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Predictive Models for Bioassessment of Large and Great Rivers

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Outline

- Overview of predictive models
  - River Invertebrate Prediction and Classification System (RIVPACS)
- Examples from National Wadeable Streams Assessment (NWSA)
- Application of models to Great Rivers

Biological Assessment

The composition of stream organisms is used increasingly to assess stream condition.

A predictive bioassessment model is one method for analyzing biological data to assess stream condition.

- RIVPACS*-type methods
  - compare the *observed* composition (***O***) to *expectations* (***E***) derived from reference sites.
  - Sites at which the assemblage composition differs significantly from expectation are declared impaired.

*Clarke, R.T., Wright, J.F, and Furse, M.T. (2002) RIVPACS models for predicting the expected macroinvertebrate fauna and assessing the ecological quality of rivers. Ecological Modelling 160:219-233.

Predictive Bioassessment Models

1. Identify and sample *reference* sites.

2. Group reference sites into clusters with similar biological assemblages.

3. Examine how natural factors vary with clusters of reference sites.

4. For each *test* site, use natural factors to predict the clusters in which the site would most likely be grouped.

5. The *expected* biological composition of the test site is predicted to be the same as that observed in the reference clusters. Expected composition is expressed as the capture probability, p_i, for each taxon, i.

Predictive Bioassessment Models

6. Compare *observed* taxa list to *expected* taxa list.

$$\left. {}^{O}\!\middle/\!{}_{E} \right._{TAXA} = \frac{\sum Y_i}{\sum p_i}$$

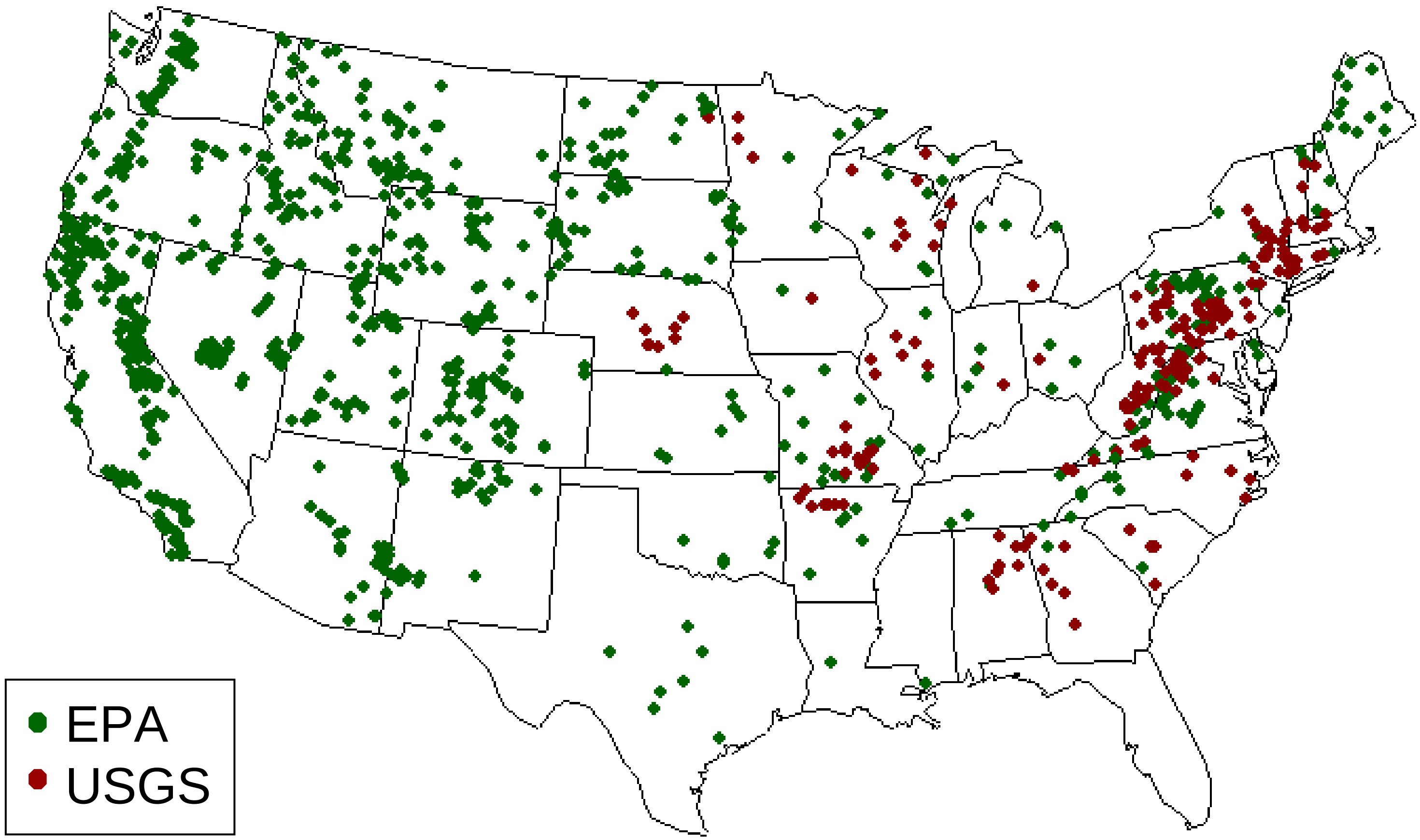
- $Y_i = 1$ if taxon *i* is present and $Y_i = 0$ if absent.
- p_i is the capture probability predicted by the model.

