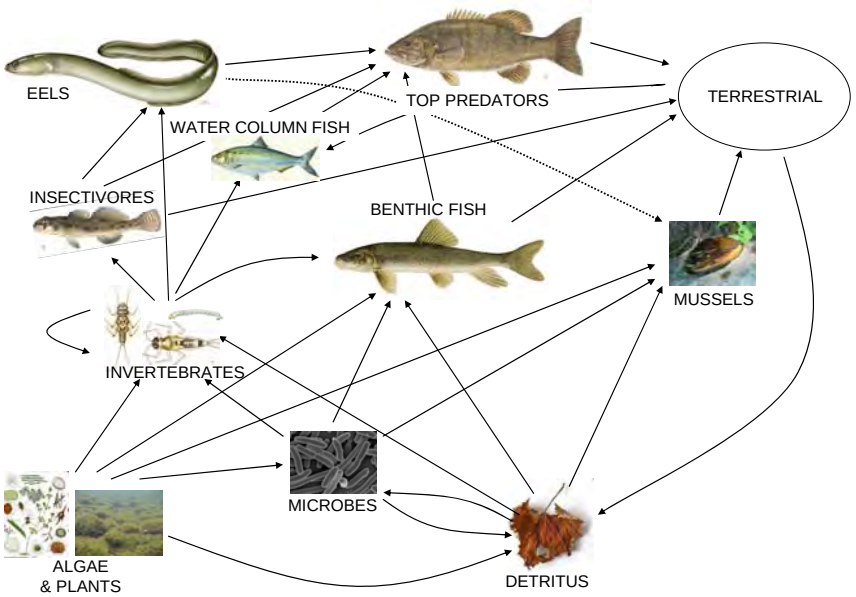
Bioassessment on the Delaware : Challenges & Approaches for a Large River



Erik Silldorff
& Bob Limbeck

18-March-2010

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

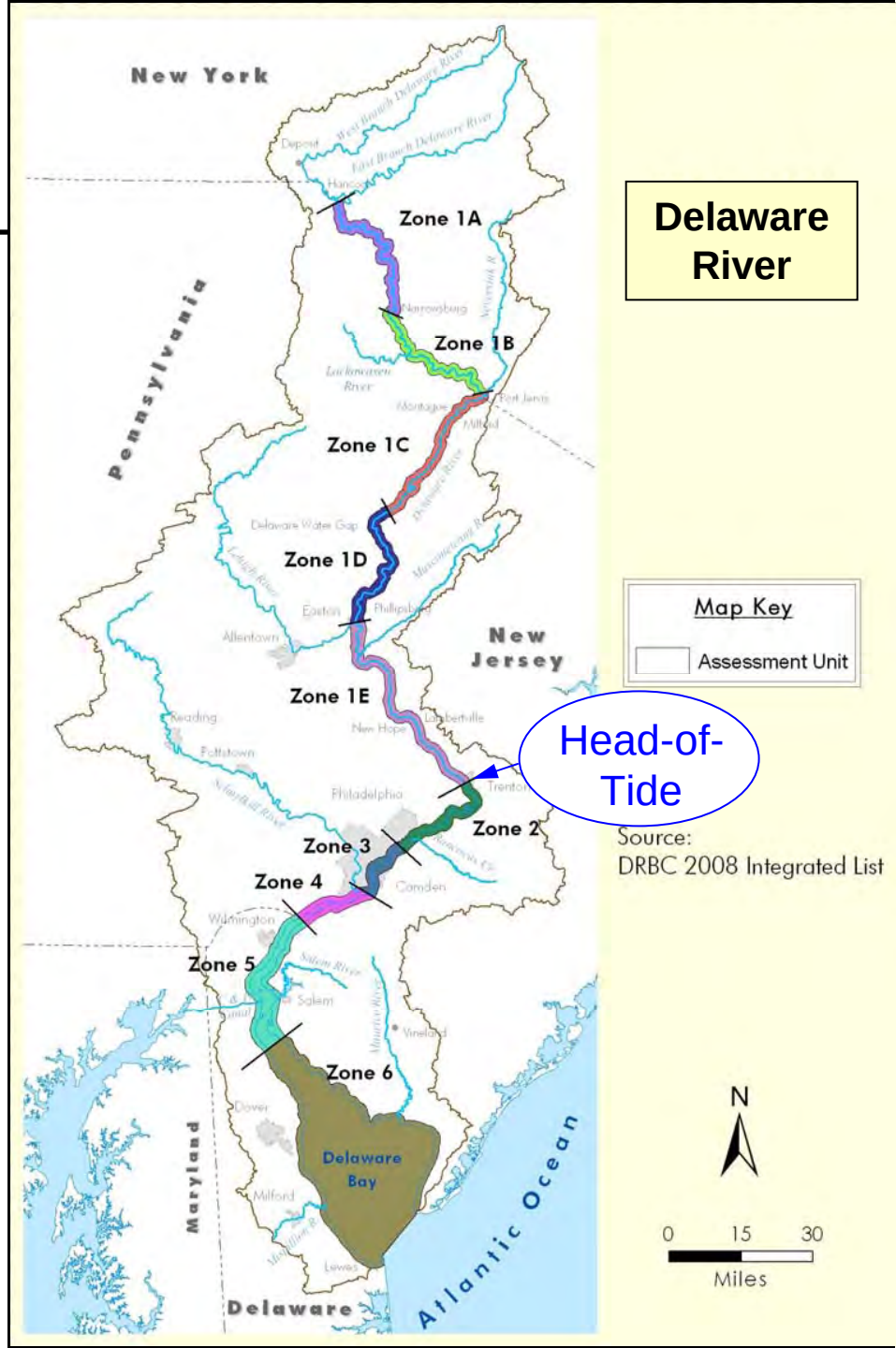
Delaware River Basin Commission

- Created in 1961
- 4 states and U.S. govt.
- 13,539 mi^2 (0.5% US)
- 5% of US water supply
- Water supply & Water quality
- Lead agency for interstate waters

Delaware River Basin Commission
DELAWARE · NEW JERSEY
PENNSYLVANIA · NEW YORK
UNITED STATES OF AMERICA

Integrated Assessment

- Mainstem interstate waters
- 305(b) decisions
- Uses assessed:
  - → Aquatic Life
  - → Public Water Supply
  - → Recreation
  - → Fish & Shellfish Consumption
- Recommend 303(d) to states



Outline

DRBC Biomonitoring Program

Issues in Translating Data to Assessment

1. What is “Reference Condition” for the Delaware River?

(2. How to Quantify an Ecological Response to Human Stress)

(3. How to Set “Impairment” Thresholds)

Invertebrate Biomonitoring

- Aug/Sept 2001-2008 surveys
- 25 stations
- Targeted riffle
  - → 1 – 3 ft/s
  - → 1 – 2 ft depth
  - → 40 – 70 mm median substrate
- Composite of 3 samples (4 ft^2)
- 500 individual target count
- genus-level taxonomy

