Algal Stream Condition Index (ASCI)

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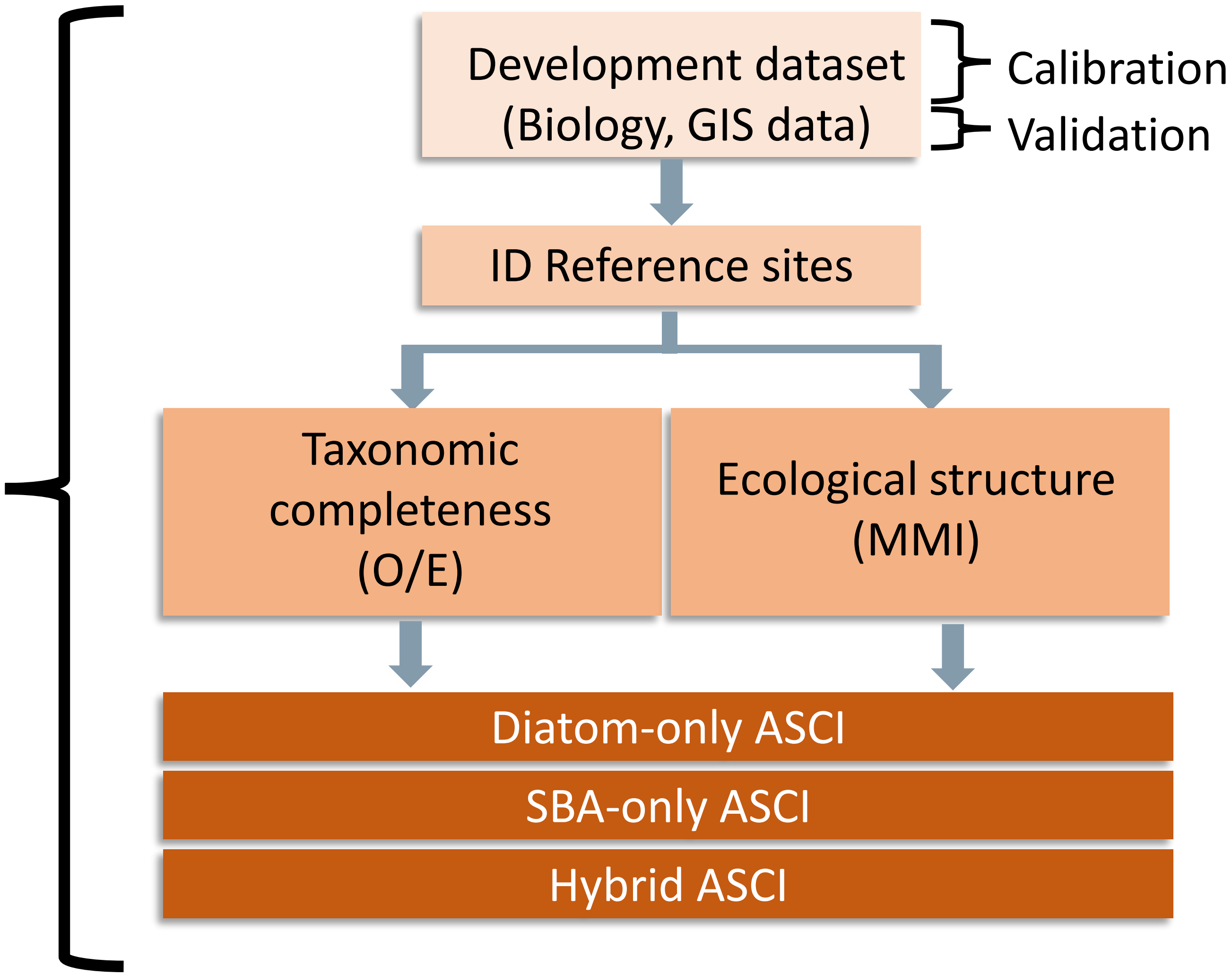
October 26, 2018

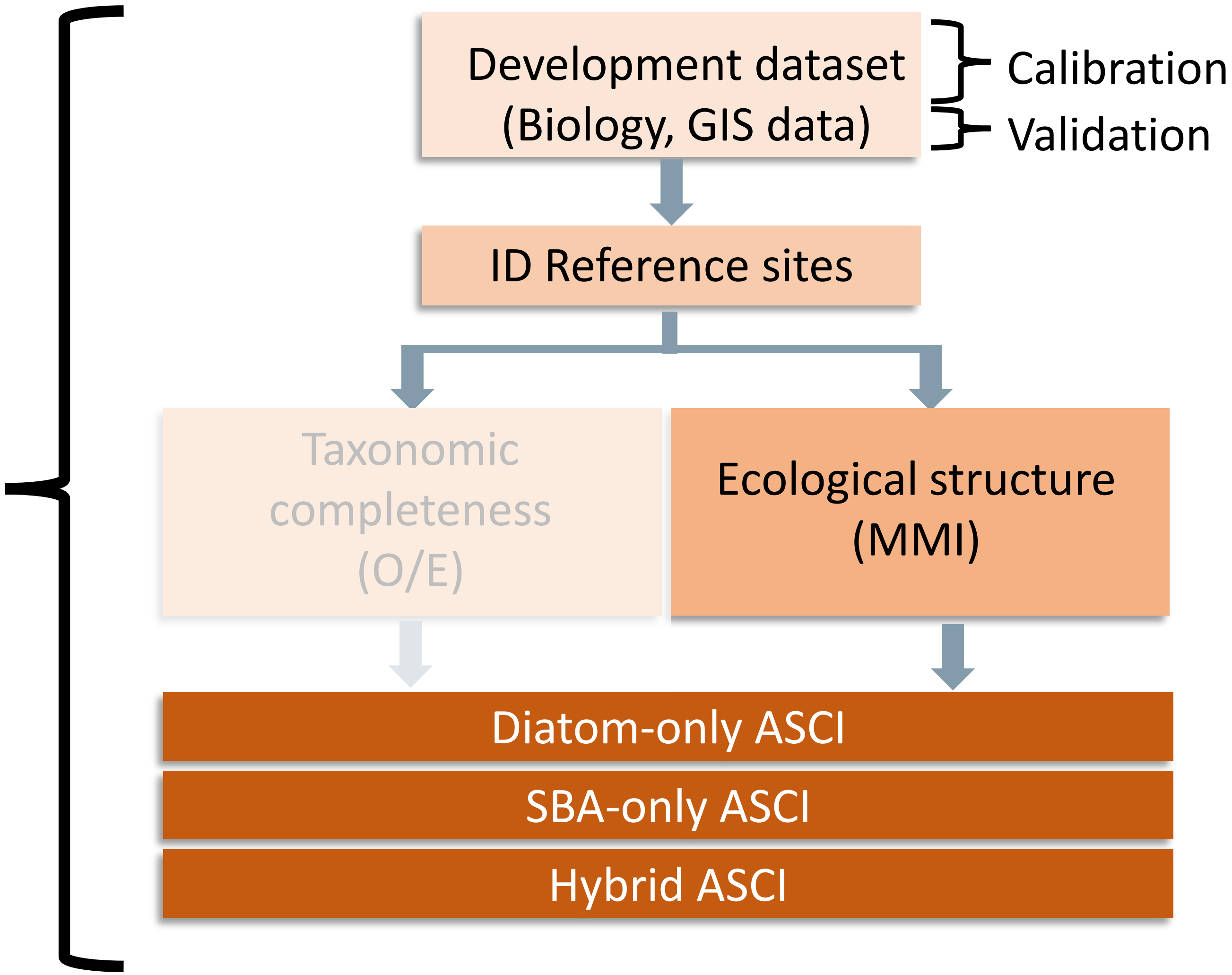
Once upon a time…

- **GOAL:**
  - Develop a statewide algal index
- **APPROACH:**
  - Model the ASCI after the CSCI
  - Develop an Observed to Expected (**O/E**) and a Multi-Metric Index (**MMI**) and a combined version
  - Develop for diatoms, soft-algae, and hybrid

