California Algal Stream Condition Index: Progress Update

July 12th, 10 am – noon

Webinar

Progress Since the Last SAG Meeting

- Science Panel reviewed the Biointegrity –Biostimulatory Science Plan
  - Written report posted to the SWRCB website

- Webinar series in progress to provide preliminary findings of different science plan components
  - June 26th webinar: Channels in Developed Landscapes
  - July 5th: Biological Condition Gradient
  - today: Algal Stream Condition Index

- For each webinar:
  - Webinar recorded and presentation materials posted
  - SAG homework assigned
  - Follow up discussion at upcoming SAG meeting

- Stakeholder-led initiative to discuss potential tenets of a "watershed approach"
  - July 21st webinar 10-11:30 am to present initial ideas
  - Follow up discussion at upcoming SAG meeting

Next Steps

- July 26th SAG meeting scheduled, with goal to provide robust discussion of technical elements. Topics include:
  - Panel feedback on Science Plan
  - Channels in Developed Landscapes
  - BCG
  - ASCI
  - Watershed

- Fall Science Panel meeting will feature focused discussion of:
  - Channels in developed landscapes technical memo and summary of potential policy applications
  - BCG manuscripts and summary of potential applications
  - Provisional ASCI
  - Update on eutrophication synthesis and statistical modeling

California Algal Stream Condition Index: Progress Update

Susie Theroux (susannat@sccwrp.org)

Roadmap to today's webinar

- Part I: Review from last webinar
- Part II: Science panel feedback
- Part III: Preliminary results: ASCI O/E
- Part IV: Preliminary results: ASCI pMMI
- Part V: Next directions
- Part VI: Homework

Part I: Review from last webinar

California stream bioassessment: bioindicators

Benthic macroinvertebrates

- Respond to physical habitat, pollutants, sediment, flow alteration
- Integrate ecological condition over time

Algae

- Direct link to water chemistry and nutrient stressors
- Short life span, rapid growth rate and rapid response to stress

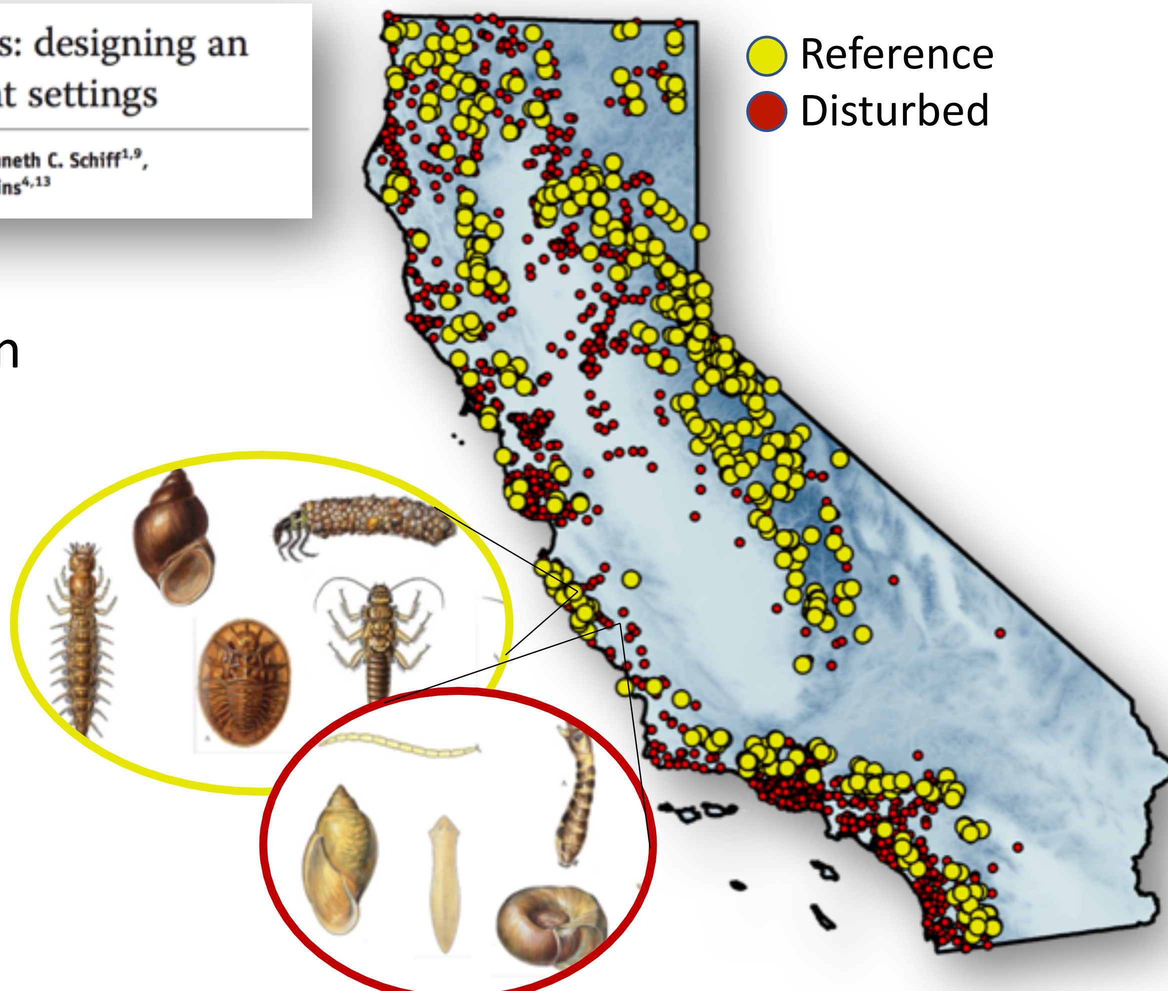
Diatoms
Soft-bodied algae
Cyanobacteria

California Stream Condition Index (CSCI)

Bioassessment in complex environments: designing an index for consistent meaning in different settings

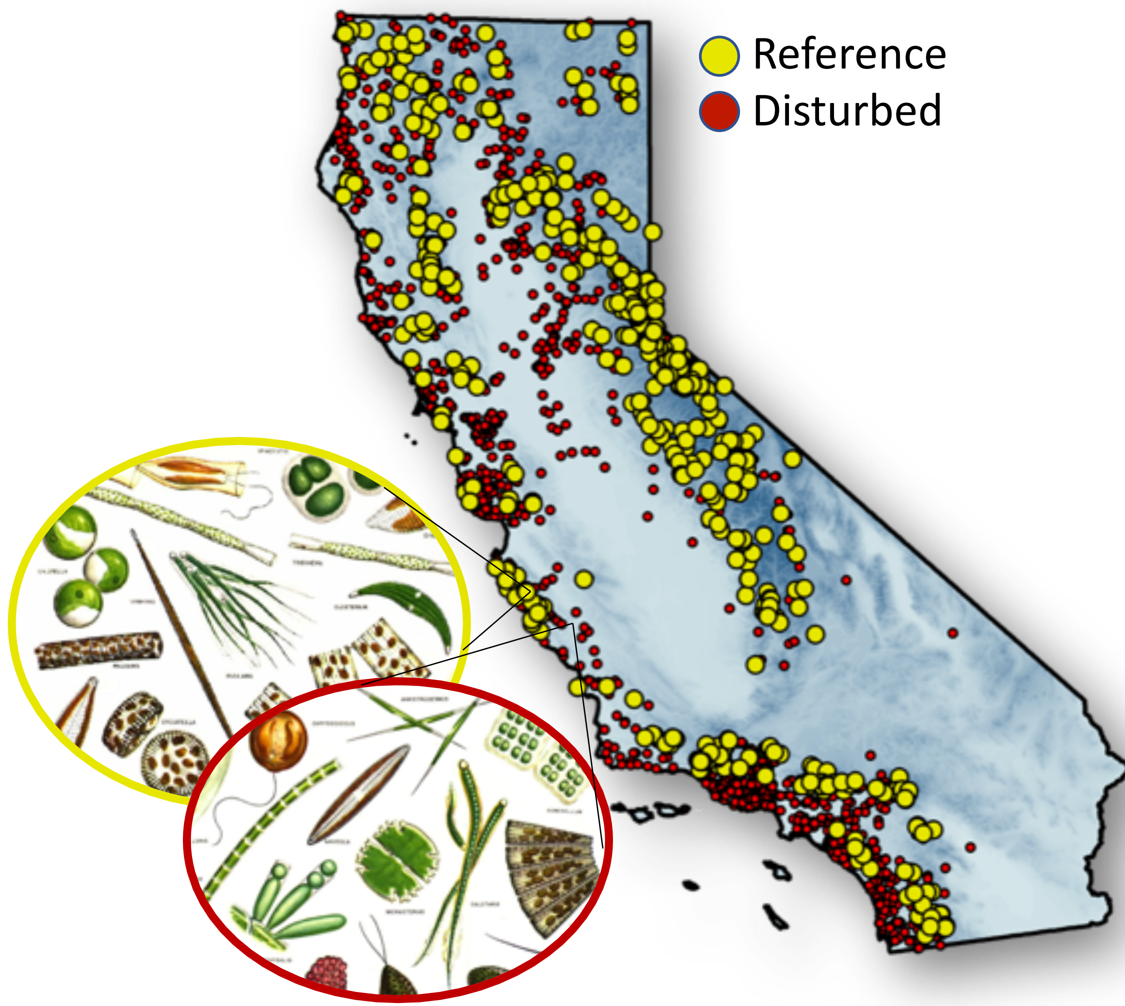
Raphael D. Mazor[1,2,5], Andrew C. Rehn[2,6], Peter R. Ode[2,7], Mark Engeln[1,8], Kenneth C. Schiff[1,9], Eric D. Stein[1,10], David J. Gillett[1,11], David B. Herbst[3,12], and Charles P. Hawkins[4,13]

- California Stream Condition Index (CSCI)
- Site-specific reference expectations
- Statewide applicability

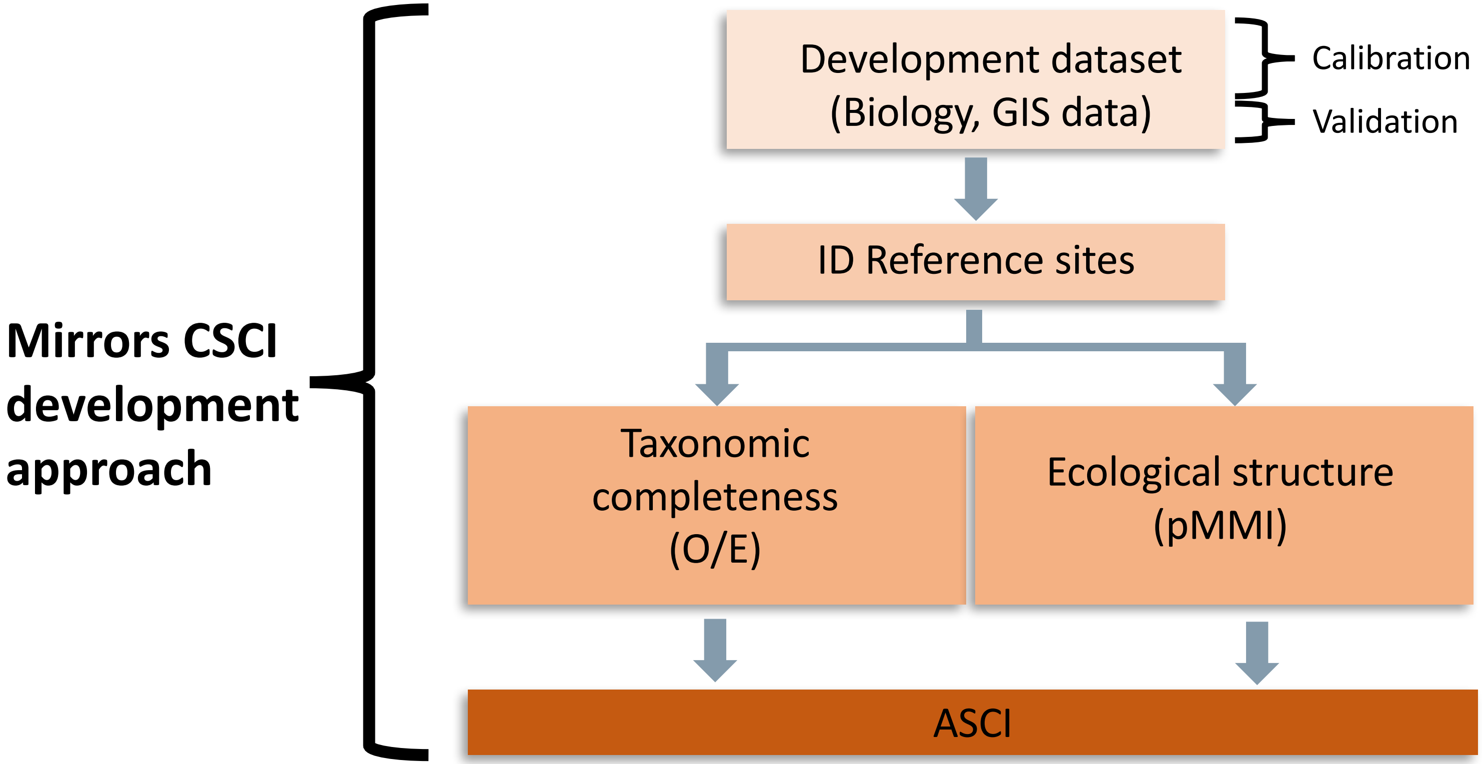


Algal Stream Condition Index (ASCI)

