Statistical modeling responses of bioassessment indices to eutrophication stressor gradients

Presentation to Stakeholder WG

Friday, March 17, 2017

Objectives

- Support decisions on numeric guidance (e.g., a numeric objective) for biostimulatory nutrients or conditions that protect biological integrity.

Process and Approach

- Present stakeholder and regulatory advisory groups with overall approach, and ascertain key points to consider
- Review approach with science panel, and identify best ways to tackle concerns
- Present model results to advisory groups and review implications

Measuring Biostimulatory factors and eutrophication indicators

- Nutrient concentrations: Total N and Total P
- Organic matter: Benthic chl A or AFDM, streambed algae cover

Other co-factors we may include (but don’t need numeric guidance now):

- Biostimulatory conditions (temp, velocity, shading)
- Habitat quality

Responses: measures of biological integrity

- Benthic macroinvertebrates
  - CSCI
- Benthic algae
  - Soft/Diatom indices (ASCIs)

When available, we can link ranges of index scores linked to BCG bins.

(in interim, we'll use thresholds based on reference distributions)

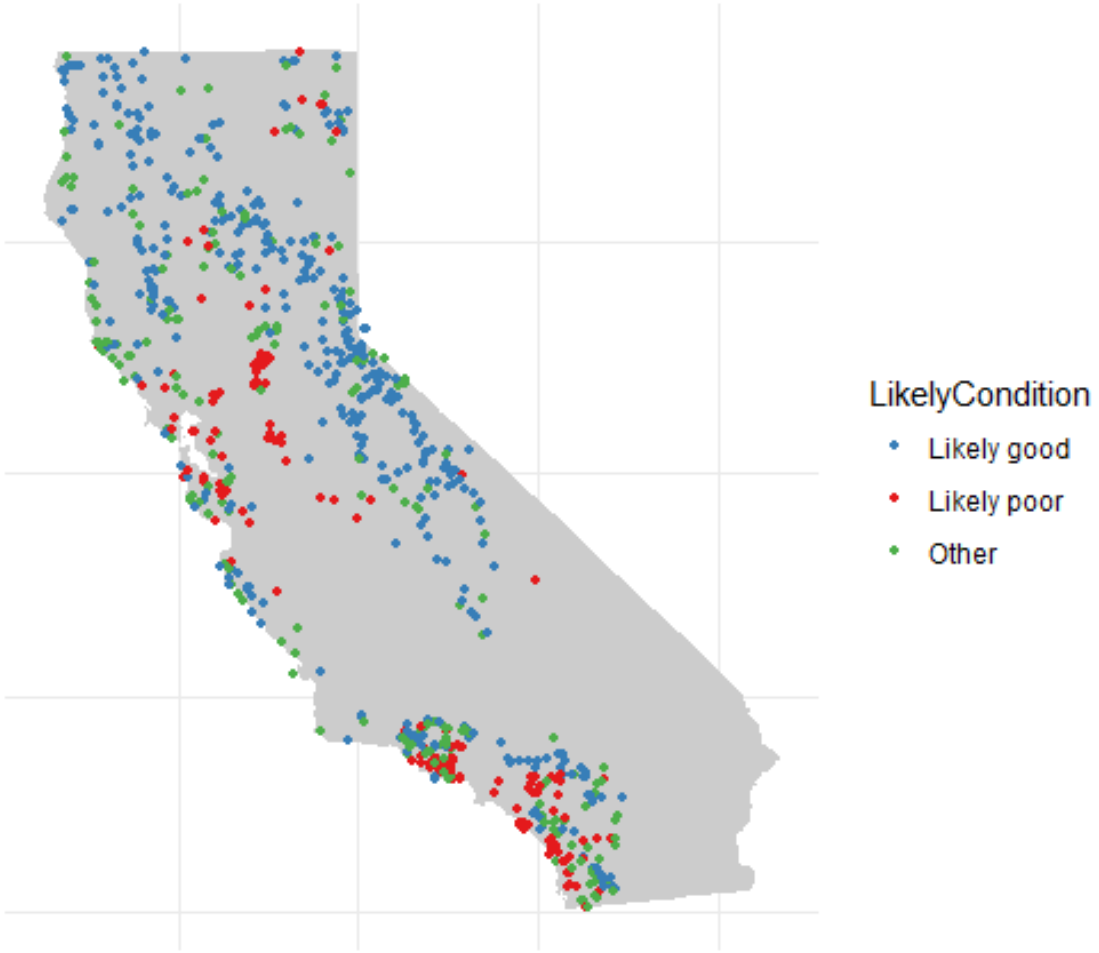
Species-level responses

- Thresholds derived for species responses may be more protective than those derived for indices, but links to beneficial uses less clear.
- May support diagnosis and causal assessment of eutrophication impacts.

How is our data set?

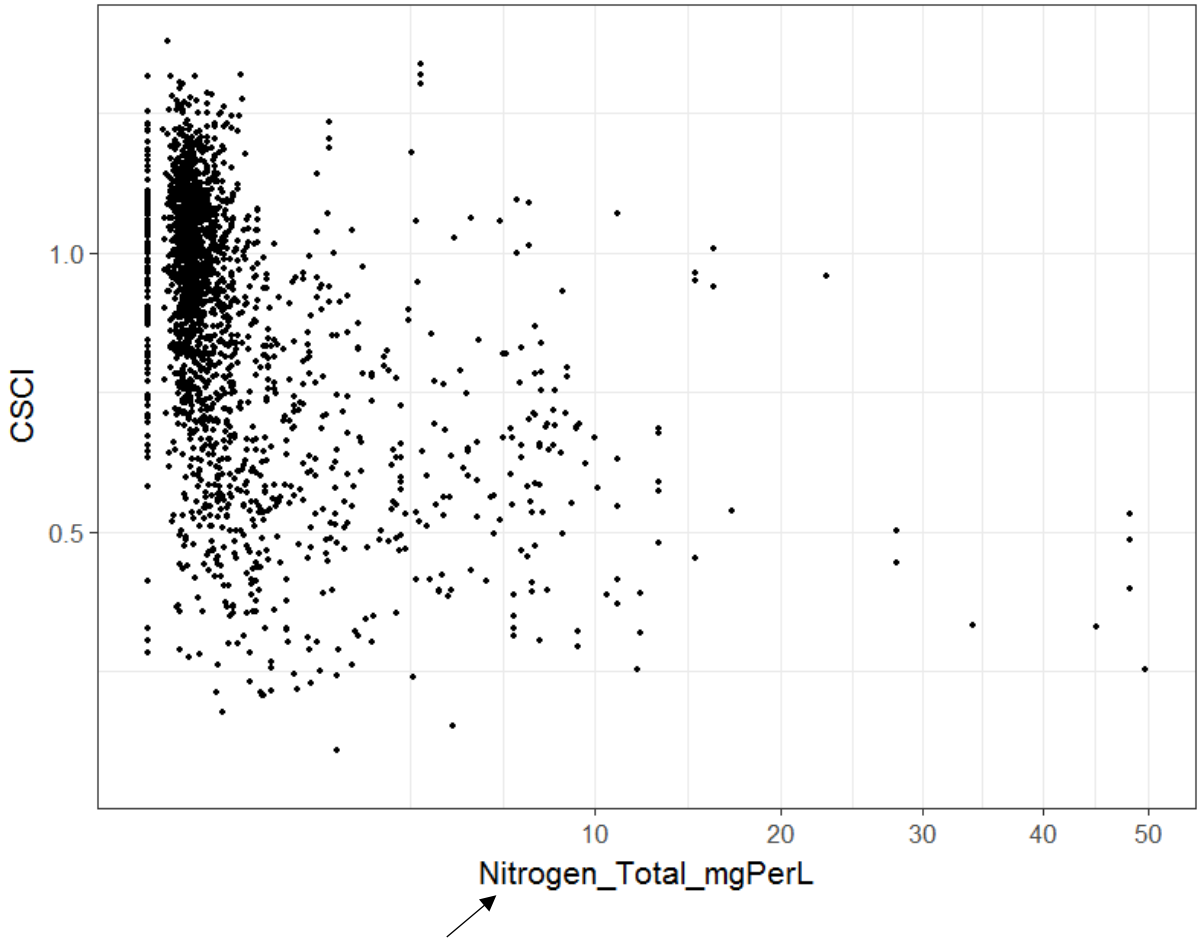
- Samples statewide collected since mid 1990s (most since 2008)
- Good representation of high-scoring sites across most regions
  - Sites in poor condition mostly in South Coast, Central Valley, Bay Area