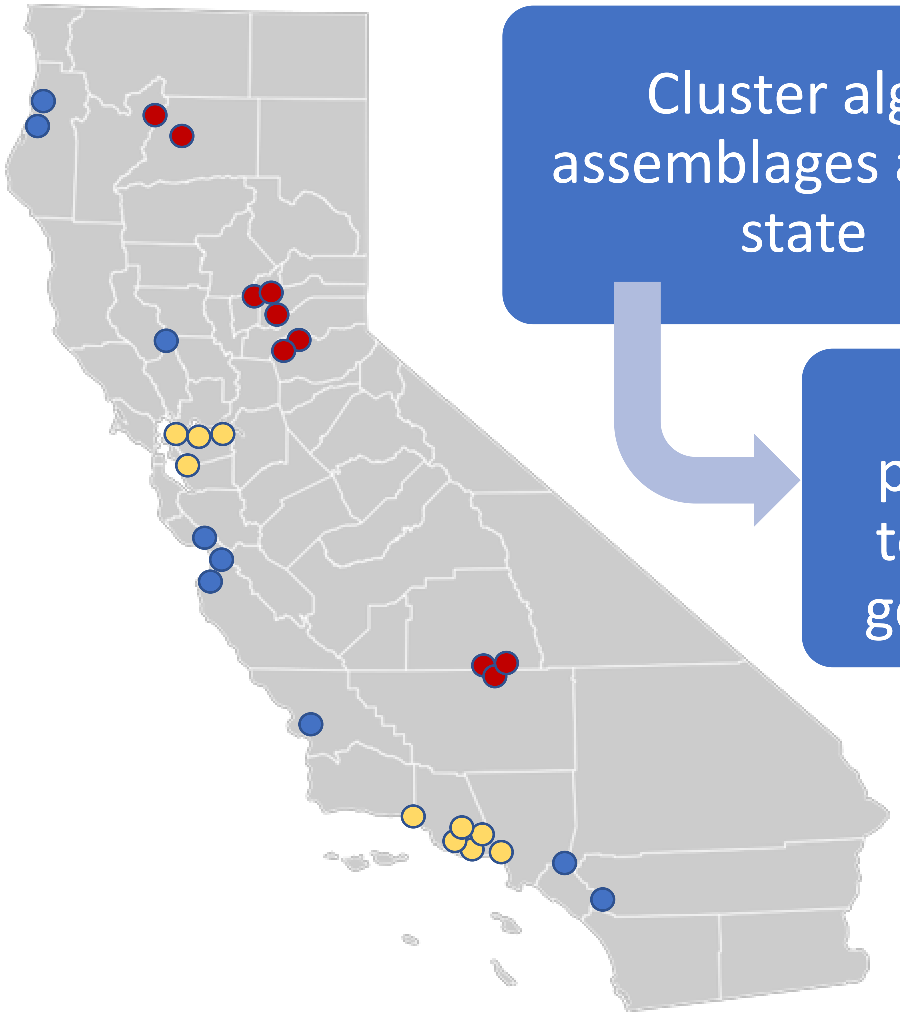


Results

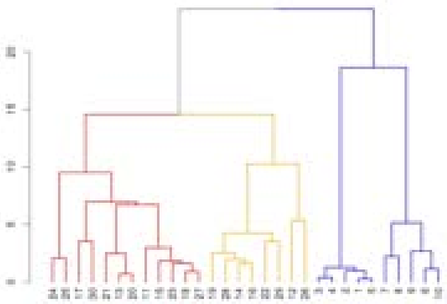
- **GOAL:**
  - Developed statewide algal indices!
- **DETAILS:**
  - O/E models had poor precision
  - Modeling did not improve MMI performance
  - MMIs for diatoms, soft-algae, and hybrid assemblages all had great performance
  - Genus-level diatom MMI had good, but not great, performance



Refresher on O/E development



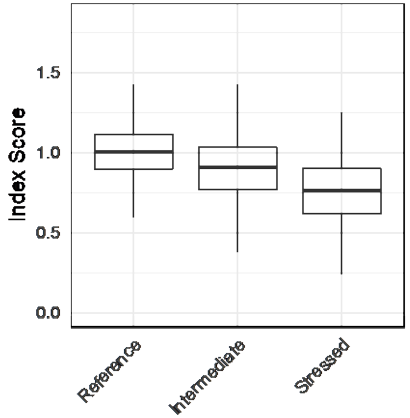
Cluster algal assemblages across state



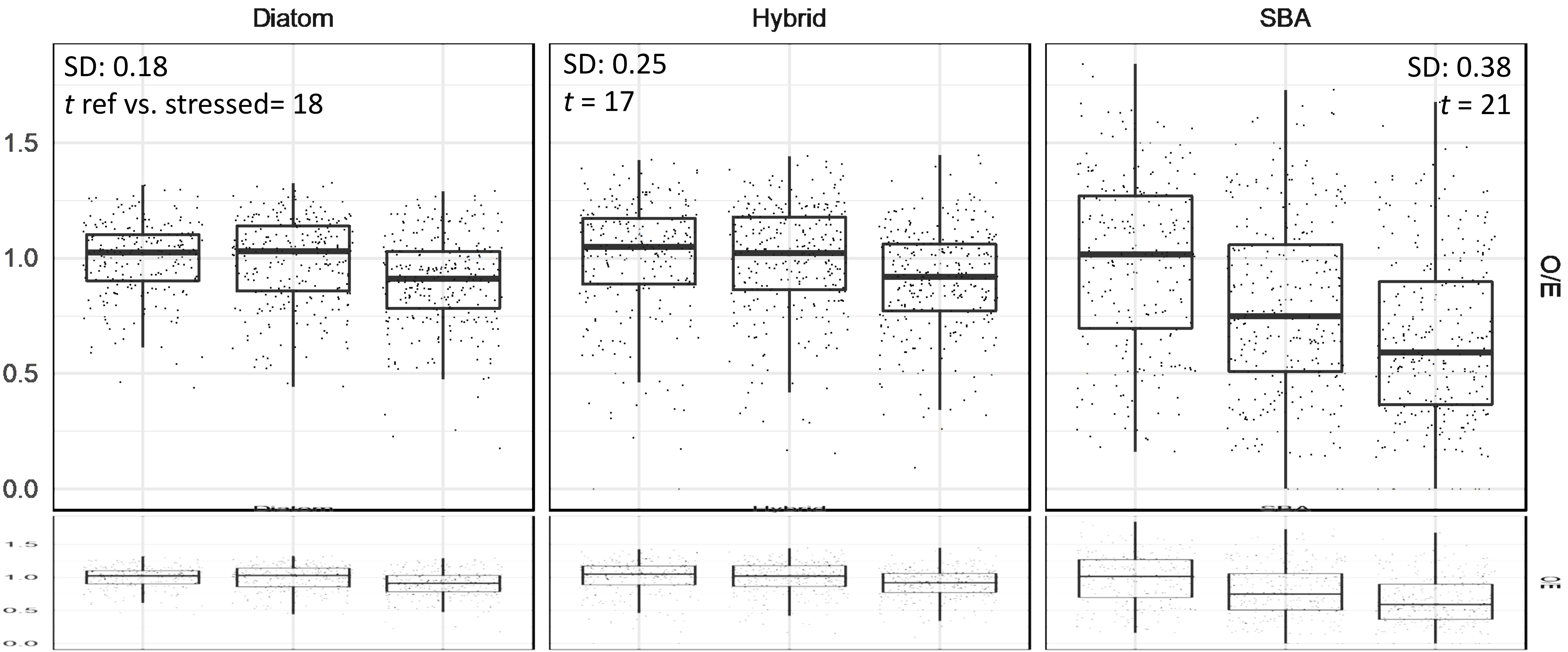
Build models to predict species at test site based on geographic setting

Location	Topography	Long-term climate	Soils	Minerology
Latitude	Watershed area*	Catchment precipitation*	Hydraulic conductance	MgO content
Longitude	Elevation range*	Local precipitation	Bulk density	CaO content
Elevation		Local temp	Erodibility	S content
			Permeability	N content
				P content

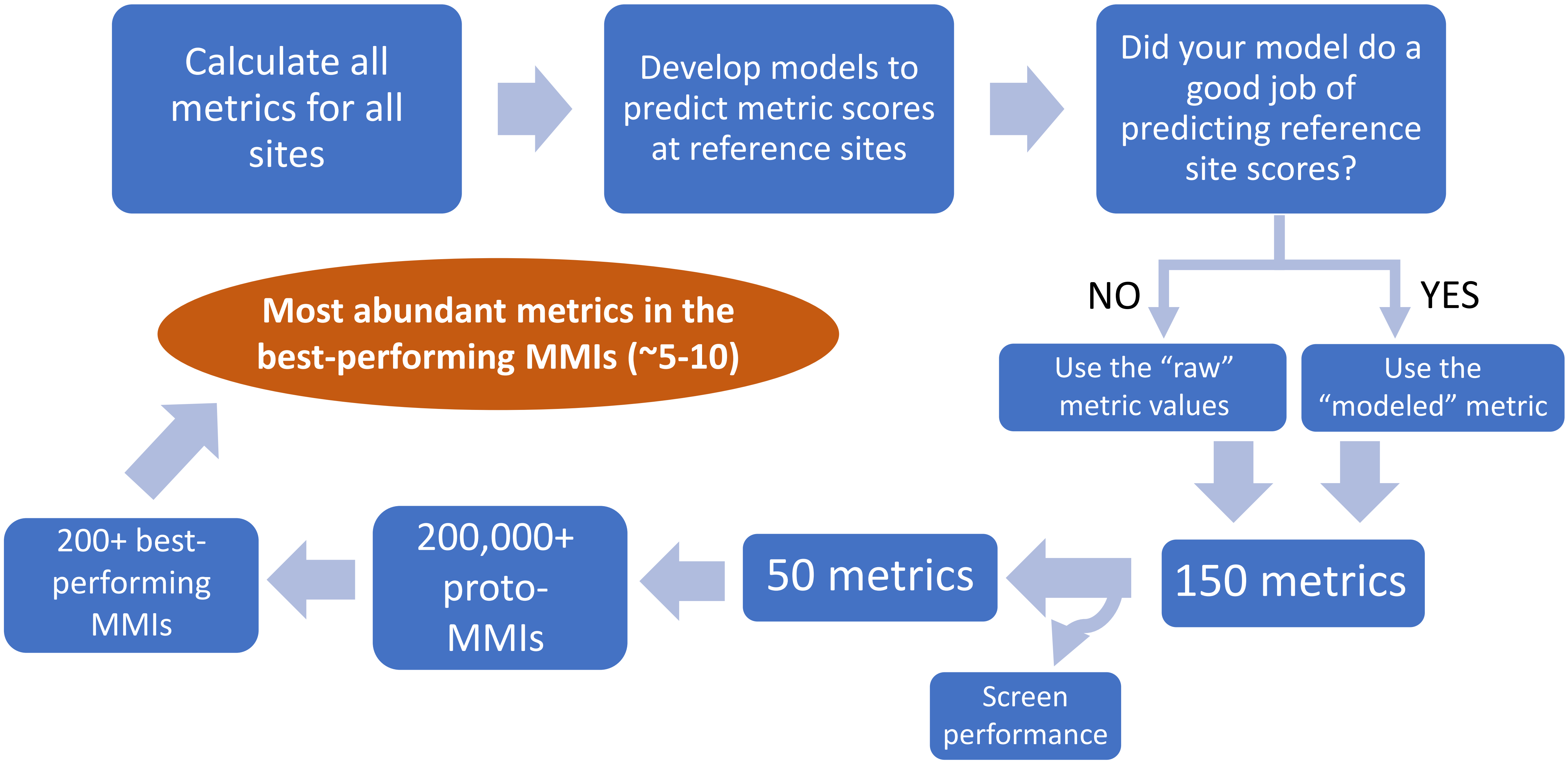
Score sites based on observed vs. expected taxa