- Consistent tool to use across state
- Landscape setting informs site-specific reference-based expectations
- Large dataset spans California ecoregions



ASCI: Development approach

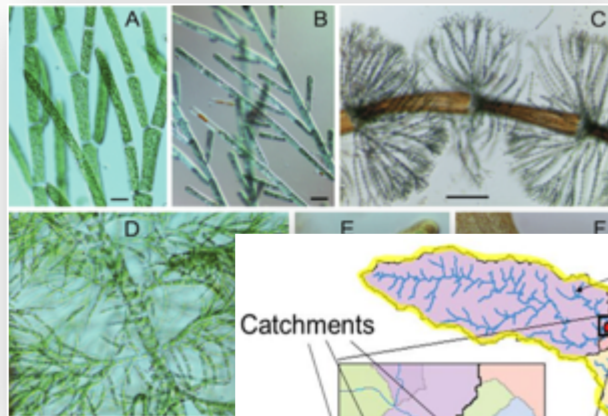


ASCI: Development dataset

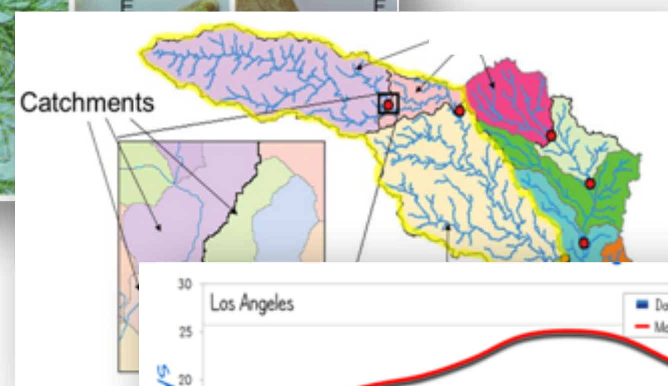
~2000 stations, 3800 taxa

- Years 2008-2016
- Stormwater Monitoring Coalition (SMC)
- Perennial Stream Assessment (PSA)
- Reference Condition Management Program (RCMP)
- Regional Monitoring Coalition (RMC)

Algae taxonomy



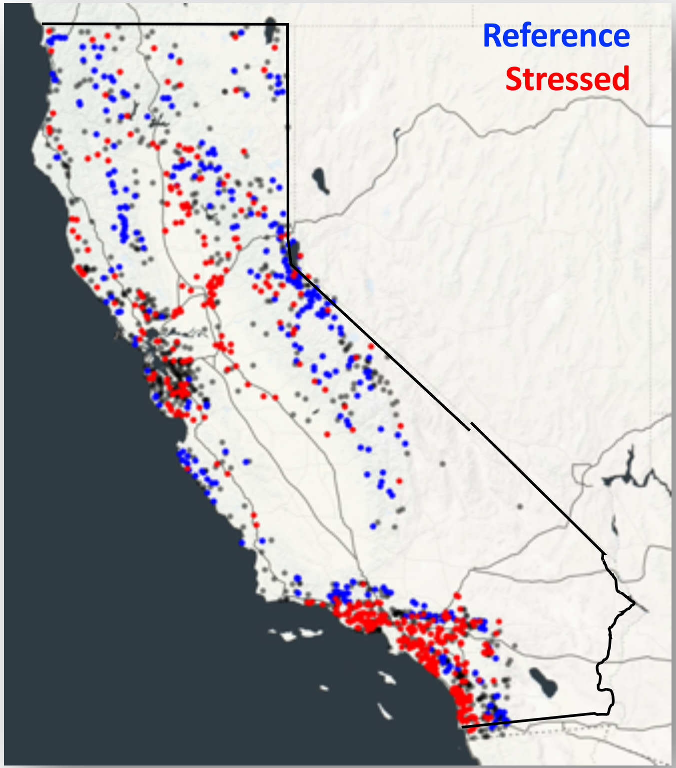
Spatial data



Weather

ASCI: Reference site selection criteria

Metric	Scale	Threshold	Unit
% agriculture	1k, 5k, WS	3	%
% urban	1k, 5k, WS	3	%
% agriculture + % urban	1k, 5k, WS	5	%
% Code 21 (developed veg)	1k, 5k, WS	7, 10	%
Road density	1k, 5k, WS	2	km/km2
Road crossings	1k, 5k, WS	5, 10, 50	crossings
Dam distance	WS	10	km
% canals and pipelines	WS	10	%
Producer mines	5k	0	mines
W1_HALL (rip. anthro. disturbance)	site	1.5	-

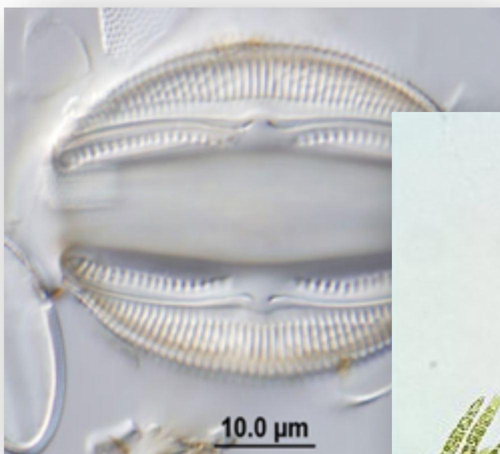


http://rpubs.com/stheroux/devdata

ASCI: two component index

Observed vs. Expected taxa (O/E)

Diatoms



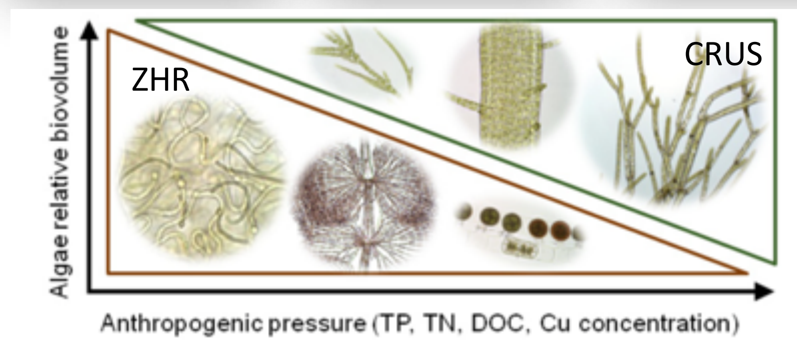
Softs

Predictive Multi-Metric Index (pMMI)

% motile taxa

% Cu tolerant

% N-fixing



Who is there?

What are they doing?

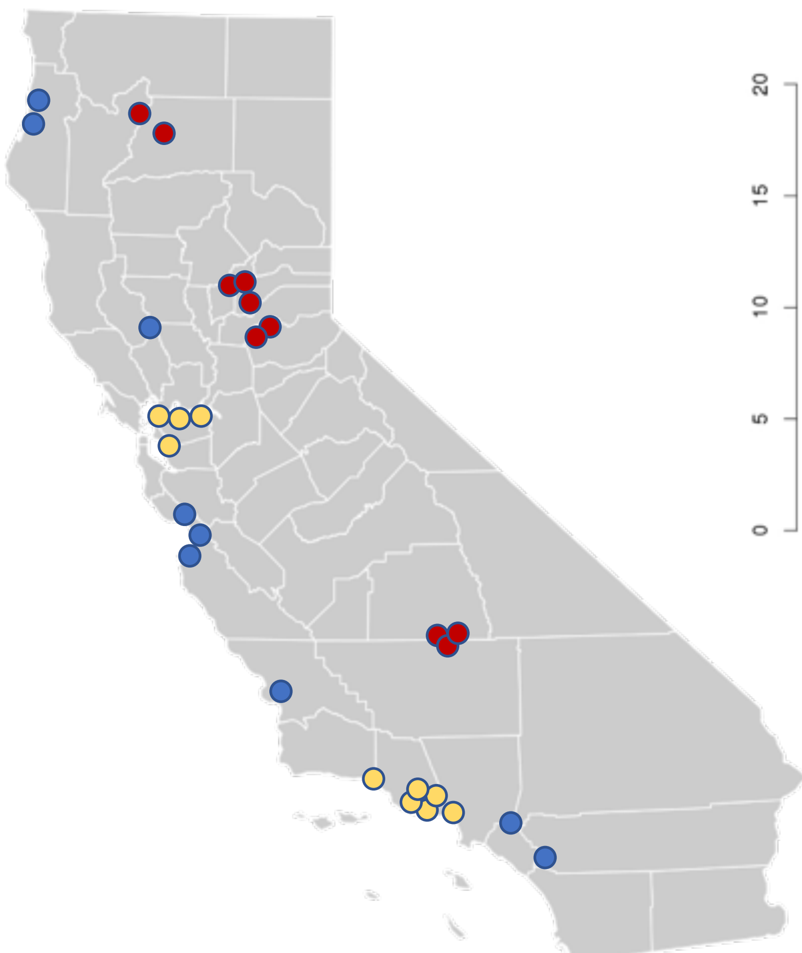
Science Panel feedback

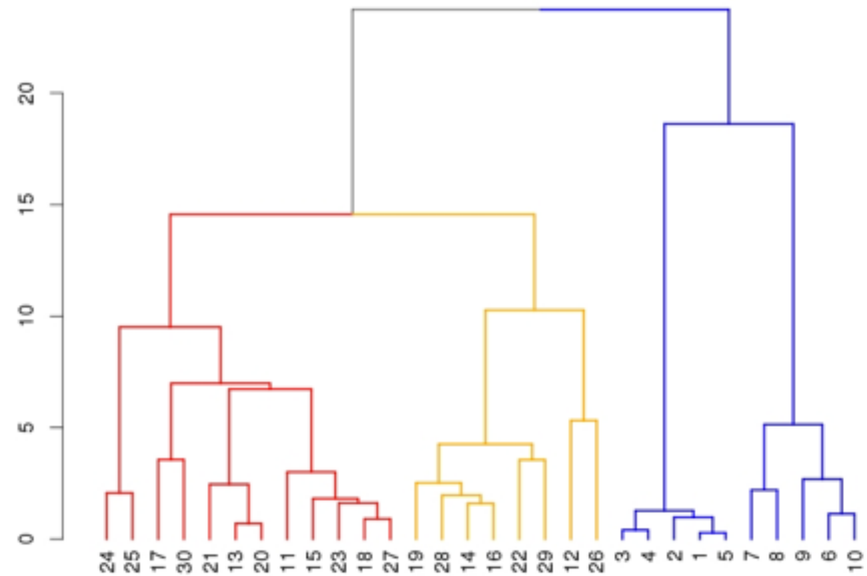
Science panel feedback

General Feedback	Tech team response
Approach is scientifically sound	☺
Do not feel obligated to use same approach as CSCI	• Evaluating ASCI performance +/- O/E • Evaluating ASCI performance with O/E as 50% of score or individual metric in MMI
Ensure taxonomic consistency in dataset	• Harmonized all species names to standardized species names • Evaluated taxonomist signal among species groupings (negative)

