Integrating Physical Habitat into Bioassessment: A Case Study

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Objectives/Summary

- Identify patterns in Physical Habitat variability, and how that variability can track or be tracked by benthic community
- Validity of using physical habitat data “on it’s own” to identify restoration objectives
- Data validation
    - Two perspectives:
        - PHab data itself
        - Validity of citizen-science PHab data (precision)

What Do We Already Know?

PHAB metrics are not like biological metrics

- Bio-metrics are a response to stress.
- PHAB metrics may be a measure of stress, a response to stress, both, or neither (yet still important for biology).

From Mazor, et al. “Assessing Physical Habitat Integrity: Developing an index for PHAB assessment”, CABW 2013

What Do We Already Know?

PHAB metrics are not like biological metrics

Sediment deficiency

- Bio metrics usually respond in one direction (e.g., increasing or decreasing metrics).
- PHAB metrics may respond in one or two directions, depending on the site and/or stressor.

Sediment excess

From Mazor, et al. "Assessing Physical Habitat Integrity: Developing an index for PHAB assessment", CABW 2013

What Do We Already Know?

PHAB metrics are not like biological metrics

- PHAB metrics often respond to stress independently.
- Bio metrics typically integrate stressors.

From Mazor, et al. “Assessing Physical Habitat Integrity: Developing an index for PHAB assessment”, CABW 2013

What Do We Already Know?

What are the challenges?

Challenge	How to solve it
1. Identifying meaningful metrics	Develop a conceptual model
2. Setting appropriate expectations	Develop statistical models based on reference condition
3. Selecting useful metrics	Screen metrics based on objective performance criteria (e.g., accuracy, precision, responsiveness)
4. Combining metrics into an index	Lots of options (all of them optional!)

Some steps are similar to biological index development, but differences are important!

From Mazor, et al. "Assessing Physical Habitat Integrity: Developing an index for PHAB assessment", CABW 2013

Choosing/Calculating Metrics

Type	Example
"Commonly" used (EMAP, Kauffman et al. 1999)	Substrate size, human influence, in-stream habitat, % cover of flow habitats, riparian vegetation, etc.
Habitat heterogeneity	Modified Shannon Diversity of habitats, habitat evenness
Landscape-scale/GIS-derived	Watershed Area, % Urban, % Impervious, etc.
Floodplain	Bankfull Height: Bankfull Width variance

Evaluating Metrics

Precision

- Small prediction error
- Low variability among replicates

Responsiveness

- Sensitivity
  - Reference versus sample usually considered
  - Here we looked at variability that is significant in structuring benthic communities, as opposed to “inherent variability”

Assessing Precision

Signal:Noise Ratio (modified from Kauffman et al. 1999)

$$\sigma^2_{st(year)}/\sigma^2_{rep}$$

σ^2st(year) = Signal: Between-sample variation

σ^2 rep = Noise: Within-sample variation, which in this case uses pooled variance from repeat visits to the same site in one year

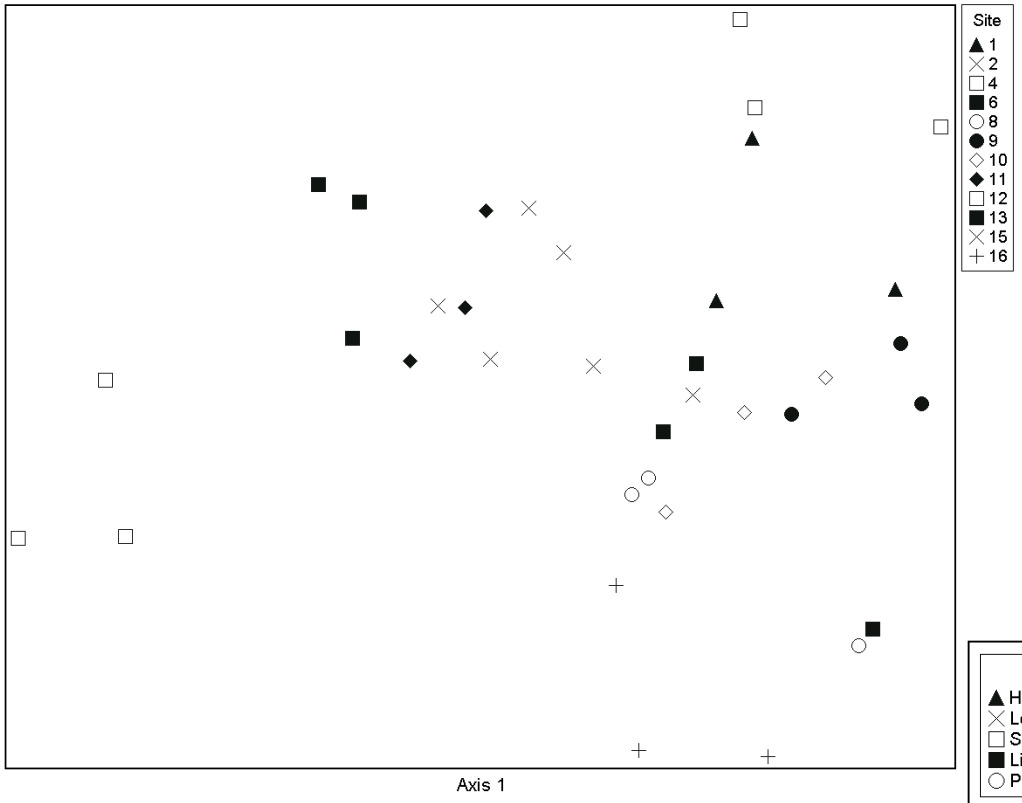
No repeat visits on Deer Creek (as with most watershed groups):

