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Using stressor-response relationships to derive candidate nutrient criteria

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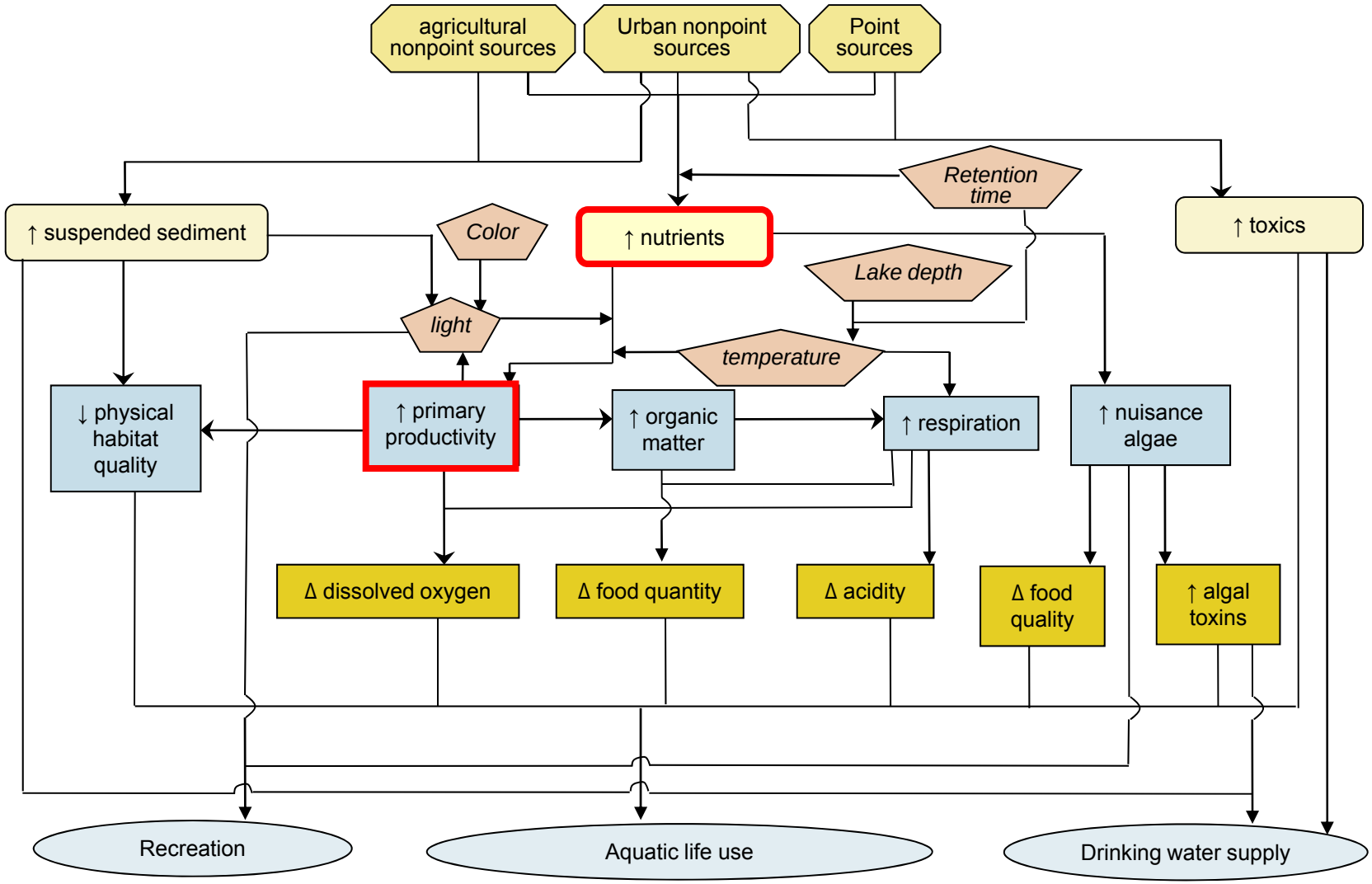
How can we use stressor-response relationships to derive candidate nutrient criteria?

1. Describe relationships between human activities, changes in nutrient concentrations, and support for designated uses (conceptual models).
2. Collect and evaluate data (data exploration).
3. Model relationships between nutrient concentrations and selected responses.
   - Classify data
   - Estimate relationships.
4. Interpret statistical model results to select criteria.