O/E model development and performance

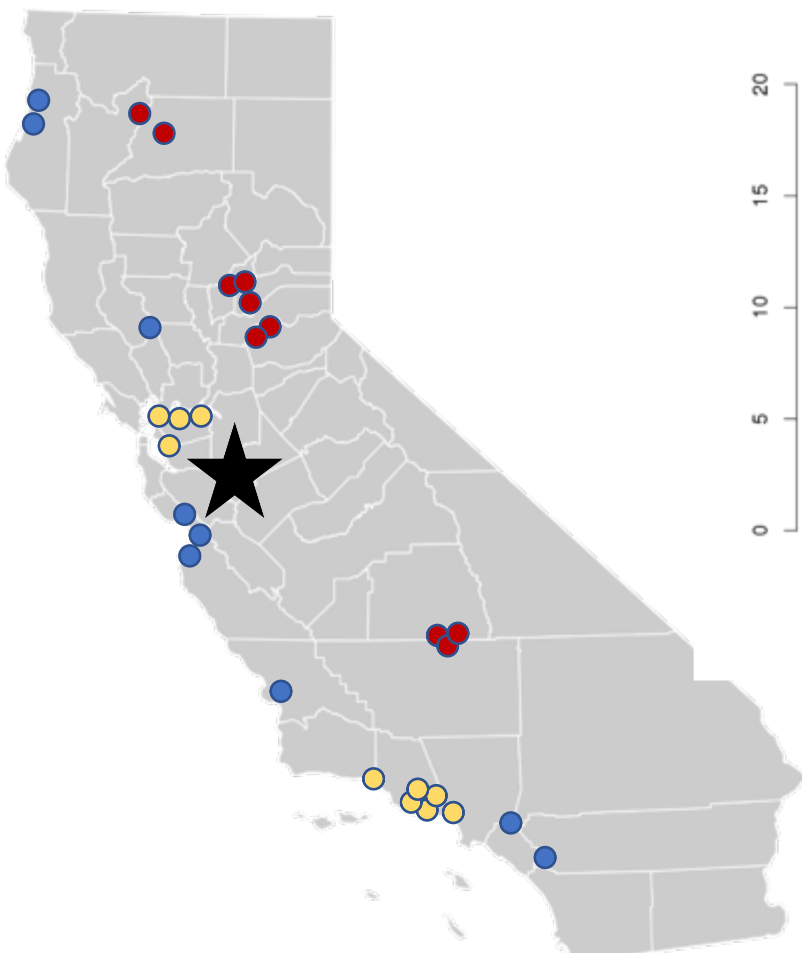
Step 1: Cluster reference sites by species membership

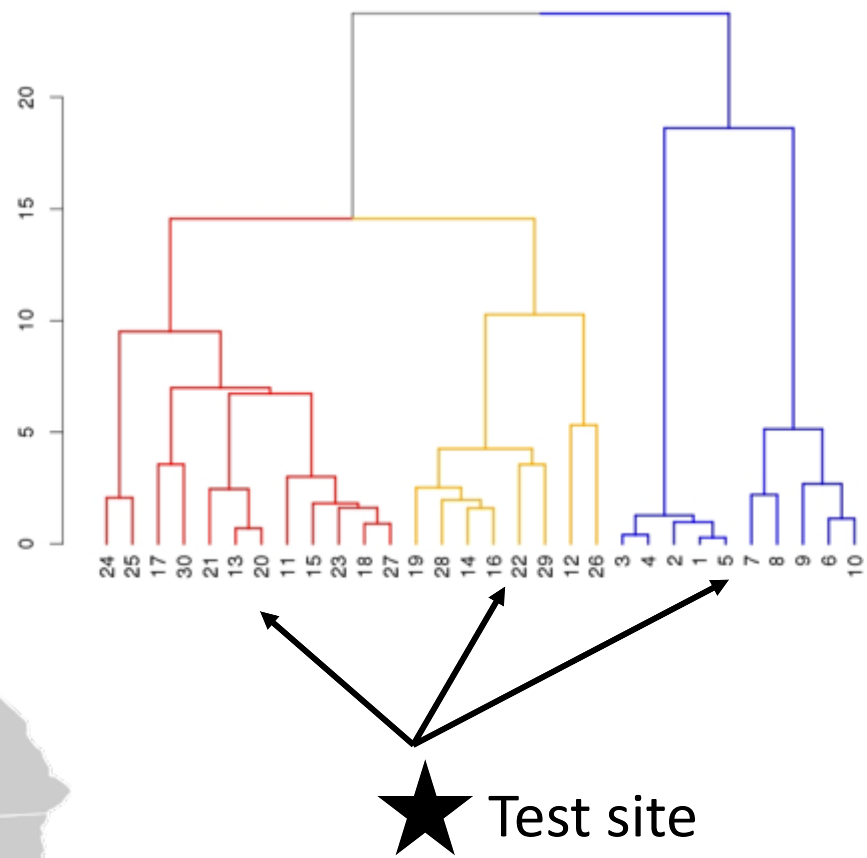




- Diatoms only
- SBA only
- Diatoms+SBA

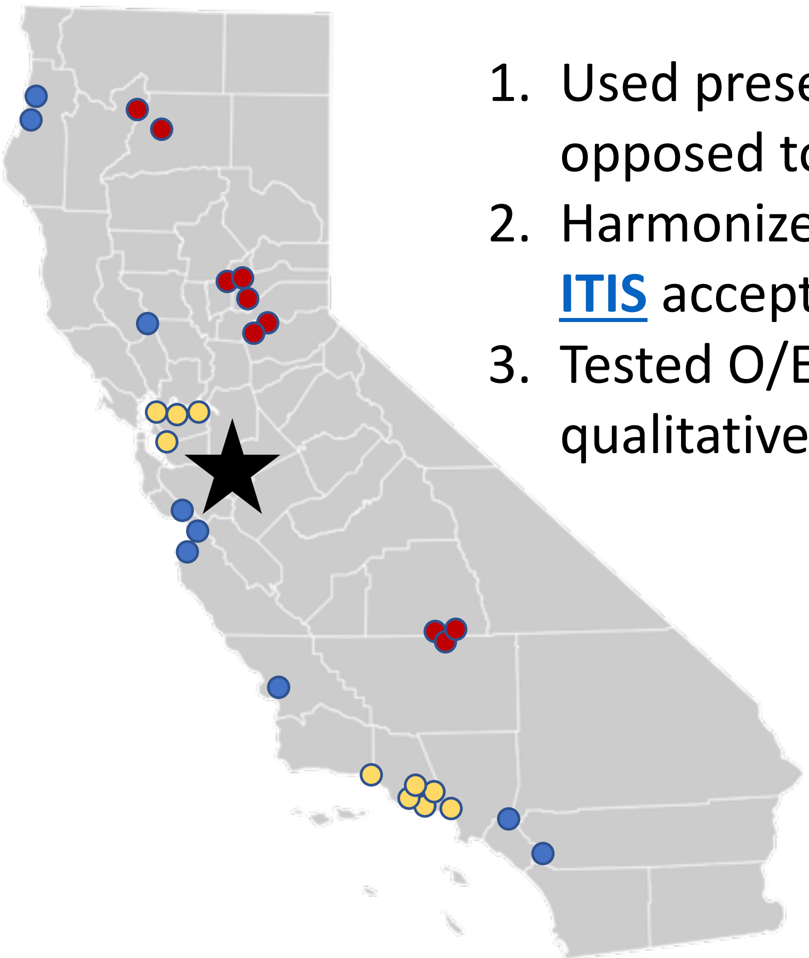
Step 2: Develop models to predict group membership using environmental variables





Probability of group membership determines expected taxa ("E")

Notes on ASCI O/E development



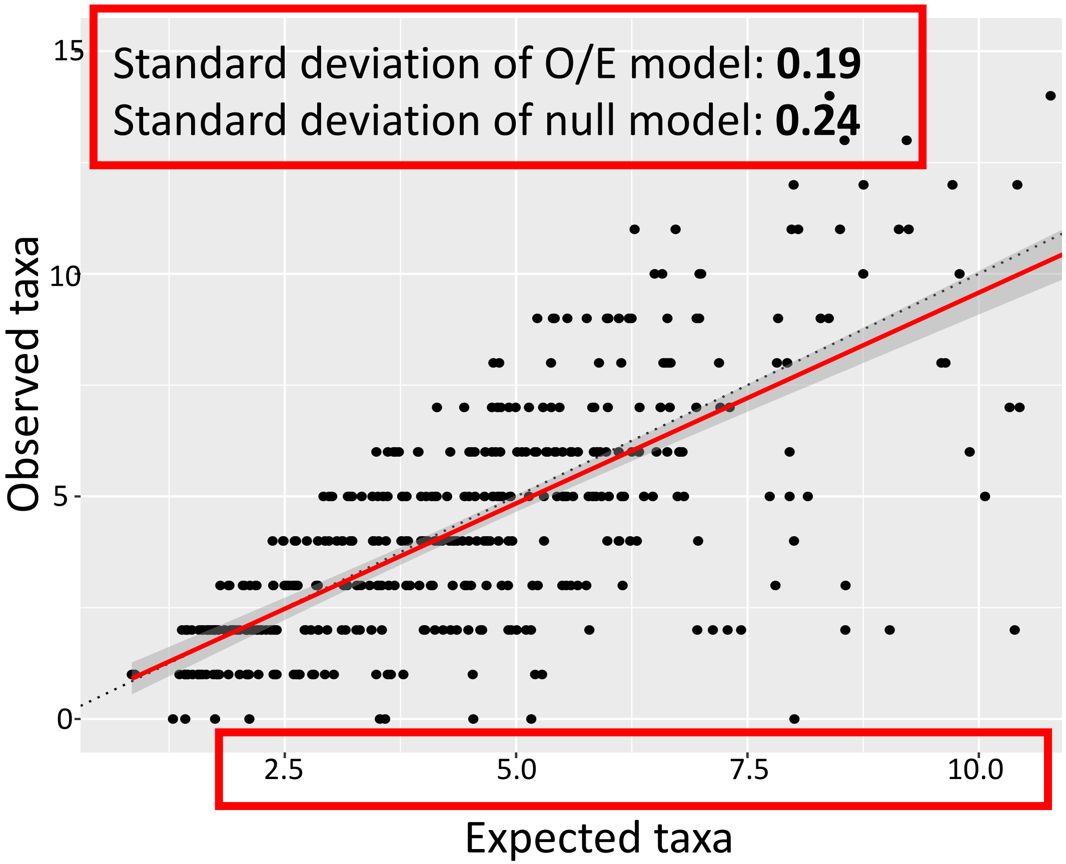
1. Used presence/absence data (as opposed to count or biovolume)
2. Harmonized all species names to **ITIS** accepted names
3. Tested O/E with and without qualitative sample

For future compatibility with DNA data (items 1–2)

For potential modification to sampling protocol (item 3)

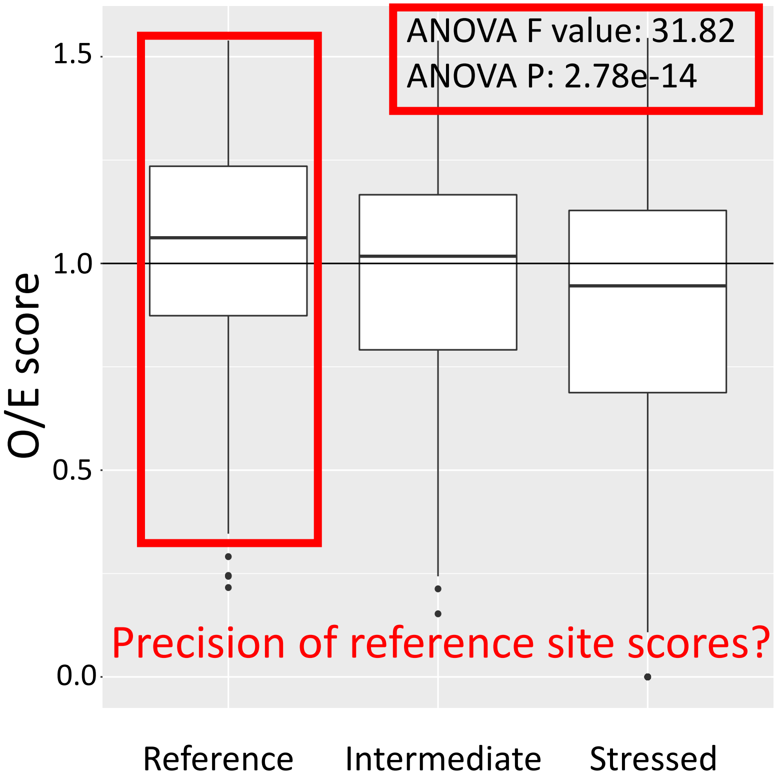
Example: Evaluating O/E performance

Is SD < 0.2?
Is O/E model < null model?



What are the ranges of expected taxa?

How well can we differentiate reference vs. stressed?