Noise: pooled variance from visits to "like" site, as identified via cluster analysis

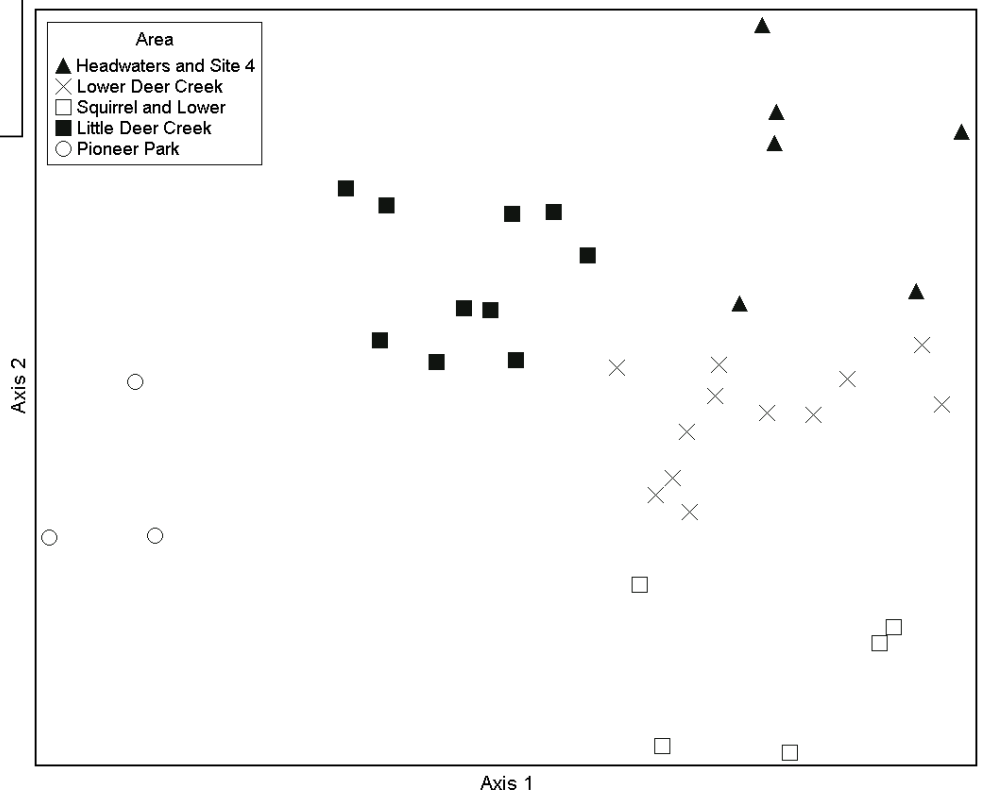
Is not as accurate a depiction of noise, but creates more discriminatory criteria: variation between "like" sites is inherently larger than the same site at different visits

Precision criteria:

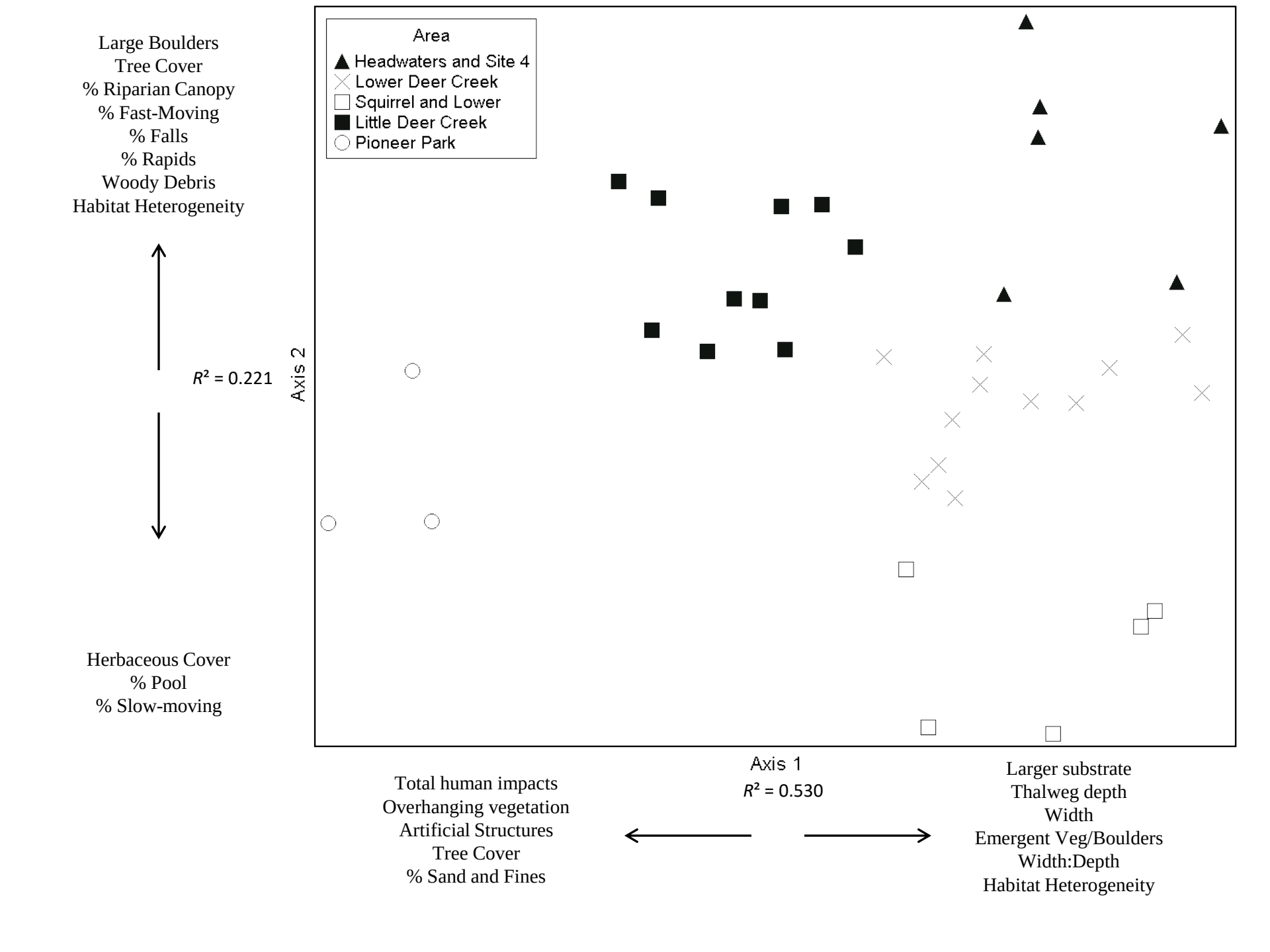
S:N ratio >2.0 ("moderately biased")

