California Stream Nutrient Objectives Stakeholder Advisory Group Webinar

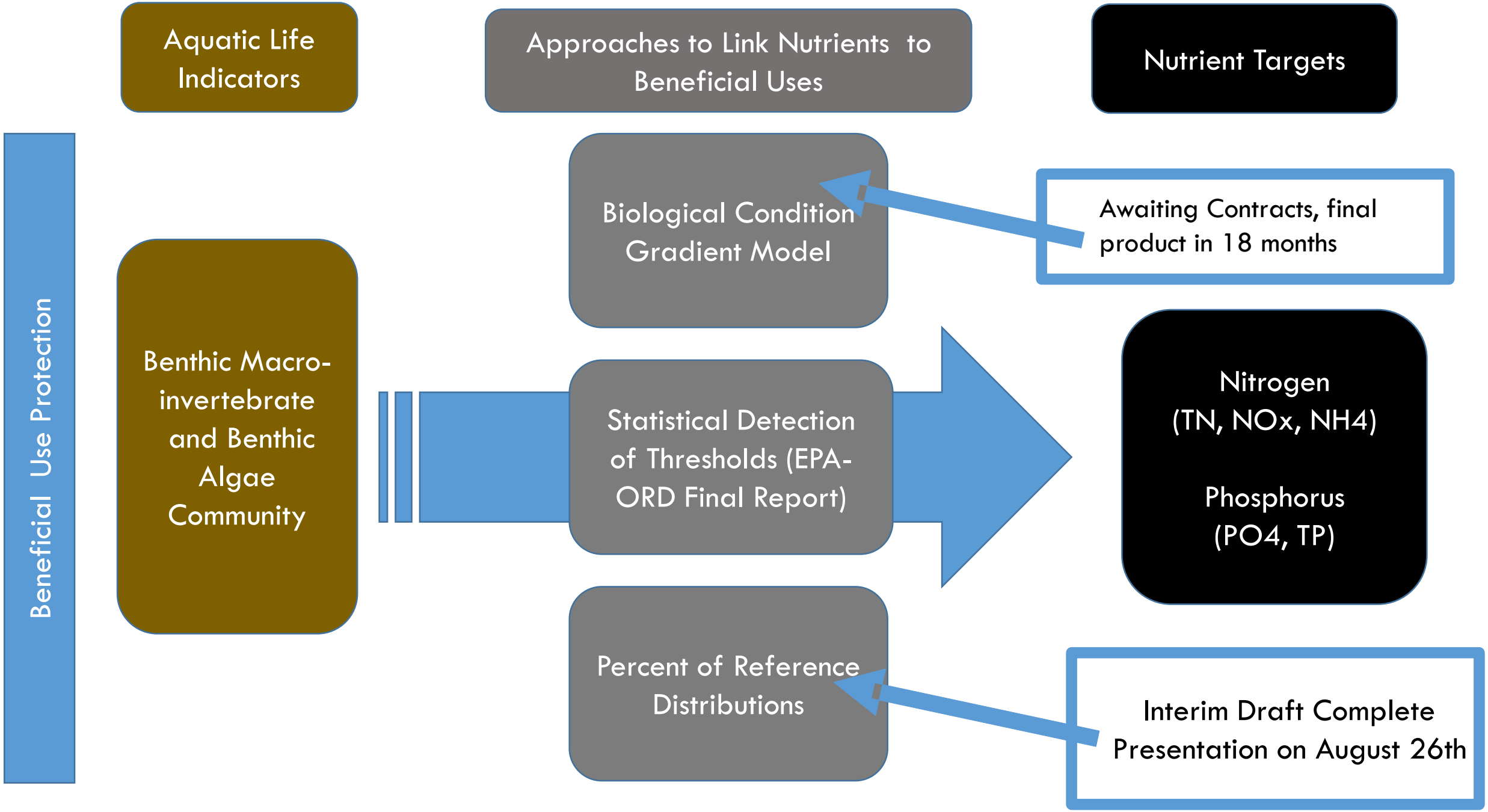
August 21, 2015

1:00 – 2:30 pm

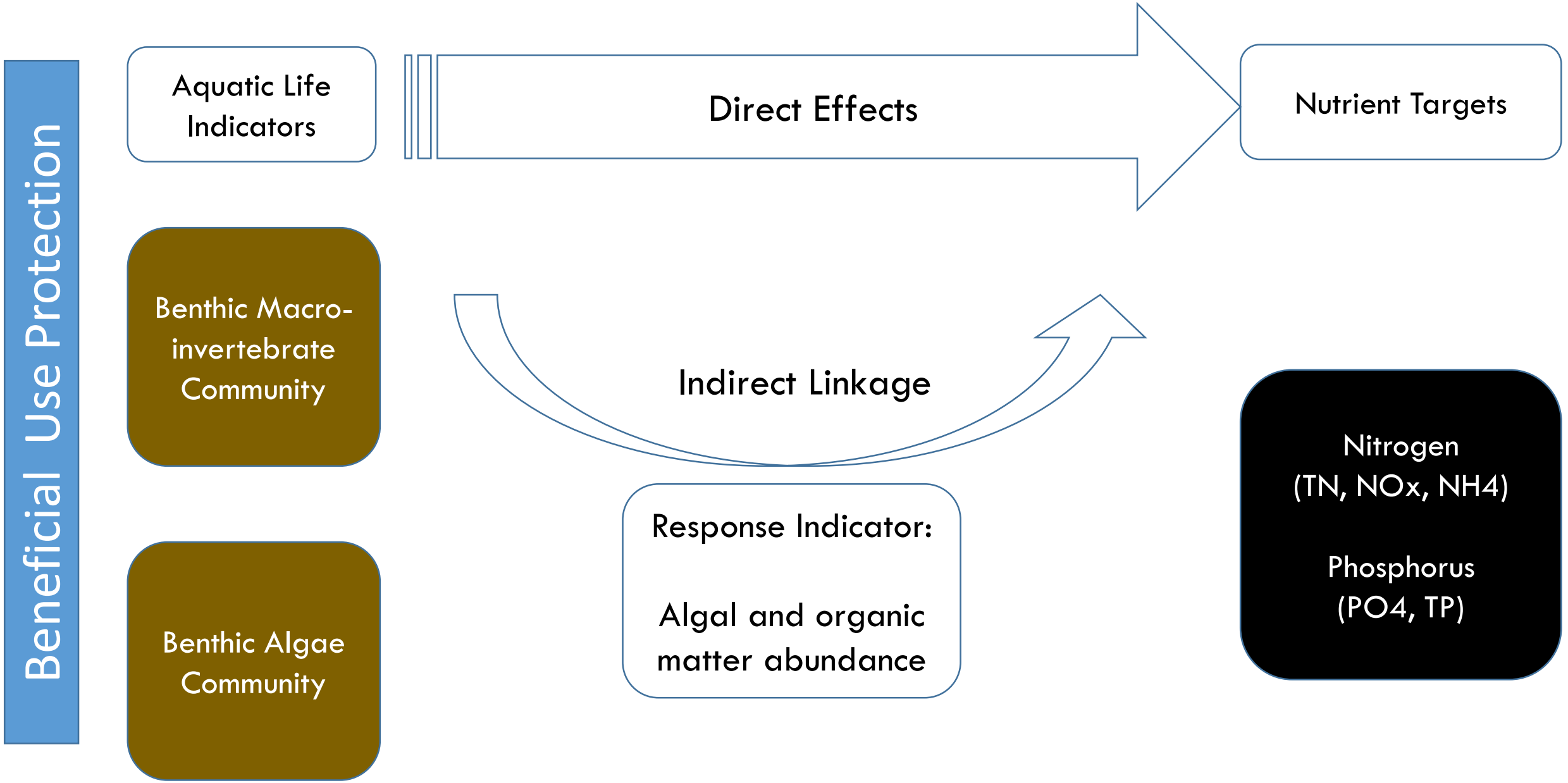
Context for Today's Meeting

- California State Water Board has a work plan to develop nutrient objectives for the State's waterbodies, focusing first on wadeable streams
- A Science Plan has been produced to describe technical activities that will support policy decisions on nutrient objectives in wadeable streams