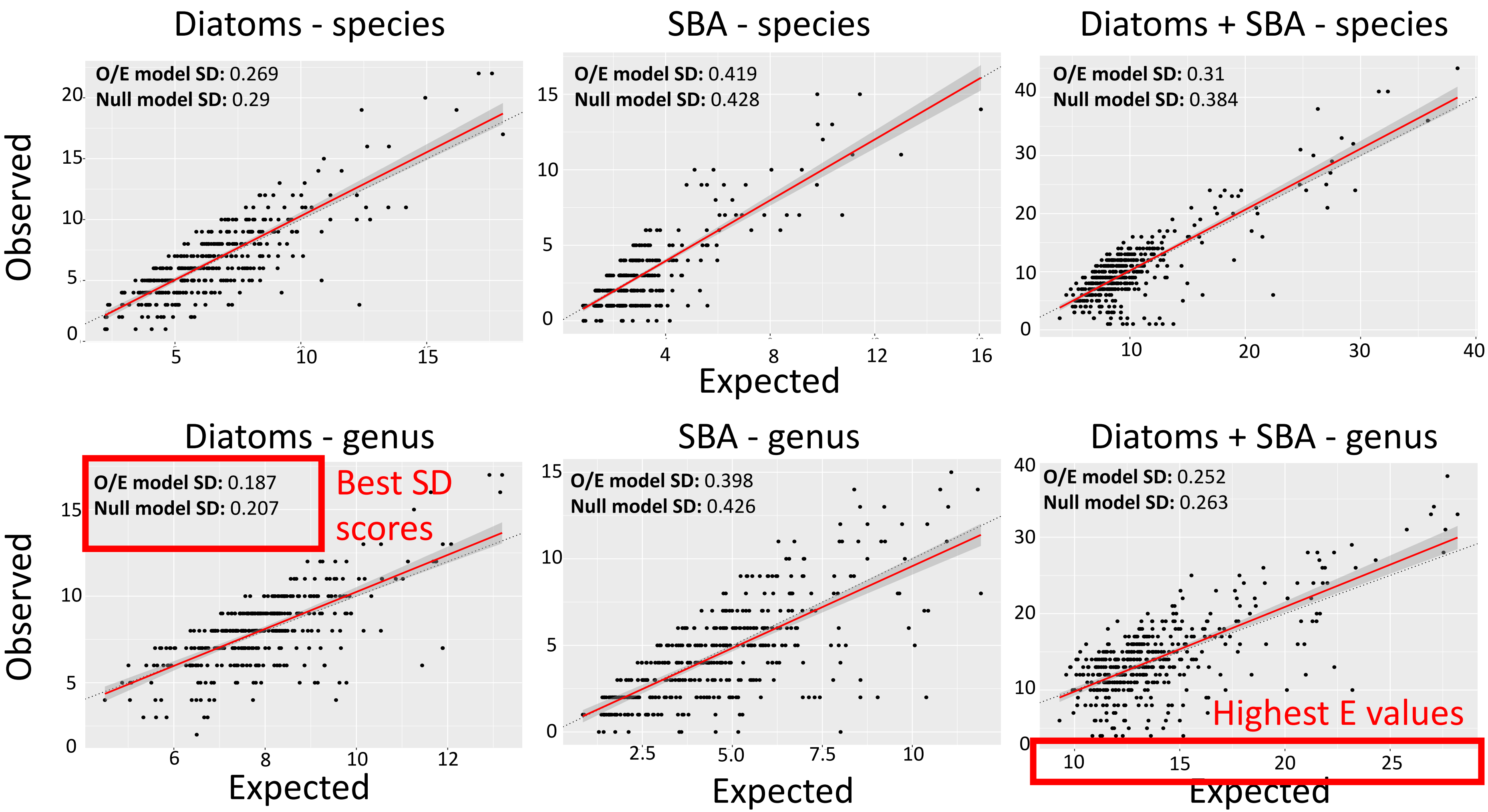


Precision of reference site scores?

O/E models: six compared

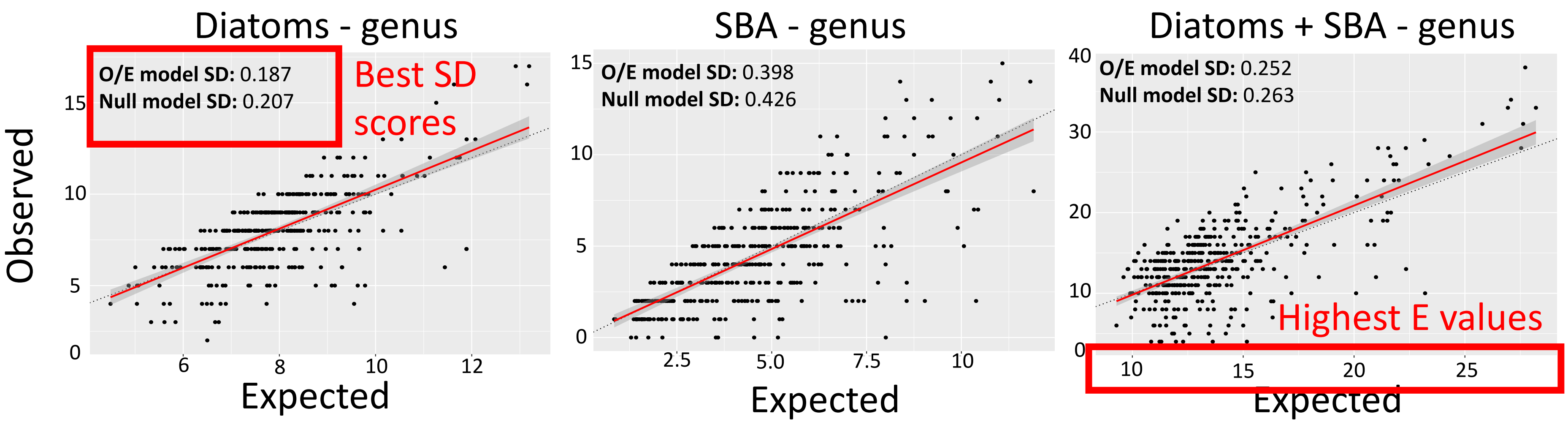
Diatoms-only Species-level	**SBA-only** Species-level	**Diatoms+SBA** Species-level
Diatoms-only Genus-level	**SBA-only** Genus-level	**Diatoms+SBA** Genus-level