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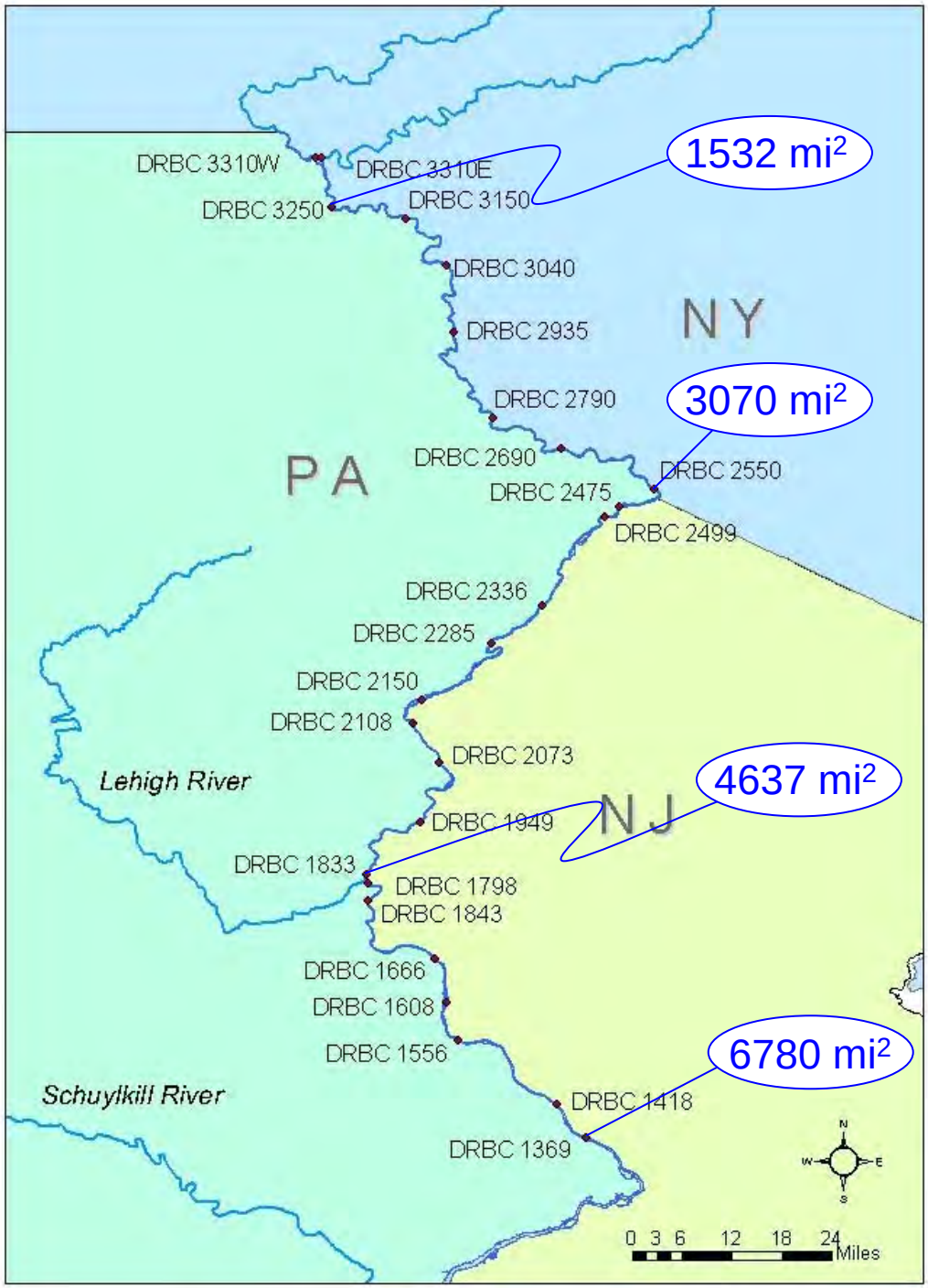
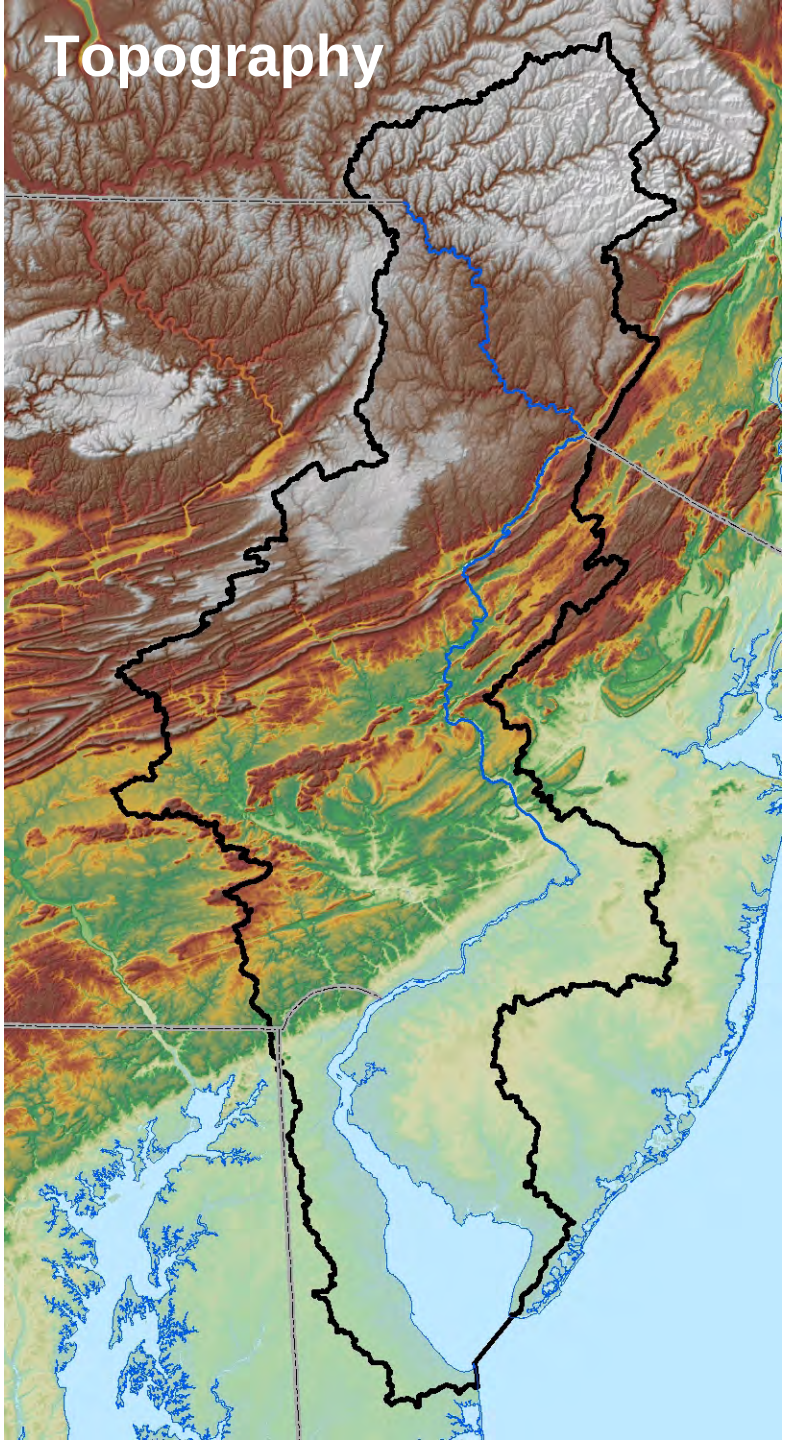