Conceptual diagram



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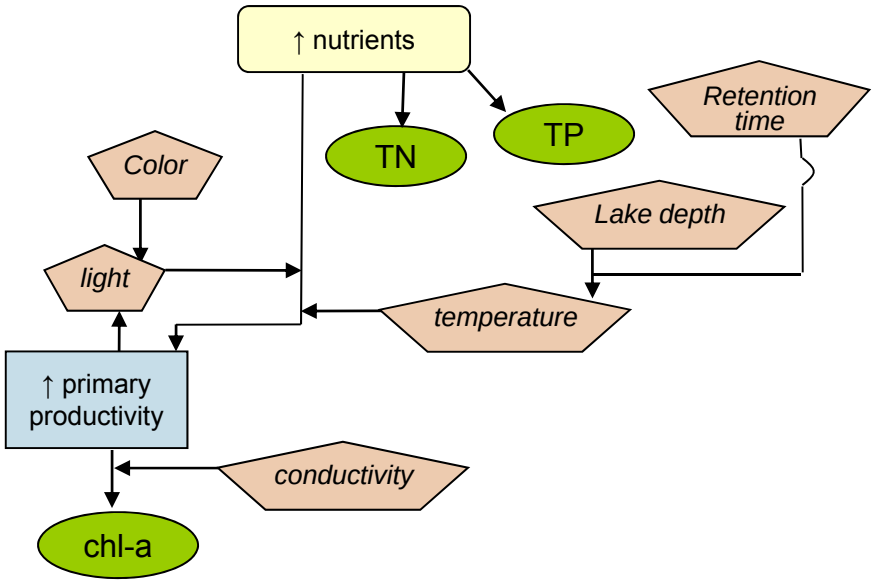
Reduced conceptual diagram with measurement variables



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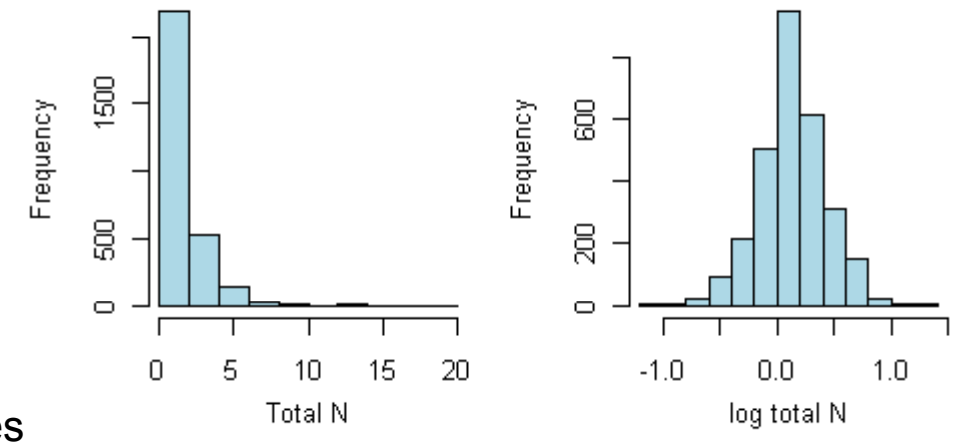
Collect and evaluate data