	Likely biological condition		
Region	Good	Poor	Other
North Coast	84	4	40
Chaparral	72	30	58
South Coast	70	124	94
Central Valley	3	33	8
Sierra Nevada	164	3	34
Deserts and Modoc	39	10	26



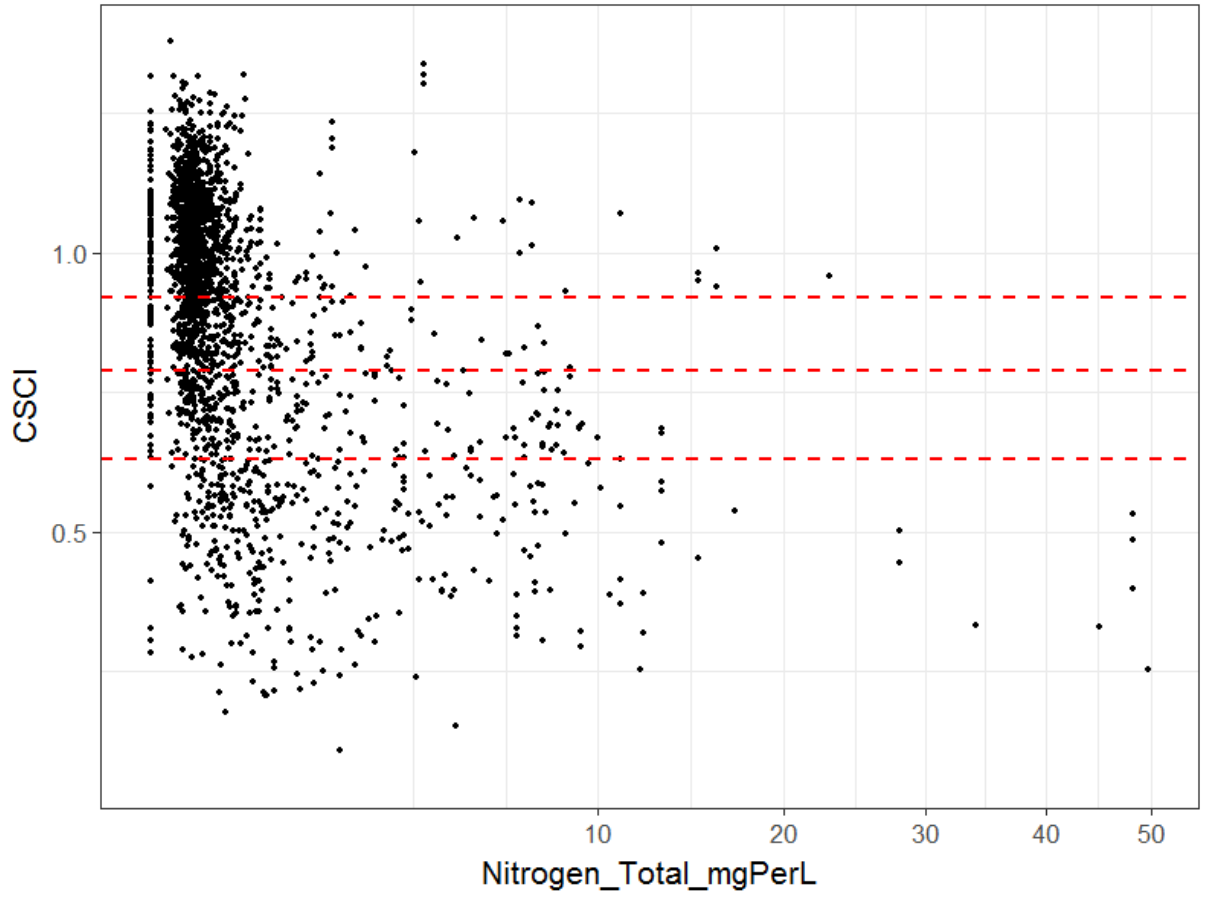
Models let us link bio-integrity to bio-stimulation

Could also put ASCI here



Could also put TP, eutrophic responses here

Models let us link bio-integrity to bio-stimulation



BCG bin 1/2

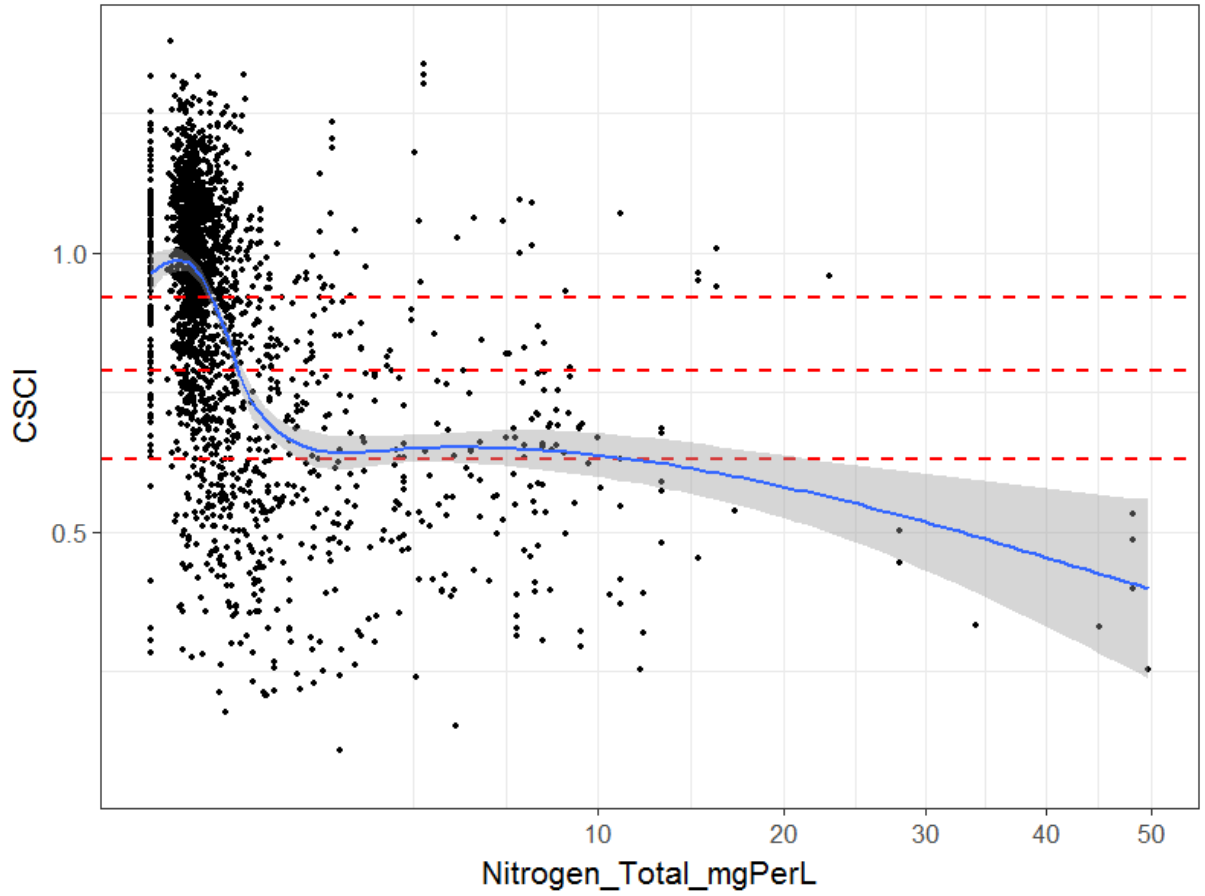
BCG bin 3

BCG bin 4

BCG bin 5/6

Thresholds derived through expert panel process.
WB selects bins where protection is a priority.