O/E_{TAXA} ~ 1 in reference sites, and decreases as taxa are lost in test sites.

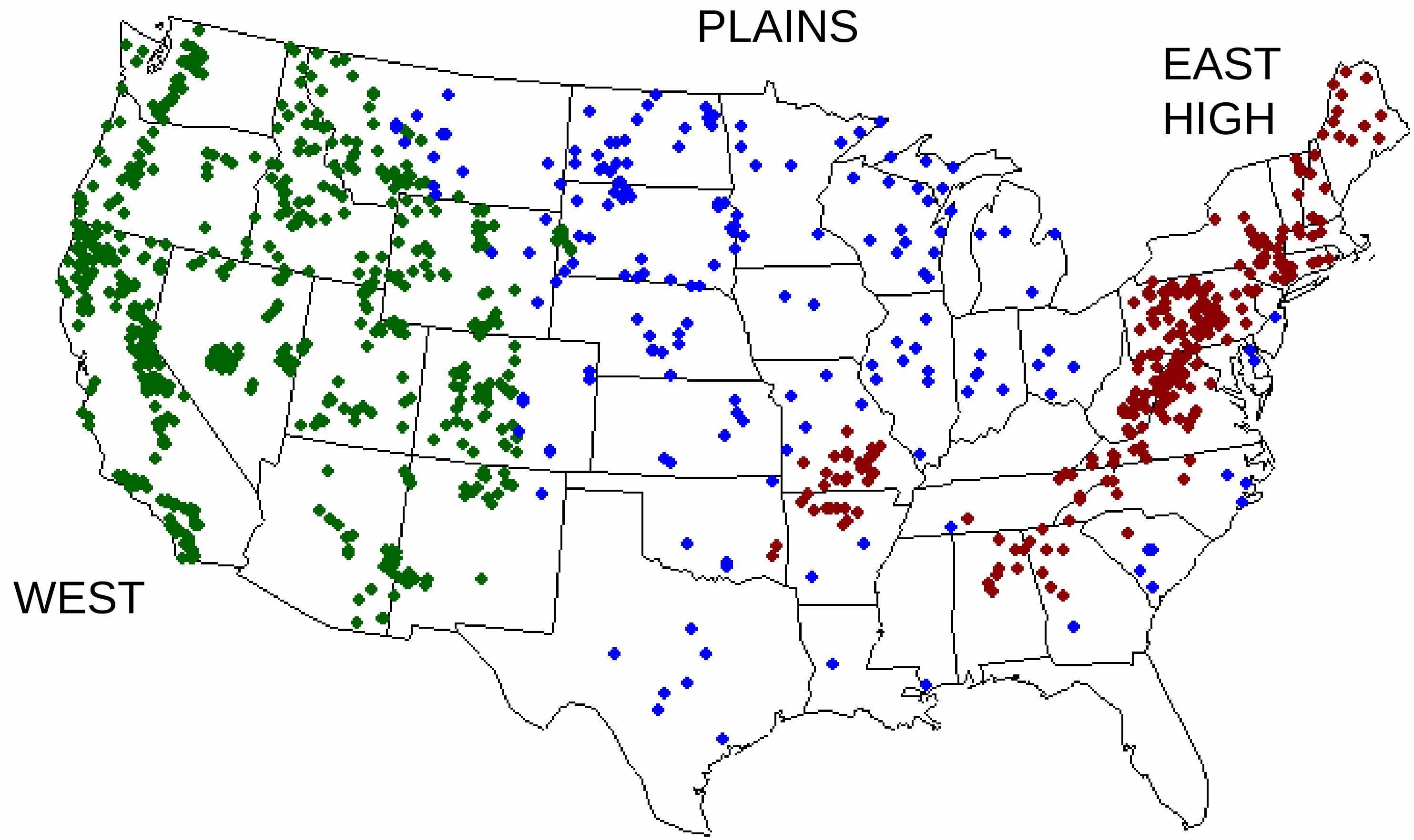
National Wadeable Streams Assessment

- Statistically representative sample of small, wadeable streams across the U.S.
- Macroinvertebrates sampled on reach-wide transects.
- Reference sites sources:
  - Statistical sites attaining reference criteria.
  - Hand-picked sites.
  - USGS sites attaining reference criteria.