O/E model performance



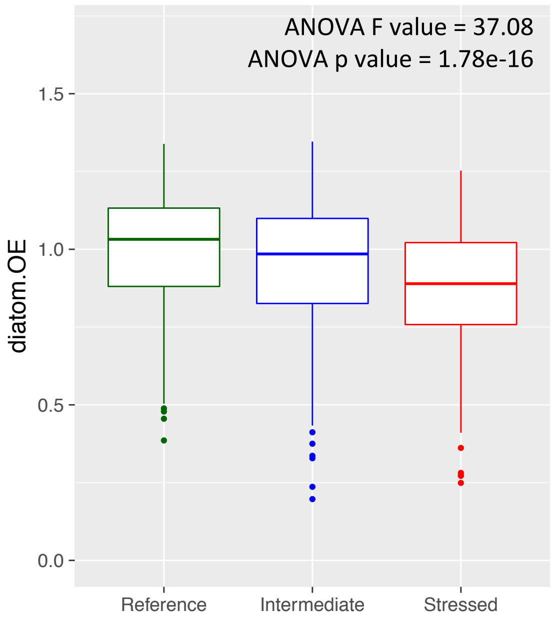
O/E model performance

Aggregating to genus-level improved O/E performance

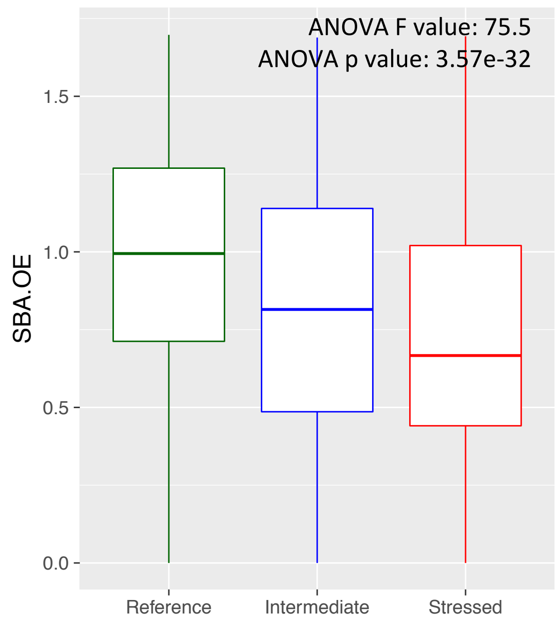


Genus O/E model performance

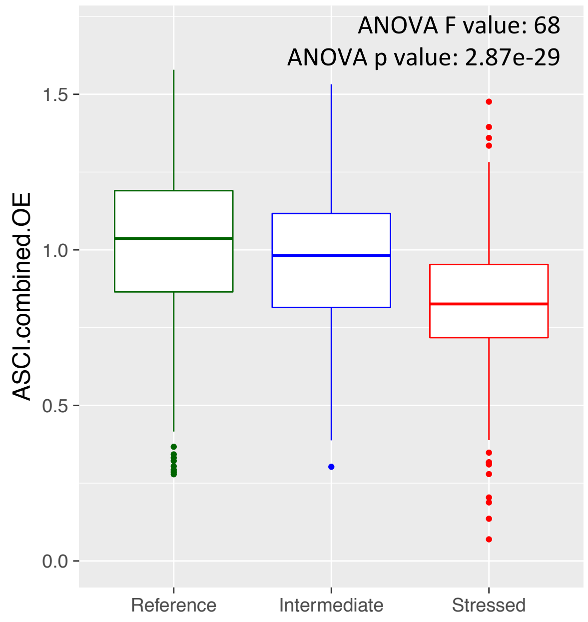
Diatoms



SBA

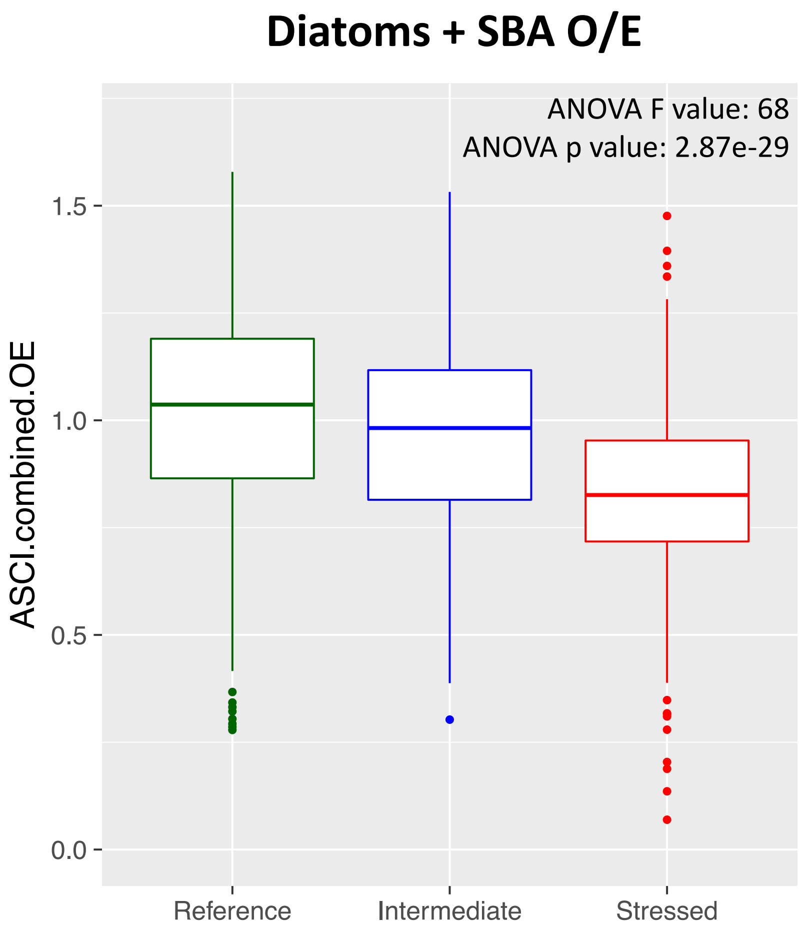


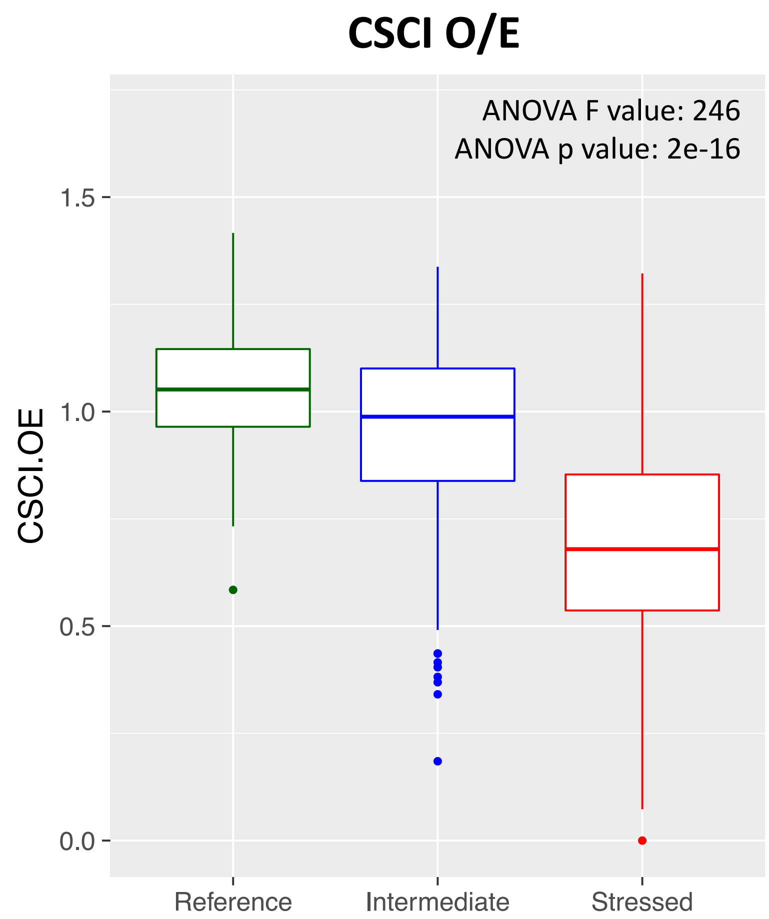
Diatoms + SBA



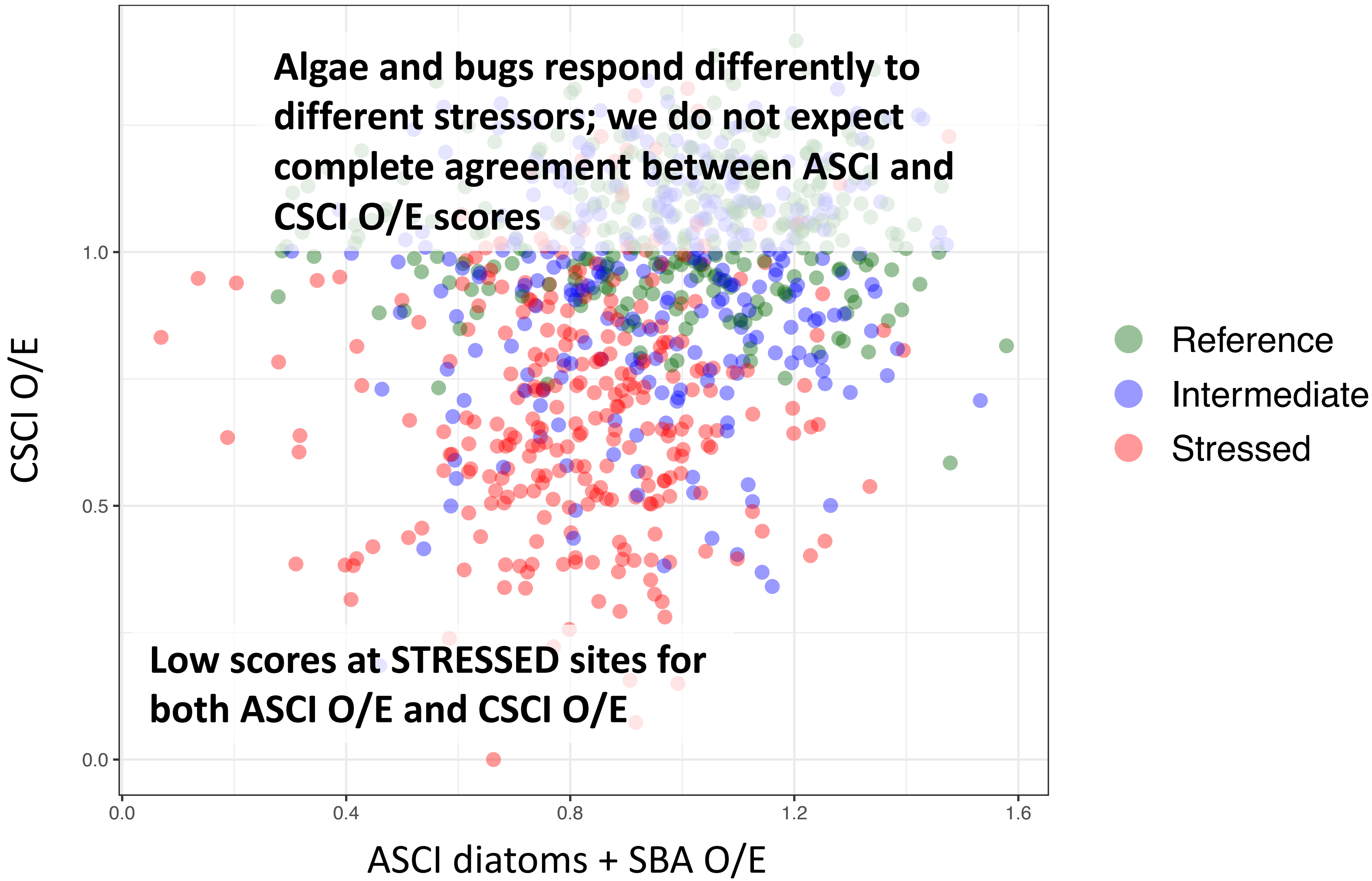
- Combined diatom + SBA O/E had best precision at reference sites and good discrimination between reference and stressed sites

O/E model performance – ASCI vs. CSCI

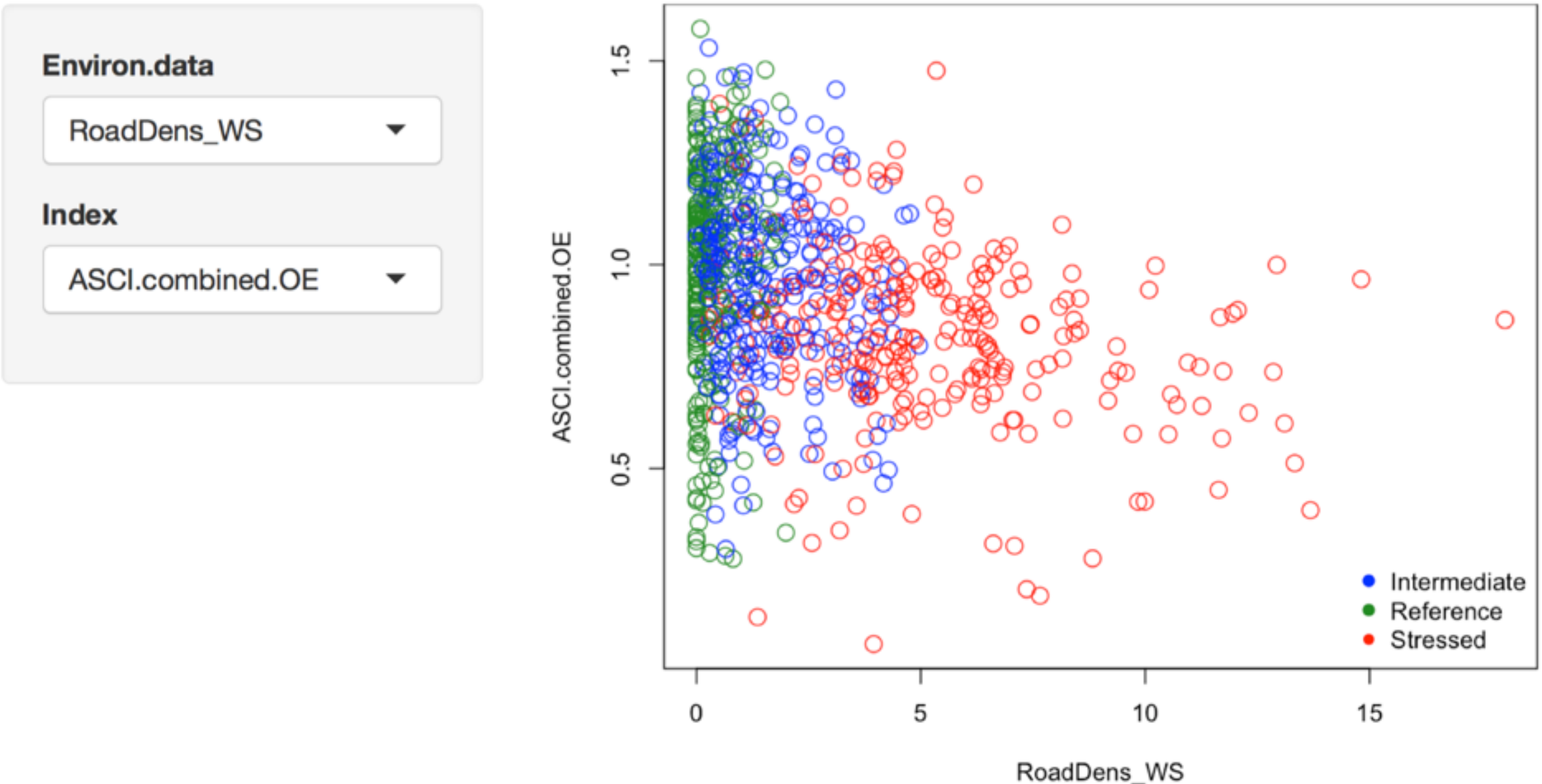




O/E model performance – ASCI vs. CSCI

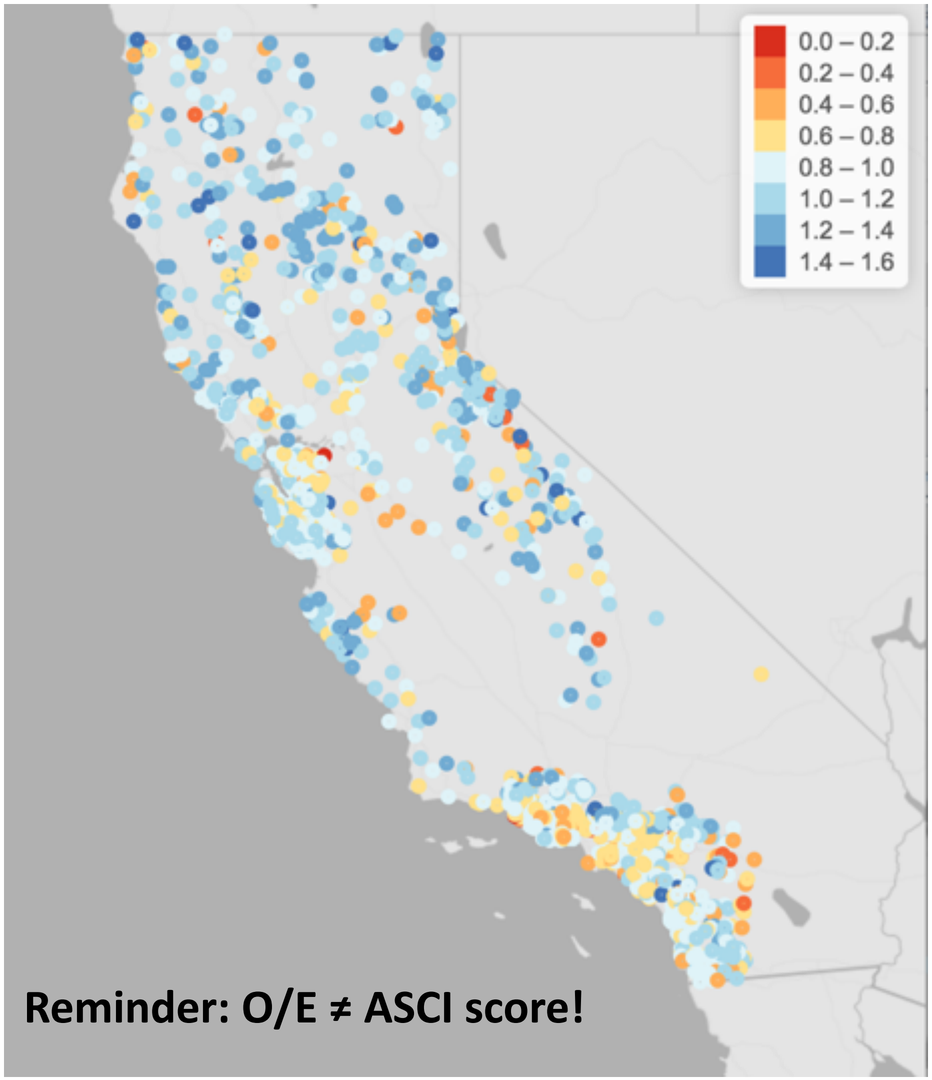


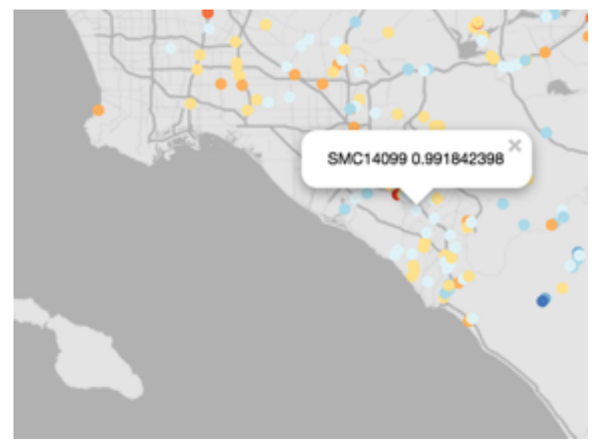
Performance across environmental gradients