Models let us link bio-integrity to bio-stimulation



BCG bin 1/2

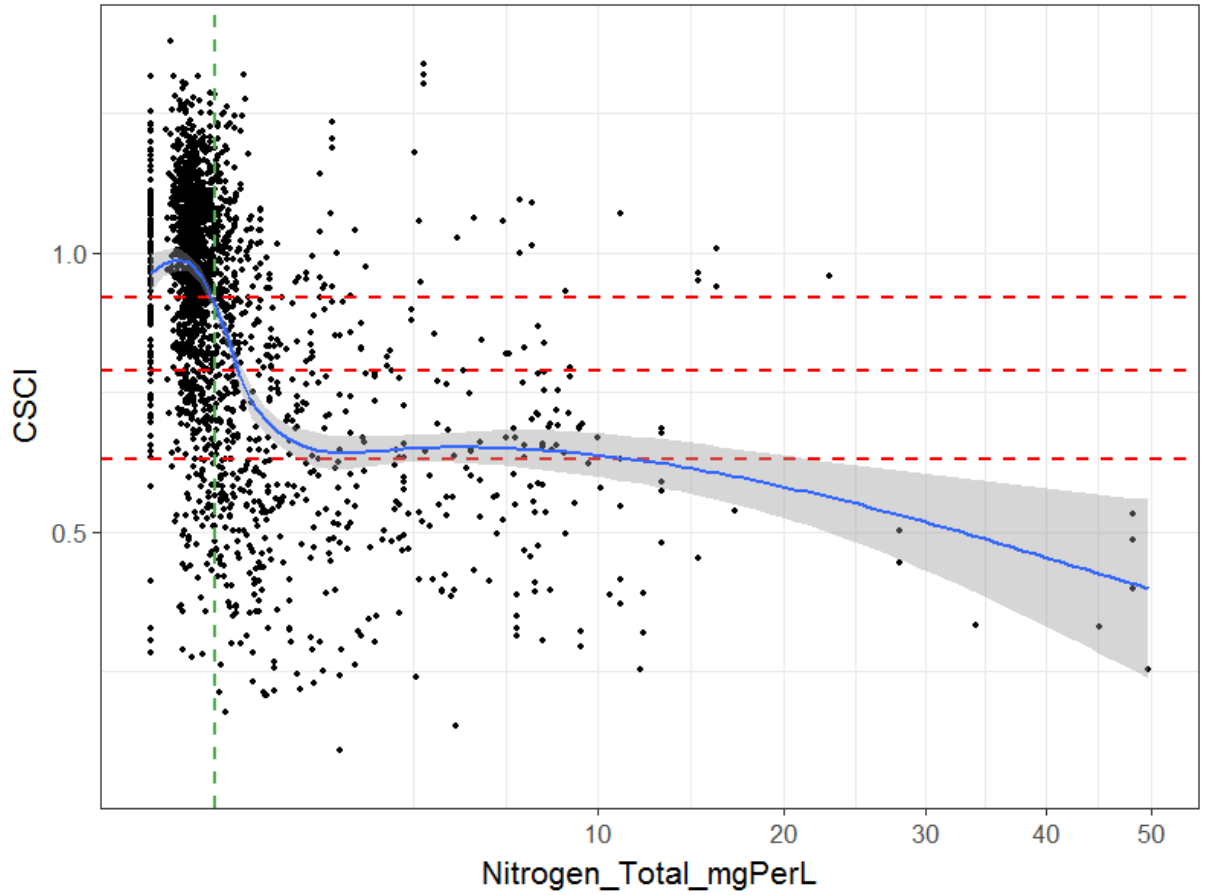
BCG bin 3

BCG bin 4

BCG bin 5/6

Several modeling approaches could be used to draw this line.