O/E – poor responsiveness, poor precision



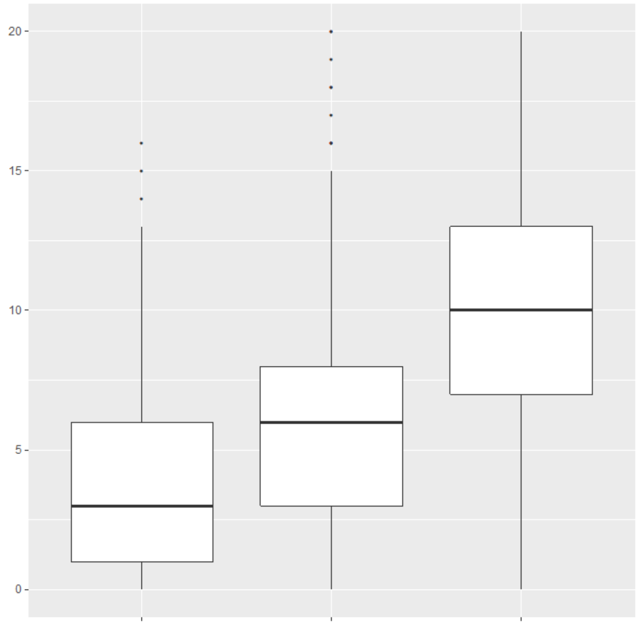
How we developed MMIs



Examples of metrics

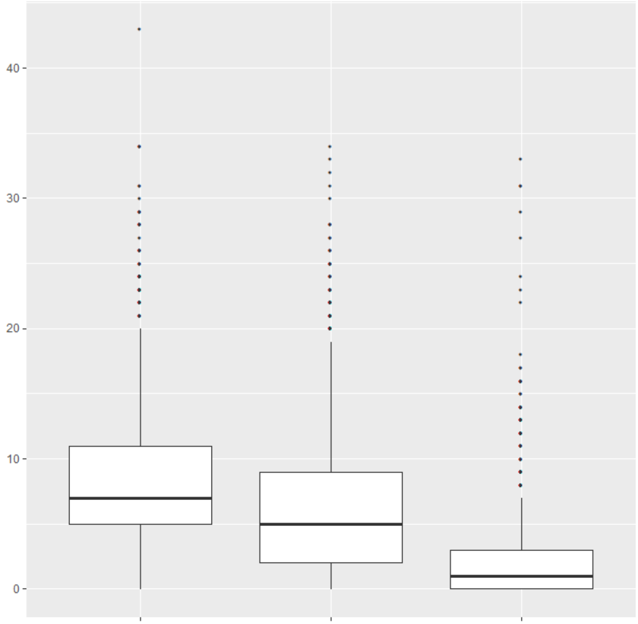
Class	Example metrics
Tolerance	BCG taxa, Tolerant/Intolerant taxa
Motility	Highly motile taxa
Dissolved oxygen	Requires 10% or 30% DO
Salinity	Brackish, freshwater taxa
Saprobility	AM/AMPS taxa
Indicator classes	High N; Low P; High Cu
Diversity	Simpson; Shannon
Taxonomic group	Amphora taxa; ZHR; CRUS taxa