https://stheroux.shinyapps.io/envgrads/

Map: ASCI diatom + SBA O/E





http://rpubs.com/stheroux/ASCIcomboOE

Efforts to improve O/E performance

	Approach	Result
Clustering method	Bayesian Hierarchical clustering**	Worse
	K-means permutations to find optimal cluster number	Improved
Candidate variables	Day of Year and Month	Improved
	Field-based variables	No improvement
	Water chemistry variables	**Will revisit**
	Antecedent climate data	**Not yet explored**
Aggregate species to higher taxonomic level	Group to genus	Improved
Subset state into sub-regions	Build individual O/E models**	Mixed results, **will revisit**

** Recommended by science panel

Draft ASCI O/E conclusions

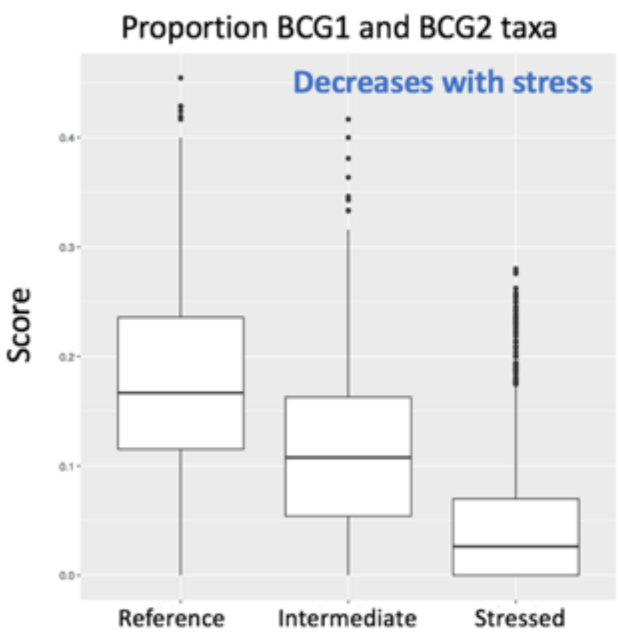
1. Aggregating to genus level improved O/E performance
2. Qualitative sample did not improve metric performance
3. SBA + diatoms O/E had best performance scores
4. **Next**: Exploring use of O/E as 50% of ASCI score (like CSCI), or as individual metric in MMI

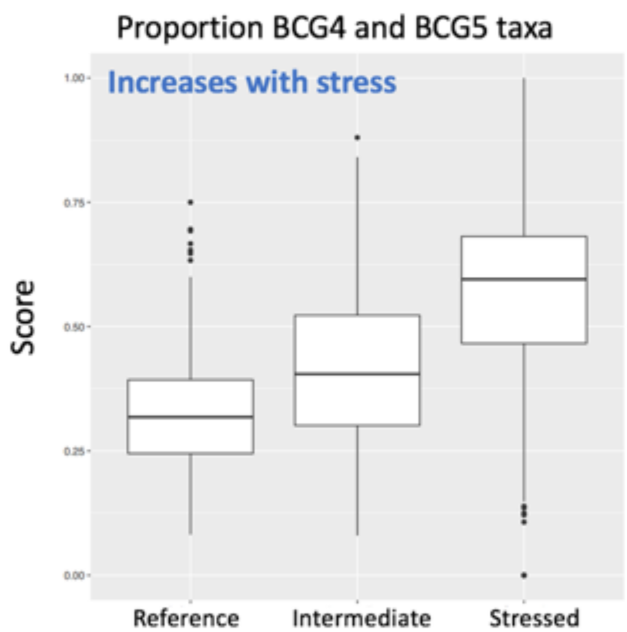
pMMI model development and performance

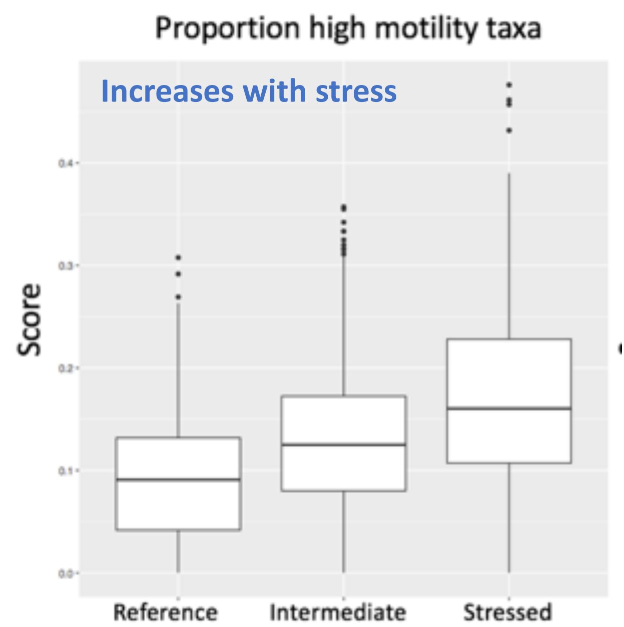
Creating a pMMI

1. Calculate 150+ metrics at reference and stressed sites
2. Create models that adjust metric values to account for major natural sources of metric variation
3. Select metrics based on ability to discriminate reference from stressed sites
4. Score metrics (after Cao et al. 2007) and assemble into composite pMMI

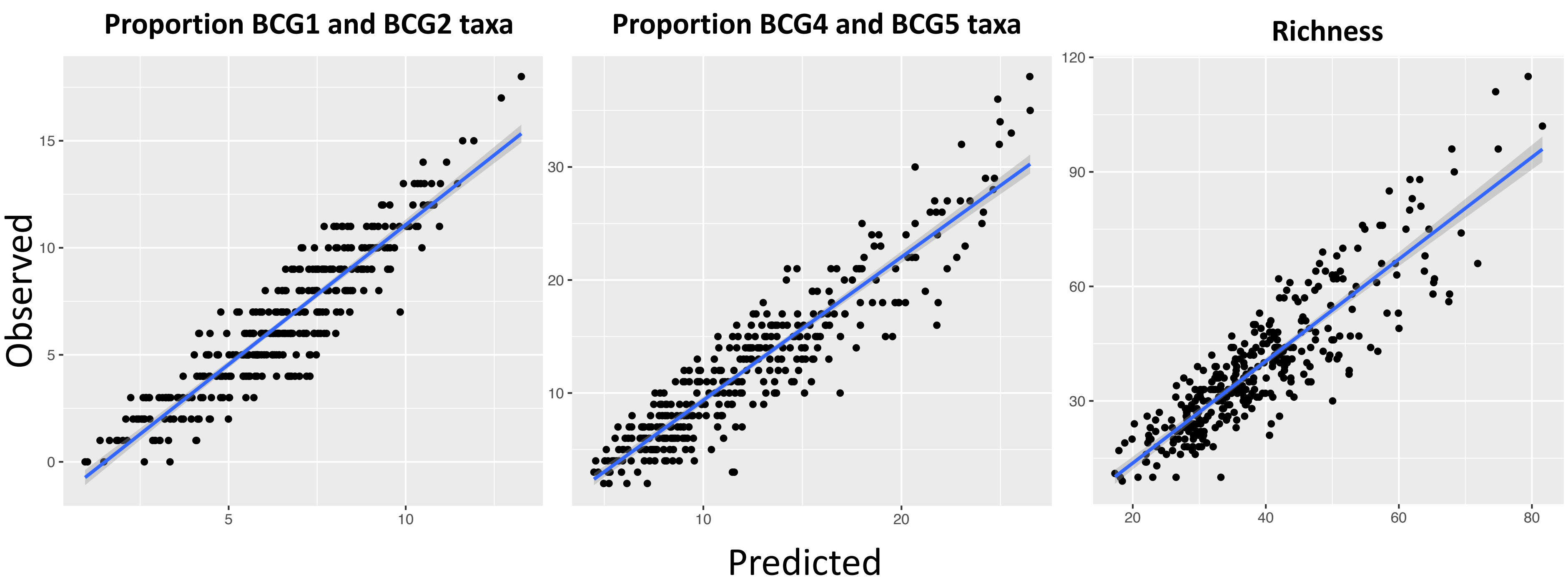
Example pMMI metrics





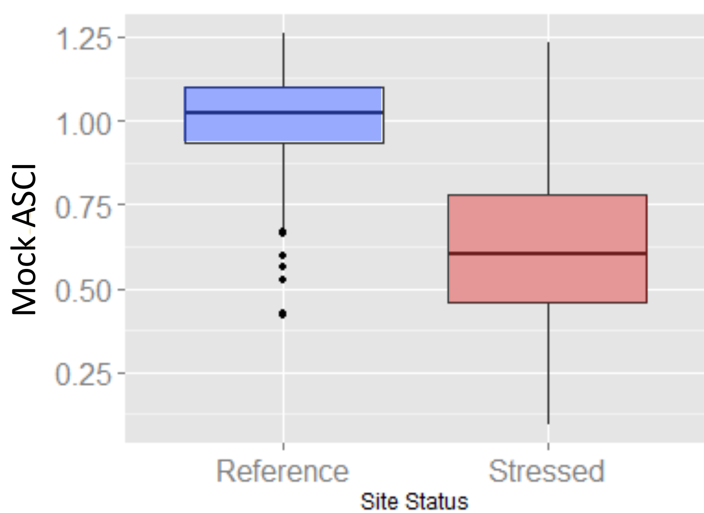


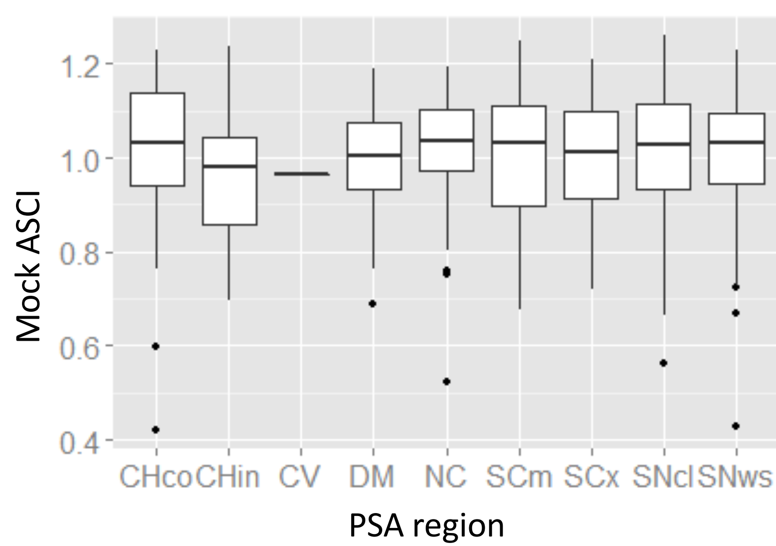
Best predicted metrics



ASCI: evaluate performance

Performance aspect	How do we measure?
Sensitivity	Big differences between reference and stressed
Precision	Low SD for reference sites
Accuracy	Validation at reference sites
Bias	No bias from natural gradients