Models let us link bio-integrity to bio-stimulation



BCG bin 1/2

BCG bin 3

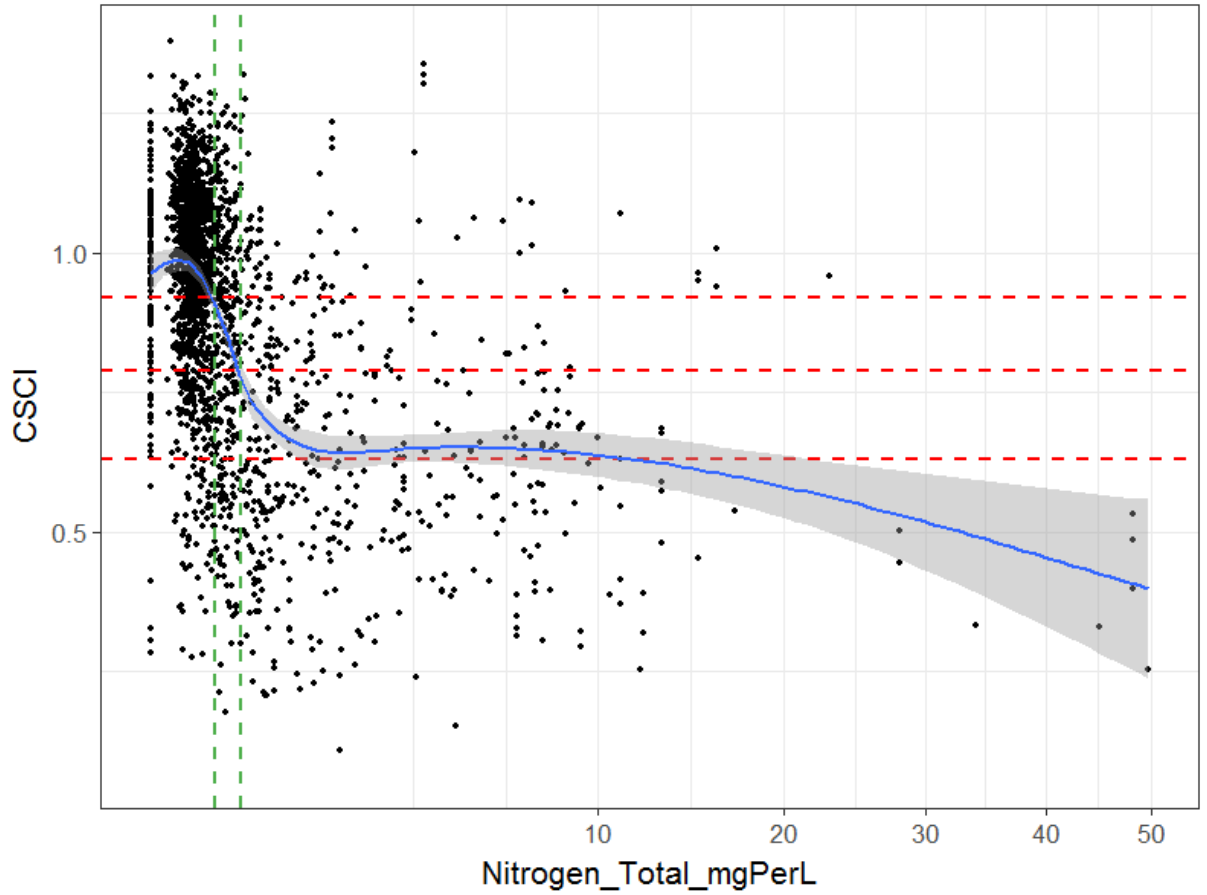
BCG bin 4

BCG bin 5/6

TN<0.2
50% of being in BCG 1/2 or better

Models allow us to identify numeric values associated with each bin

Models let us link bio-integrity to bio-stimulation



BCG bin 1/2

BCG bin 3

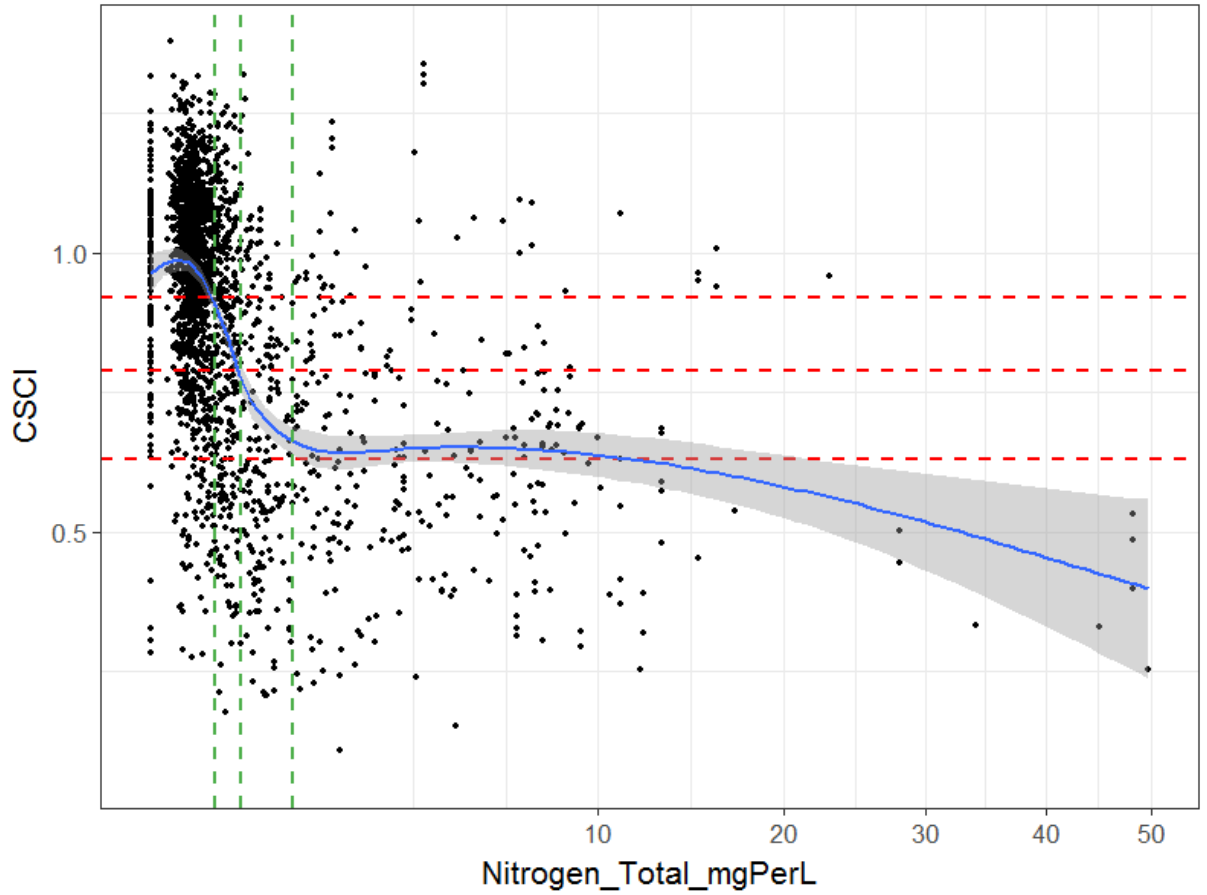
BCG bin 4

BCG bin 5/6

TN<0.4
50% of being in BCG 3 or better