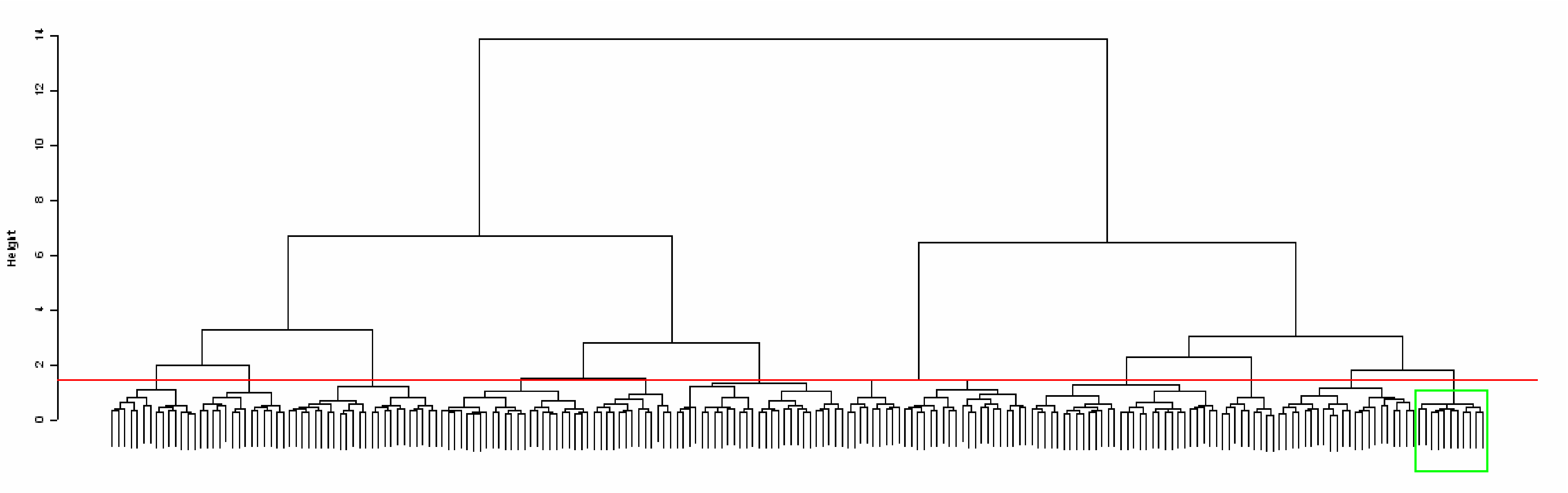
Reference Sites for National WSA



Super-Ecoregions

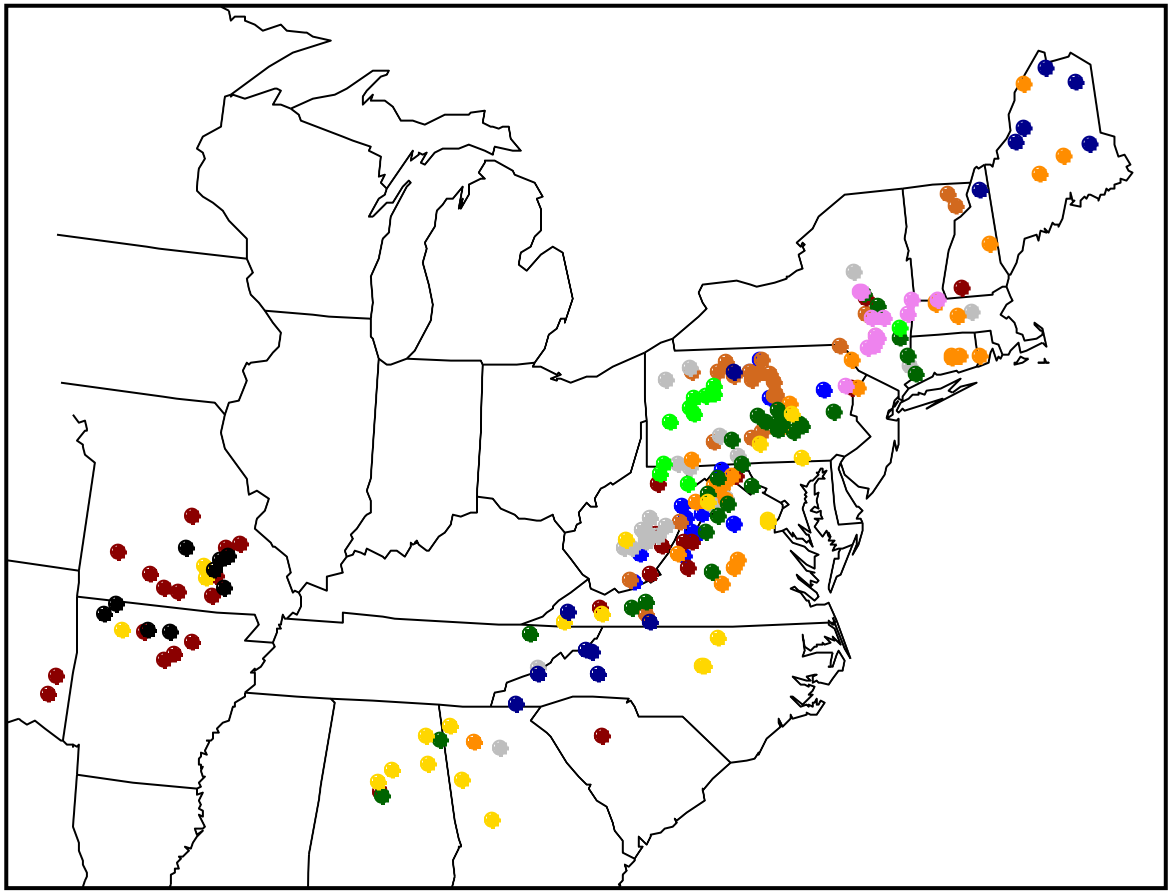