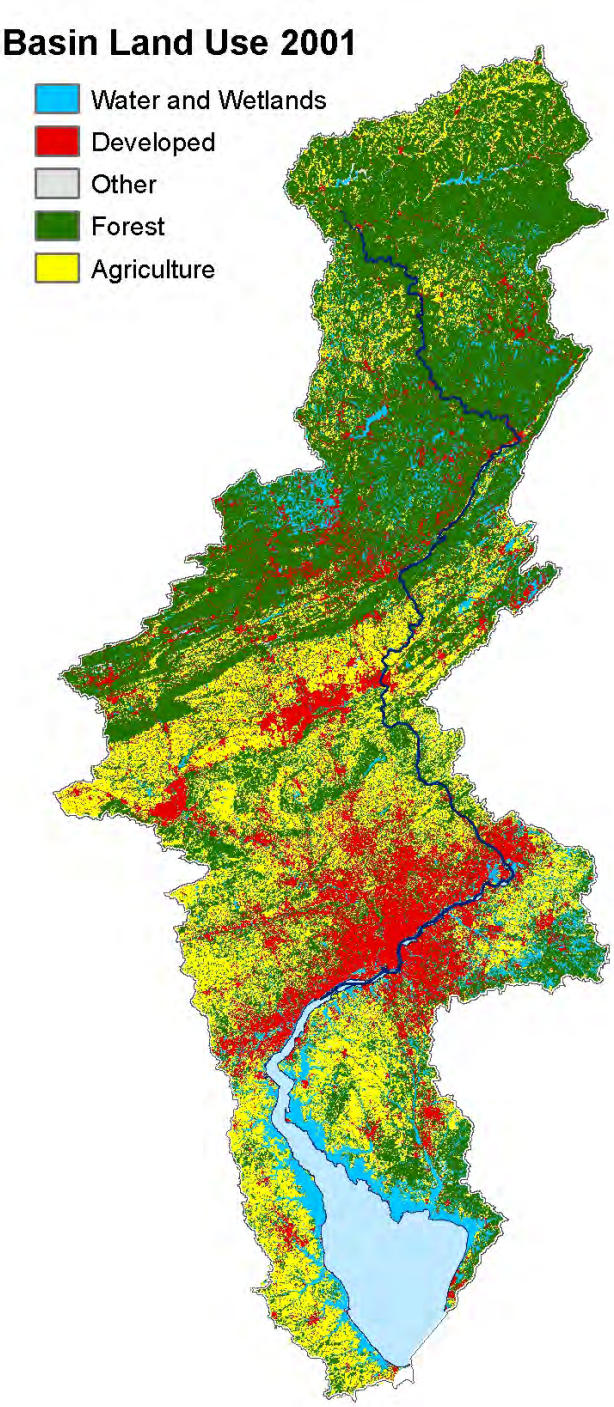
Issue #1: What Is Reference for the Delaware River?

Options

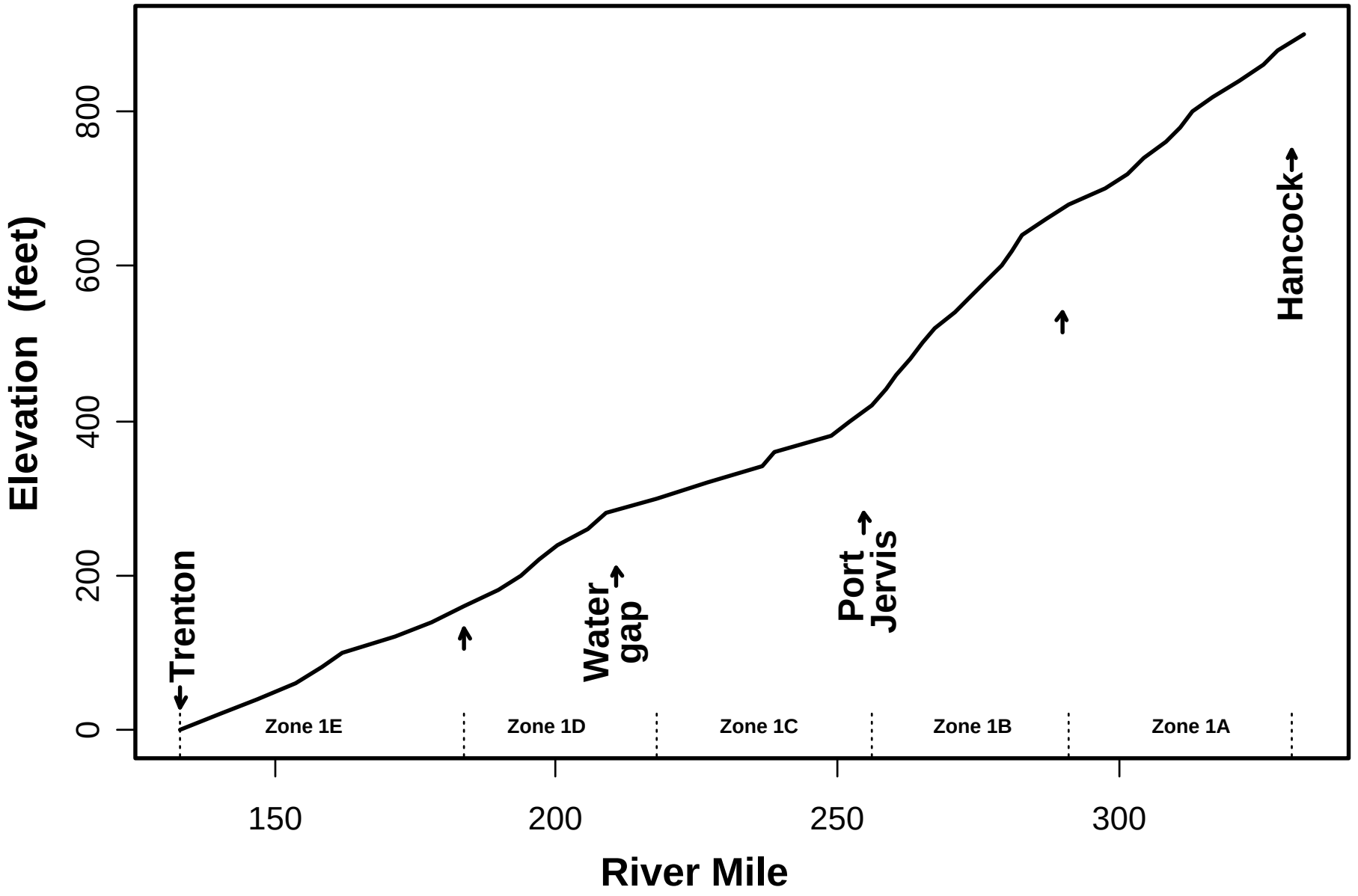
- Historical conditions
- Regional reference
- System-defined reference

Basin Tour


Topography


Basin Land Use 2001
Water and Wetlands
Developed
Other
Forest
Agriculture

Basin Tour: Stream Gradient (~5 ft/mi median)