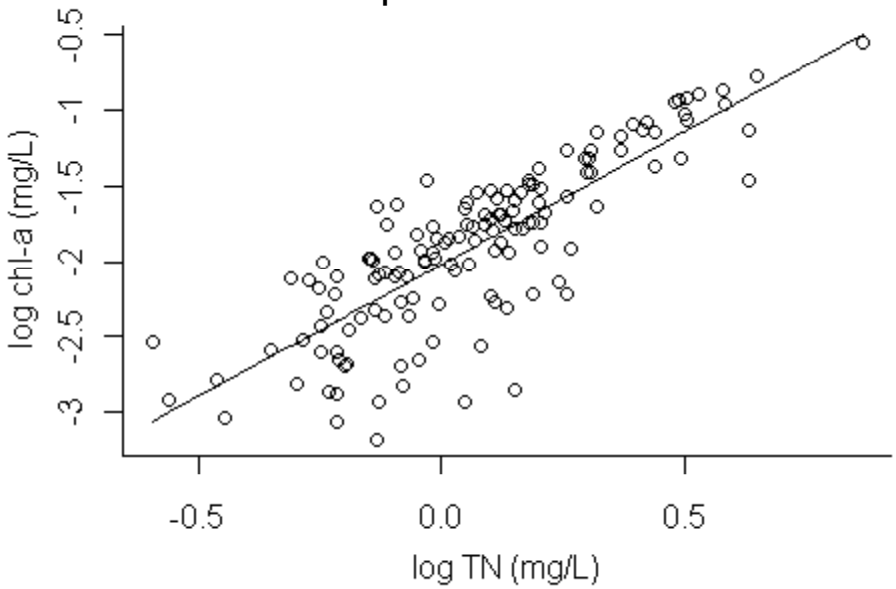
- Identify variables quantifying nutrient concentration and a response variable that measures support of the designated use.
  - Nutrient concentration variables: (e.g.,TN, TP).
  - Response variable:
    - Measures support of designated use (e.g., chl-a)
- Explore data set to understand relationships between nutrient variables, response variables, and possible confounding variables.

Exploratory data analysis

Variable distributions



Relationships between variables



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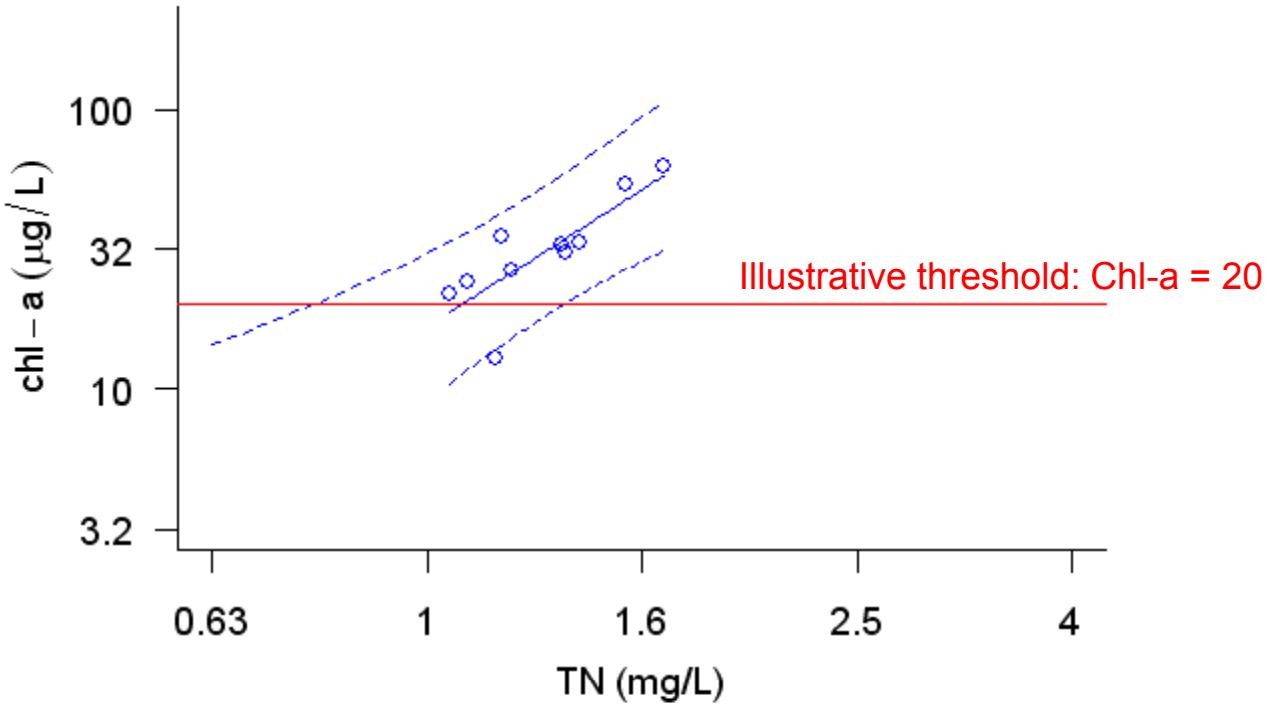
Model relationships

- Classify data
  - Ecoregions
  - Simple classification
  - Agglomerative clustering
  - Propensity score analysis
- Estimate relationships
  - Simple linear regression

Single lake example

- Most monitoring data are cross-sectional (e.g., 1-2 samples collected from many different sites), but uncertainty in a model for a single lake is much easier to interpret.