Clusters for Eastern Highlands

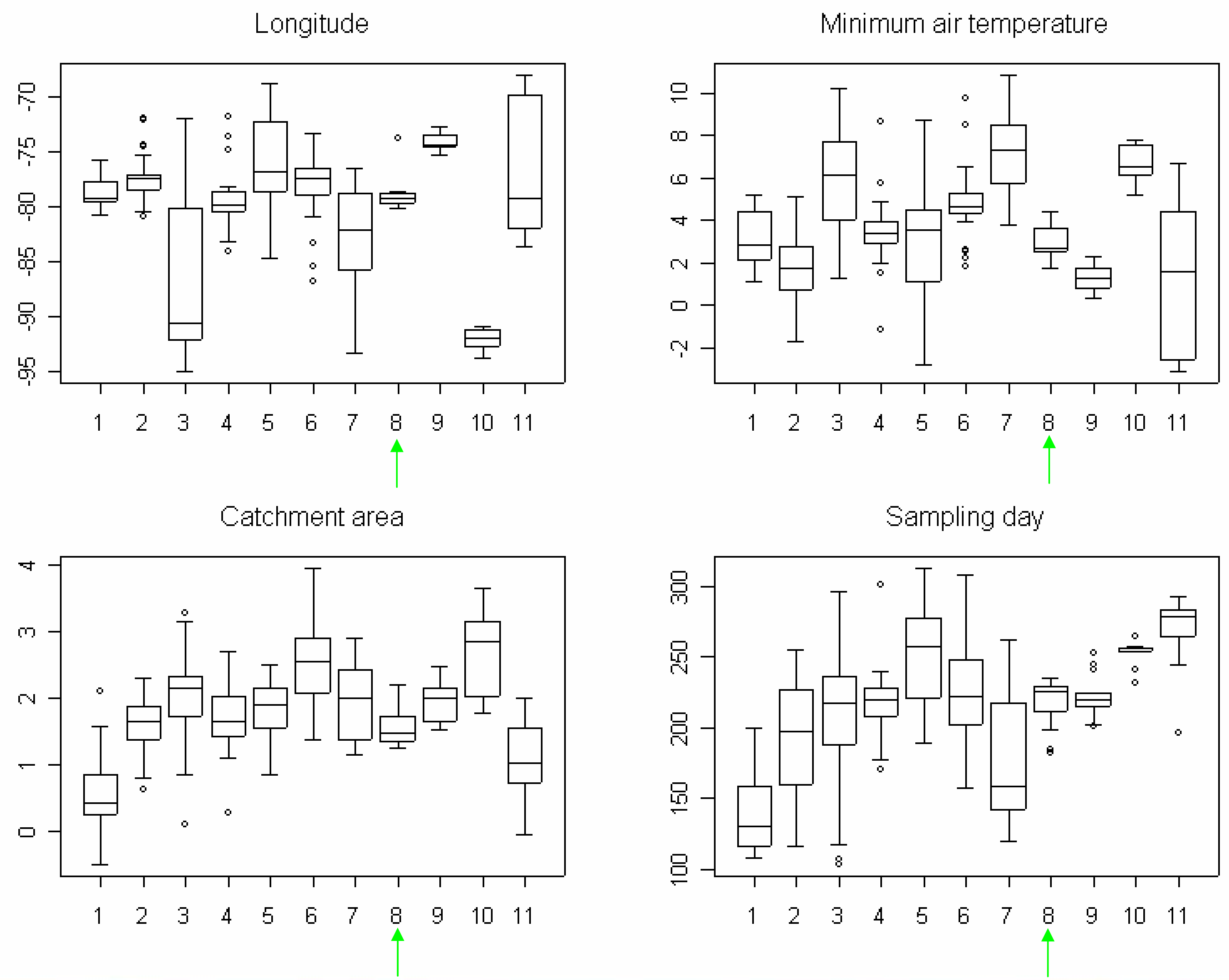


11 clusters with 9-25 reference sites per cluster.