  - An independent Science Panel has reviewed this plan; findings and recommendations are available on the Water Board website
- Today (and next week) we will report out on some of the interim products from that Science Plan
- We are planning a fall meeting to provide response to Science Panel recommendations and discuss your feedback on these interim products

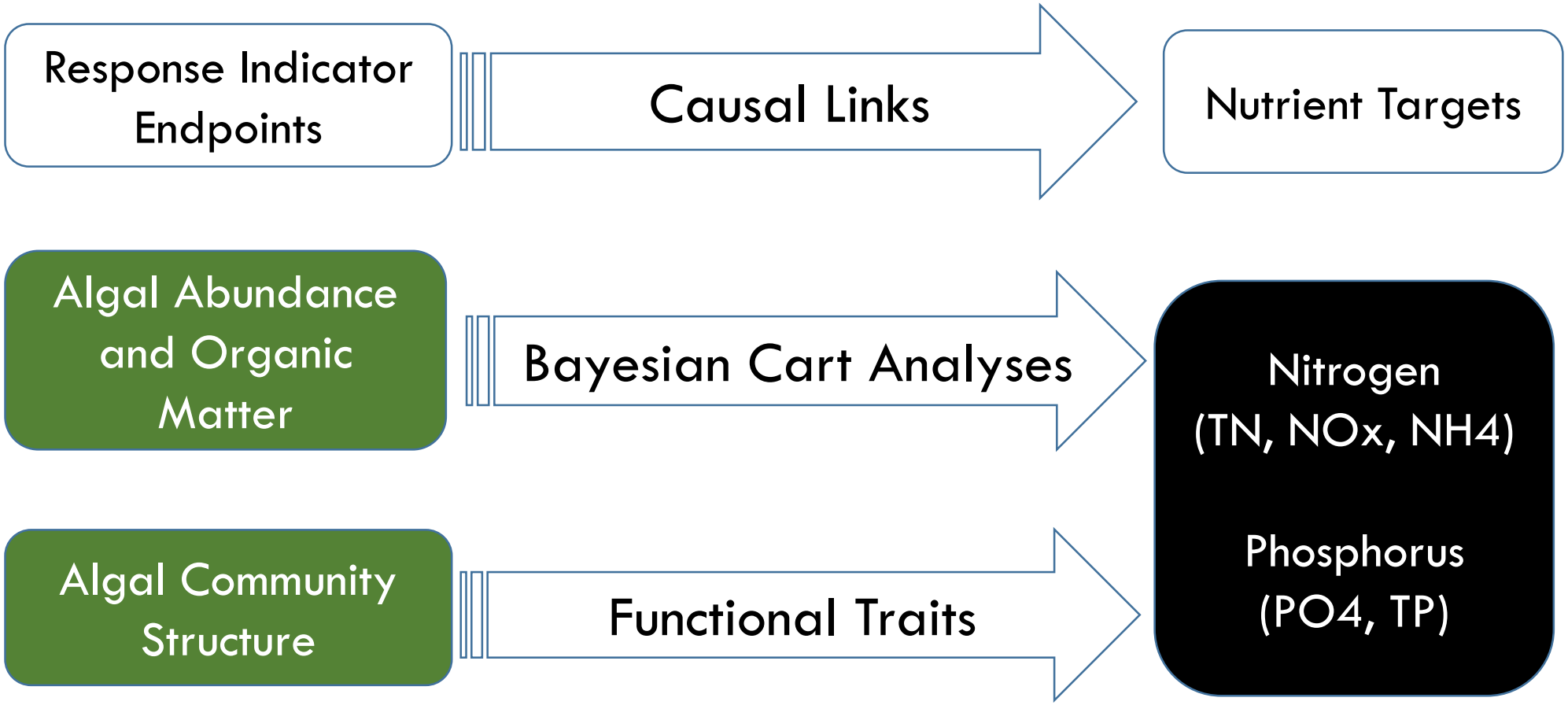
Science To Support Decisions on Nutrient Targets Protective of Beneficial Uses