When accounting for *within-site* variability, a criterion associated with the mean value seems reasonable.

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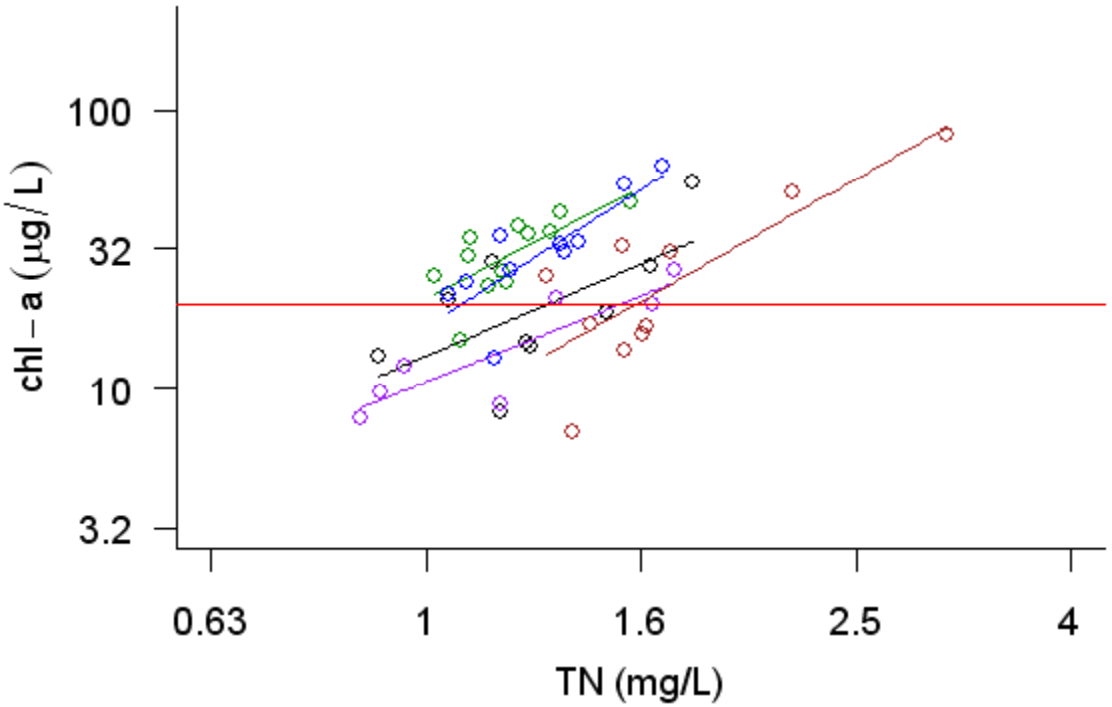
Relationships estimated with data from several lakes



Responses to increased TN (i.e., slopes of line) are similar across lakes, but intercepts differ, giving slightly different candidate criteria.

When accounting for *across-site* variability, the lowest criterion would be most protective.