Models allow us to identify numeric values associated with each bin

Models let us link bio-integrity to bio-stimulation



BCG bin 1/2

BCG bin 3

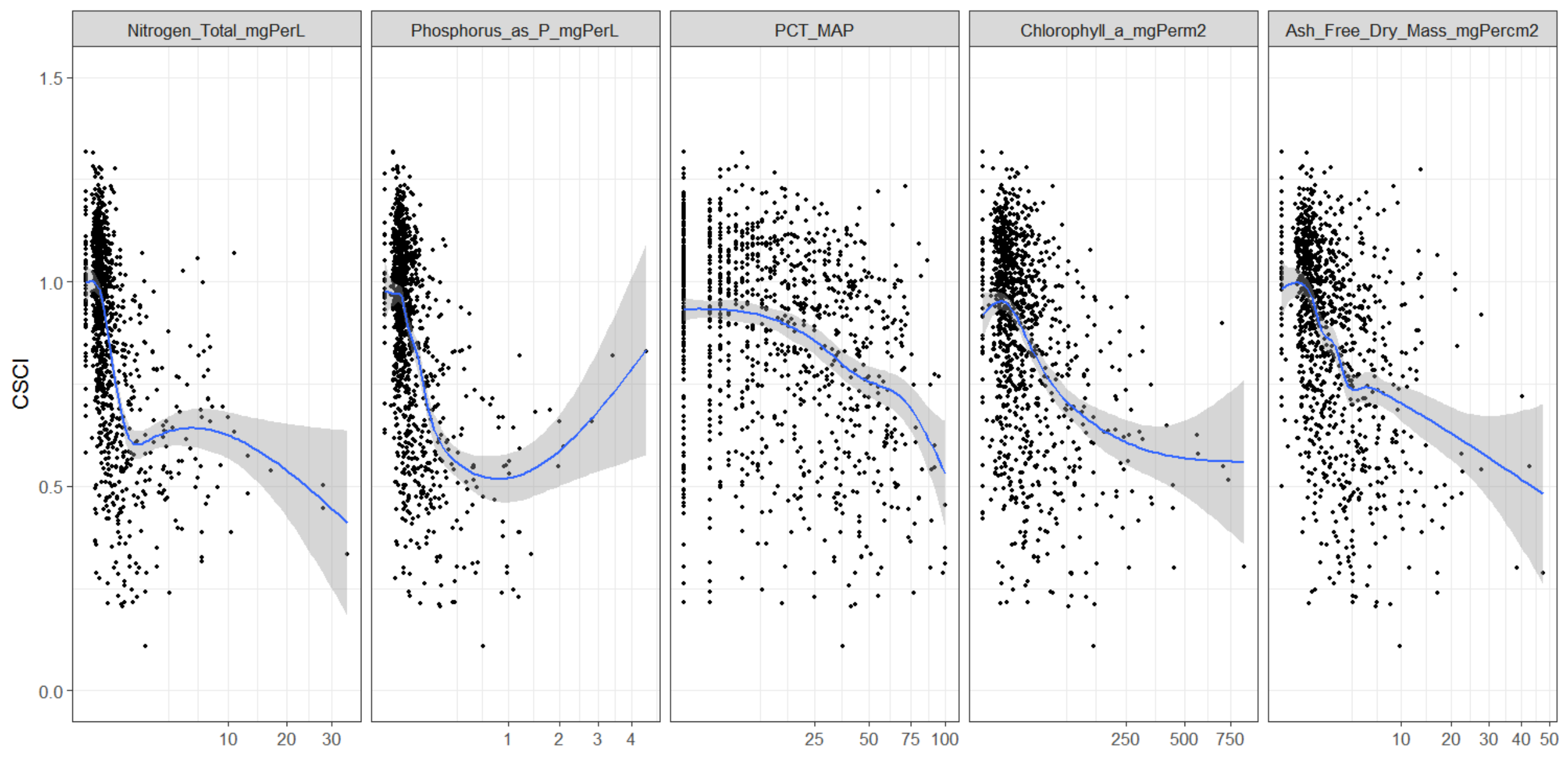
BCG bin 4

BCG bin 5/6

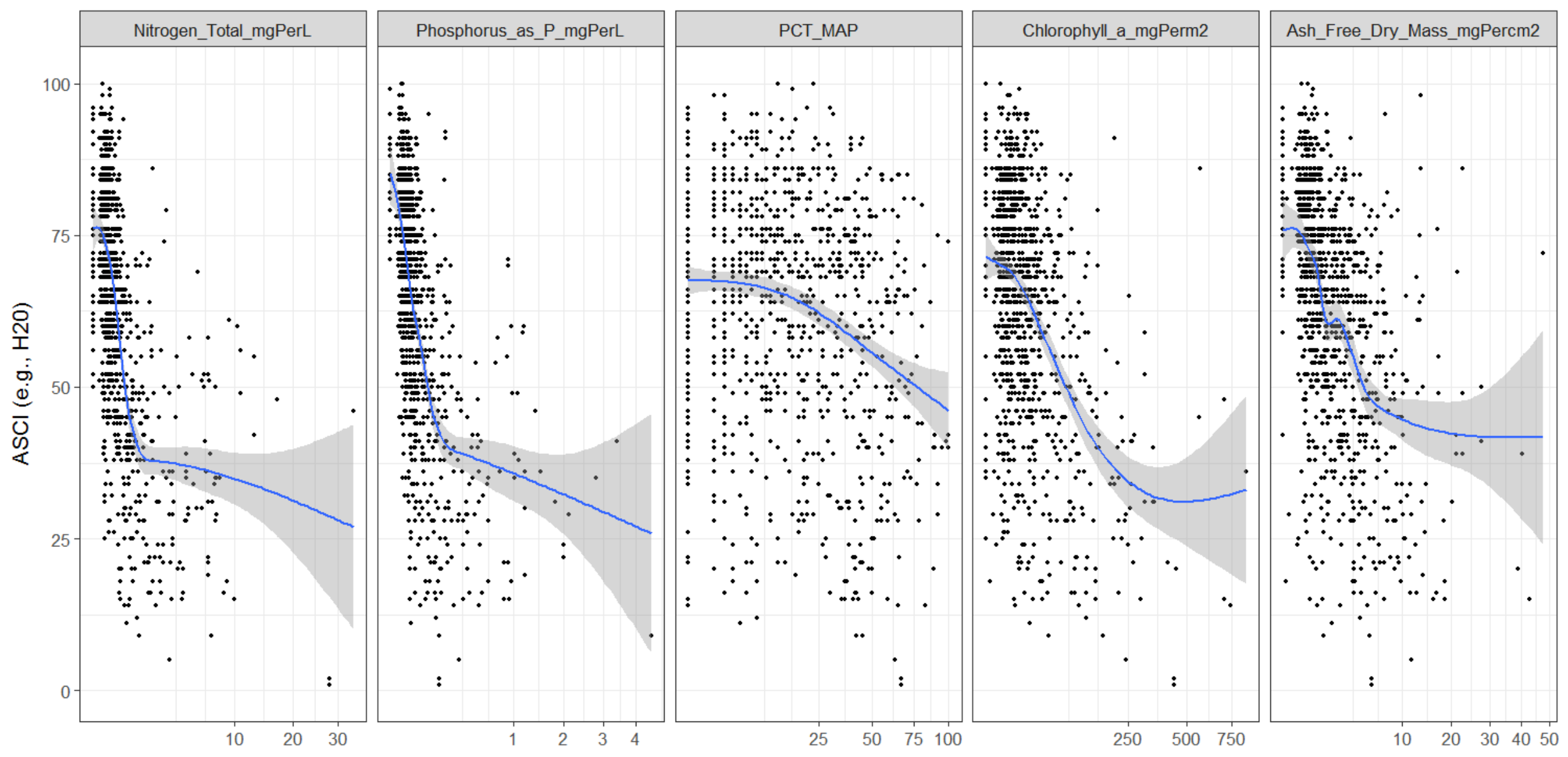
TN<1

50% of being in BCG 4 or better

Models allow us to identify numeric values associated with each bin

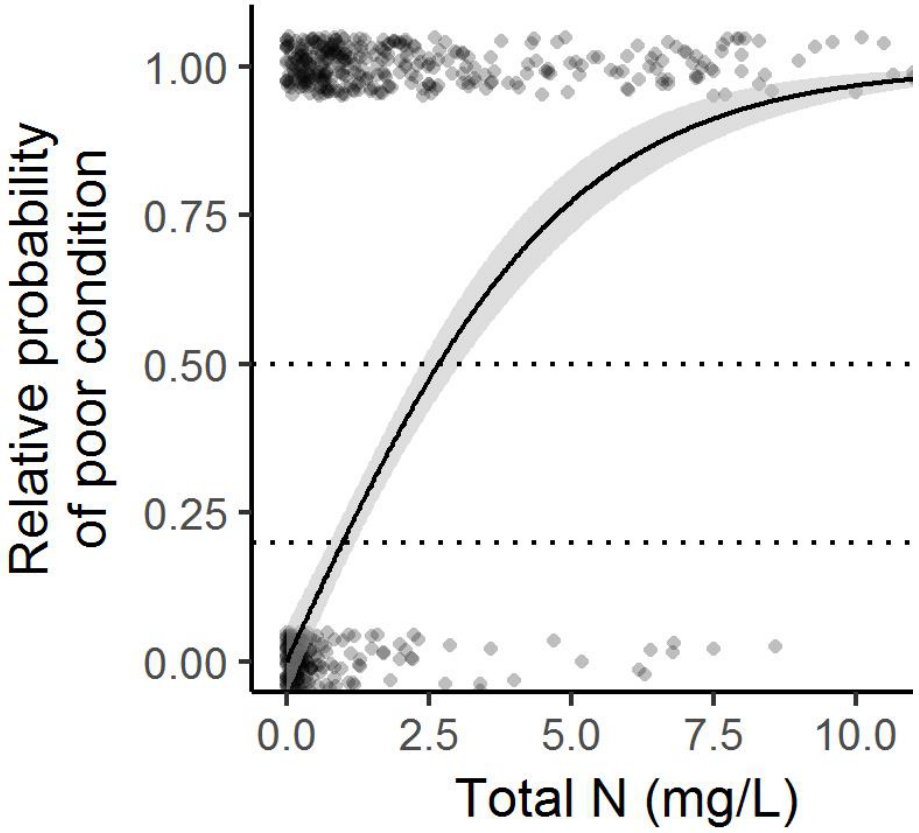


Most of the “action” is at fairly low concentrations.



Algae likely to show a similar pattern.