% most tolerant taxa
hybrid metric



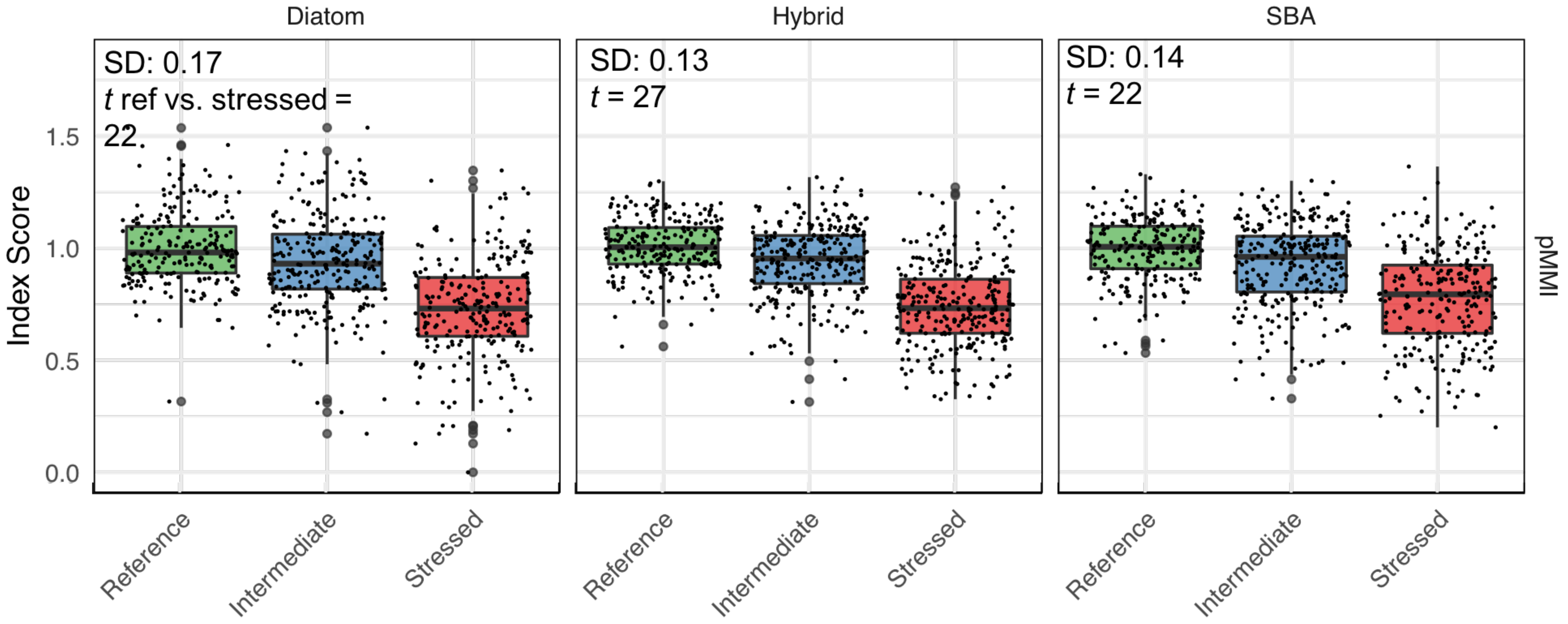
Reference Intermediate Stressed

% sensitive taxa (BCG 2)
hybrid metric



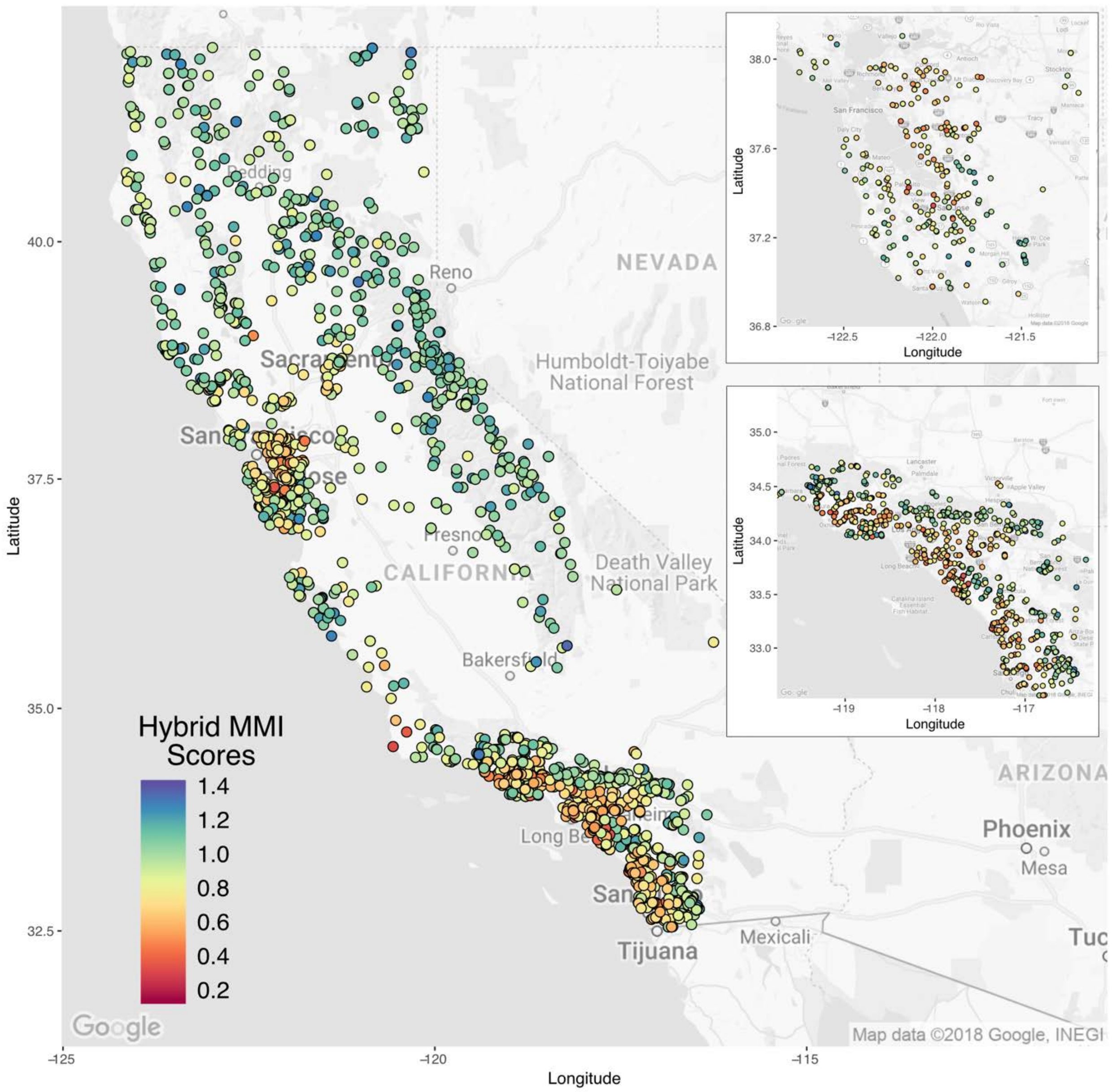
Reference Intermediate Stressed

MMI results – better precision and responsiveness than O/E

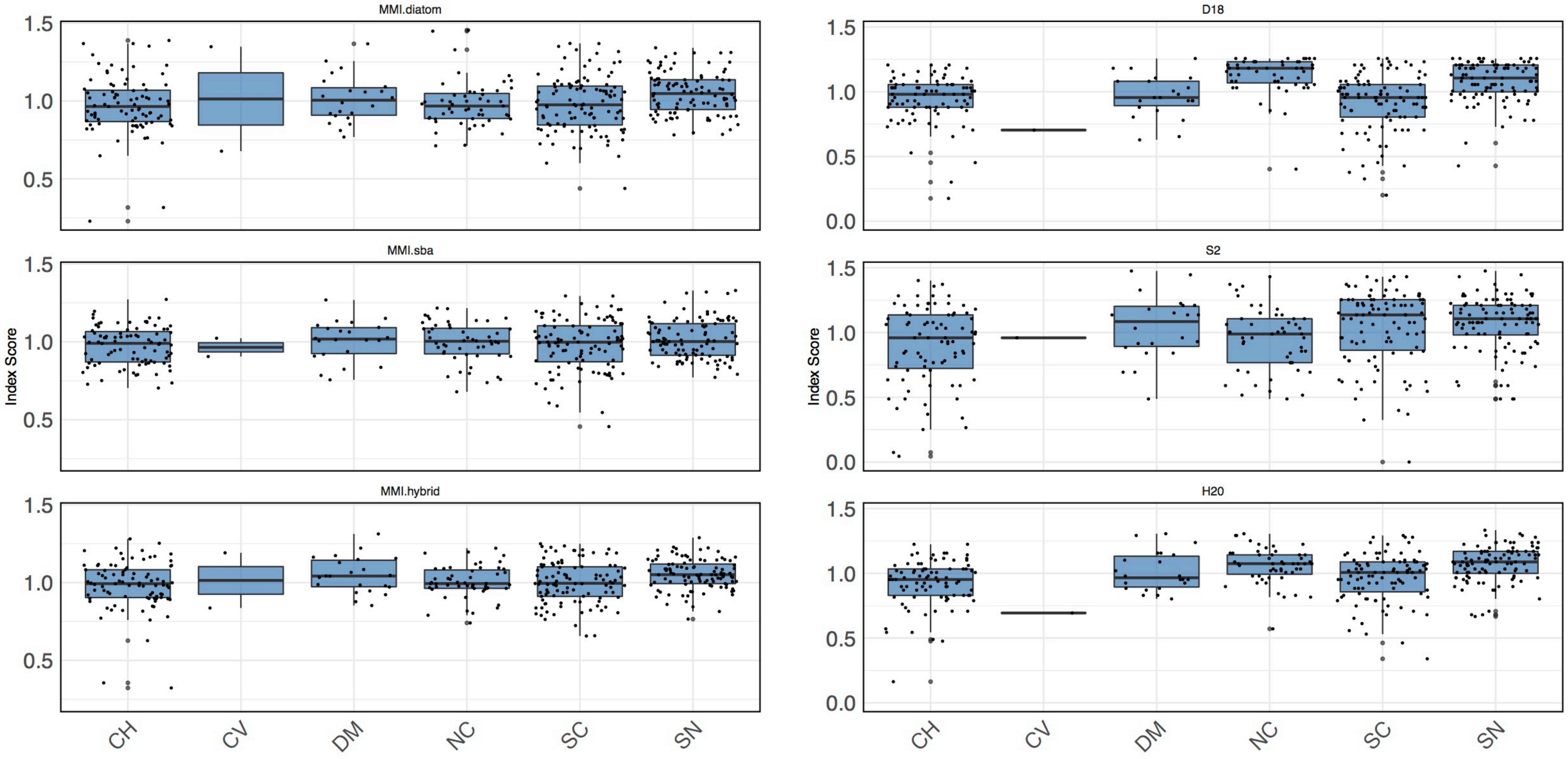


MMI results

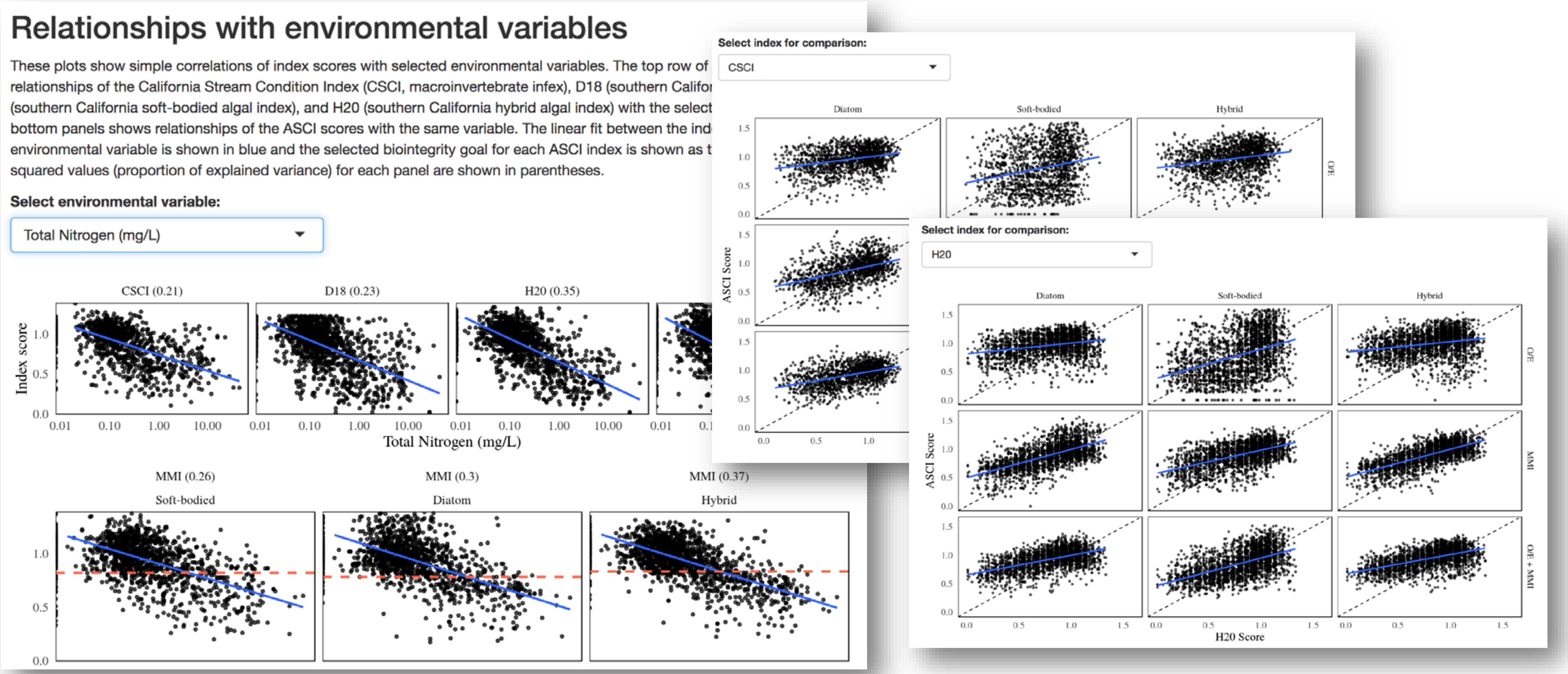
- Why did modeling not improve MMI performance?
    - Modeling with geographic variables helped to decrease regional bias for many metrics
    - However, for some metrics, regional bias scores were still too high even after modeling
    - No geographic clustering of algal communities, difficult to predict with geographic variables (same issue with O/E)
    - Algal diversity is high across the state, low at individual sites, potentially the result of highly fragmented algal communities



Low regional bias for MMI indices ...and much lower than SoCal IBI



Good response to stressor gradients



https://sccwrp.shinyapps.io/ascifigs/

Conclusions

- O/E models had poor performance, are not recommended
- All three assemblages (diatoms, SBA, hybrid) had strong MMIs that respond well to stressor gradients
- Improved regional bias performance for the species-level MMIs makes them excellent options for statewide application
- The diatom genus-level pMMI had good performance, although not as strong as the species-level MMIs
- **Next steps: Science Panel feedback December, possible submission targeted for late January**

Questions?