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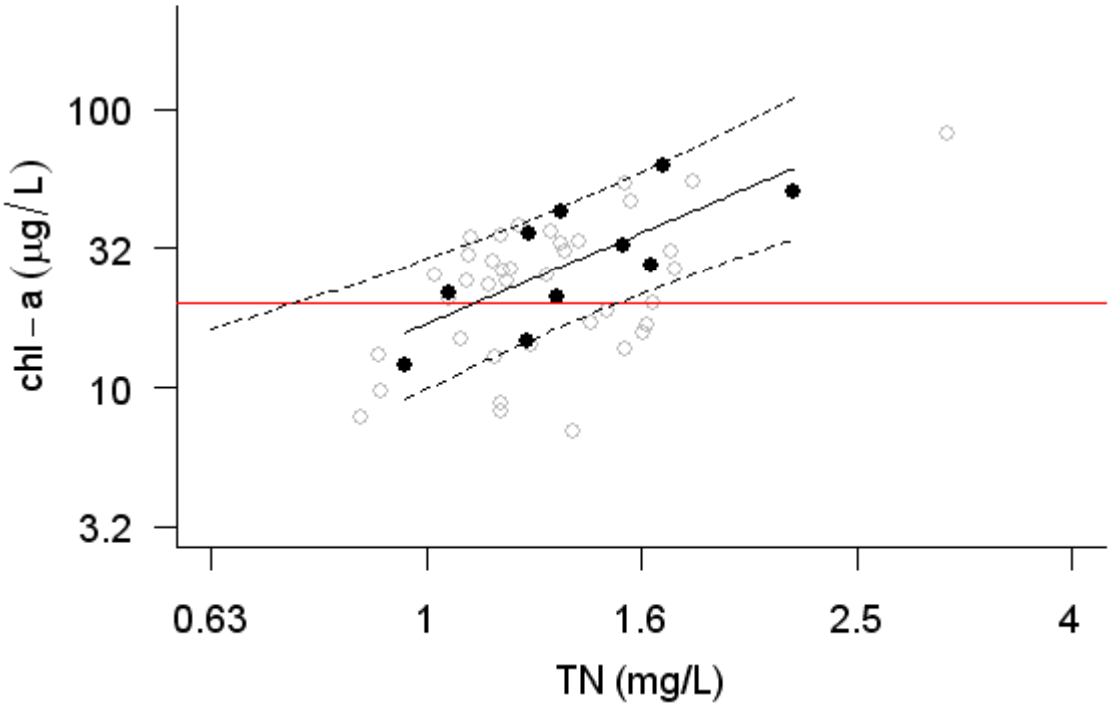
Example of cross-sectional data



Prediction intervals associated with cross-sectional data include both *within-site* and *across-site* variability, so selecting the appropriate prediction interval to use for criteria derivation is more difficult.

Accuracy of estimated relationship also depends in part on whether responses within each site are similar….classification is key.

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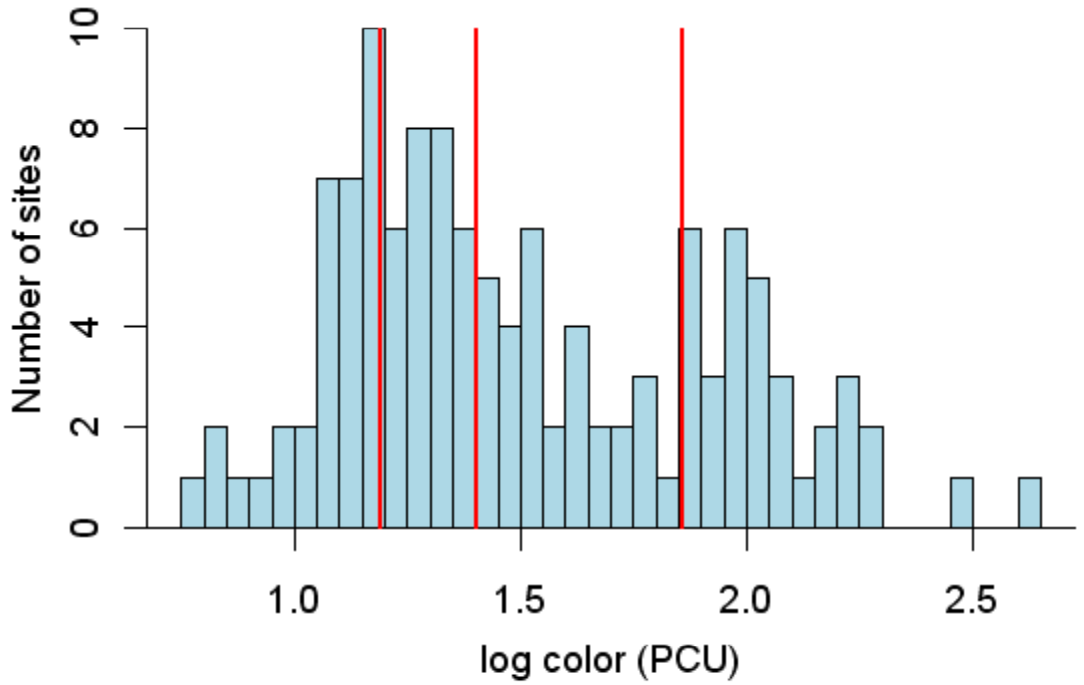
Classification

- Classification can improve the *accuracy* and *precision* of estimates of stressor-response relationships by identifying groups of sites in which we expect similar stressor-response relationships.