Models allow us to explore different levels of risk tolerance



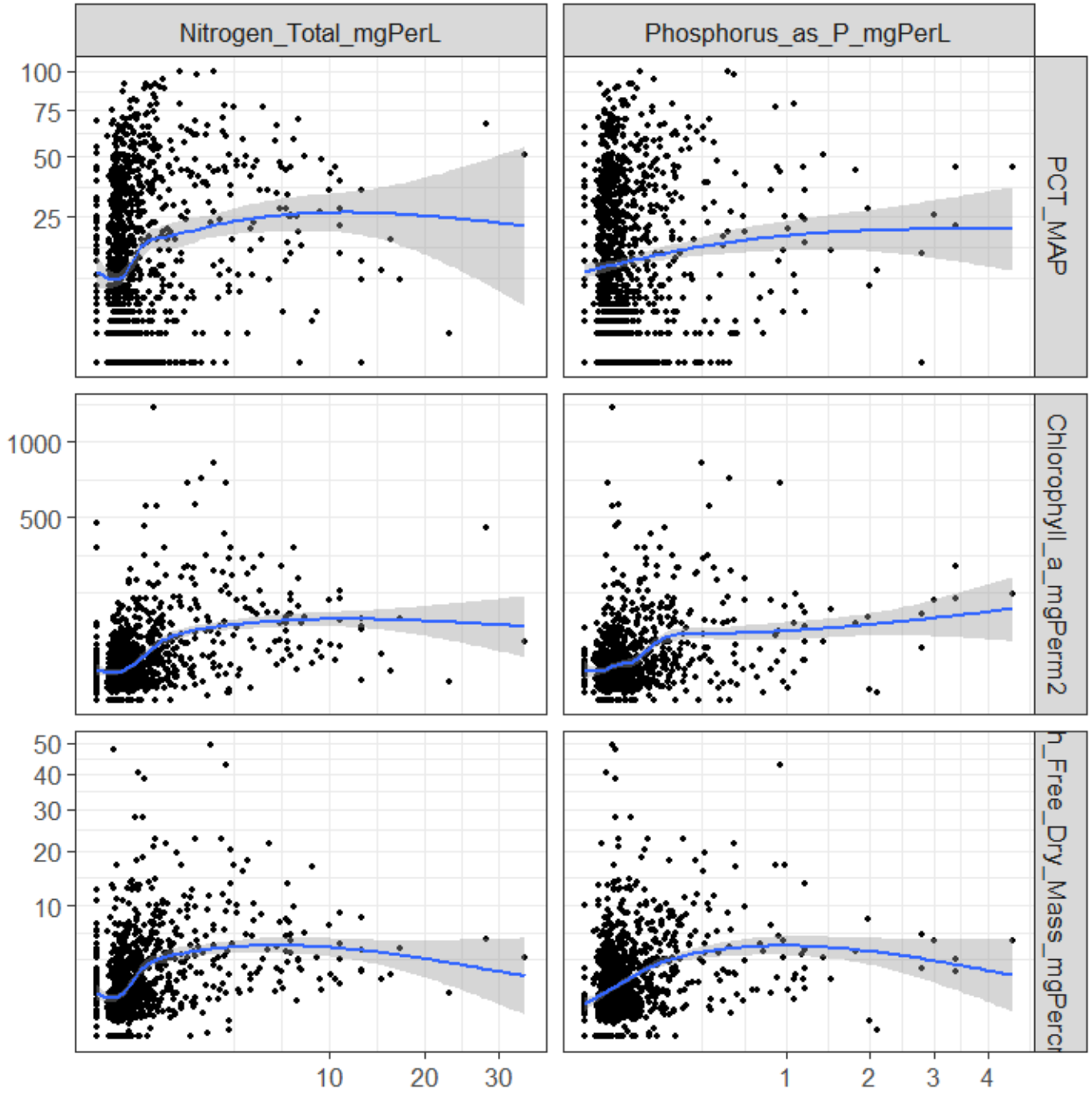
TN > 2.5: 50% increase in risk of poor condition

TN > 1: 20% increase in risk of poor condition

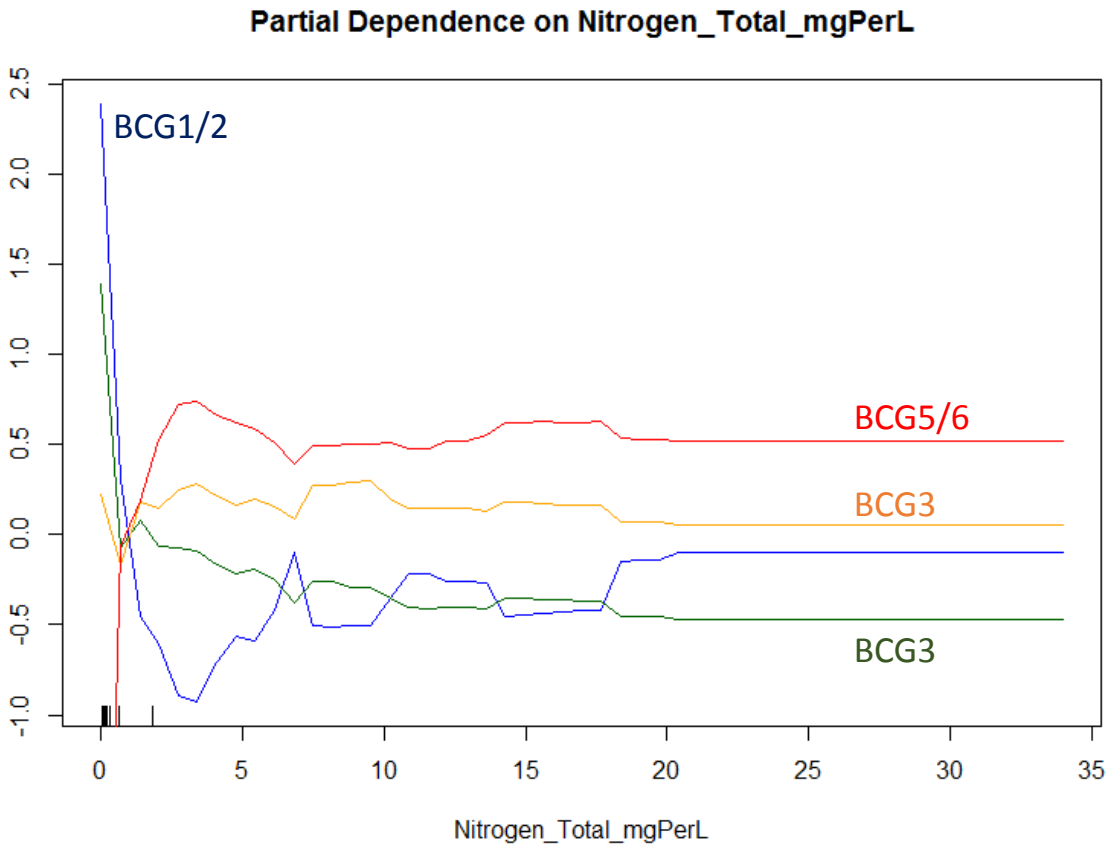
Considerations in developing a model

- Several types of models may be suitable (e.g., logistic regression, random forest, etc.)
- Broad-scale applicability: Statistical models vs. “watershed approach”
- Probabilistic: What levels of nutrients/OM have an acceptably low probability of poor CSCI/ASCI scores?
- Interactions: Can you account for interacting effects of two or more biostimulatory stressors?
- Site-specificity: Are certain sites more responsive/resilient to nutrient inputs than others?
- Confounding: Can you disentangle biostimulation from habitat degradation or other stressors that affect bio-integrity?