Basin Tour: Substrate

Basin Tour: Substrate

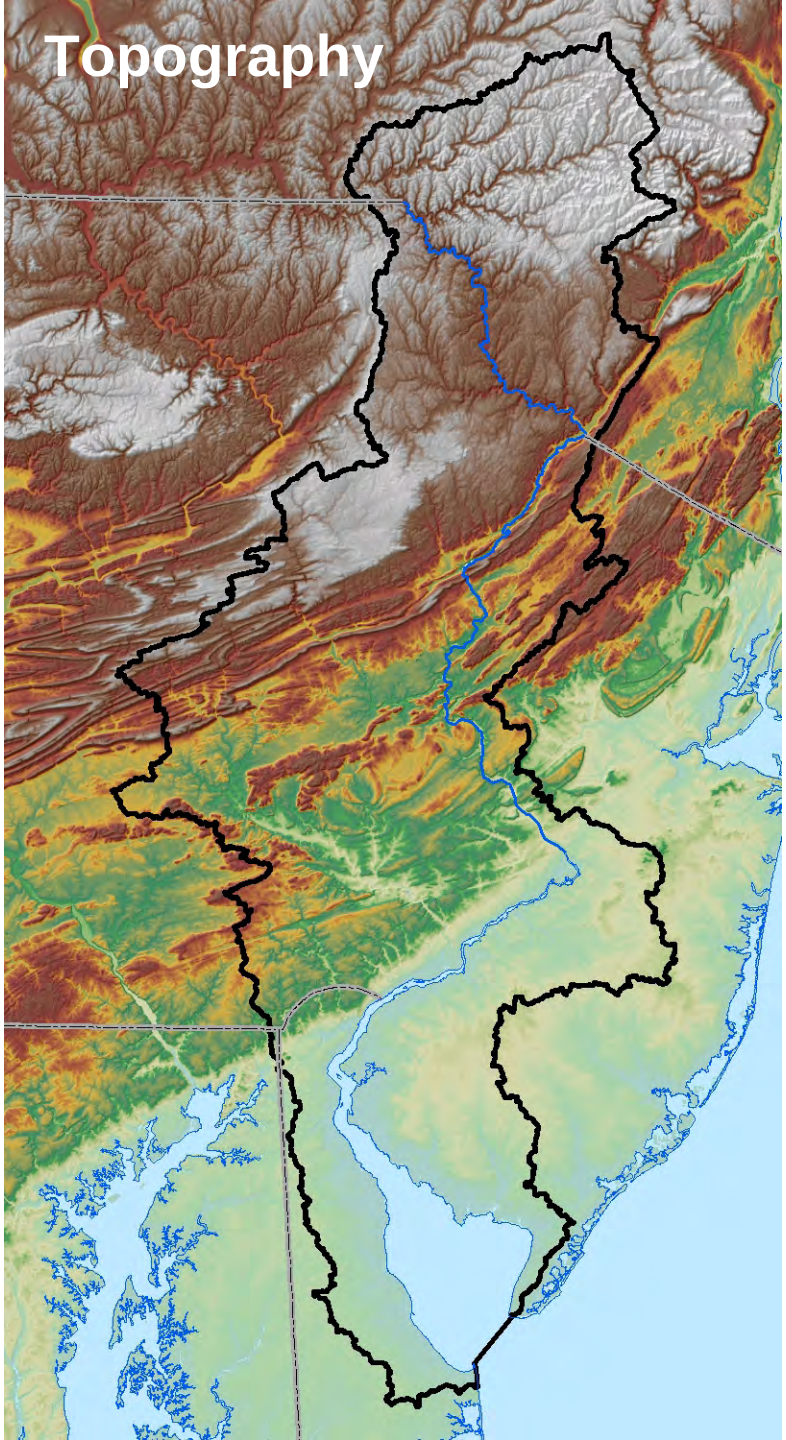
Basin Tour: Substrate

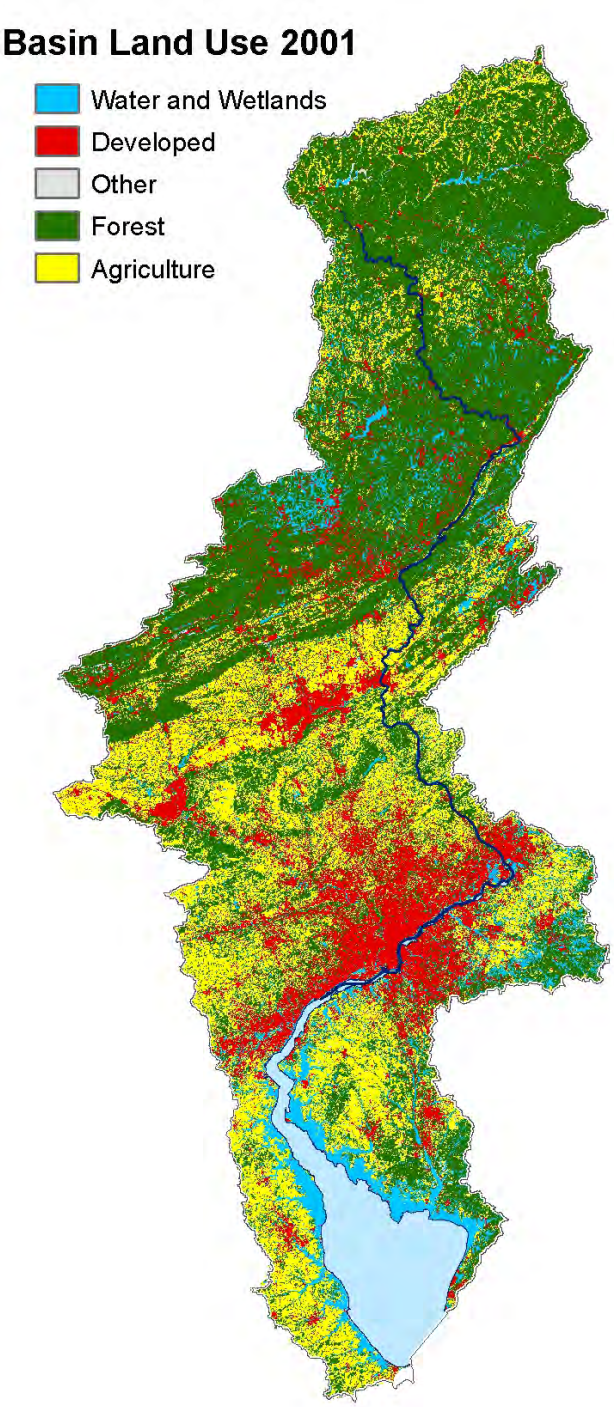
Basin Tour: Water Depth

Unique Status

- 3 National Parks Service units
- “Wild & Scenic” designations
- Longest free-flowing river east of the Mississippi
- DRBC “Anti-degradation”