Classifying by a single variable is straightforward: split data set into consecutive ranges of variable of interest.

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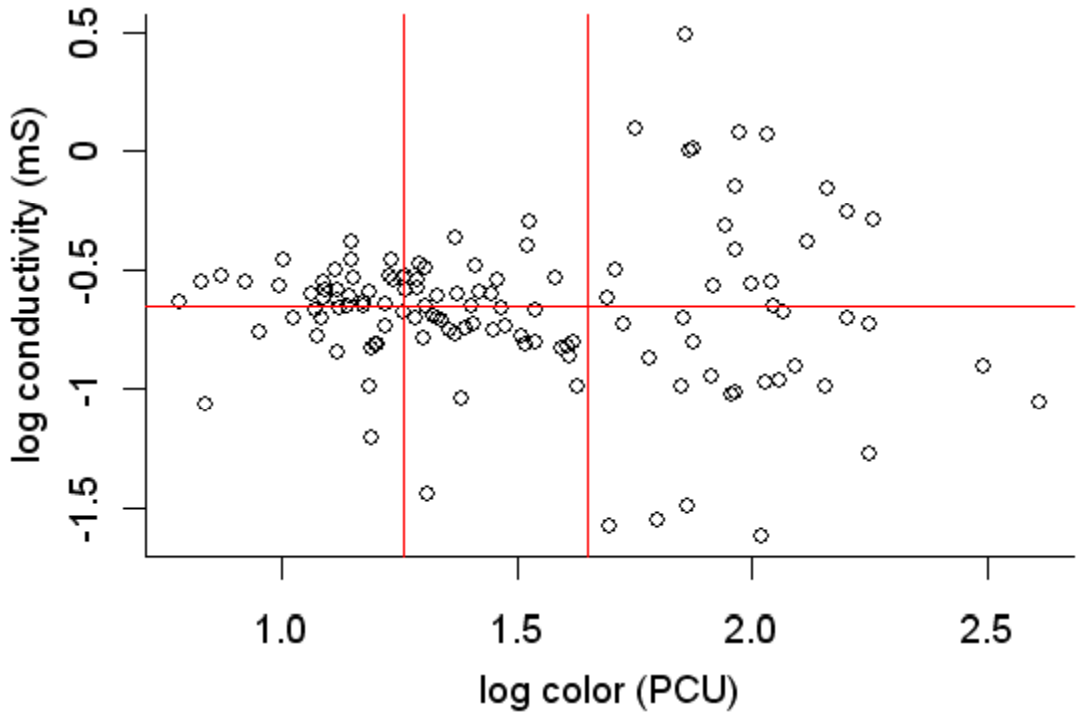
Classifying with multiple variables



Simple splitting becomes impractical if the number of classification variables is much greater than 2.

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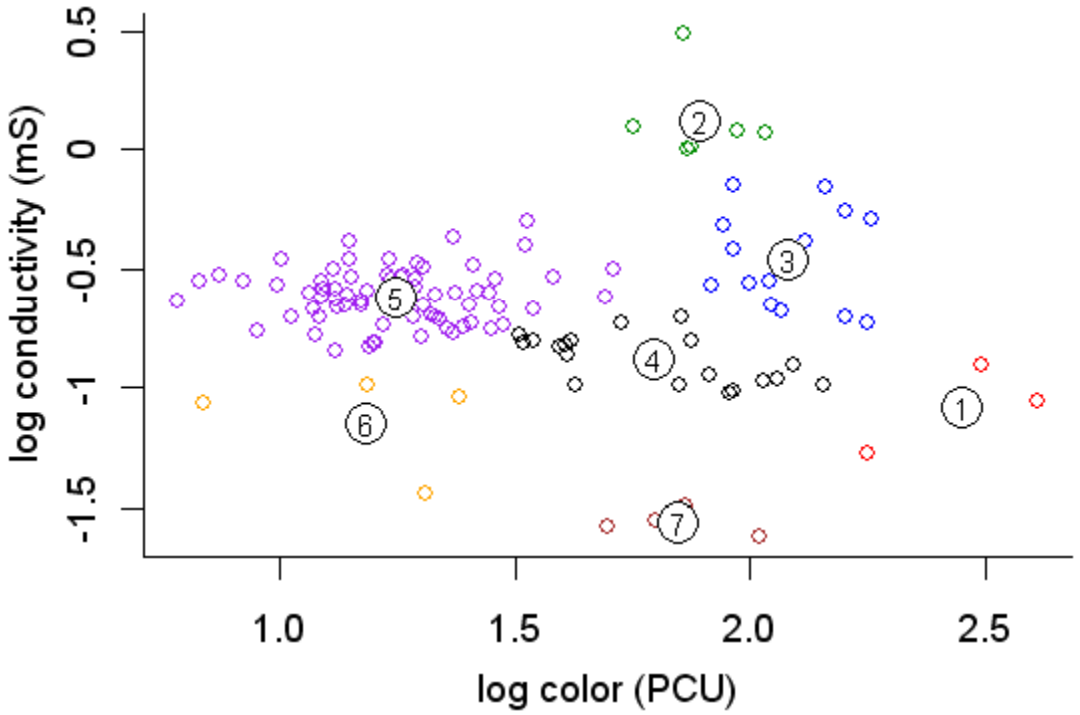
Classifying with multiple variables: agglomerative clusters