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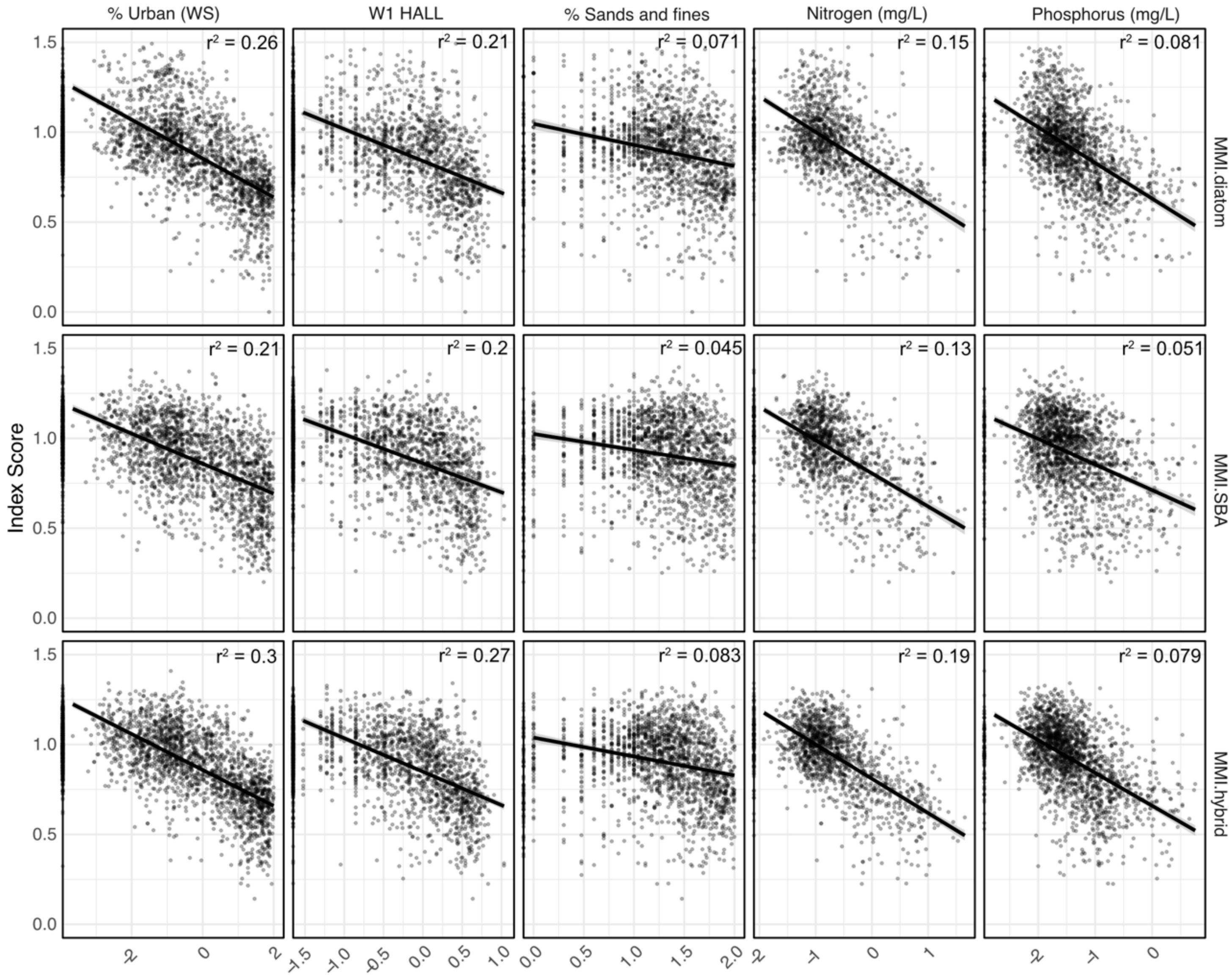
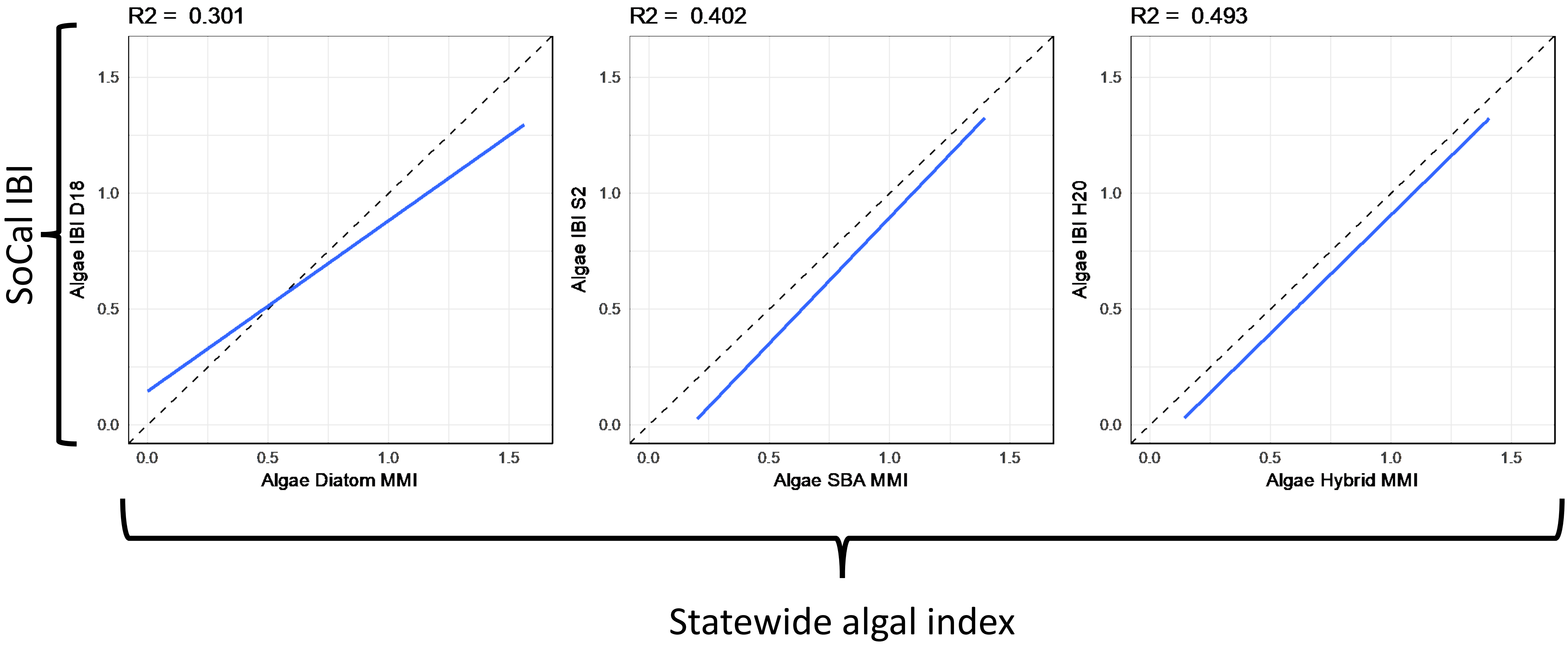
Bonus slides