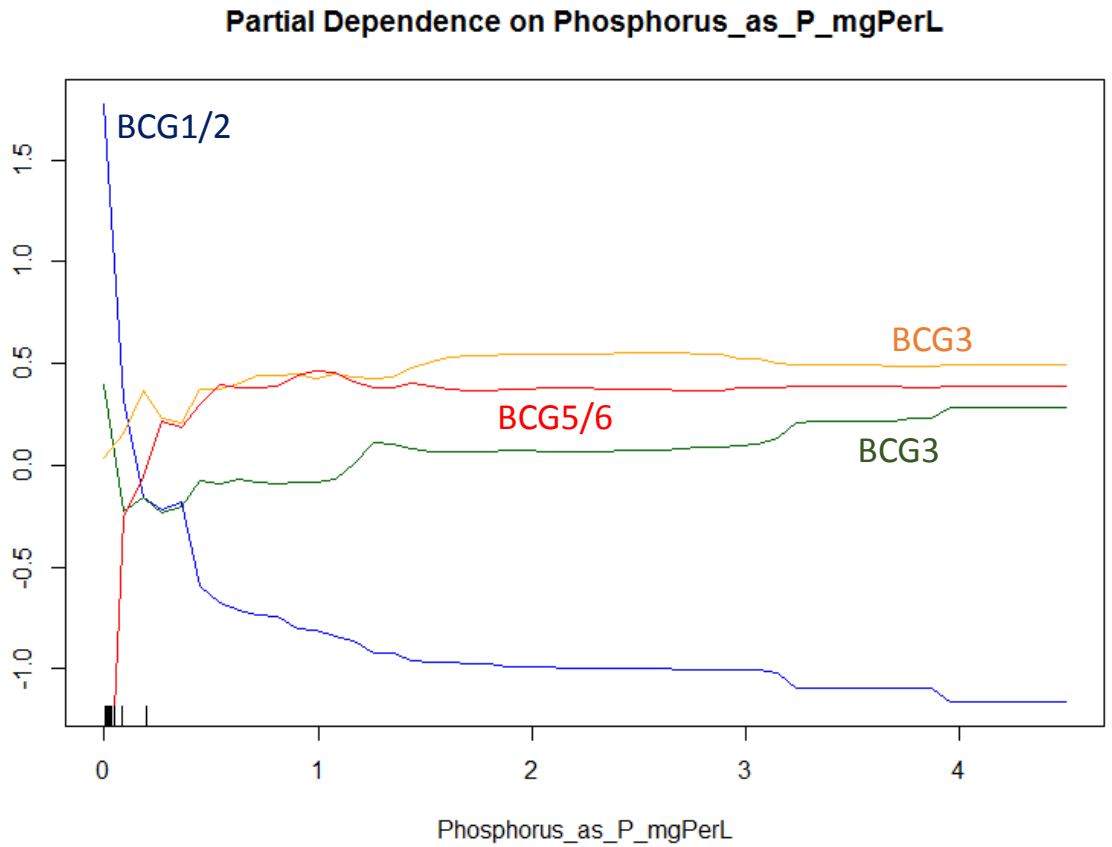
QUESTIONS


Nitrogen_Total_mgPerL
Phosphorus_as_P_mgPerL
PCT_MAP
Chlorophyll_a_mgPerm2
h_Free_Dry_Mass_mgPerc
100
75
50
25
1000
500
50
40
30
20
10
10
20
30
1
2
3
4