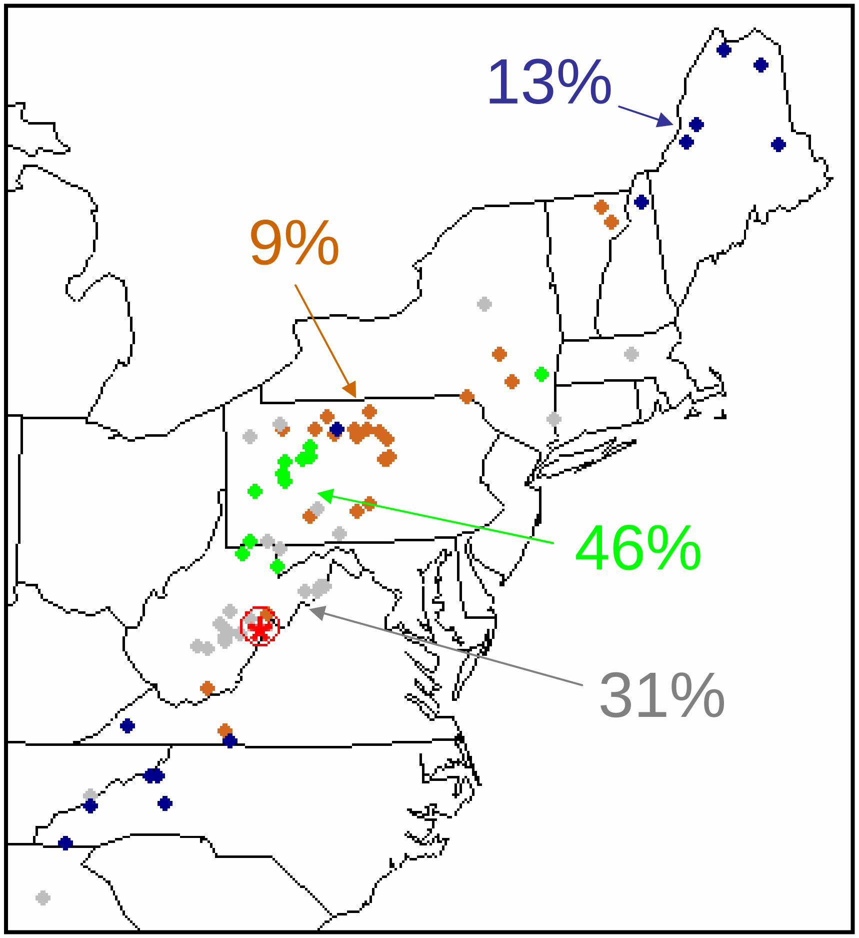
Clusters in the Eastern Highlands



Predictor Variables within Clusters



