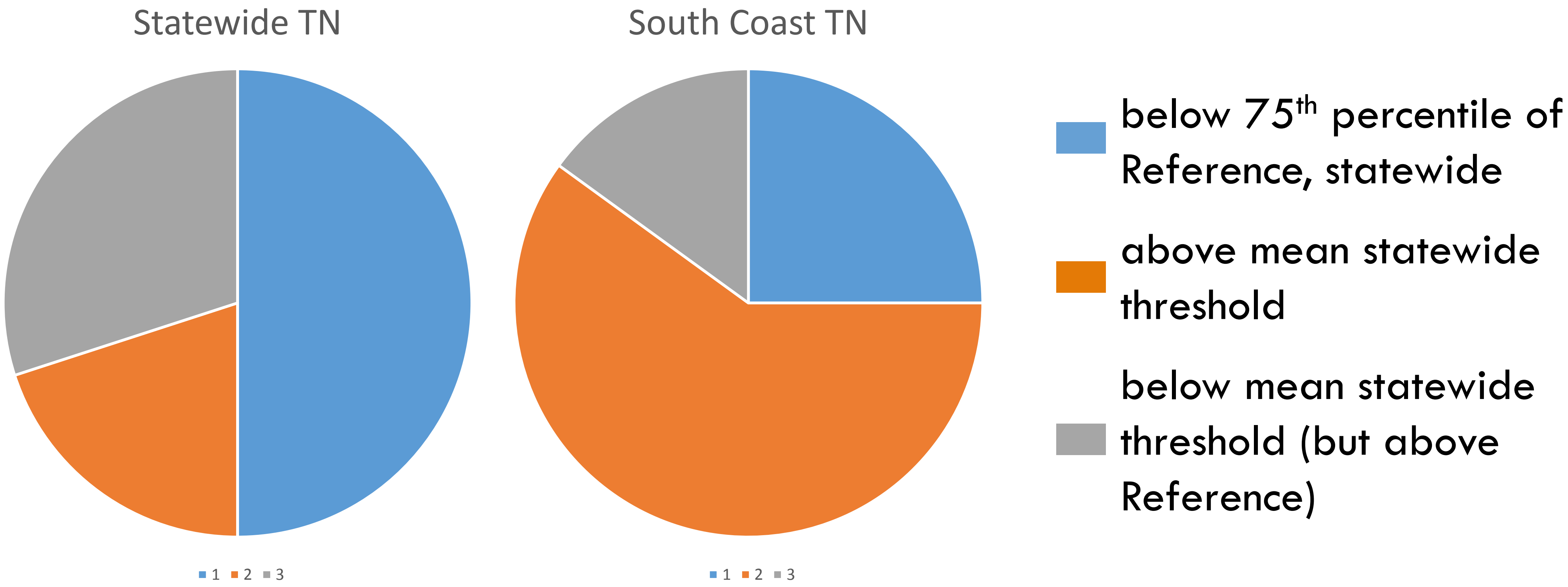
Only 17% of stream miles statewide are estimated as **> chlorophyll mean threshold** (but 40% of South Coast)



Only 20% of stream miles statewide are estimated as **> TN mean threshold** (but 60% of South Coast)



Summary of Findings on Thresholds

- Support for a range of thresholds of adverse effects of benthic chlorophyll *a*, AFDM, and TN and TP concentrations on bug and algal community structure

- Most were within ranges reported in literature (when available) with respect to bugs and diatoms
  - however, were lower than current NNE endpoint values

- Although relationships between benthic chlorophyll *a* concentrations and aquatic life indicators were observed, support for thresholds of response to AFDM and nutrient concentrations were stronger

- Most thresholds > 75^{th} percentile of Reference stream reaches statewide

- No strong effect of region detected in thresholds (based on comparison of ONE region (South Coast) with statewide results)

EPA-ORD Report Findings Group Discussion

Next Steps- Target Dates

December 17, 2014	Input on Candidate Science Panel Member
December 19, 2014	Written comments on Wadeable Streams Science Plan and EPA-ORD report
January 2015	Distribute revised Wadeable Streams Workplan
March 2015:	First Science Panel Meeting
To Be Announced	Focus groups by sector to discuss implementation ideas