Aquatic Life Indicators
Approaches to Link Nutrients to Beneficial Uses
Nutrient Targets
Beneficial Use Protection
Biological Condition Gradient Model
Awaiting Contracts, final product in 18 months
Benthic Macro-invertebrate and Benthic Algae Community
Statistical Detection of Thresholds (EPA-ORD Final Report)
Nitrogen (TN, NOx, NH4)
Phosphorus (PO4, TP)
Percent of Reference Distributions
Interim Draft Complete Presentation on August 26th

Two Approaches to Link Nutrients to Response Indicators



Focus of today's webinar: Modeling Relationship Between Potential Response Indicators and Nutrients



B-Cart Report in Draft, Focus of Today's Webinar

Technical Products Status and Schedule For Review

Product	Status	SAG/RG	Science Panel
Conceptual Approach and Waterbody Classification	Interim report draft complete	Fall 2015	Winter 2015
Candidate Indicator Review	In progress		
Percentile of Reference	Interim report draft complete		
B-CART Nutrient-Response Modeling	Interim report draft complete		
Biological Condition Gradient Model	Contract pending	14 months	18 months
Algal Community Nutrient Response Relationships	Analyses complete		
Synthesis and Recommendations	Pending completion of technical elements	16 months	18 months

Goal of Today's Webinar: Nutrient-Response Modeling

Provide an overview of the approach and findings of analyses to relate nutrients to indicators of algal abundance/organic matter

(Preview of science that you will see in interim report)

Preview approach to relate algal species composition to nutrient concentration (work in support of Biological Condition Gradient Model)

Models Relating Algal Abundance to Nutrients and Co-factors in California Wadeable Streams

Betty Fetscher
Martha Sutula

Background

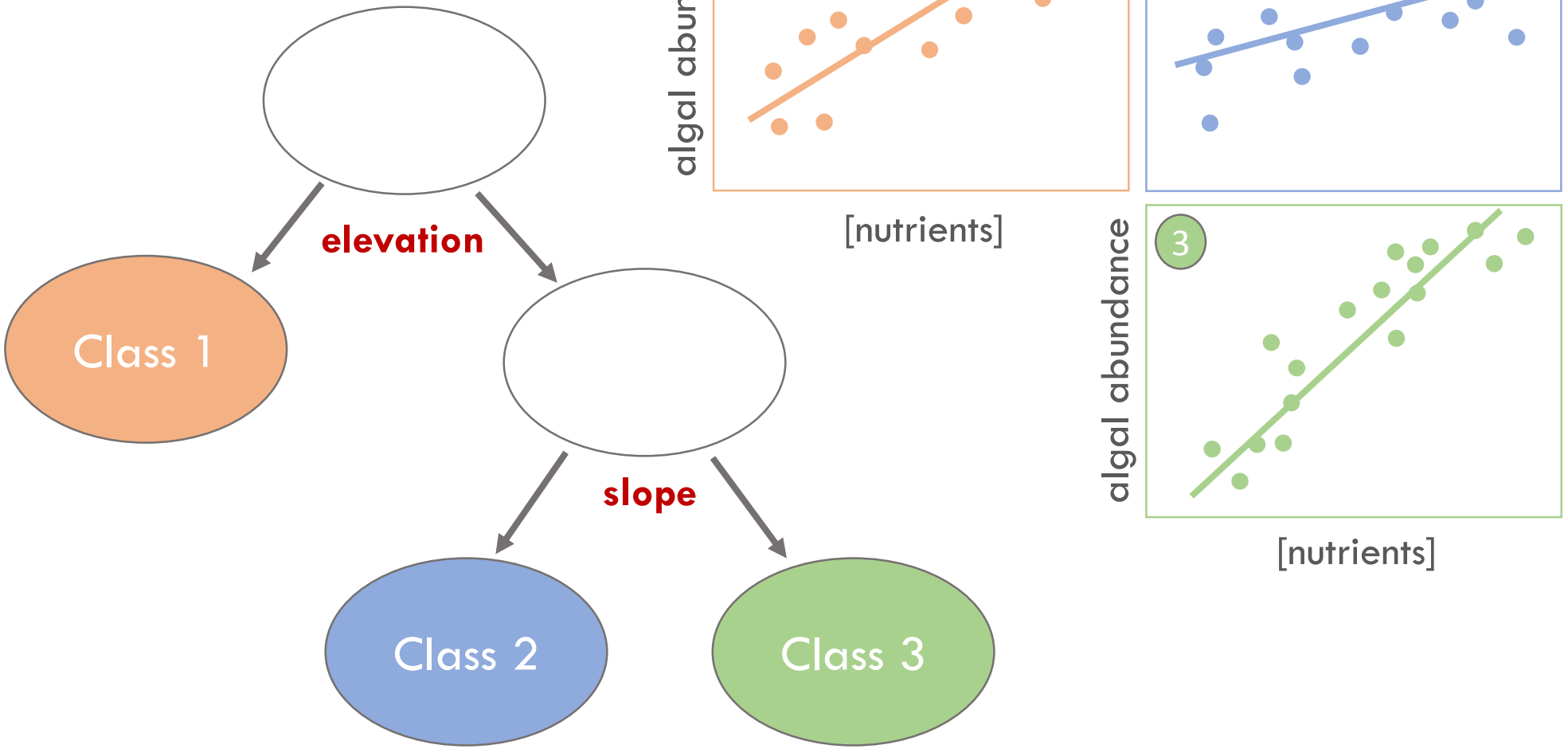
- Biomass-based endpoints under the NNE would require a translation back to nutrient concentrations for management purposes
- Numerous factors modulate biomass response to nutrients and need to be accounted for in models
- Previous ("1st-generation") work (Fetscher *et al.* 2014) generated models with high predictive power, but uncertainty about implementation details means alternative modeling approaches should also be considered
  - *Today we will present "2nd-generation" models*

Modeling Approach:

Bayesian Classification and Regression Trees (B-CART) analysis

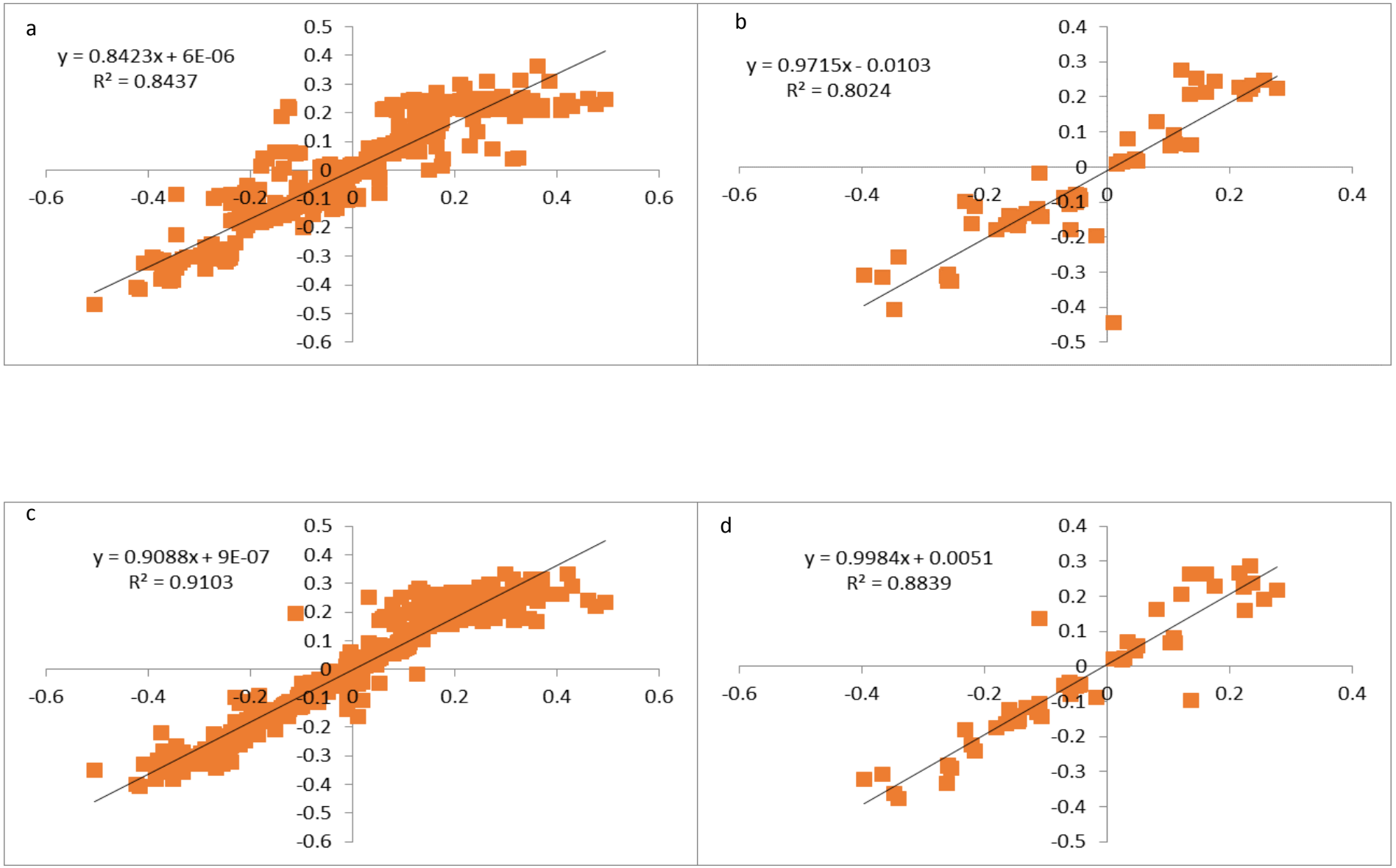
- Models primary producer abundance response to nutrients
  - chlorophyll *a*
  - AFDM
  - macroalgal % cover
- Uses site-specific factors (natural gradients only, for 2nd-generation) to assign sites to classes
  - ➢ *This differs from the previous version, which included anthropogenic*
- Yields simplified set of regression models to predict algal biomass by site "class", along with a set of rules to define the classes

How B-CART Works



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

1st-Generation B-CART Model Performance



Interpreting 1st-Generation Model Results

- Very impressive predictive power!
- Anthropogenic gradients (including nutrients themselves) were included as classification & predictor variables, and these were retained (=important) in most of the final models
- But there are questions as to whether to include anthropogenic factors in the models (more on that later…)