Bonus slides

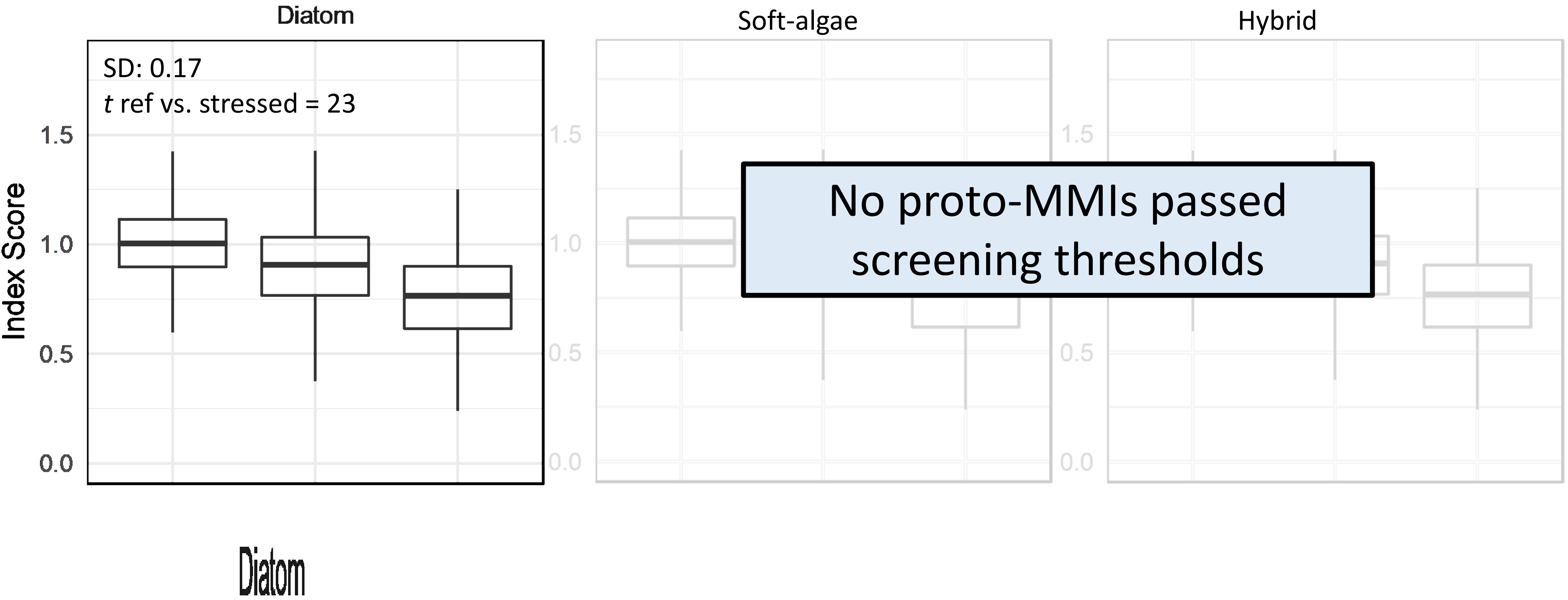
Response to stressor gradients



Algal MMIs vs. SoCal IBI



Genus-level MMI

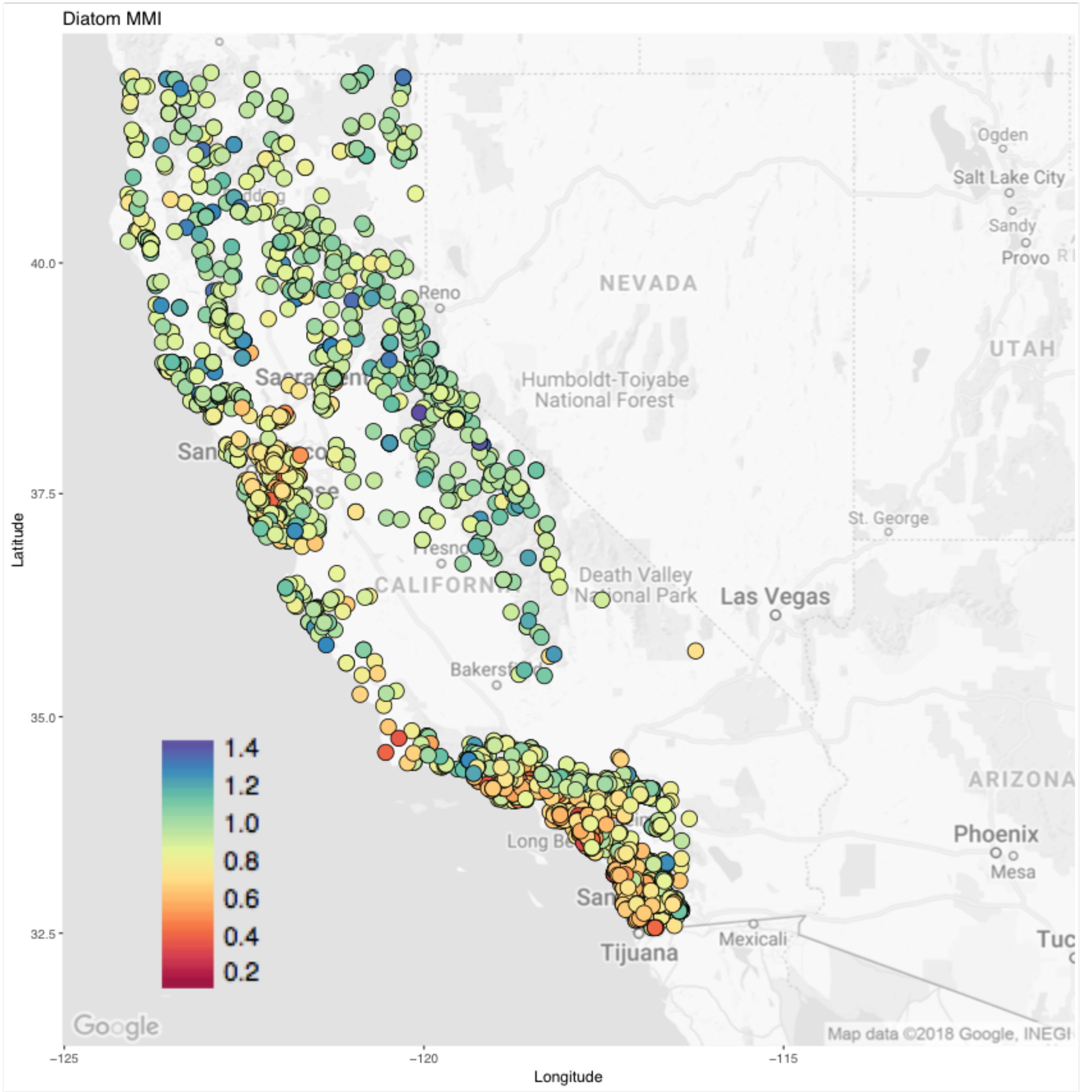


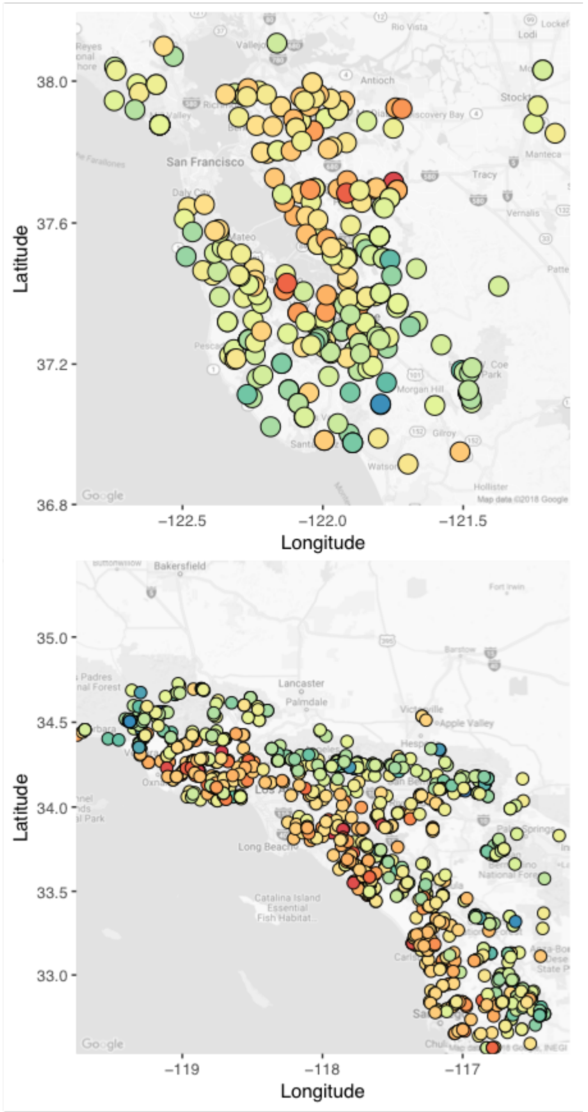
Choosing the best-performing indices

				Accuracy			Precision		Responsiveness		Spearmans Correlation (Rho)		
				Mean score	F	Var	Among sites (SD)	Within sites (SD)	t	Var	TN	TP	SpCond
Index	**Level**	**Assemblage**	**Type**	**Cal**	**Cal**	**Cal**	**Cal**	**Cal**	**Cal**	**Cal**			
OE+MMI	species	diatoms	Predictive	1.00	0.34	0.13	0.14	0.07	18.68	0.50	-0.44	-0.37	-0.48
OE+MMI	species	hybrid	Predictive	1.00	2.60	0.05	0.17	0.09	17.70	0.35	-0.40	-0.36	-0.40
OE+MMI	species	sba	Predictive	1.00	1.74	0.07	0.24	0.13	20.56	0.39	-0.40	-0.43	-0.32
O/E	genus	diatoms	Predictive	1.01	0.49	-0.13	0.18	0.11	9.5	0.30	-0.305	-0.176	-0.314
O/E	genus	hybrid	Predictive	1.01	0.48	-0.18	0.25	0.16	8.0	0.20	-0.294	-0.202	-0.266
O/E	genus	sba	Predictive	1.01	0.66	-0.11	0.38	0.29	15.7	0.27	-0.316	-0.356	-0.227
MMI	species	diatoms	Null	1.00	3.31	0.16	0.17	0.09	22.30	0.52	-0.49	-0.49	-0.59
MMI	species	hybrid	Null	1.00	2.28	0.14	0.13	0.08	27.20	0.59	-0.55	-0.51	-0.55
MMI	species	sba	Null	1.00	1.34	-0.08	0.14	0.09	21.86	0.40	-0.45	-0.33	-0.41
pMMI	genus	diatoms	Pred	1.00	1.91	-0.17	0.17	0.13	22.65	0.32	-0.42	-0.41	-0.40