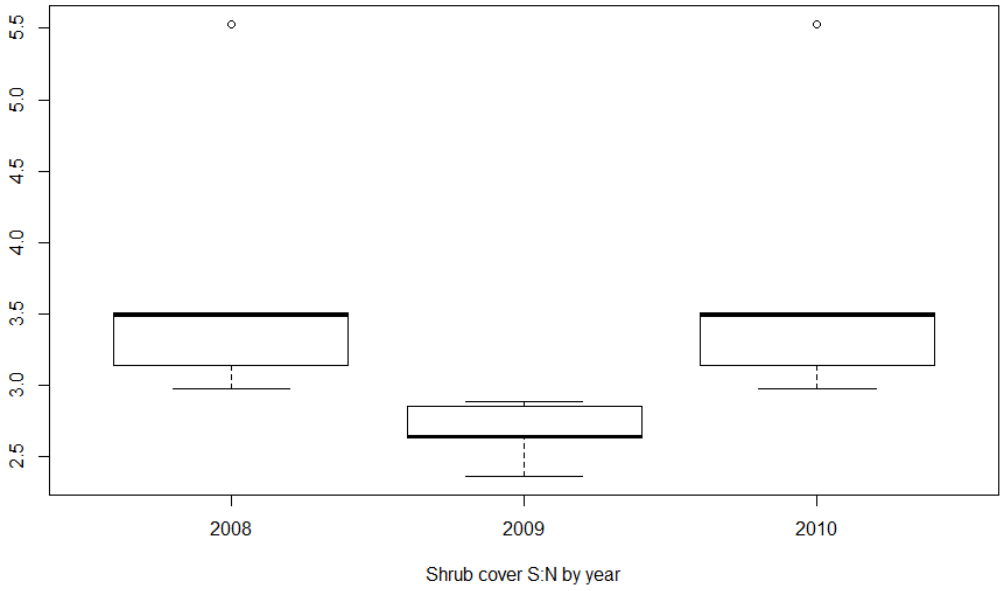


Sites do not cluster relative to stream location

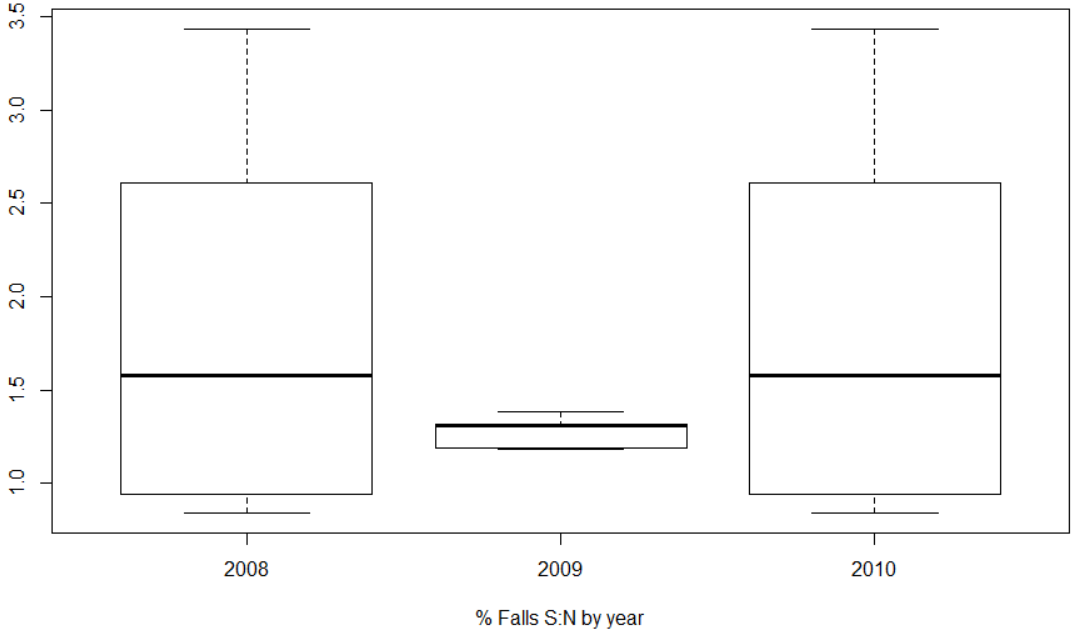


By identifying groups via cluster analysis, we can better define “stream site” within the same stream