2nd-Generation B-CART, List of Variables

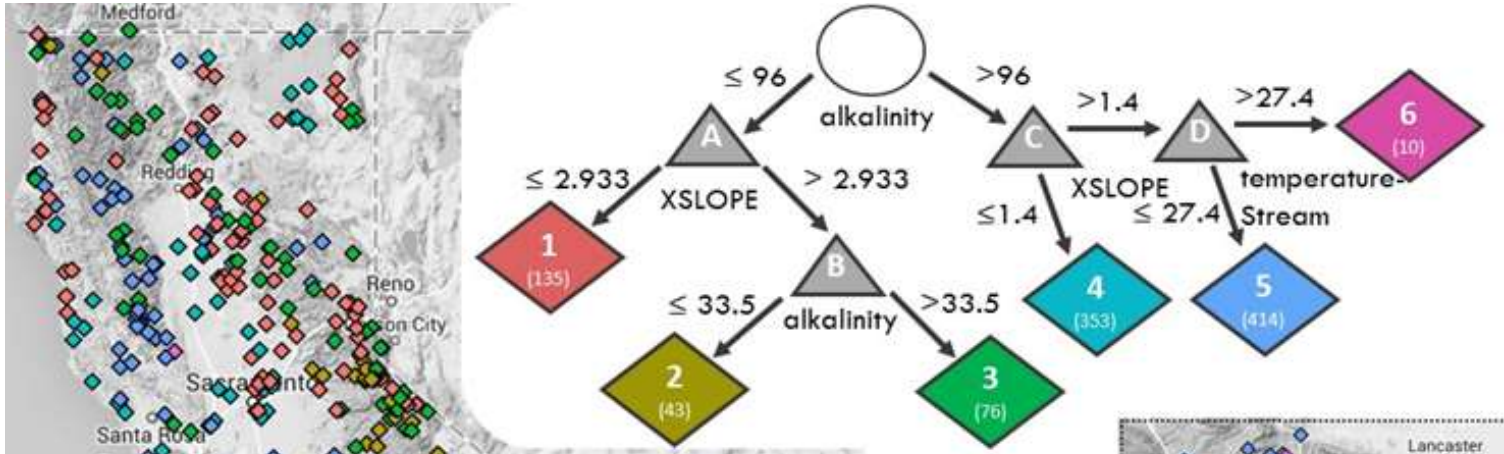
- **RESPONSE VARIABLES** (algal biomass indicators of eutrophication)
  - benthic chlorophyll *a*
  - benthic ash-free dry mass (AFDM)
  - macroalgal percent cover (PCT_MAP)
- **EXPLANATORY VARIABLES**
  - **Nutrients**
    - total nitrogen (TN)
    - total phosphorus (TP)
    - nitrate + nitrite (NO_x)
    - orthophosphate (PO_4)
    - ammonium (NH_4)
  - **Landscape - geographic**
    - site elevation
    - watershed area
    - percent sedimentary geology in the catchment
    - modeled atmospheric deposition
  - **Landscape - meteorological**
    - mean monthly % cloud cover (3-mo antecedent mean)
    - mean monthly max temperature (3-mo antecedent mean)
    - mean monthly solar radiation (3-mo antecedent mean)
    - total precipitation (3-mo antecedent total)
    - degree days from onset of growing season to sampling date
    - day of year
  - **Local physical habitat ("PHab")**
    - percent cover of coarse particulate organic matter in streambed
    - percent cover of fine substrata in streambed
    - percent sand + fines in streambed
    - percent canopy cover
    - estimated days of accrual (i.e., number of days since last scour event)
    - mean stream depth
    - mean stream width
    - slope, reach-level
    - stream discharge
    - stream temperature
  - **Water chemistry (general)**
    - alkalinity
    - conductivity
    - turbidity

2 model types examined:
- classifier-heavy
- predictor-heavy

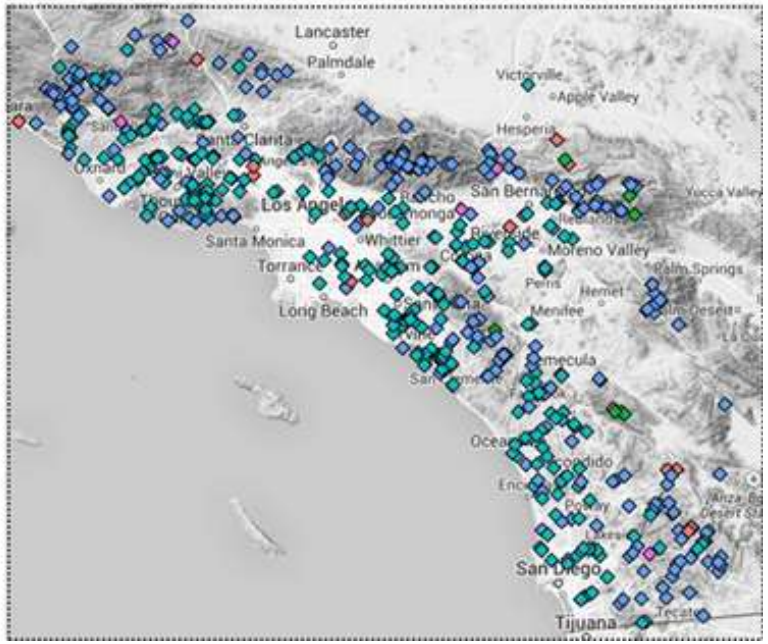
2nd-Generation B-CART, Final Classifiers

Model	biomass response variable	alkalinity	day of year	reach slope	percent coarse particulate organic matter (CPOM)	stream temp-erature	canopy closure (XDENMID)	percent fine sub-strata	turbidity x depth
classifier -heavy	chlorophyll *a*	X		X		X			
	AFDM	X	X		X				
	macroalgal percent cover (PCT_MAP)	X	X				X		
predictor -heavy	chlorophyll *a*	X	X	X					
	AFDM	X	X		X				
	macroalgal percent cover (PCT_MAP)	X	X					X	X