Basin Tour


Topography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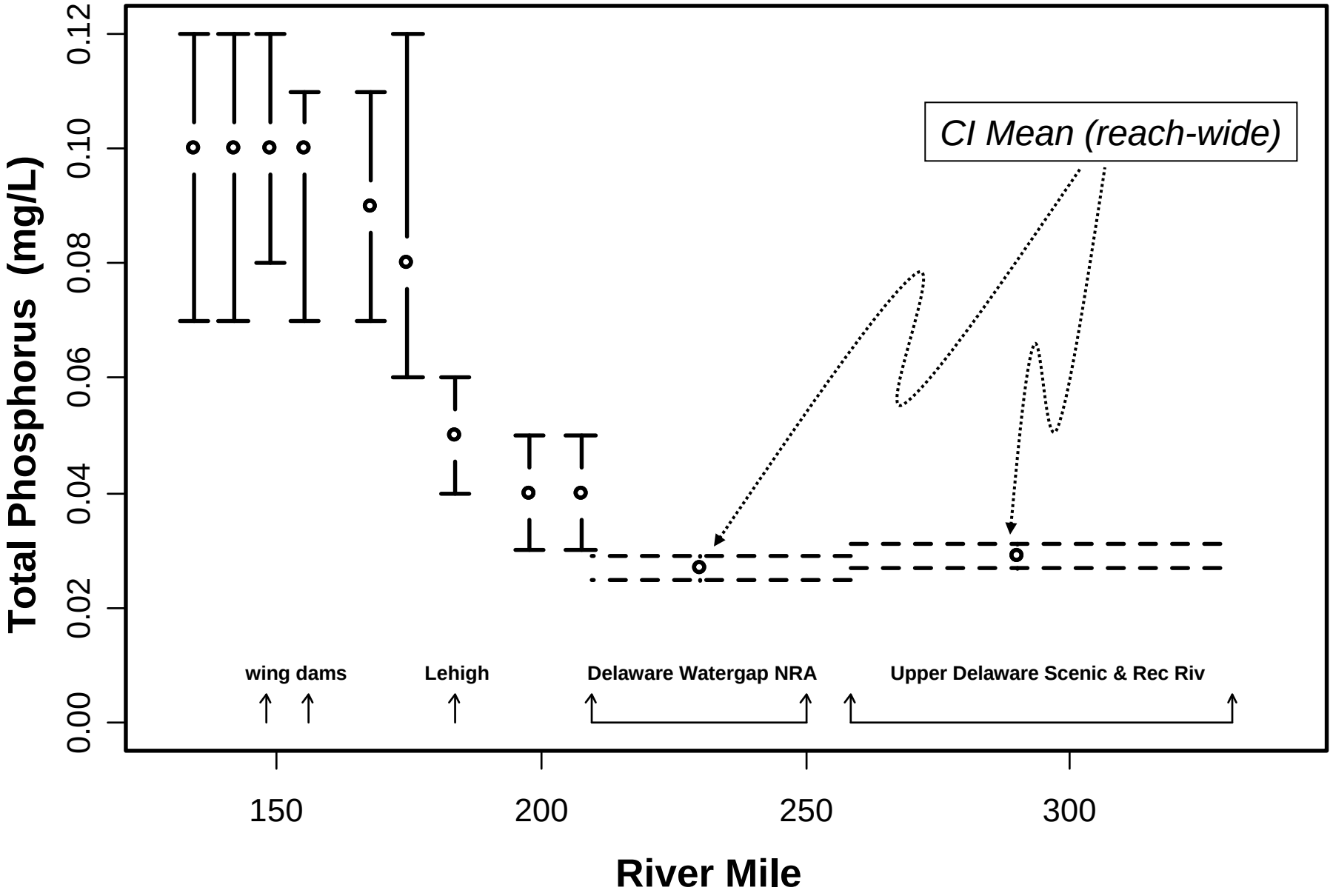
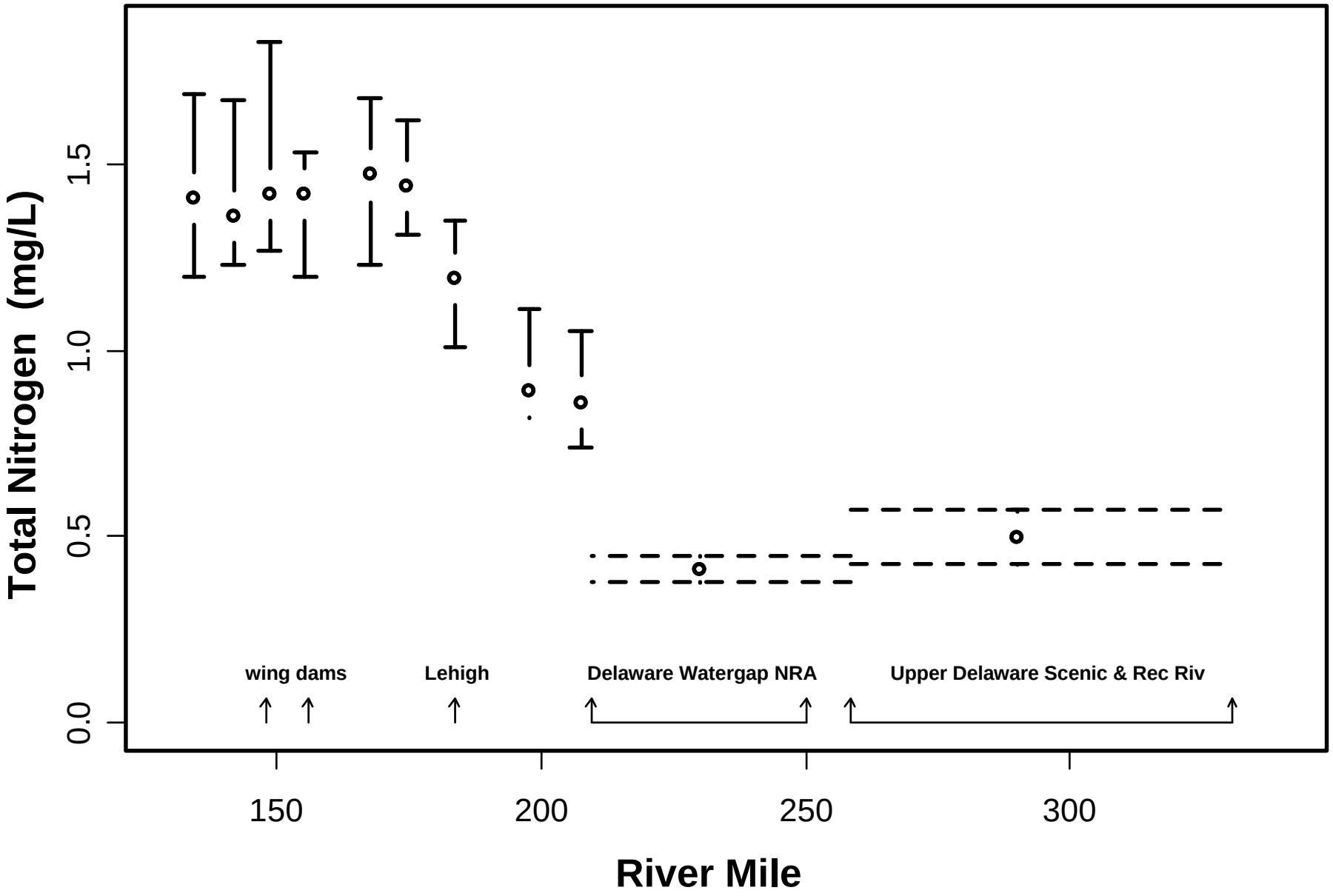
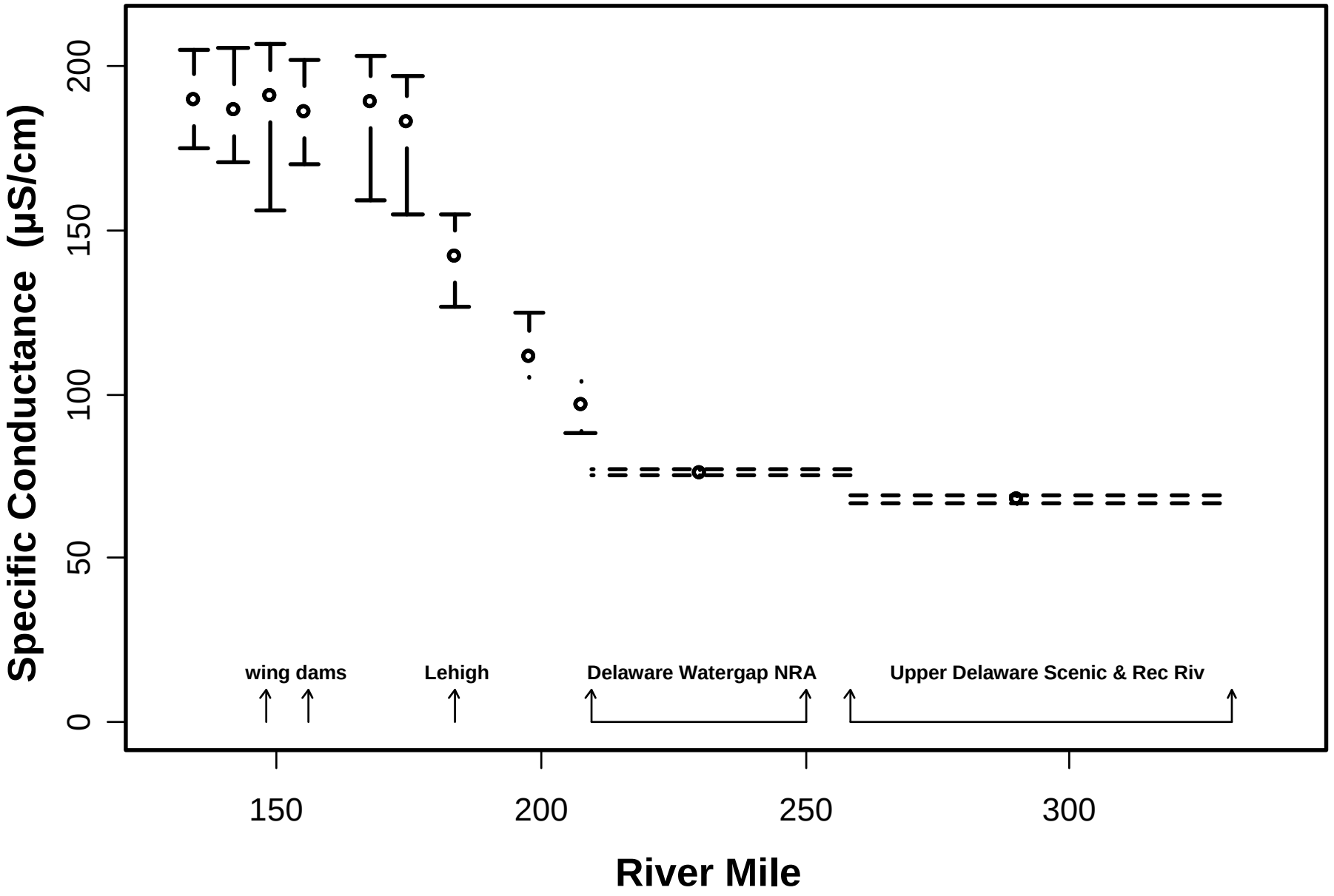
BasinTour: Total Phosphorus