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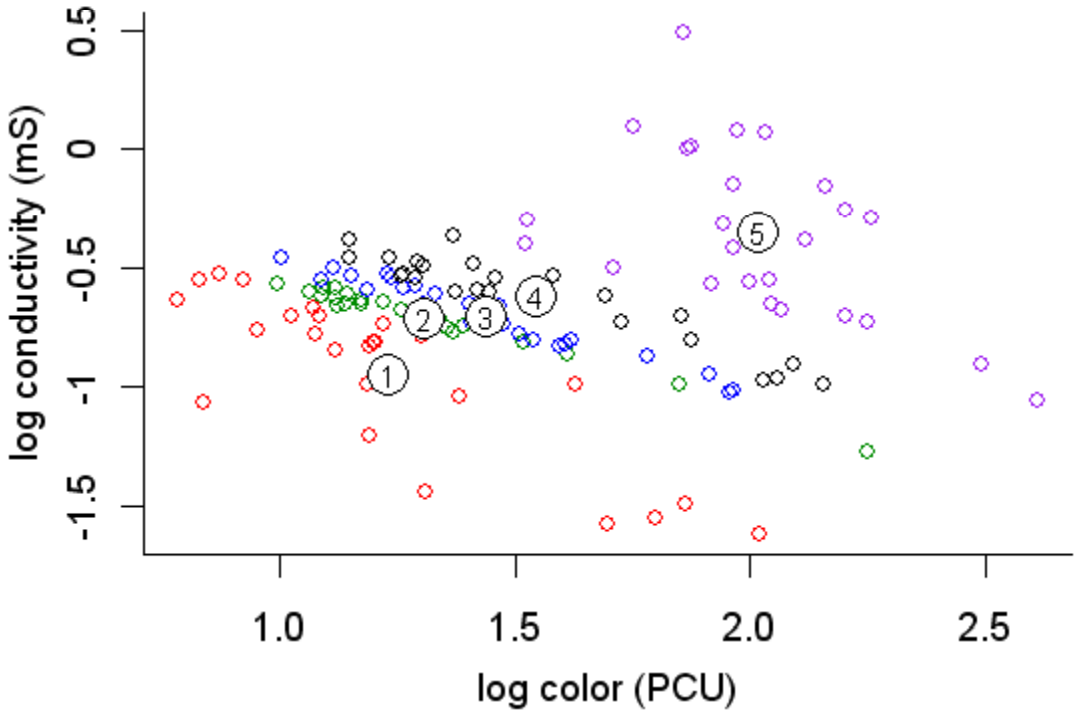
Classifying with multiple variables: propensity score analysis



Classifications based on propensity scores are designed to minimize correlation between covariates and the nutrient variable.

Relationships estimated in propensity score classes are less likely to be confounded.