Large Boulders
Tree Cover
% Riparian Canopy
% Fast-Moving
% Falls
% Rapids
Woody Debris
Habitat Heterogeneity
R^2 = 0.221
Herbaceous Cover
% Pool
% Slow-moving
Area
Headwaters and Site 4
Lower Deer Creek
Squirrel and Lower
Little Deer Creek
Pioneer Park
Axis 2
Axis 1
R^2 = 0.530
Total human impacts
Overhanging vegetation
Artificial Structures
Tree Cover
% Sand and Fines
Larger substrate
Thalweg depth
Width
Emergent Veg/Boulders
Width:Depth
Habitat Heterogeneity



Shrub cover S:N by year

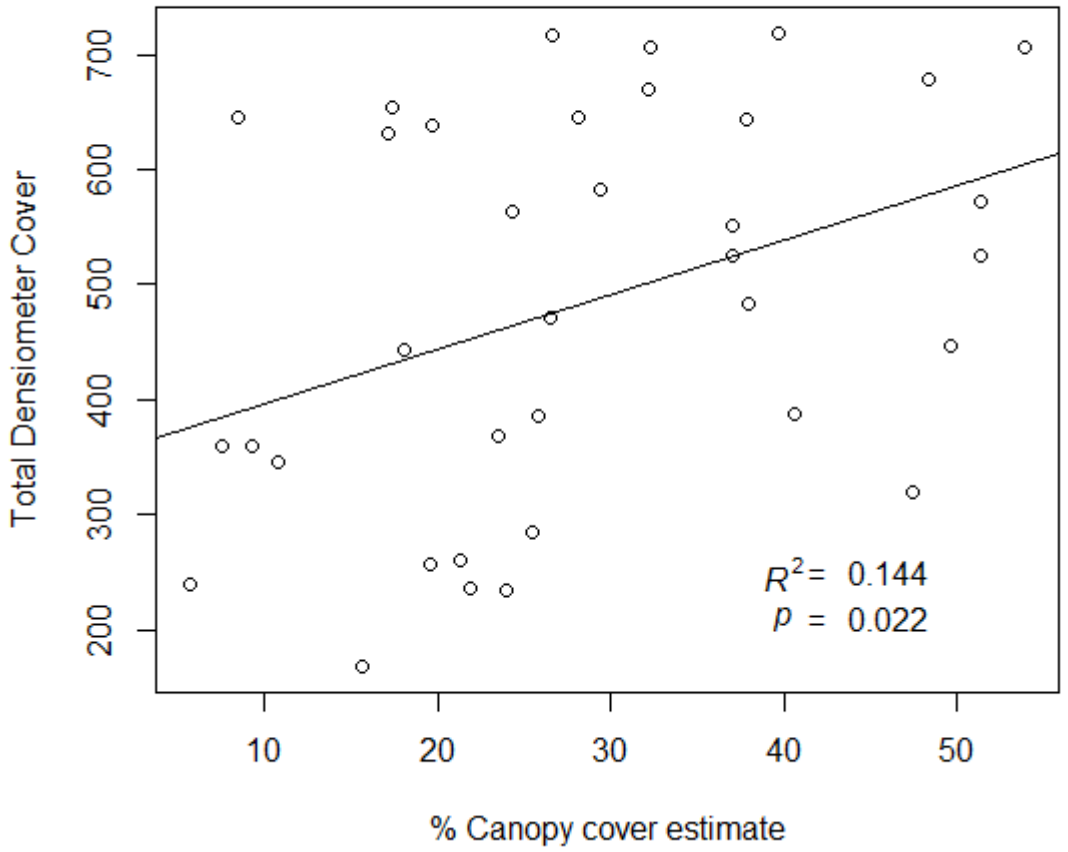


% Falls S:N by year

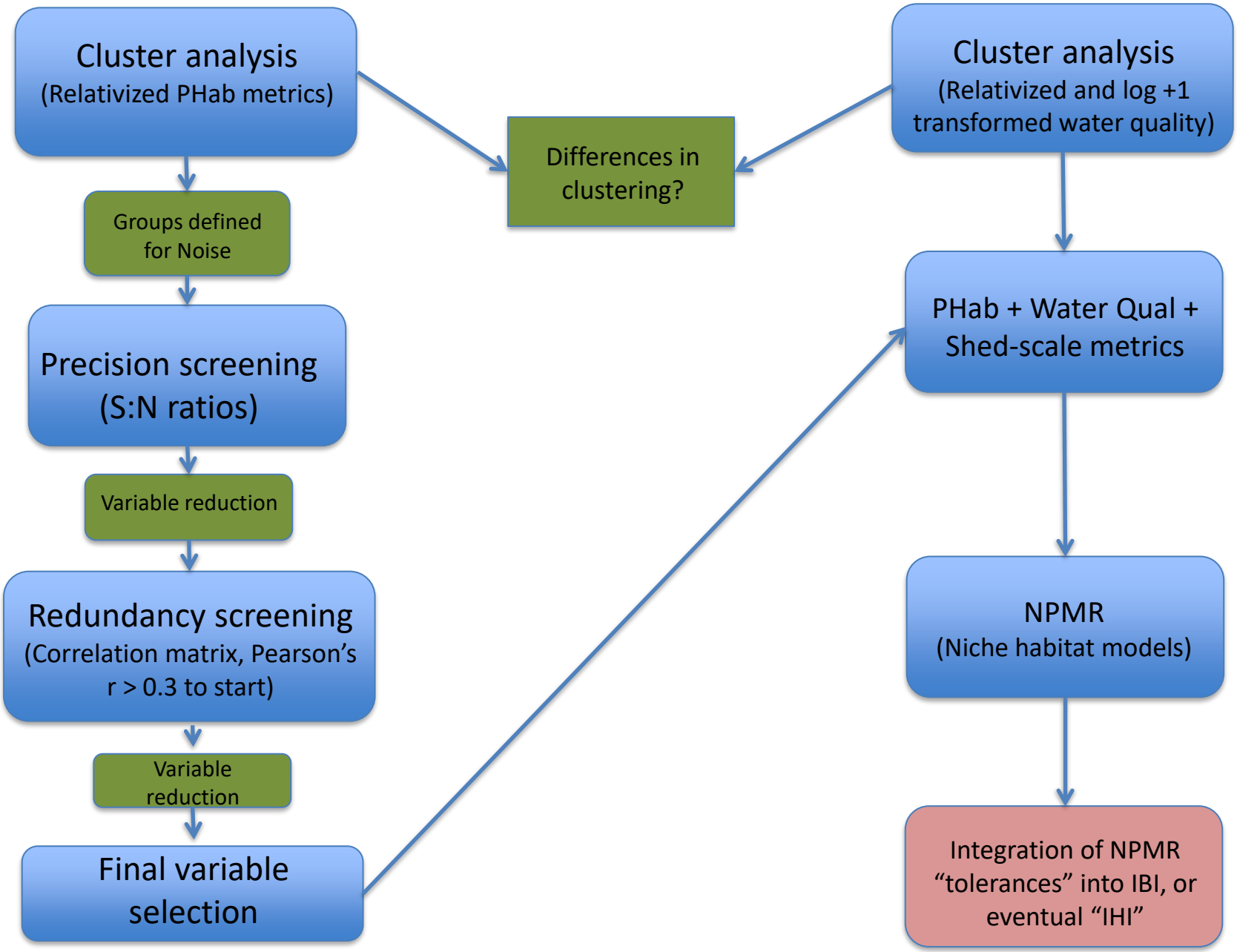
The majority of “noisy” variables are those related to estimates of percent cover.