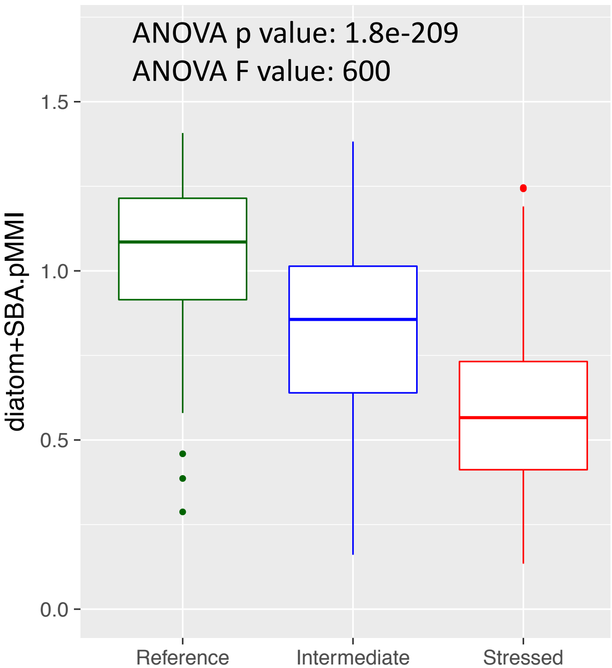


How we combined metrics into an MMI

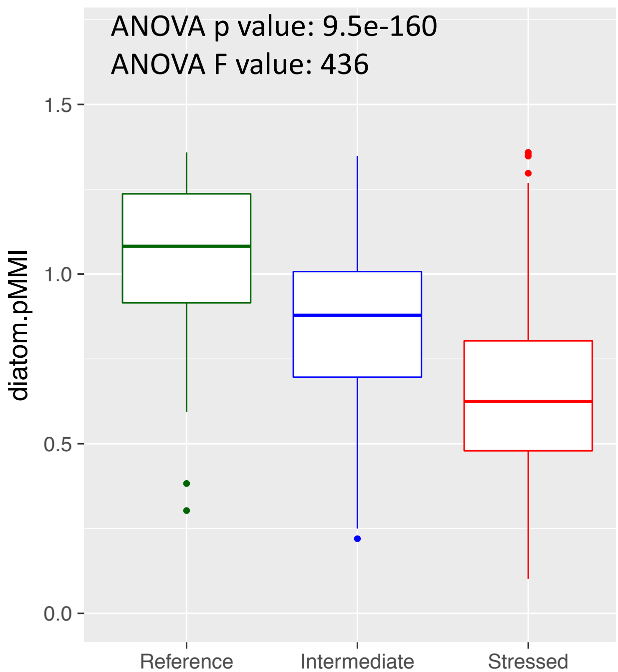
- Select best-performing metrics
  - Pass screening thresholds
  - Are minimally correlated (statistically)
  - Non-redundant (philosophically)
- Calculate all permutations of best metrics
- Select combination of metrics with greatest discrimination between reference and non-reference sites
- Each metric standardized by reference mean and averaged together

Best ASCI pMMIs

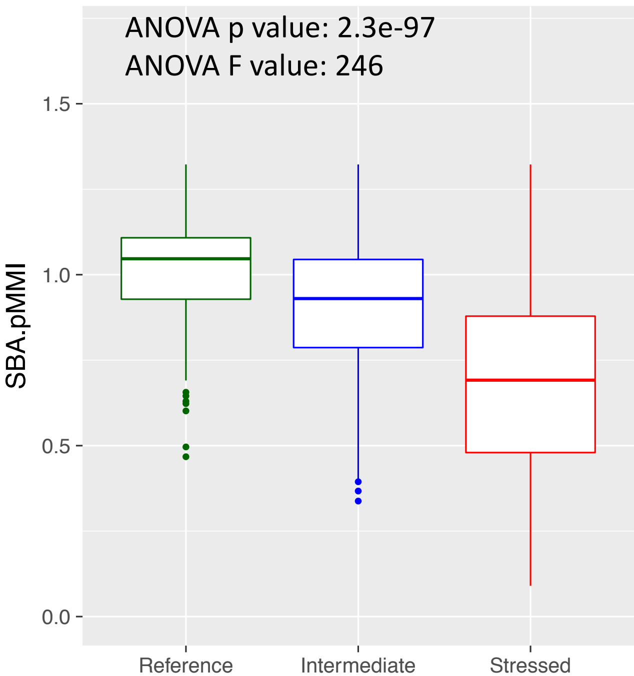
Diatoms + SBA



Diatom



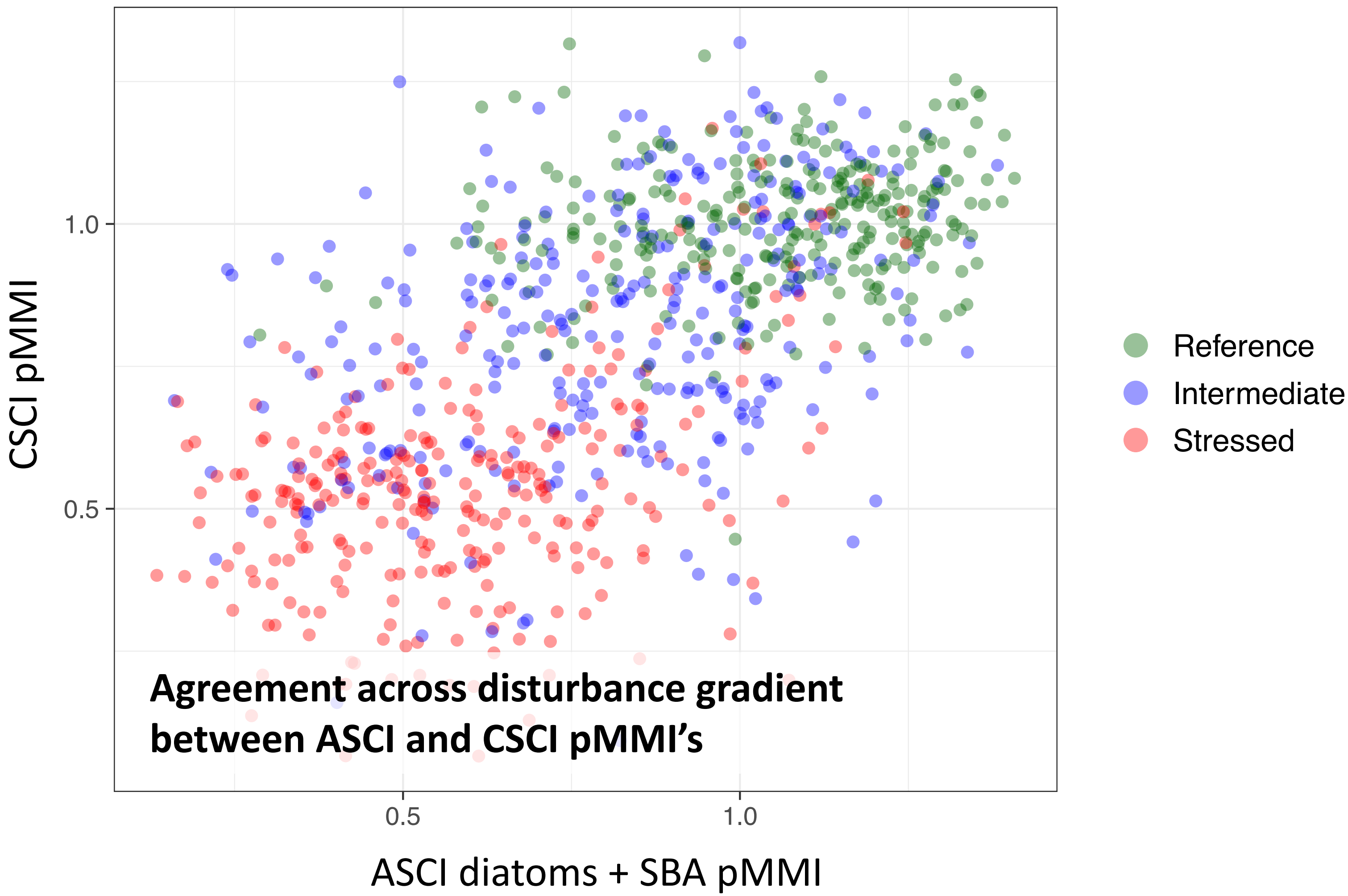
SBA



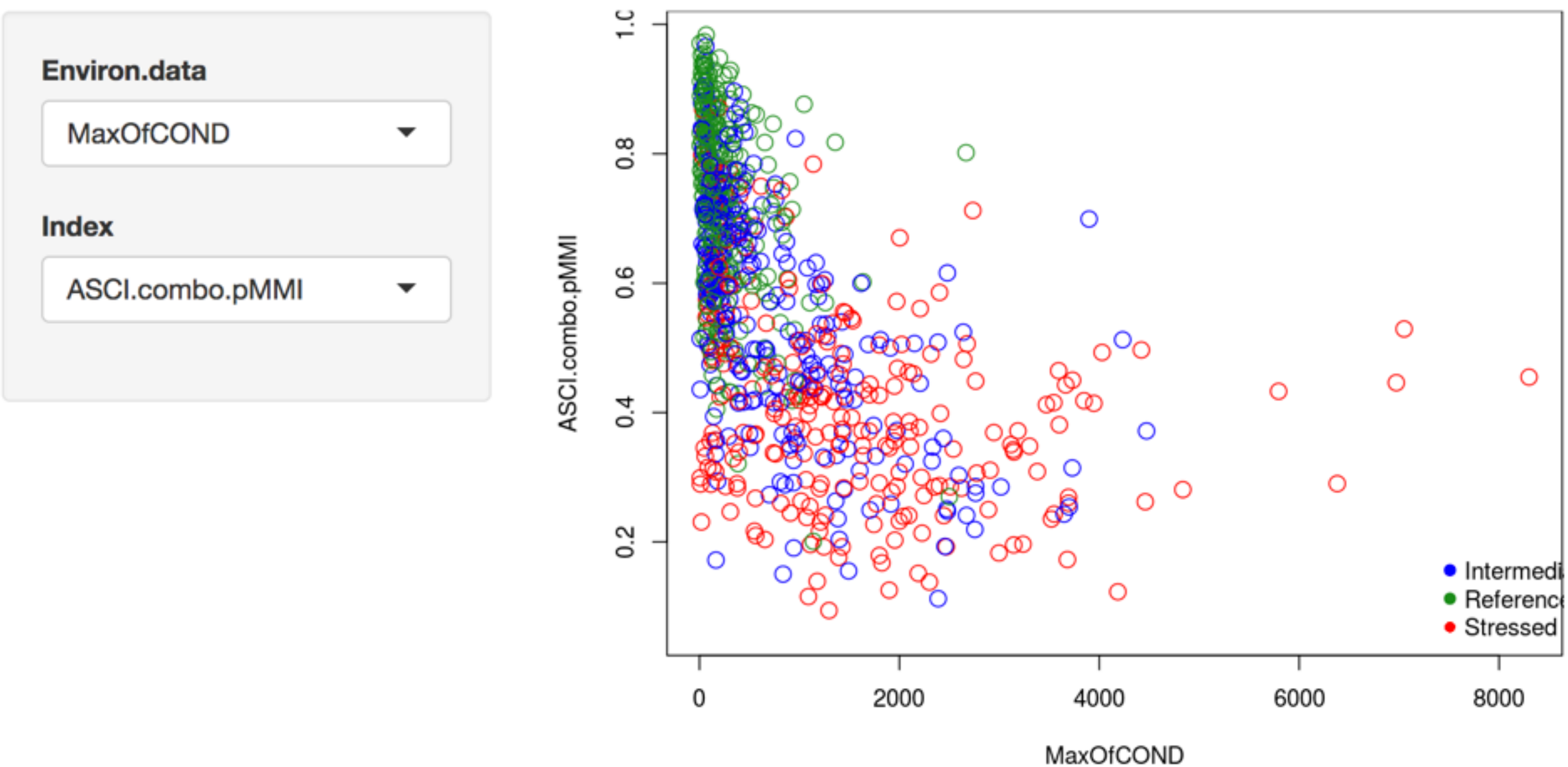
Selected pMMI metrics

	Diatoms + SBA		Diatoms		SBA	
	Metric	**Response to stress**	**Metric**	**Response to stress**	**Metric**	**Response to stress**
Tolerance	Proportion BCG 5 taxa	Increase	Proportion BCG 5 taxa	Increase	Proportion BCG 4, 5 taxa	Decrease
	Proportion BCG 1,2 taxa	Decrease				
	Proportion highly motile taxa	Increase	Proportion highly motile taxa	Increase		
Autoecological guild	Proportion N heterotrophic taxa	Increase	Proportion N heterotrophic taxa	Increase	Proportion high DOC indicators	Increase
	Richness alpha-meso/polysaprobous	Increase	Richness alpha-meso/polysaprobous	Increase	Proportion high P indicators	Increase
	Richness 10 or 30% dissolved oxygen taxa	Increase	Richness > 30% dissolved oxygen taxa	Increase		
	Proportion Brackish-Freshwater salinity taxa	Increase				
Taxonomy					Proportion Green algae	Increase