Predicted clusters for a single test site

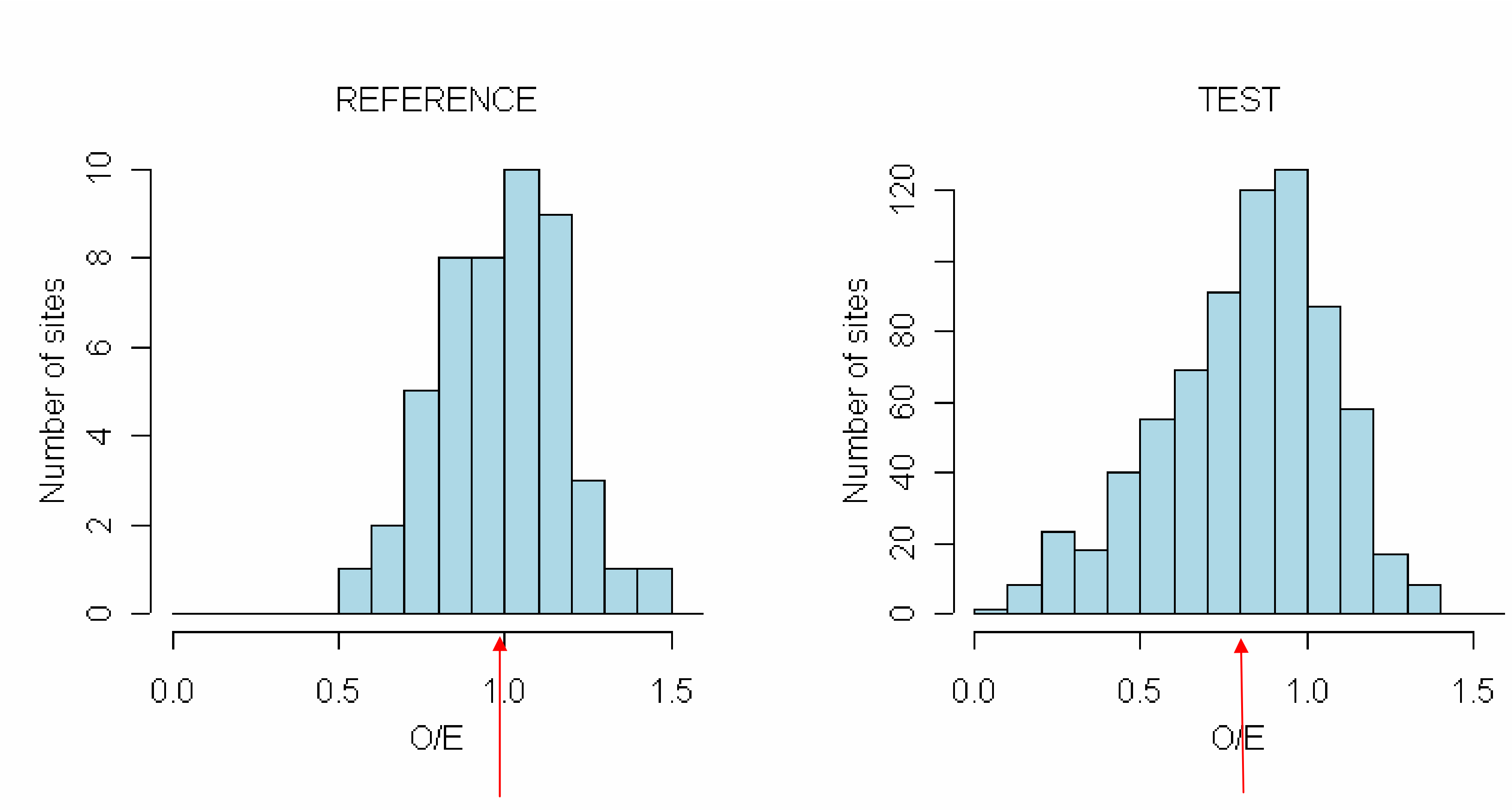


Computing Probability of Occurrence (Acroneuria)