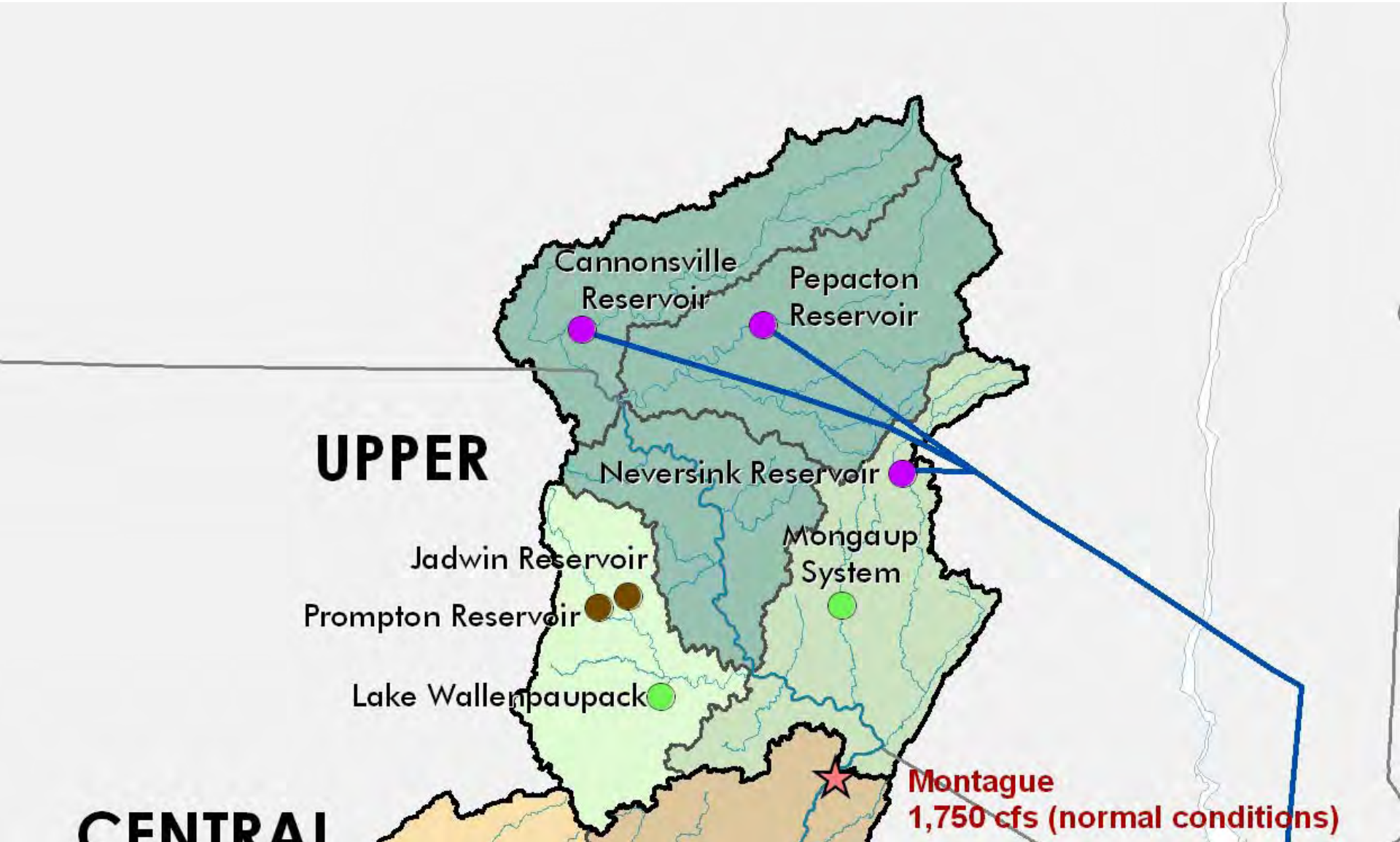
BasinTour: Total Nitrogen



BasinTour: Conductivity



Reservoir Influence: Hydrology, Temperature



Motivation & Decision for Reference

Reference Qualities

1. Excellent & consistent benthic habitat
2. Excellent water quality for upper 150 miles (above Lehigh)
3. Relatively consistent gradient

Human Influences

1. Temperature alteration in upper 30 miles (above Callicoon)
2. Altered water quality in lower 50 miles (below Lehigh)
3. Hydrology moderately altered throughout