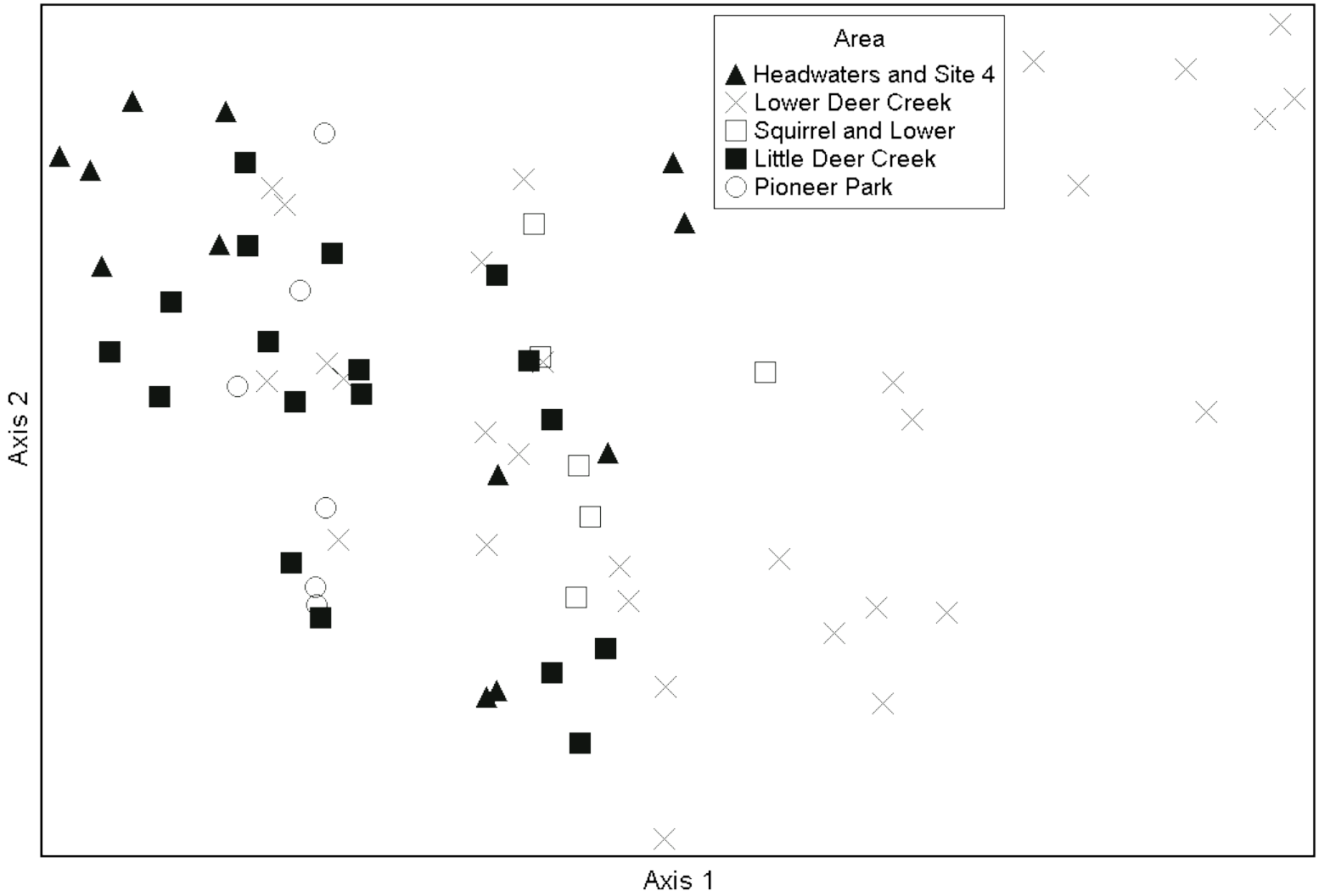
Highly subjective

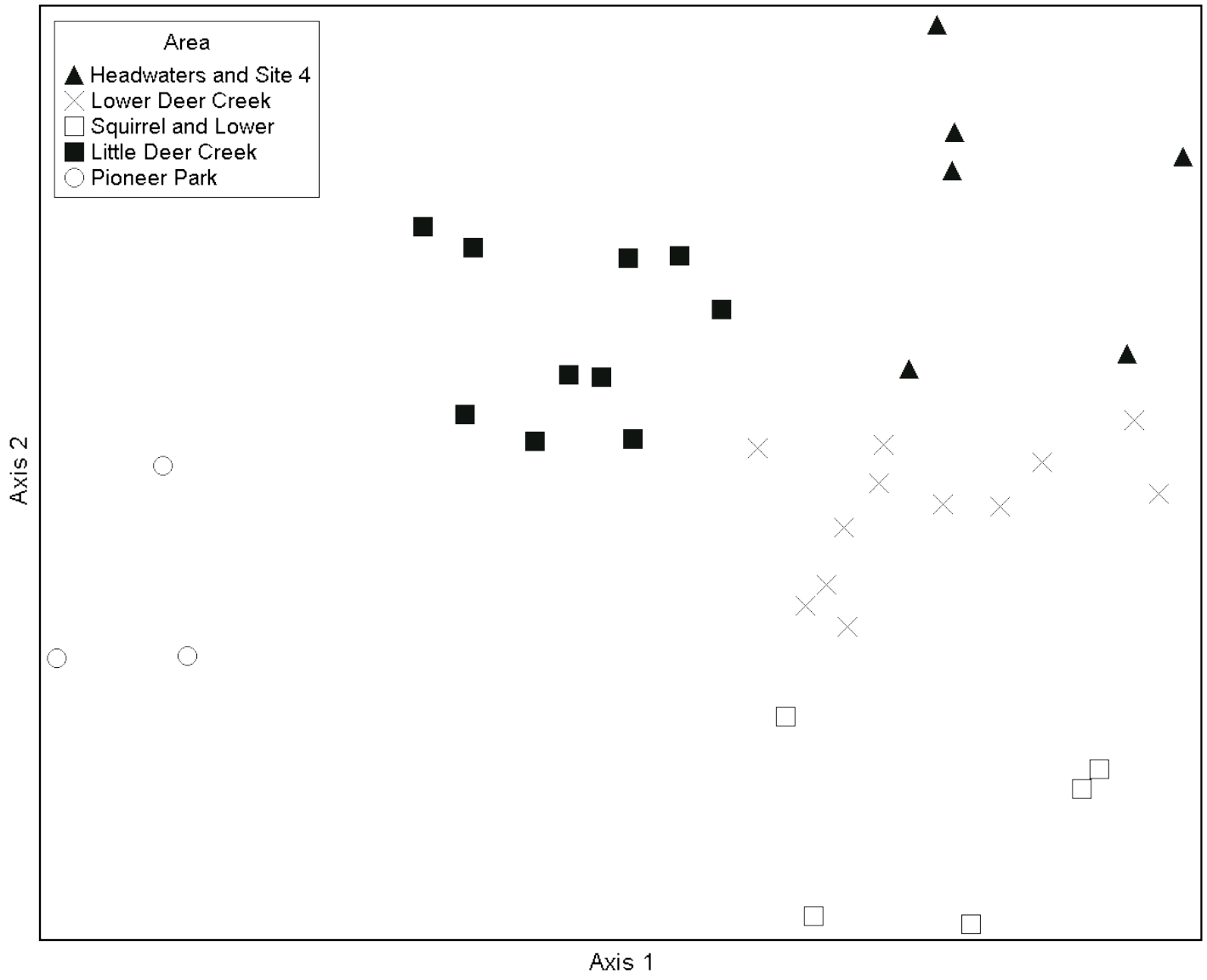
Can be addressed with better training, maintenance of one “estimator”, etc.



Some of the “noisy” variables can be dropped in favor of more precise measurements of similar properties


Cluster analysis
(Relativized PHab metrics)
Groups defined for Noise
Precision screening (S:N ratios)
Variable reduction
Redundancy screening
(Correlation matrix, Pearson's r > 0.3 to start)
Variable reduction
Final variable selection
Differences in clustering?
Cluster analysis
(Relativized and log +1 transformed water quality)
PHab + Water Qual + Shed-scale metrics
NPMR
(Niche habitat models)
Integration of NPMR "tolerances" into IBI, or eventual "IHI"