Frequency of Occurrence in Cluster	Probability of Cluster Membership
0.58	0.09
1.00	0.31
0.18	0.46
0.50	0.13

$$p = 0.58\times0.09 + 1.00\times0.31 + 0.18\times0.46 + 0.50\times0.13 = 0.51$$

Model Results: Eastern Highlands



Mean(O/E) = 0.99

Mean(O/E) = 0.81

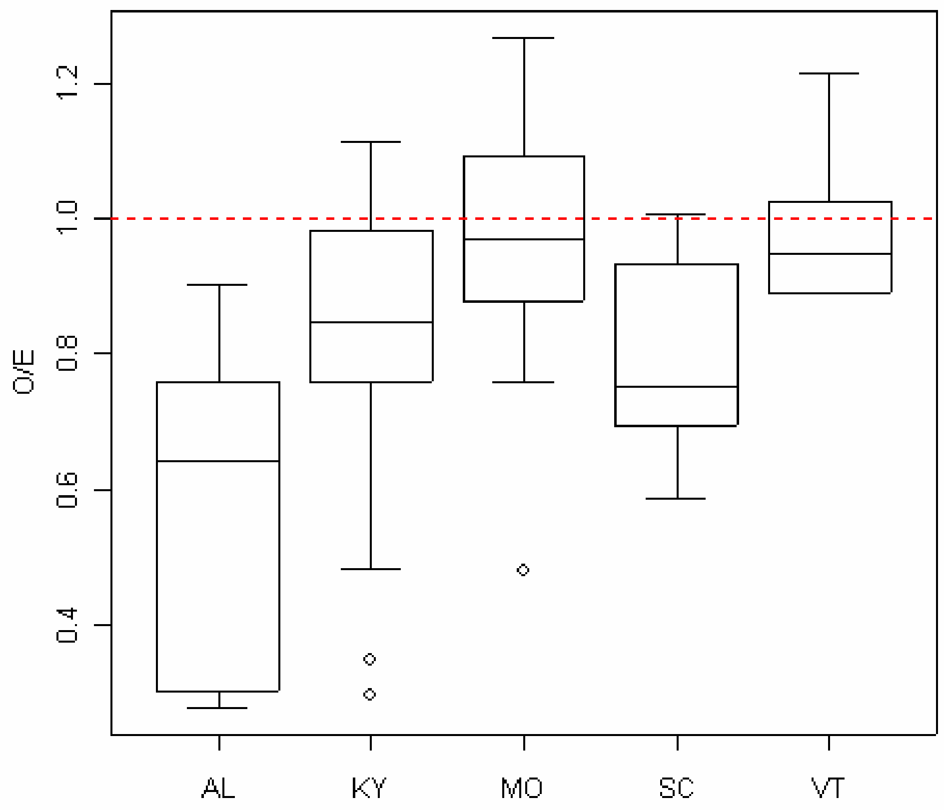
US EPA ARCHIVE DOCUMENT

Useful Properties of O/E

- Index value has an intuitive ecological meaning.
  - *e.g., O/E = 0.5 suggests that only half of the taxa that are expected were observed.*
- Index value is expressed in scaled units and can be compared across different locations.
- One model can account for variability across a large region.
- Model is developed without any assumptions regarding stressor gradients.

Other properties

- Predictions can be sensitive to sampling method.



O/E values at state reference sites differ because of different sampling methods.

Other properties (2)

- Predictive models are most useful for controlling for many different natural gradients.
- In regions where natural gradients are weak, or dominated by a single factor, simpler models can be as effective as RIVPACS.

	WEST	PLAINS	EAST HIGH
% improvement over null model	17%	8%	27%

Conclusions

- RIVPACS-style predictive models can provide a very useful measure of biological condition.
- Further testing is required to establish whether and how predictive models can be applied in Great River.