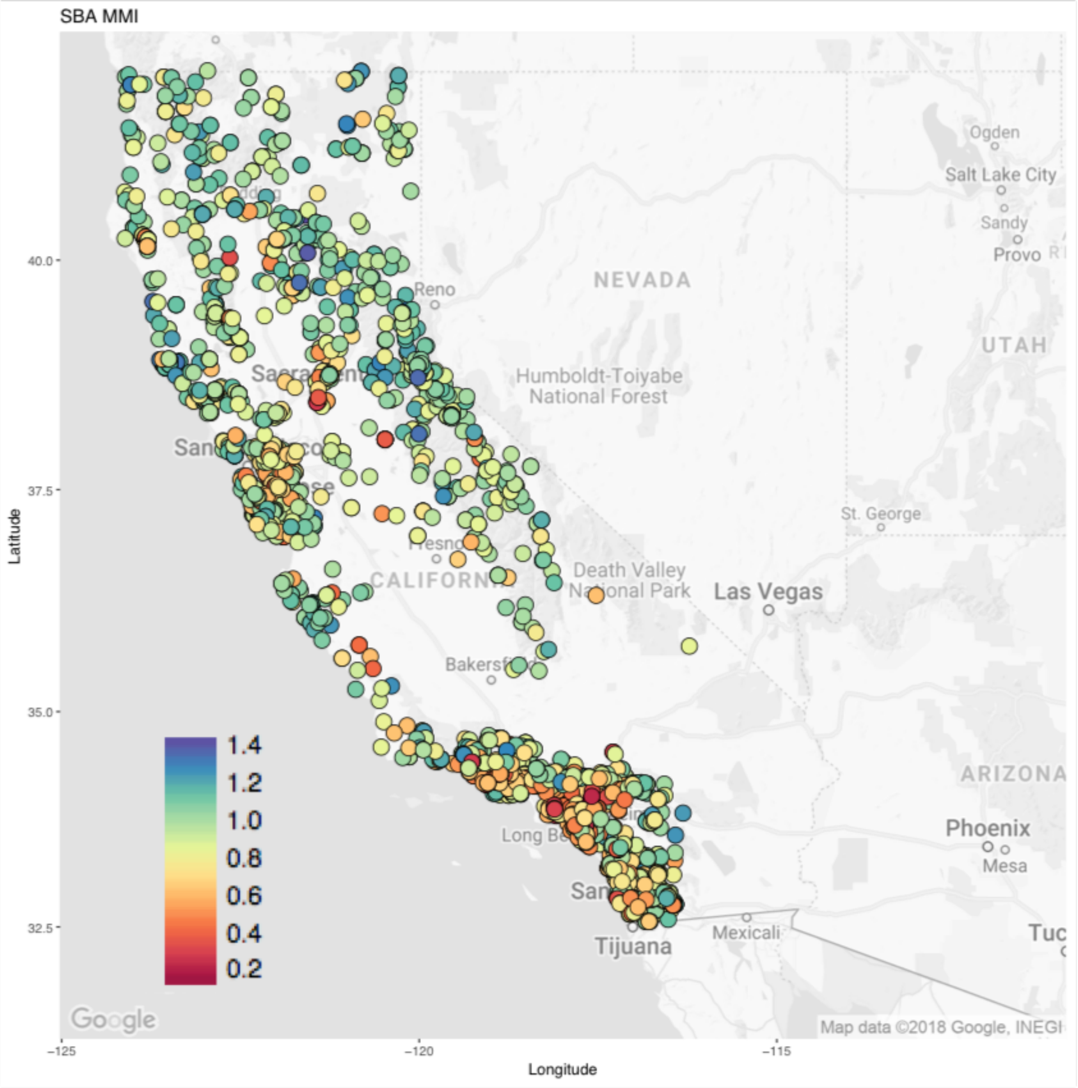
(p)MMIs with strongest performance

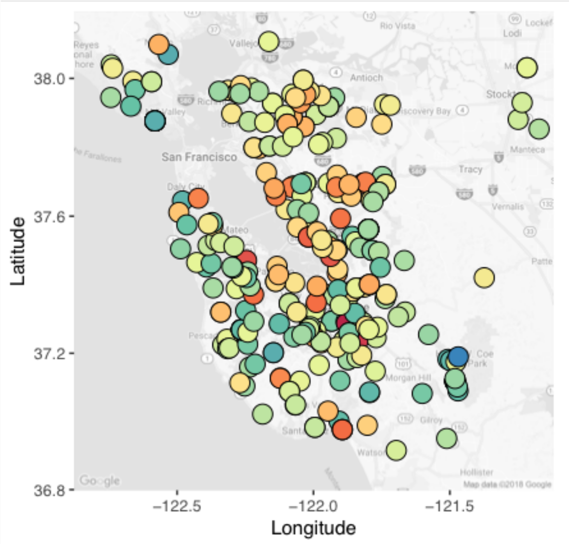
Diatom MMI scores

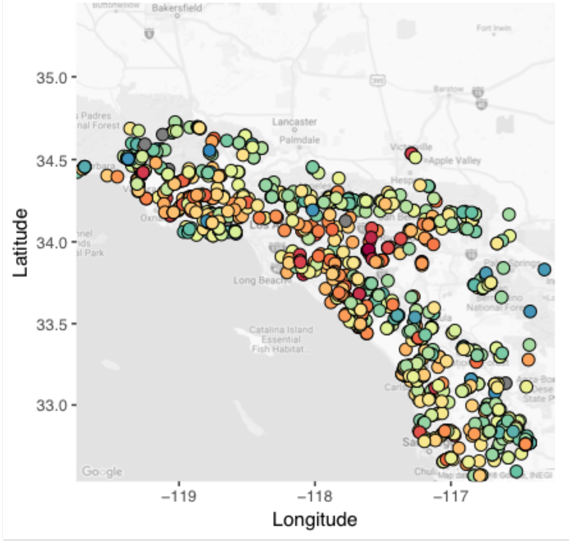




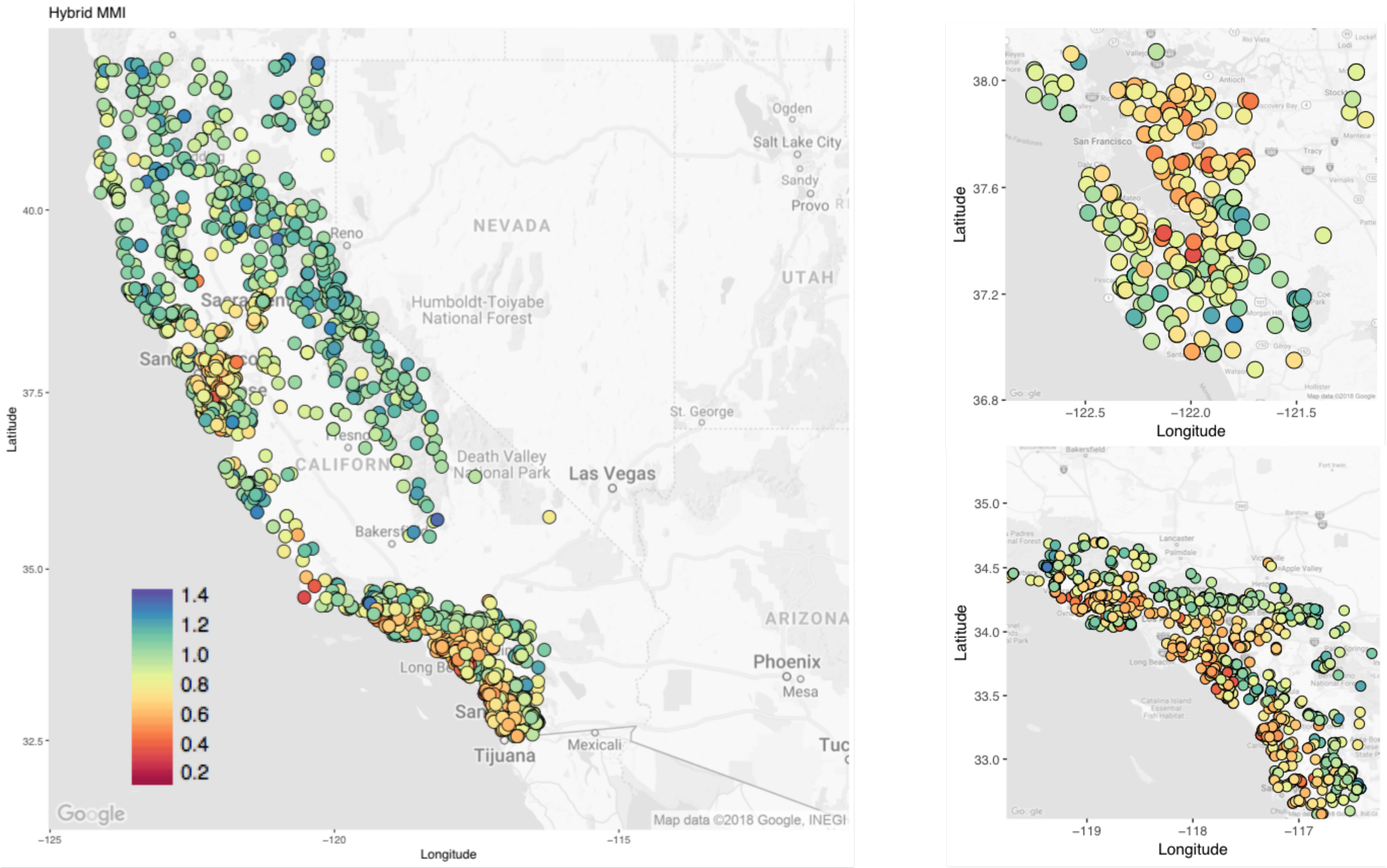
Soft-algae MMI scores







Hybrid MMI scores



Genus-level MMI

Description	Diatom	SBA	Hybrid	Diatom-genus	Response to stress
Count species: BCG 3 taxa	x	x	x		Increase
Count species: high copper indicators		x			Increase
Count species: high DOC indicators		x			Increase
Count species: low total phosphorous indicators		x			Decrease
Count species: of SPI 2 taxa				x	Decrease
Proportion individuals: most tolerant taxa		x			Increase
Proportion species: Cyclotella taxa	x		x	x	Increase
Proportion species: Green algae		x			Increase
Proportion species: high copper indicators			x		Increase
Proportion species: high DOC indicators			x		Increase
Proportion species: low total nitrogen indicators			x		Decrease
Proportion species: low total phosphorous indicators	x				Decrease
Proportion species: NHHONF taxa	x		x		
Proportion species: non-ref indicators		x			Increase
Proportion species: SPI 4+5 taxa				x*	Increase
Proportion species: Suriella taxa	x		x	x	Increase
Proportion species: taxa requiring at least 10% oxygen	x		x		Increase
Richness: NAHON taxa				x	Increase
Proportion species: Gomphonema taxa				x	Decrease
Proportion species: least tolerant taxa				x	Decrease

*denotes predictive metric

Metrics in each MMI

Description	Diatom	Soft-algae	Hybrid	Response to stress
Count species: BCG 3 taxa	x	x	x	Increase
Count species: high copper indicators		x		Increase
Count species: high DOC indicators		x		Increase
Count species: low total phosphorous indicators		x		Decrease
Count species: of SPI 2 taxa				Decrease
Proportion individuals: most tolerant taxa		x		Increase
Proportion species: Cyclotella taxa	x		x	Increase
Proportion species: Green algae		x		Increase
Proportion species: high copper indicators			x	Increase
Proportion species: high DOC indicators			x	Increase
Proportion species: low total nitrogen indicators			x	Decrease
Proportion species: low total phosphorous indicators	x			Decrease
Proportion species: NHHONF taxa	x		x	
Proportion species: non-ref indicators		x		Increase
Proportion species: SPI 4+5 taxa				Increase
Proportion species: Suriella taxa	x		x	Increase
Proportion species: taxa requiring at least 10% oxygen	x		x	Increase

Looking forward

- SWAMP Bioassessment workgroup will be discussing
  - Guidance on selecting indices to use
  - Using multiple lines of evidence
- Algae SOP may be updated following ASCI roll-out
  - Do we still need to collect a qualitative fraction?
- Transitioning to DNA-based algae taxonomy
  - Pilot studies are on-going to evaluate sequencing approaches for DNA-based algae taxonomy
  - ASCI may be retrofitted or modified to accommodate DNA data