Example of 2nd-Generation B-CART Tree



chlorophyll *a*, classifier-heavy

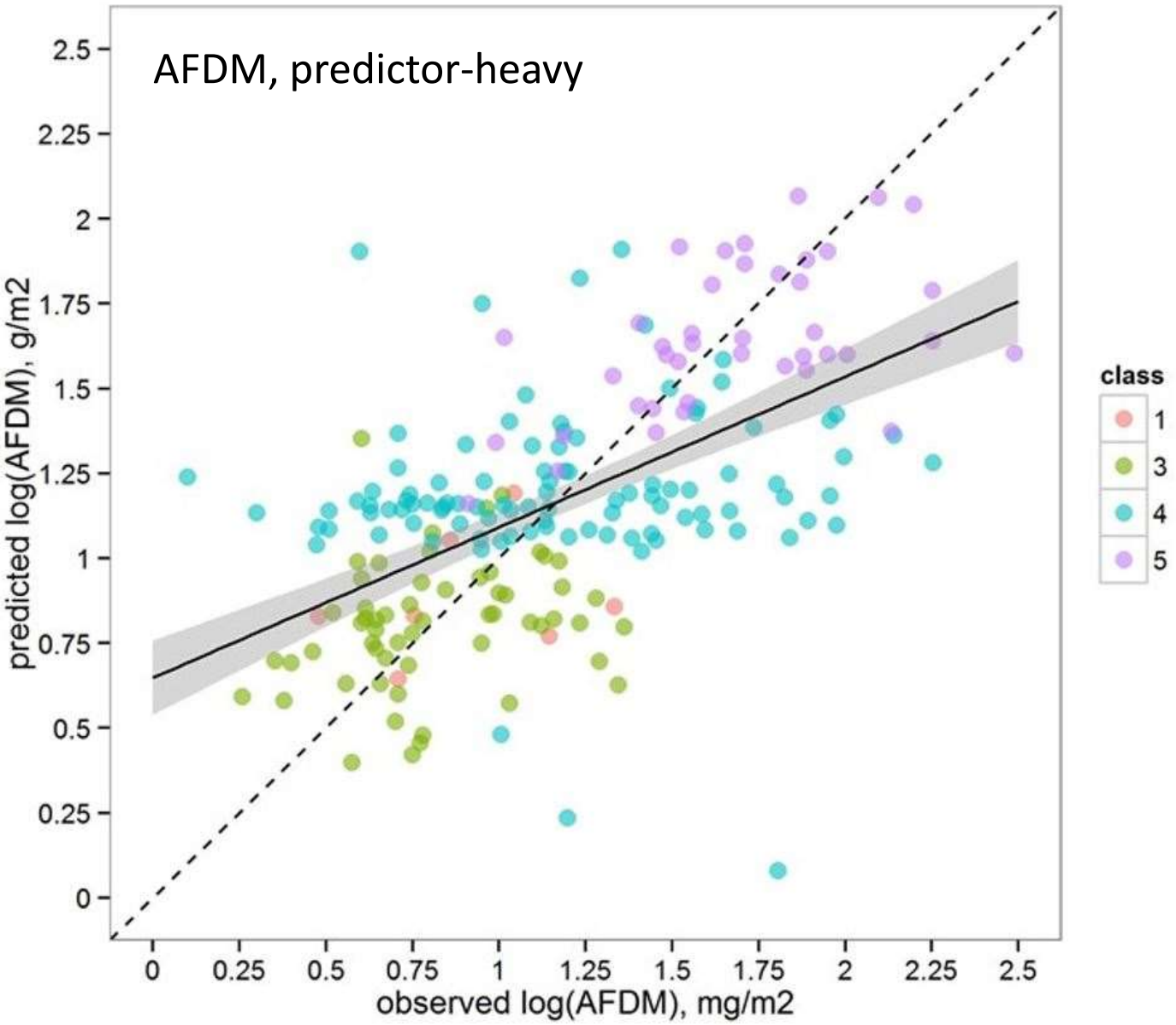


Predictive Power of 2nd-Generation B-CART Models

Model	Biomass Response	Intercept	Slope	Adjusted R^2
classifier-heavy	AFDM	0.761 (0.083)	0.364 (0.062)	0.348
	chlorophyll *a*	0.867 (0.070)	0.343 (0.046)	0.375
	macroalgal percent cover	0.594 (0.068)	0.376 (0.056)	0.440
predictor-heavy	AFDM	0.694 (0.067)	0.389 (0.052)	0.209
	chlorophyll *a*	0.448 (0.082)	0.497 (0.064)	0.435
	macroalgal percent cover	0.812 (0.027)	0.247 (0.023)	0.261

Example of 2nd-Generation Observed vs. Predicted

- Suboptimal fit
- Biased



Pros/Cons of Including Anthropogenic Factors (nutrients, etc.)

Cons:

- Including nutrients as classifiers can truncate nutrient gradients within classes

- Some anthro factors are confounded with nutrients, thus risking the removal of an unquantified portion of the nutrient variance from the nodal regression relationships

  - *Concern about the cons prompted the 2nd-generation analysis*

Pros/Cons of Including Anthro Factors (nutrients, etc.)

Pros:

- B-CART forces linear regression relationships within tree nodes, and allowing nutrient concentrations to classify sites can accommodate any potential non-linear relationships

- Certain anthropogenic factors can be important in modulating biomass response to nutrients, and thus perhaps should not be ignored (e.g., % imperviousness→ peak flows→scouring; herbicides)

B-CART Models – Sum Up

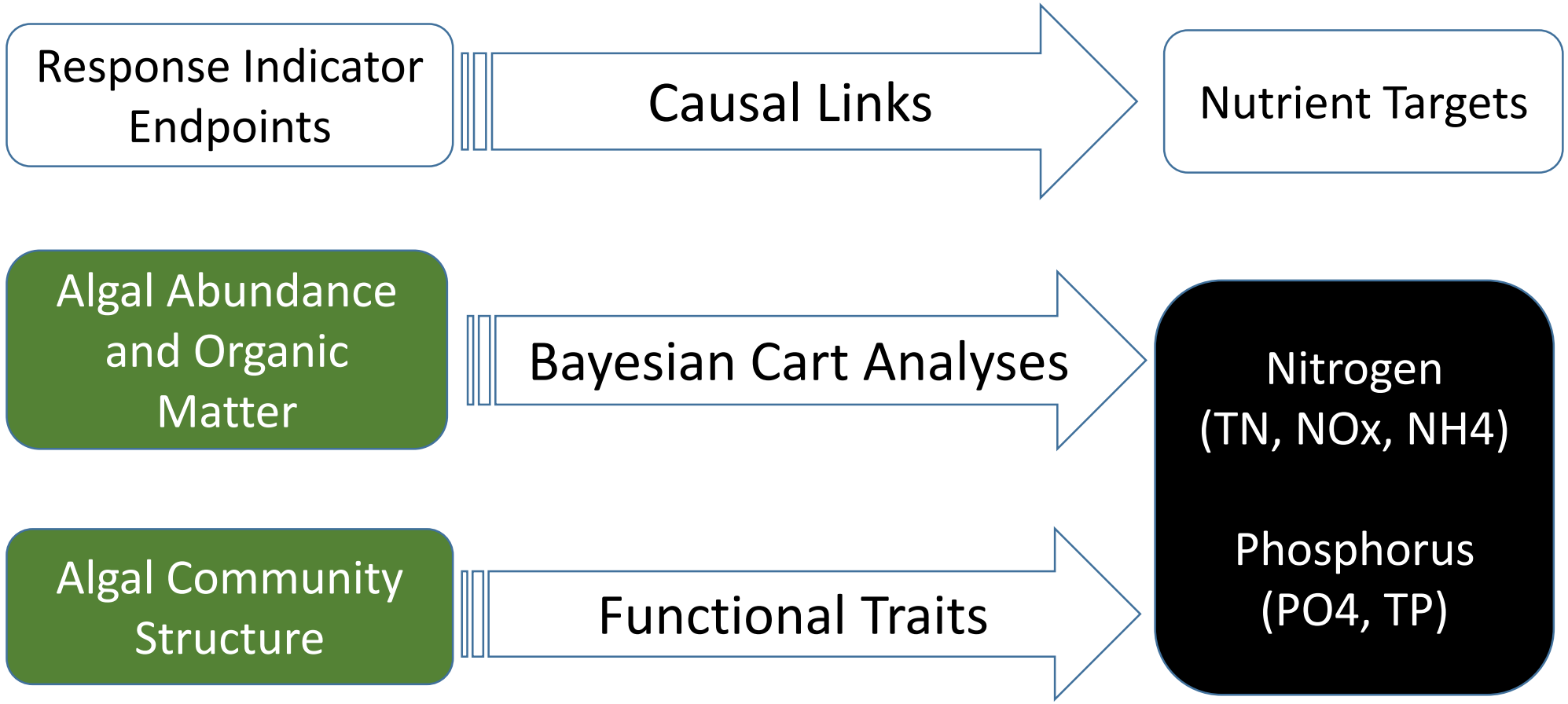
- 1st–generation models performed much better than 2nd
- Excluding anthropogenic factors in 2nd-generation increased noise (weakening predictive power) and may have contributed to bias in model results
- Will need to understand how the models might be used, in order to determine what modeling approach is most appropriate (i.e., is it OK to leave in nutrients and other anthropogenic factors in order to reap improved model performance?)