Area
Headwaters and Site 4
Lower Deer Creek
Squirrel and Lower
Little Deer Creek
Pioneer Park
Axis 2
Axis 1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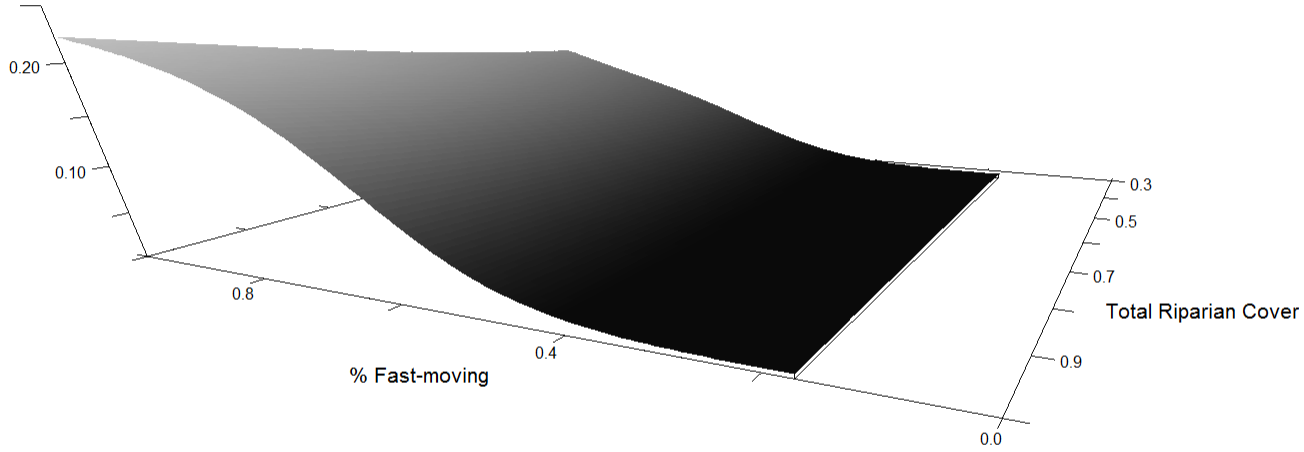
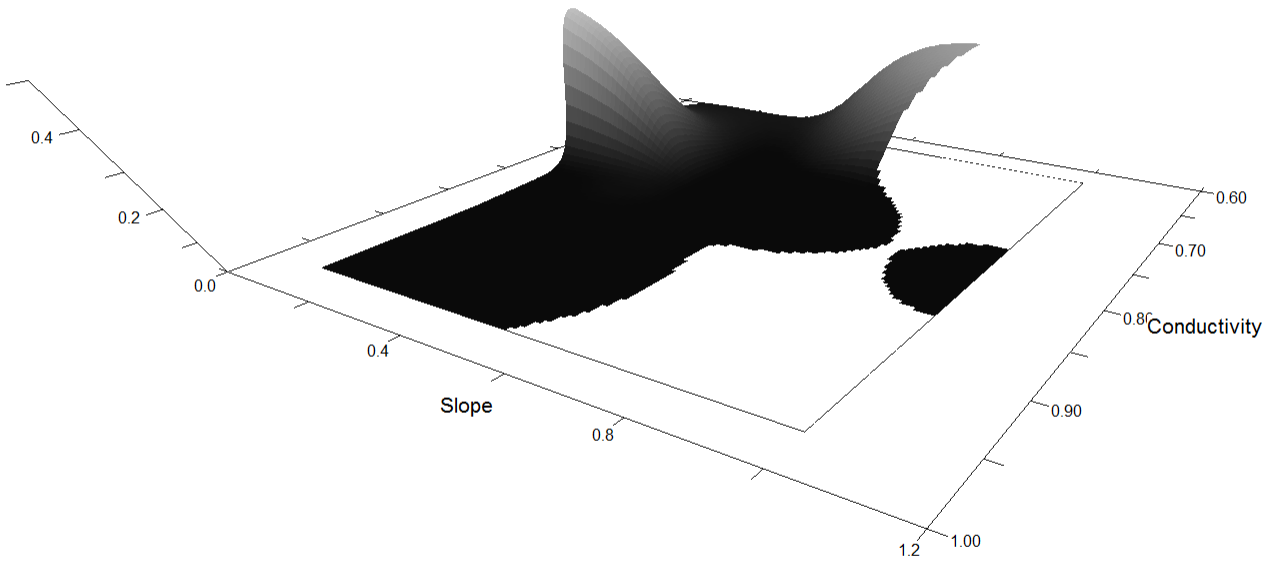