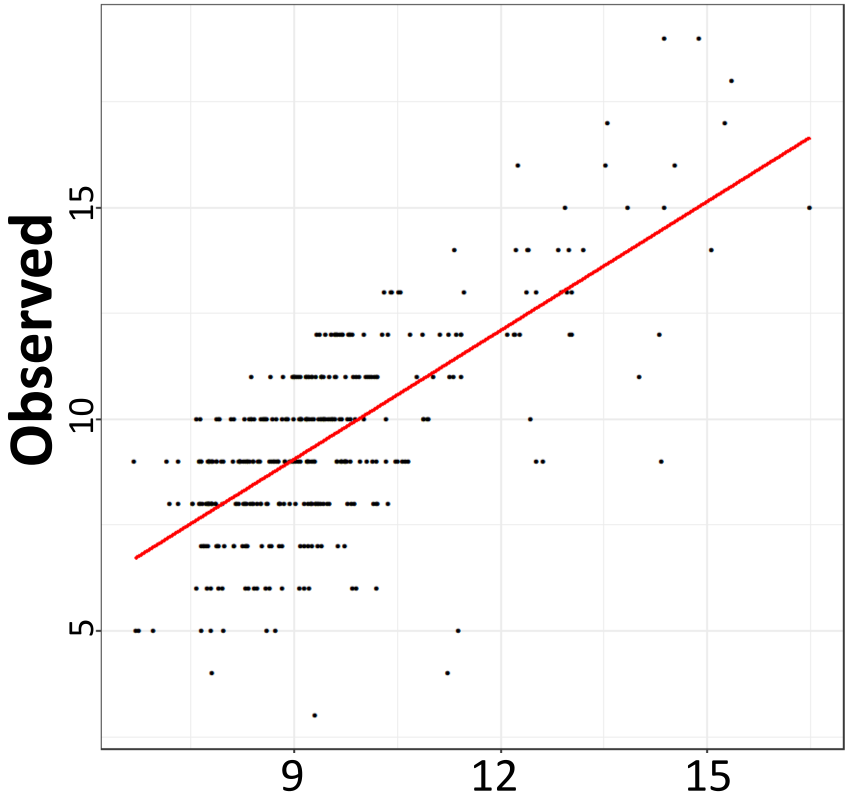
Examples of metrics

Class	Example metrics
Tolerance	BCG taxa, Tolerant/Intolerant taxa
Motility	Highly motile taxa
Dissolved oxygen	Requires 10% or 30% DO
Salinity	Brackish, freshwater taxa
Saprobility	AM/AMPS taxa
Indicator classes	High N; Low P; High Cu
Diversity	Simpson; Shannon
Taxonomic group	Amphora taxa; ZHR; CRUS taxa

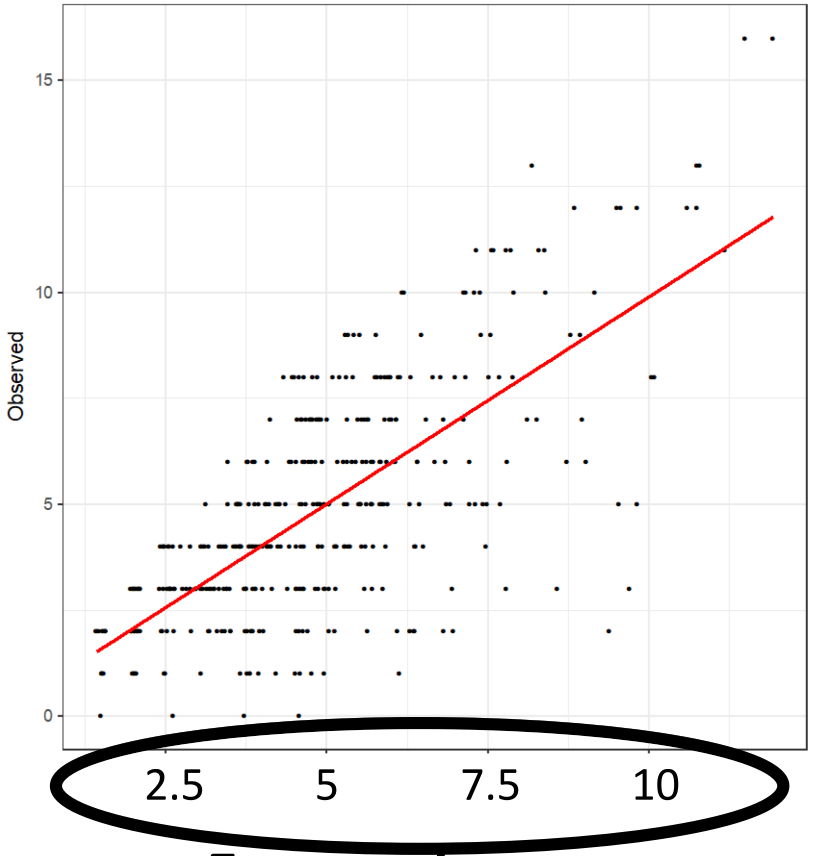
- Generally, trait attributes are assigned to algae at the species
  - Literature
  - Observations from field/lab studies
  - Indicator species analysis for California
  - Other diatom indices (e.g. French diatom index SPI)

Observed vs. Expected reference site scores

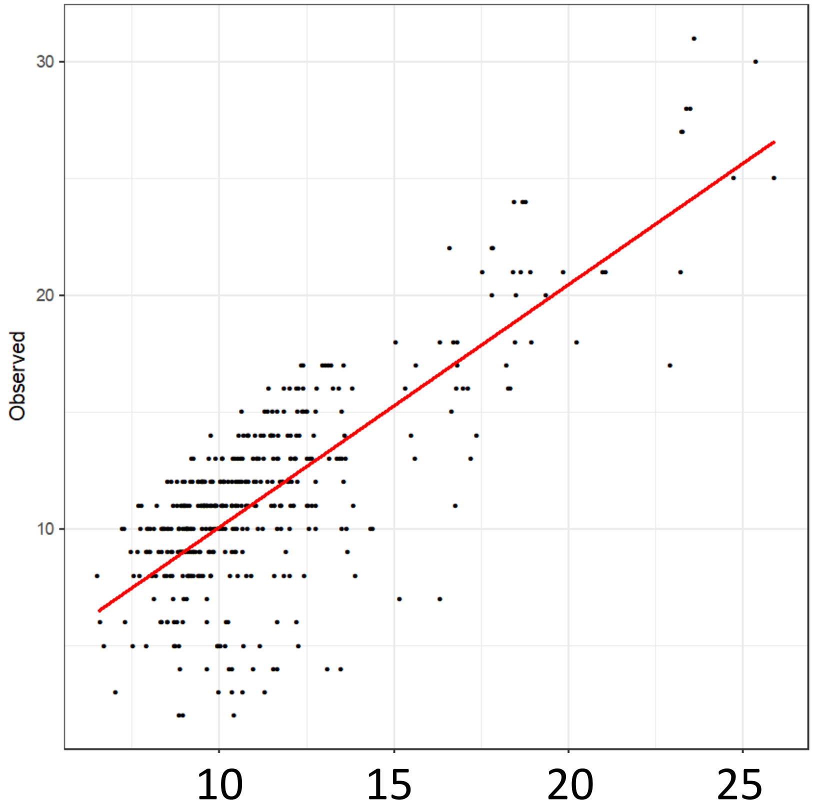
Diatoms



Soft-algae



Hybrid



Expected taxa

Models plagued by low E values,
leads to poor performance

Table 1. Performance measures to evaluate the ASCI. pMMI = predictive multimetric index, and observed (O)/ expected (E) taxa index at calibration (Cal) sites. For accuracy tests, only reference sites were used. Accuracy: mean score (ref) = mean score of reference sites (* indicates value is mathematically fixed at 1); F = F-statistic for differences in scores at reference calibration sites among 5 PSA regions (Central Valley); Var = variance in index scores explained by natural gradients at reference sites. Precision: among sites = standard deviation of scores at reference sites; within sites = standard deviation of within-site residuals for reference calibration and validation sites with multiple samples. Responsiveness: t = t-statistic for difference between mean scores at reference and stressed sites, var = variance in index scores explained by human-activity gradients at all sites. Red scores indicate lower performance scores for each measure.

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				Mean score	F	Var	Among sites (SD)	Within sites (SD)	t	Var	TN	TP	SpCond
Index	**Level**	**Spp**	**Type**	**Cal**	**Cal**	**Cal**	**Cal**	**Cal**	**Cal**	**Cal**			
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pMMI	genus	diatoms	Pred	1.00	1.91	-0.17	0.17	0.13	22.7	0.32	-0.42	-0.41	-0.40

Final ASCI(s)

- O/E indices had consistently poor performance for all three assemblages
- MMI indices were high-performing
- Winning MMI indices did not include any predictive metrics, thus making them standard MMI indices (like the SoCal IBI) ¯_(ツ)_/¯
- Diatom genus MMI had pretty good performance, not as good as species-level MMI
- New algal MMIs have much less regional bias scores than the previous algal IBI therefore making them excellent options for statewide application

AlgaeField	AlgaeValue	AlgaeValueDescr
OxygenRequirements	DO_30	>30% DO saturation
OxygenRequirements	DO_50	>50% DO saturation
OxygenRequirements	DO_75	>75% DO saturation
OxygenRequirements	DO_10	about 10% DO saturation or less
OxygenRequirements	DO_100	nearly 100% DO Saturation
Saprobity	AMPS	alpha-meso/polysaprobous
Saprobity	AM	alpha-mesosaprobous
Saprobity	BM	beta-mesosaprobous
Saprobity	OS	oligosaprobous
Saprobity	PS	polysaprobous
TrophicState	E	Eutrophic
TrophicState	I	Indifferent
TrophicState	M	Mesotrophic
TrophicState	ME	Mesotrophic-Eutrophic
TrophicState	O	Oligotrophic
TrophicState	OM	Oligotrophic-Mesotrophic
TrophicState	PH	Polytrophic (Hypereutrophic)
NitrogenUptakeMetabolism	NAHON	N-autotrophic-high organic N
NitrogenUptakeMetabolism	NALON	N-autotrophic-low organic N
NitrogenUptakeMetabolism	NHHONF	N-heterotrophic-high organic N (facultative)
NitrogenUptakeMetabolism	NHHONO	N-heterotrophic-high organic N (obligate)