Looking Ahead:

Quantifying Algal Taxon Relationships to Nutrients

- Exploratory exercise that can help with the upcoming Biological Condition Gradient (BCG) development effort
- Uses Indicator Species Analysis to identify relationships between algal (diatom/soft) taxa relative occurrences and binned (quartiles) nutrient concentration categories
- Has identified taxa with affinities to low *vs.* high nutrient concentrations for 5 nutrient types (TN, TP, NO_x, NH_4 OPO_4)

Modeling Relationship Between Potential Response Indicators and Nutrients



B-Cart Report in Draft, Focus of Today's Webinar

Example: Diatom Indicator Taxa for TN

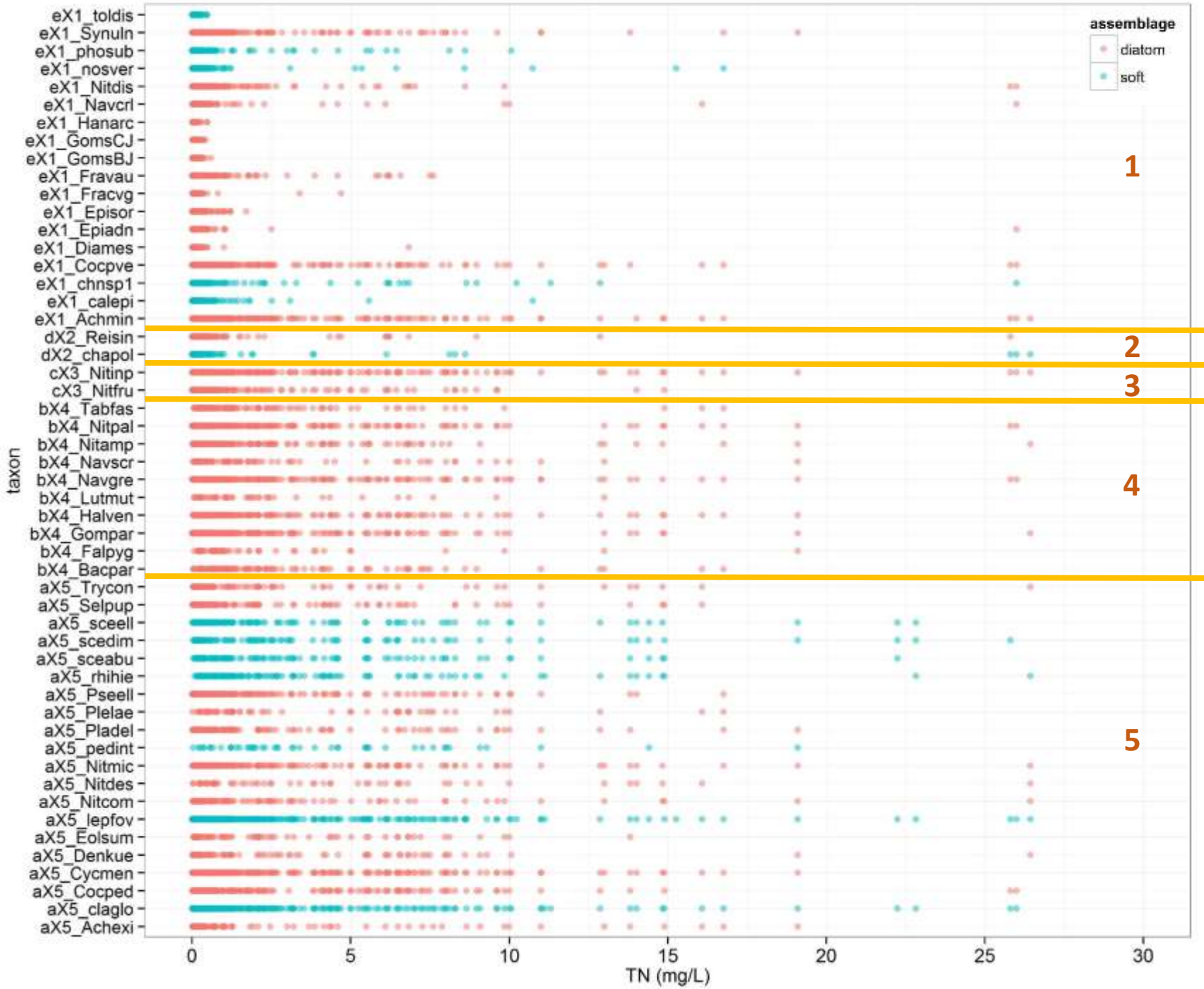
maxGroup	diatom	maxGroup	diatom	maxGroup	diatom
1	*Achnanthidium minutissimum*	4	*Bacillaria paradoxa*	5	*Achnanthidium exiguum*
	Cocconeis placentula var euglypta		*Fallacia pygmaea*		*Cocconeis pediculus*
	Diatoma mesodon		*Gomphonema parvulum*		*Cyclotella meneghiniana*
	Epithemia adnata		*Halamphora veneta*		*Denticula kuetzingii*
	Epithemia sorex		*Luticola mutica*		*Eolimna subminuscula*
	Fragilaria capucina var gracilis		*Navicula gregaria*		*Nitzschia communis*
	Fragilaria vaucheriae		*Navicula schroeteri*		*Nitzschia desertorum*
	Gomphonema sp B SWAMP JPK		*Nitzschia amphibia*		*Nitzschia microcephala*
	Gomphonema sp C SWAMP JPK		*Nitzschia palea*		*Planothidium delicatulum*
	Hannaea arcus		*Tabularia fasciculata*		*Pleurosira laevis*
	Navicula cryptotenella				*Pseudostaurosira elliptica*
	Nitzschia dissipata				*Sellaphora pupula*
	Synedra ulna				*Tryblionella constricta*
2	*Reimeria sinuata*				
3	*Nitzschia frustulum*				
	Nitzschia inconspicua				