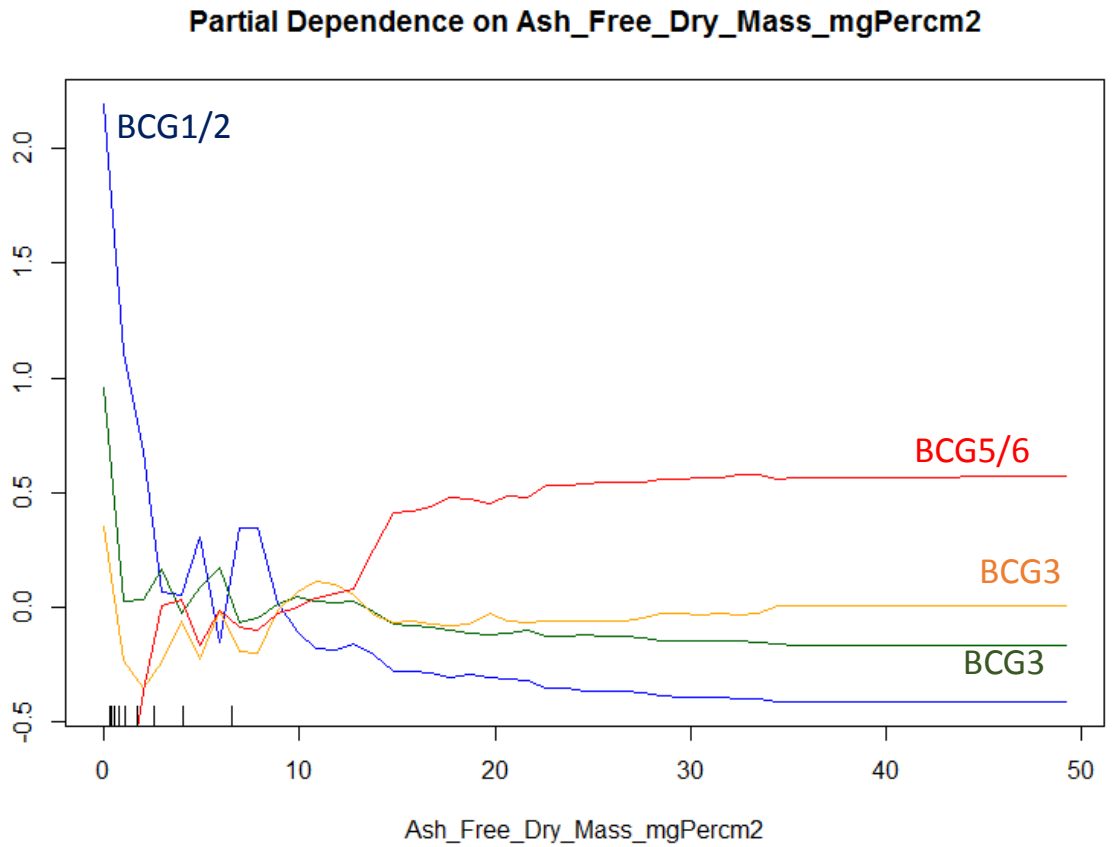
Partial dependence plots



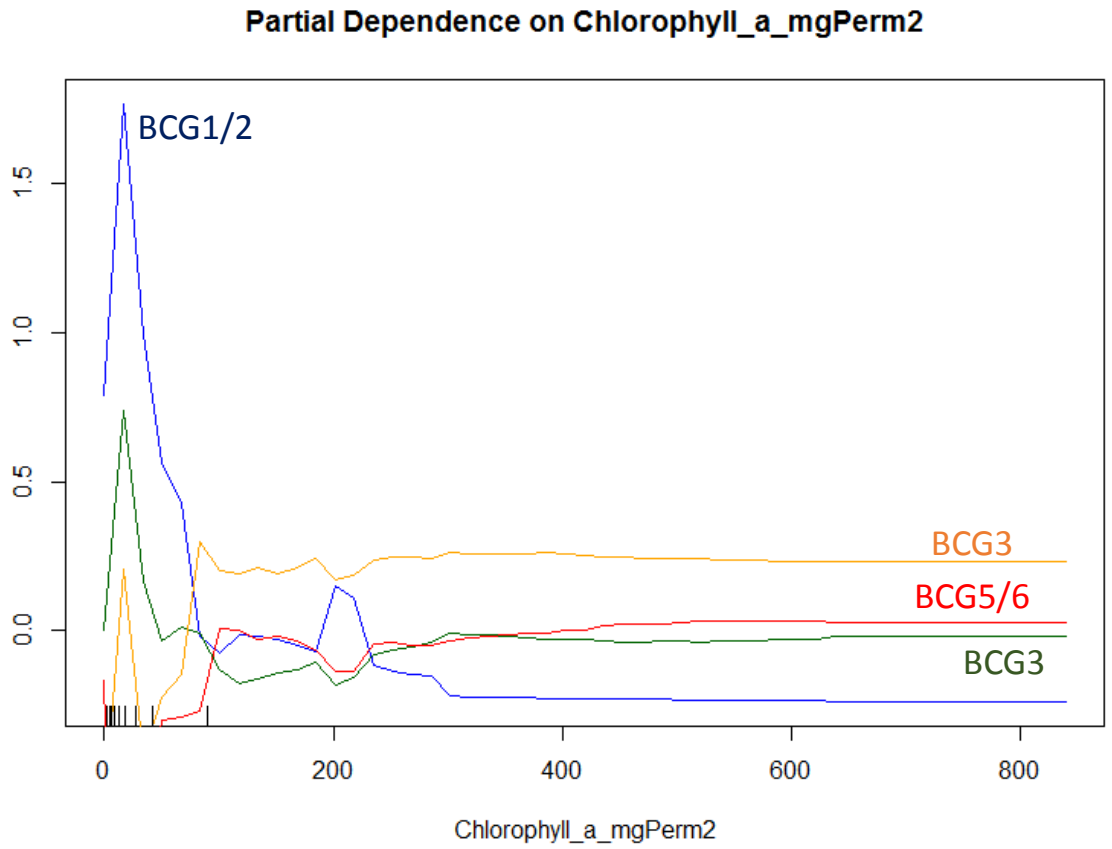
Partial dependence plots



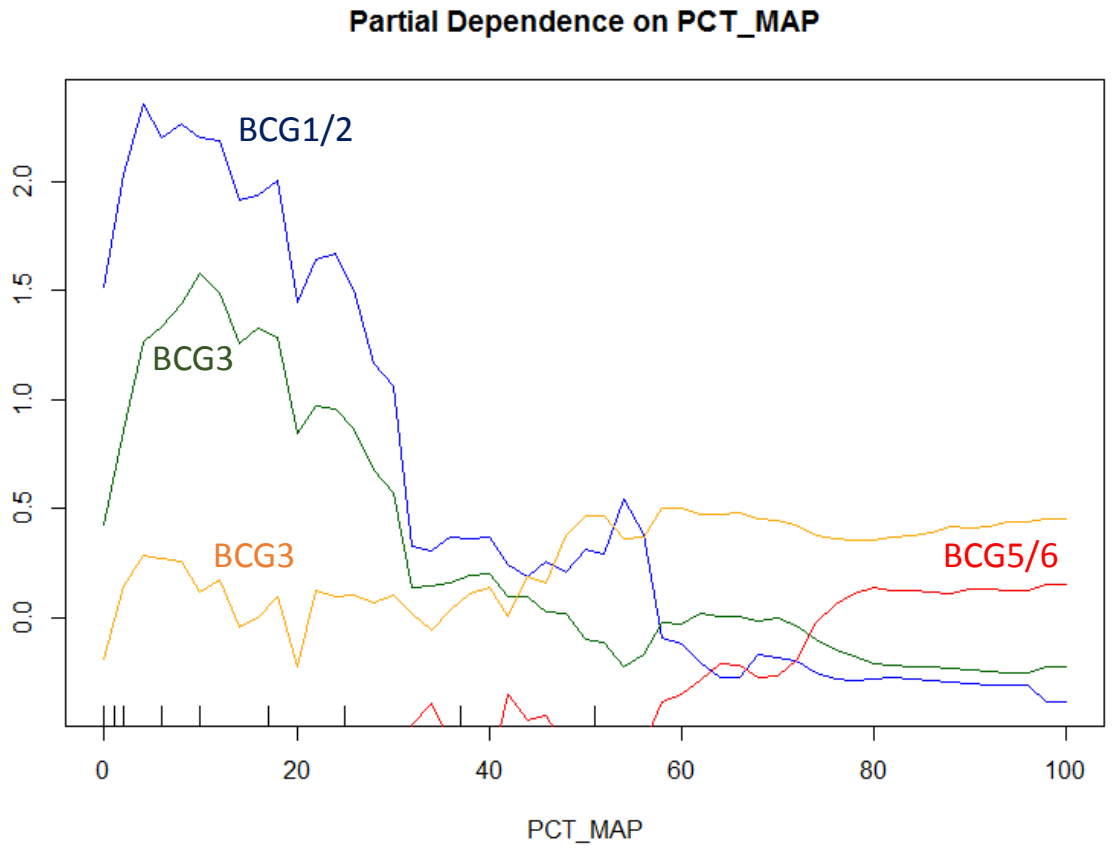
Partial dependence plots



Partial dependence plots



Partial dependence plots

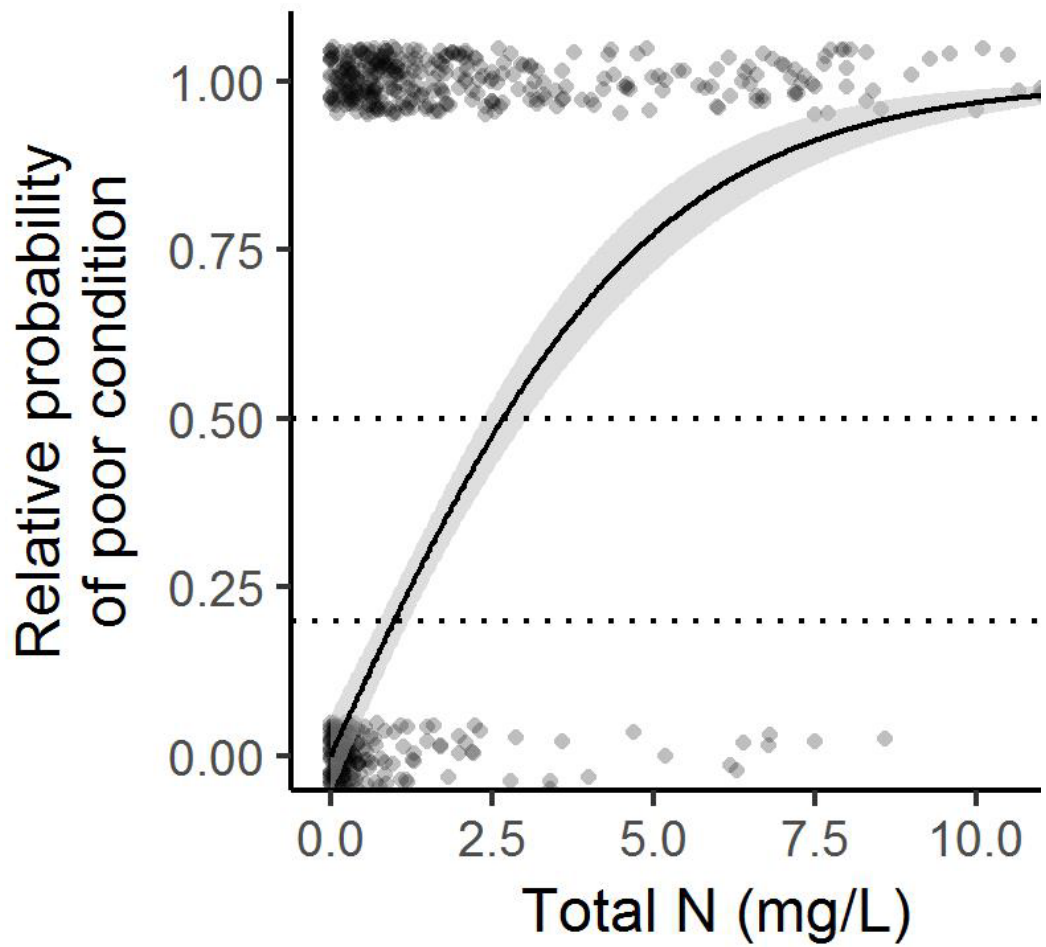


RF model: BCG~Nutrients + organic matter

- Error rate: 38.15%

Predicted class

True class	BCG12	BCG3	BCG4	BCG56
BCG12	531	29	16	19
BCG3	119	26	23	26
BCG4	73	16	30	49
BCG56	46	9	21	136


Relative probability
of poor condition
1.00
0.75
0.50
0.25
0.00
0.0
2.5
5.0
7.5
10.0
Total N (mg/L)