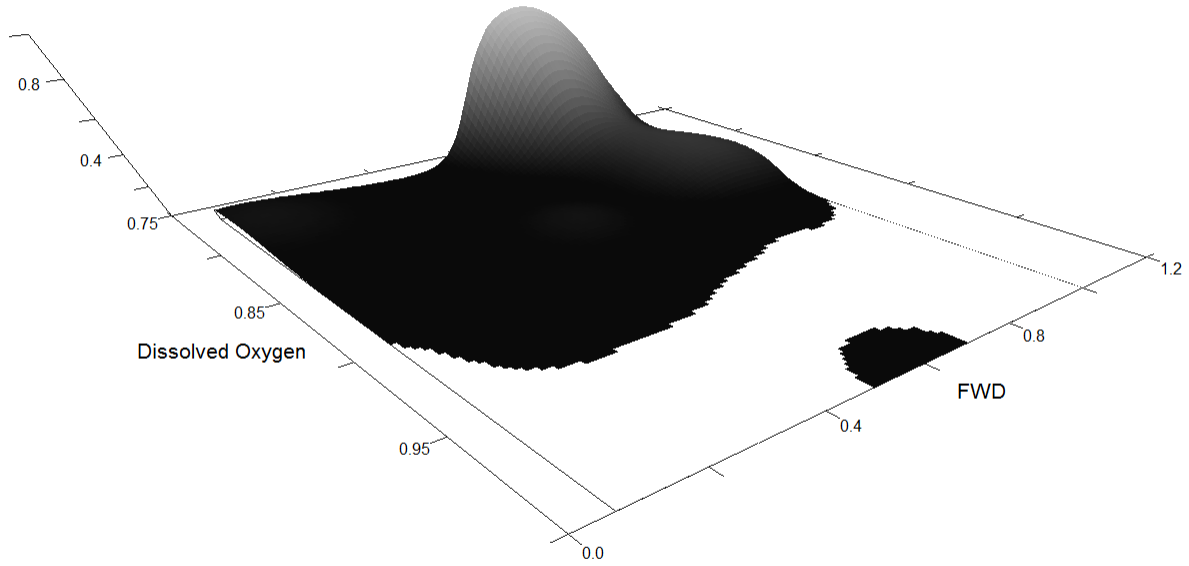
Plecoptera: perlodidae

Some families demonstrate curvilinear response to primarily physical habitat instead of water quality



Trichoptera: Limnephilidae

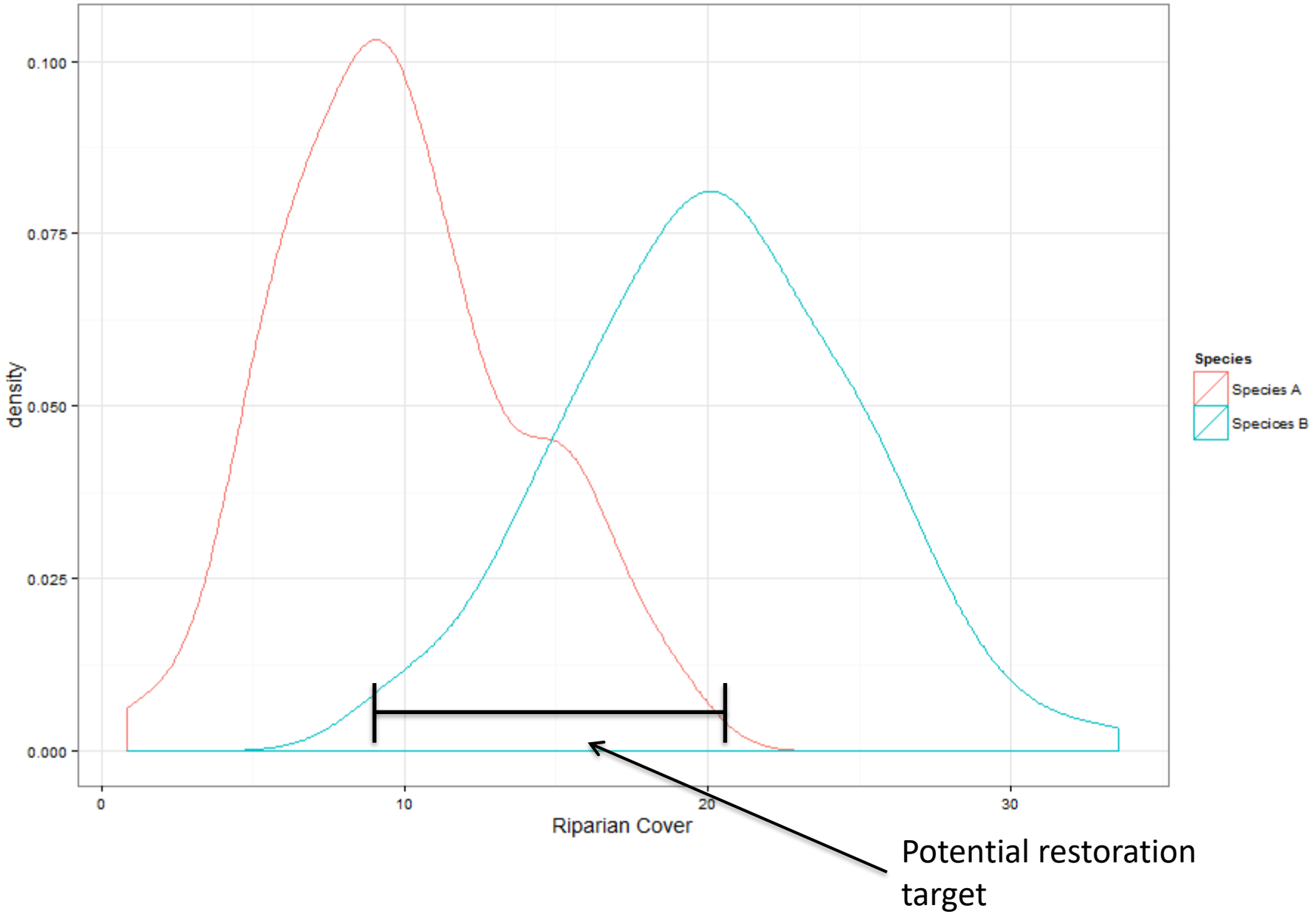
Other show bimodal response to interactions of physical habitat and water quality



Trichoptera: Psychodidae

And still others show unimodal responses to either habitat or water quality, but only when both are considered

Organisms do not show linear responses, and respond interactively to multiple stressors, so should our indices of benthic integrity


0.100
0.075
0.050
0.025
0.000
density
0
10
20
30
Riparian Cover
Species
Species A
Species B
Potential restoration target


THANK YOU!
Questions? Contact Jeff Lauder:
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