Example: Soft Algae Indicator Taxa for TN

maxGroup	soft algae
1	Calothrix epiphytica
1	Chantransia sp 1
1	Nostoc verrucosum
1	Phormidium subfuscum
1	Tolypothrix distorta
2	Chamaesiphon polymorphus
5	Cladophora glomerata
5	Leptolyngbya foveolarum
5	Pediastrum integrum
5	Rhizoclonium hieroglyphicum
5	Scenedesmus abundans
5	Scenedesmus dimorphus
5	Scenedesmus ellipticus

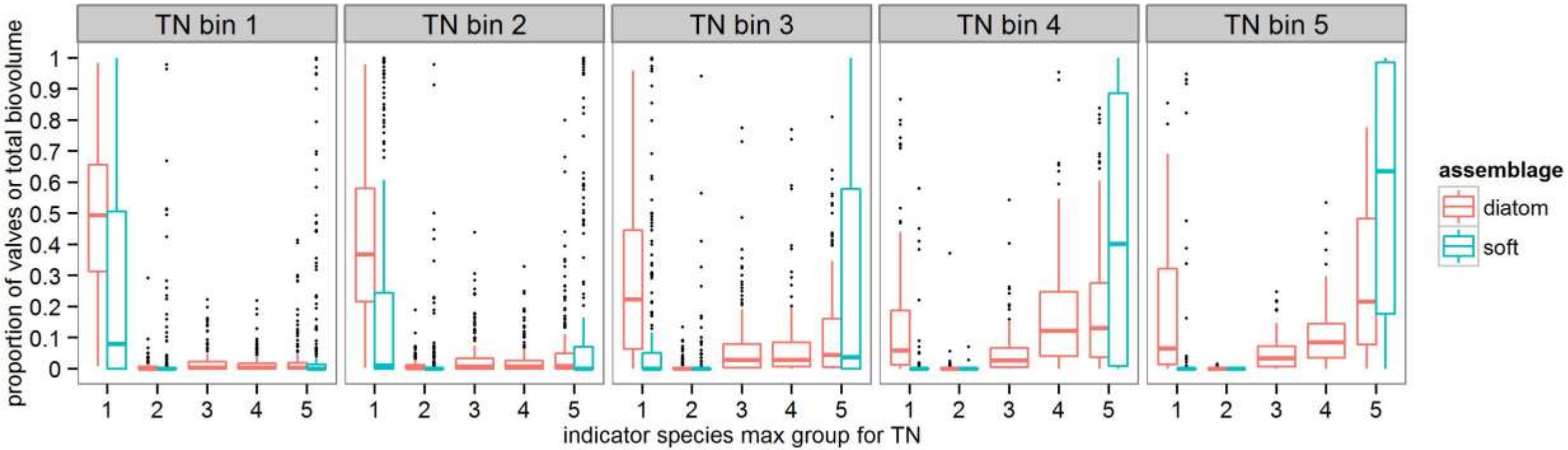
Groundtruthing Results:

Occurrence of algal taxa within TN maxGroup categories across TN gradient



Groundtruthing Results:

proportions of taxa belonging to to the indicated maxGroups, across TN bins



Quantifying Algal Taxon Relationships to Nutrients – Sum Up

- Indicator Species Analysis was successful at identifying taxa with strong fidelity to sites with different nutrient concentrations
- Results align well with values in the literature, where available
- This information has several applications within the context of BCG development

Questions? Comments?

Next Steps

- Next technical webinar August 26, 1-2:30 pm Pacific Time
  - Response indicator endpoints and nutrient targets as a percentile of reference (Michael Paul, Tetra Tech)

- Release of draft (interim) reports in September 2015

- Targeting October 2015 for next stakeholder meeting focused on technical elements
  - Response to Science Panel recommendations
  - Feedback on interim reports
  - BCG workplan discussion and technical approach for mapping channels in "developed landscapes"[1]

- Next Science Panel Meeting: January/February 2016

[1] Pending new Water Board contract start

Water Board Staff Policy Schedule

Milestone	Estimated Date
Focus group meetings (Dischargers – Industry, Publicly Owned Treatment Works - , Agriculture, Stormwater, Concentrated Animal Feed Operations/Grazers/Dairy, Environmental Groups, Non-governmental organizations and Tribes)	September 2015- December 2015
Publicly available draft plan and technical staff report	January 2017
Scientific peer review and staff responses	January 2017
Draft substitute environmental documentation (i.e. project alternatives, environmental impacts, economic factors)	April 2017
Public comment period: Draft plan, staff reports, and draft substitute environmental documentation	Summer 2017
Board Workshop	2017
Board Adoption Meeting	2017