CSCI.pMMI vs. ASCI.pMMI

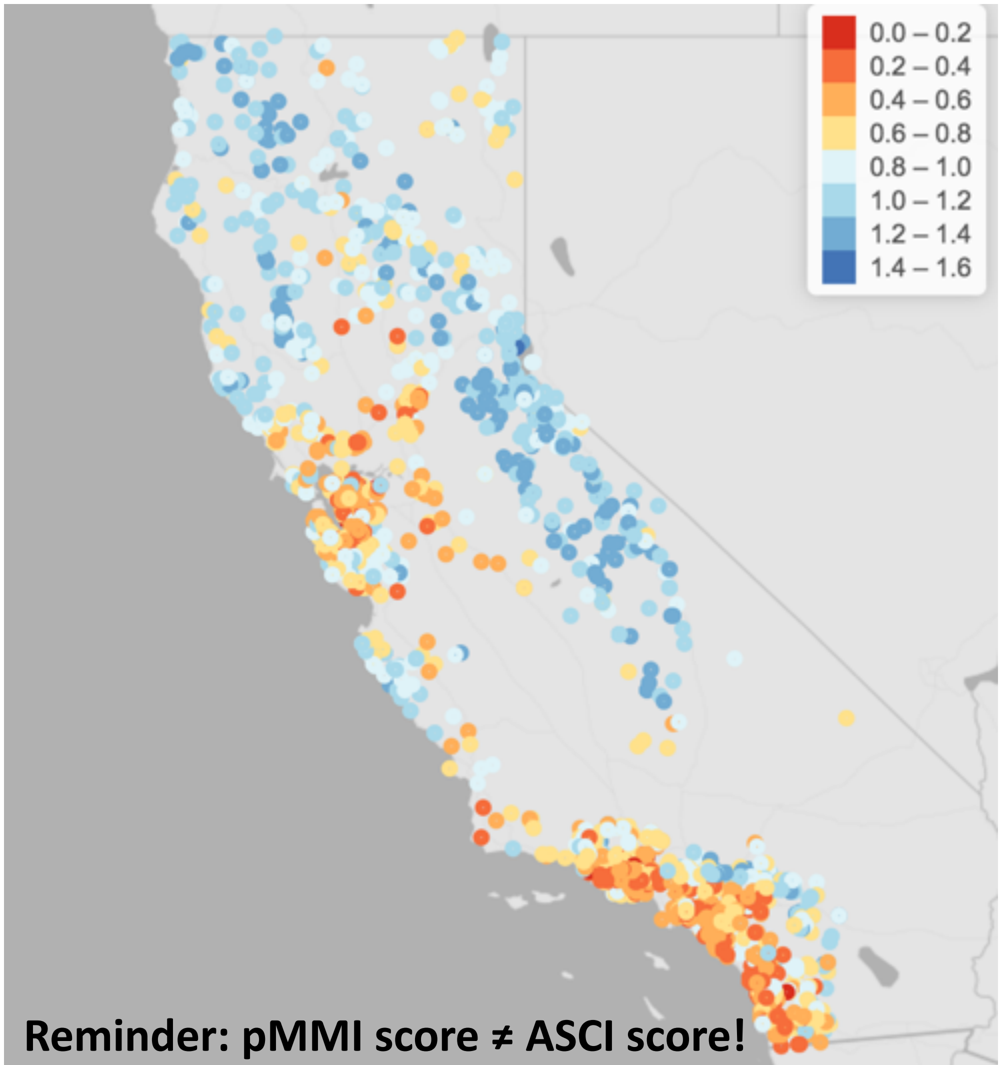


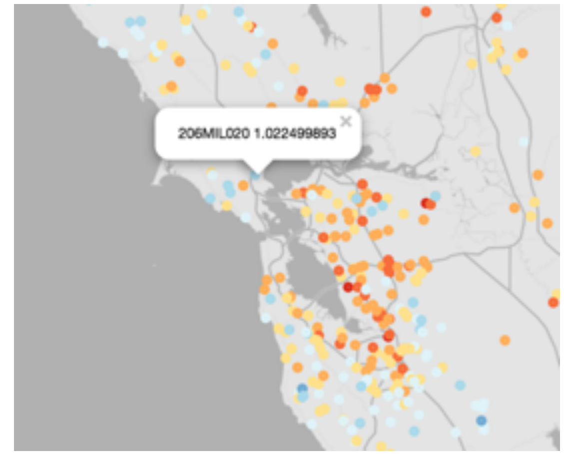
Performance across environmental gradients

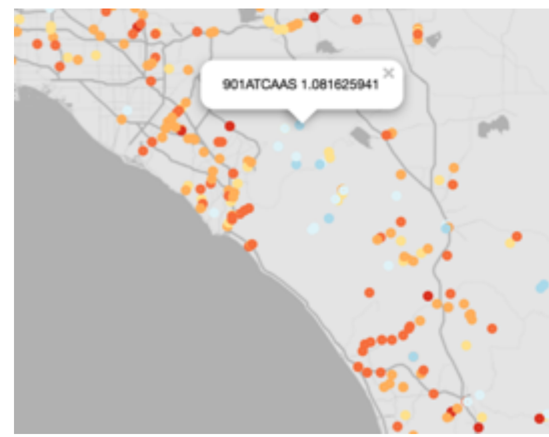


https://stheroux.shinyapps.io/envgrads/

Map: ASCI diatom + SBA pMMI

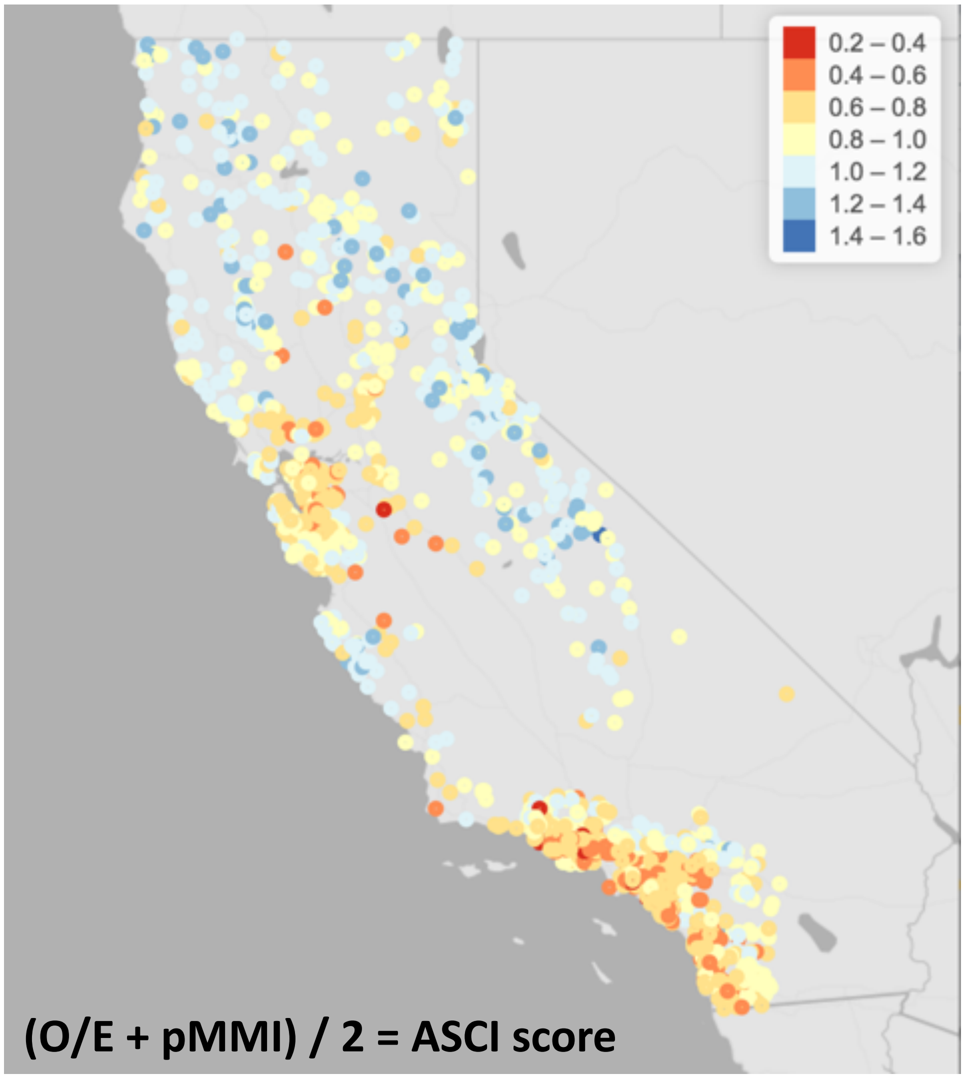


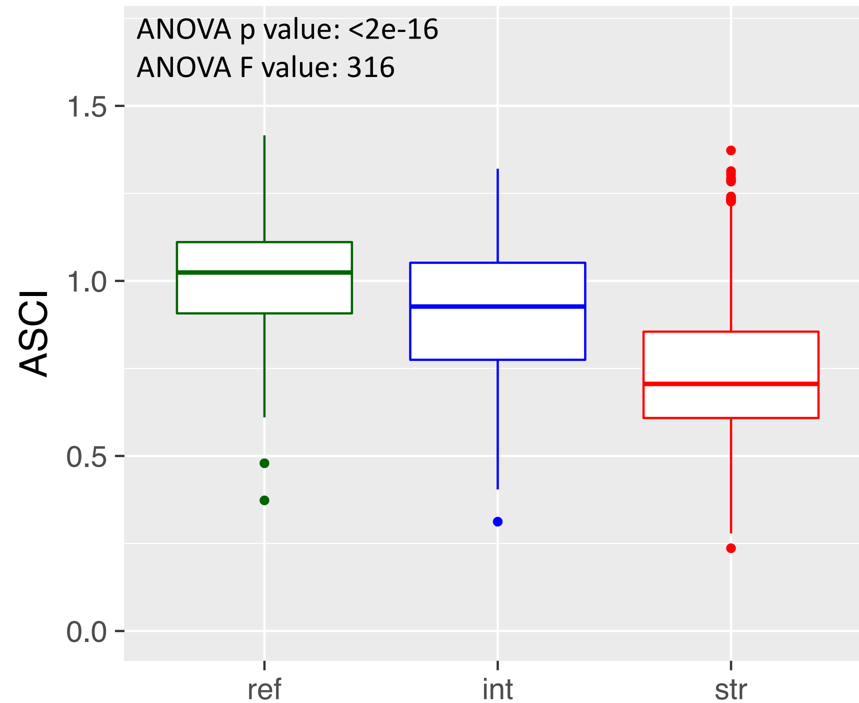




http://rpubs.com/stheroux/ASCIcombopMMI

Draft ASCI: diatoms + SBA O/E + pMMI





http://rpubs.com/stheroux/draftASCI

Next steps in ASCI development: *for review with Science Panel*

- Explore ASCI performance in a variety of landscape settings (e.g. high mountain, channelized streams) and in relation to various stressors (e.g. high nutrient, high development)
- Determine best performing combinations
  - O/E:
    - Diatoms vs. SBA vs. both
    - Genus vs. species level
  - pMMI:
    - Diatoms vs. SBA vs. both
    - Genus vs. species level
- Determine O/E weight
  - 50% of ASCI score vs. incorporation into pMMI

Homework for stakeholders

- Review websites of preliminary ASCI O/E and pMMI performance
- Come prepared to July 26 Stakeholder meeting with ASCI questions and comments

Timeline

Description	Estimated Date
Developmental dataset	3/2017
Reference site designation	3/2017
Oral presentation on preliminary results of index construction and performance	4/2017
Index development - Graphs and tables summarizing O/E model, MMI model and ASCI model and validation	6/2017
Oral presentation on comparison of ASCI performance to other indices	6/2017
Draft ASCI manuscript	9/2017
Science Panel meeting	9/20/2017
Stakeholder feedback	9/2017 – 1/2018

Questions?

susannat@sccwrp.org