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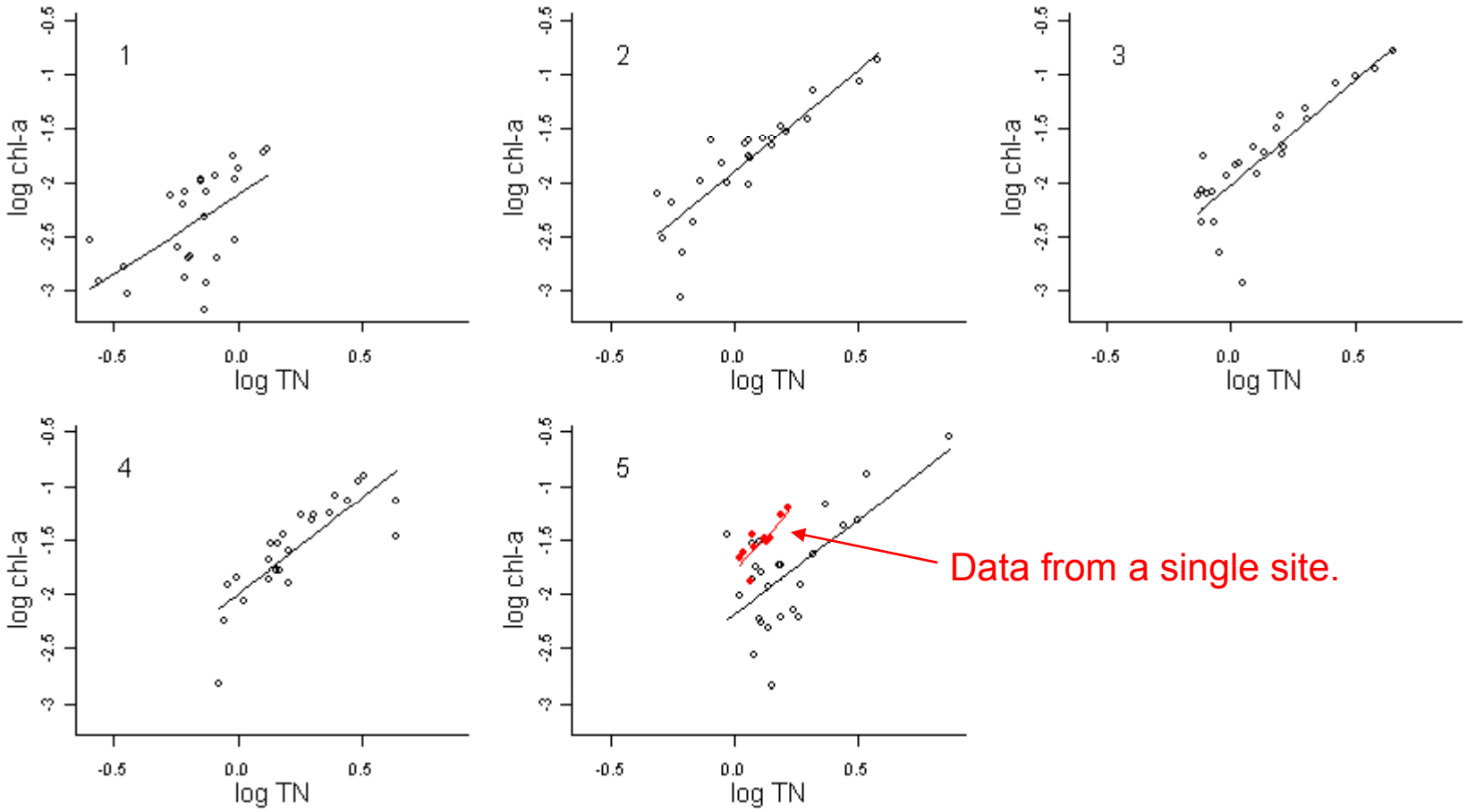
Estimate stressor-response relationships within classes



Data from a single site.

With appropriately designated classes, stressor-response relationships are more accurate and precise, and associated criteria are more easily interpreted.

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Finalize classification

- Defining a classification scheme will be iterative.
  - Combine classes?
    - Fewer classes: easier to implement and explain to stakeholders
  - Consider response thresholds within different classes
  - Consider pre-existing classes

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Conclusions

- Some ideas to consider when using stressor-response relationships to develop nutrient criteria:
  - Base analyses on conceptual models.
  - Explore data prior to developing statistical models.
  - Classification can help increase accuracy and precision of stressor-response models.
  - Interpreting prediction uncertainty in regression models is less difficult if variability in observations is split into within- and across-site components.