Uncertainty

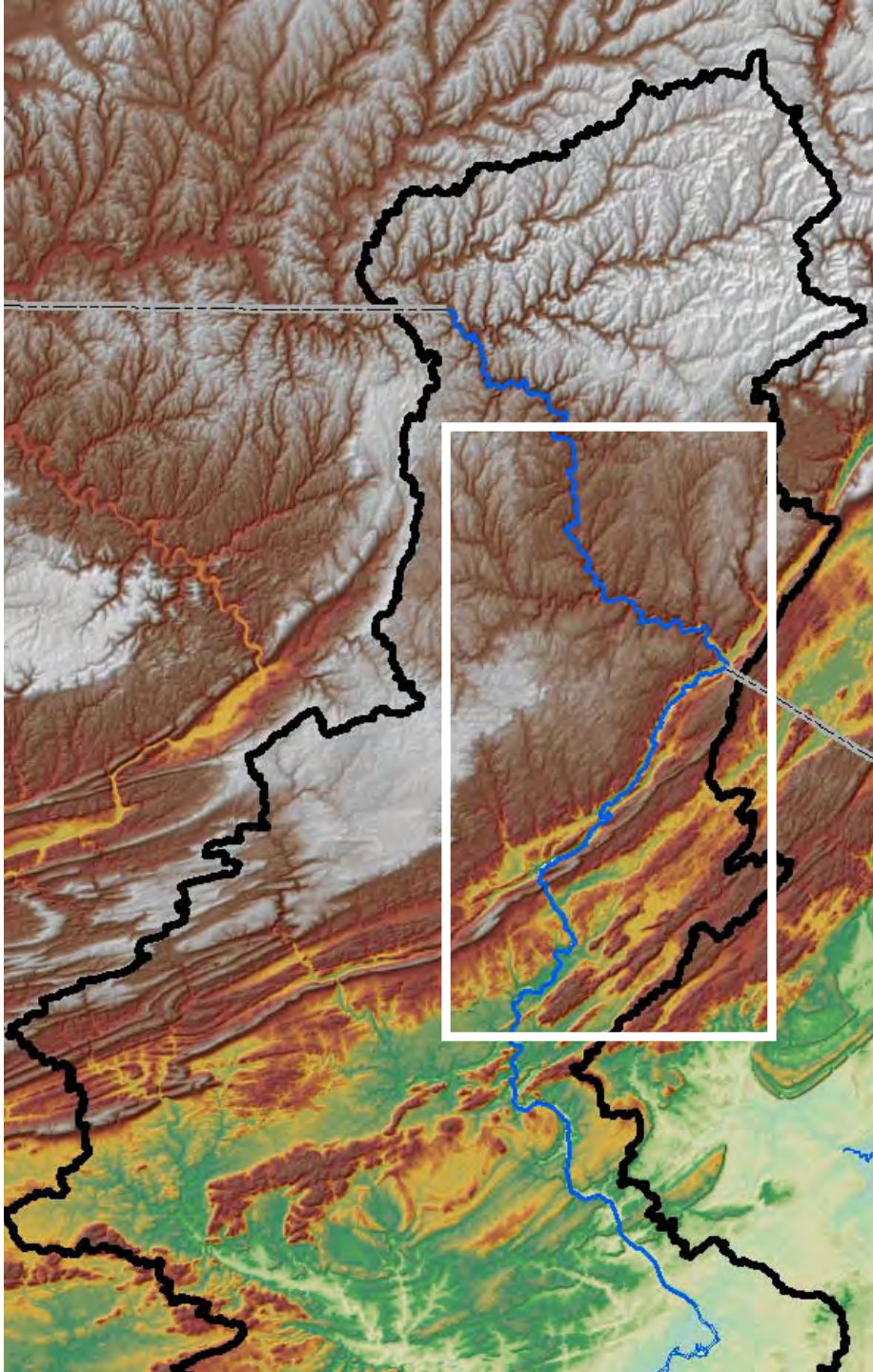
1. Natural vs Human contribution to Nitrogen, Conductivity transition zone

Reference Decision:

Callicoon (RM 305)

to

Lehigh R. (RM 184)



Reference Decision:

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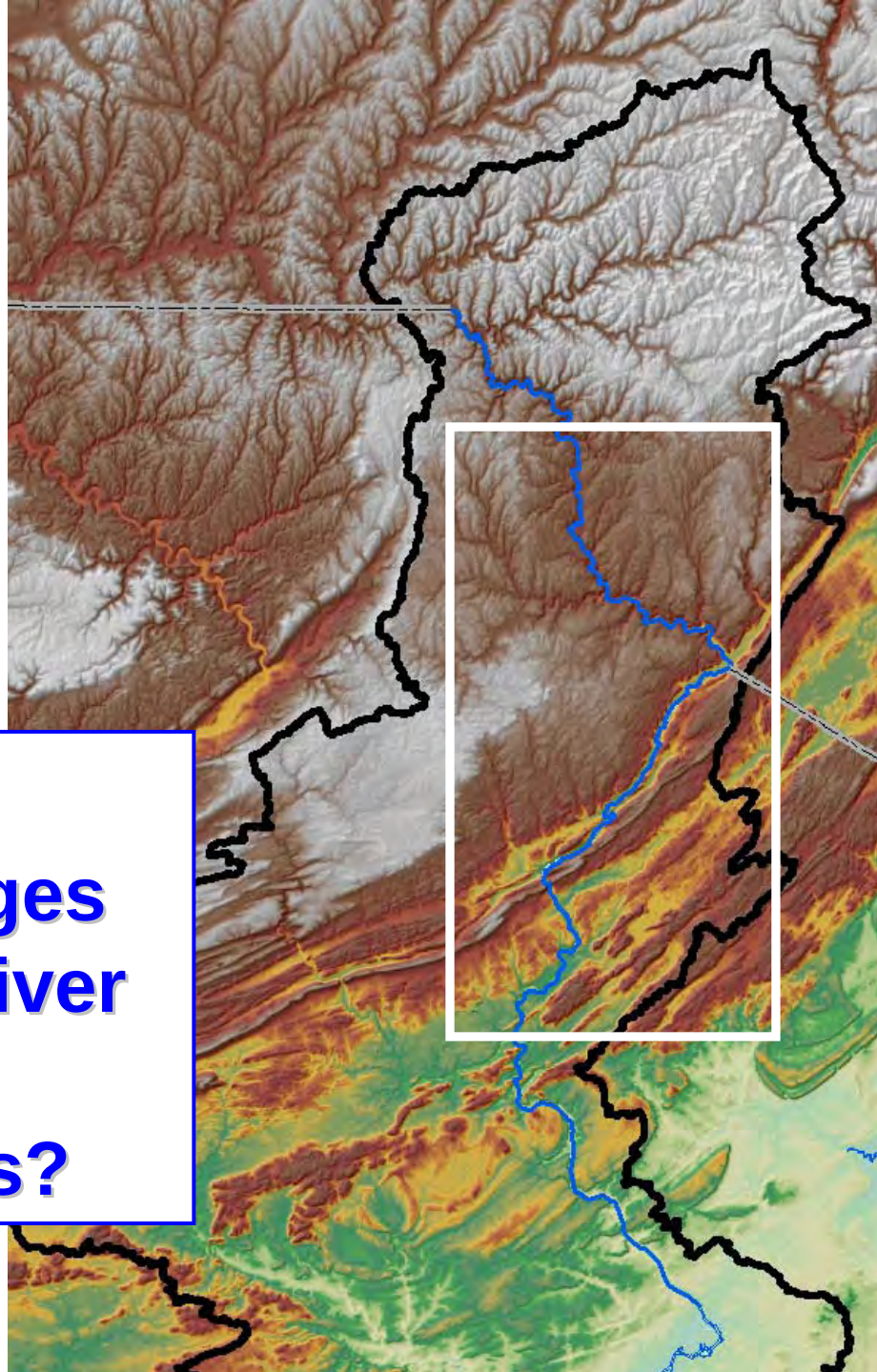
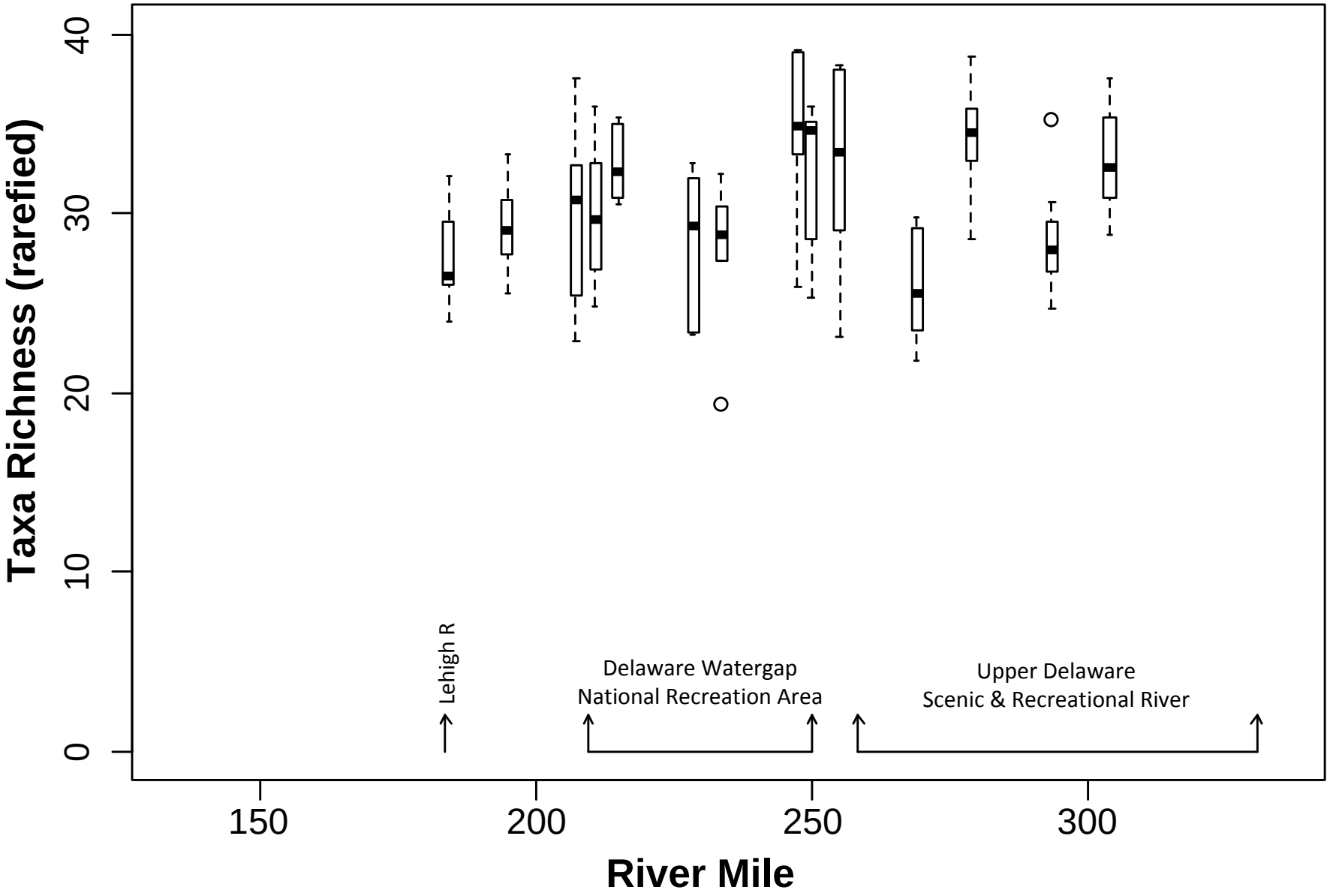
Question:

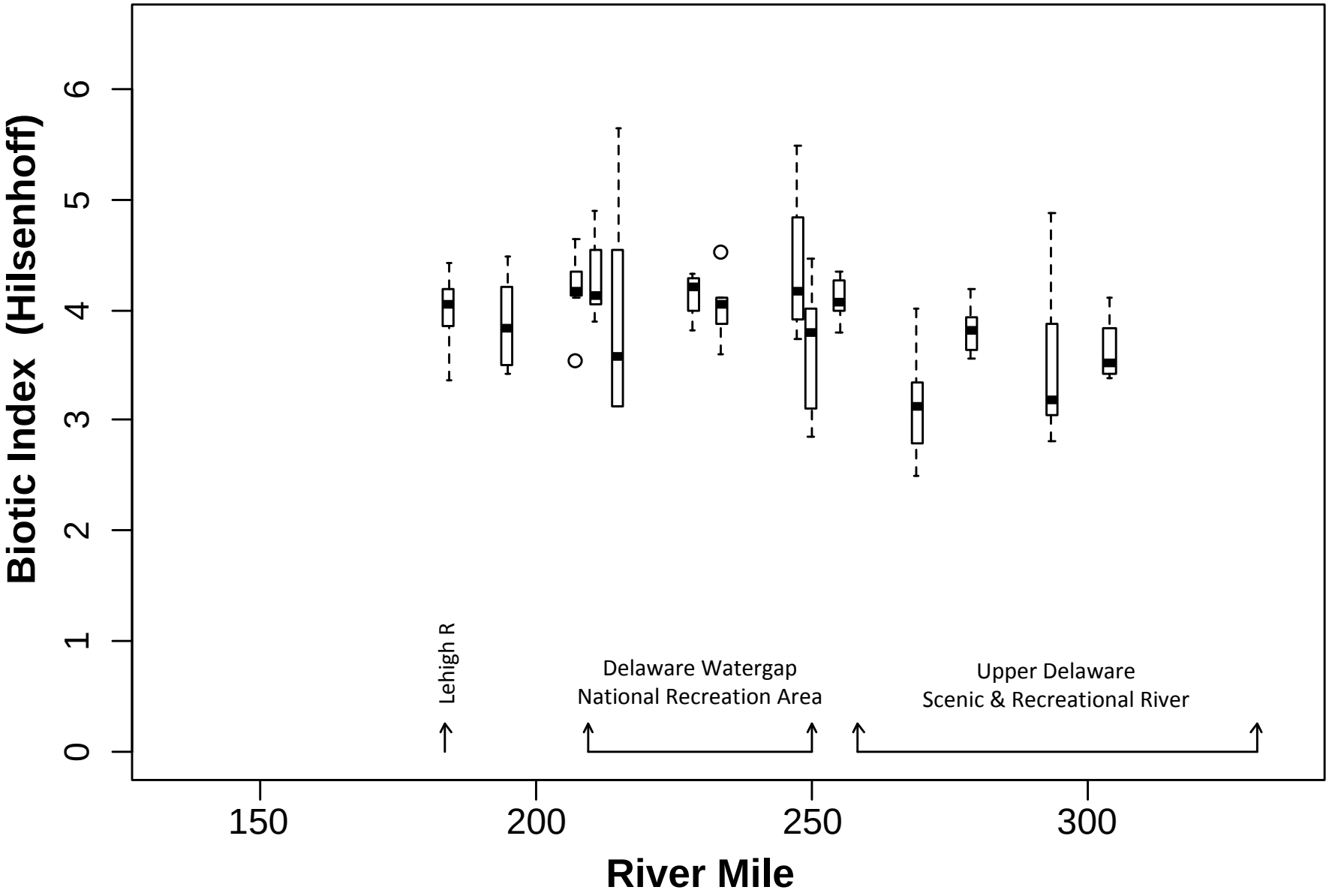
Do longitudinal changes along the Delaware River require different "reference" standards?



Longitudinal Change: Taxa Richness



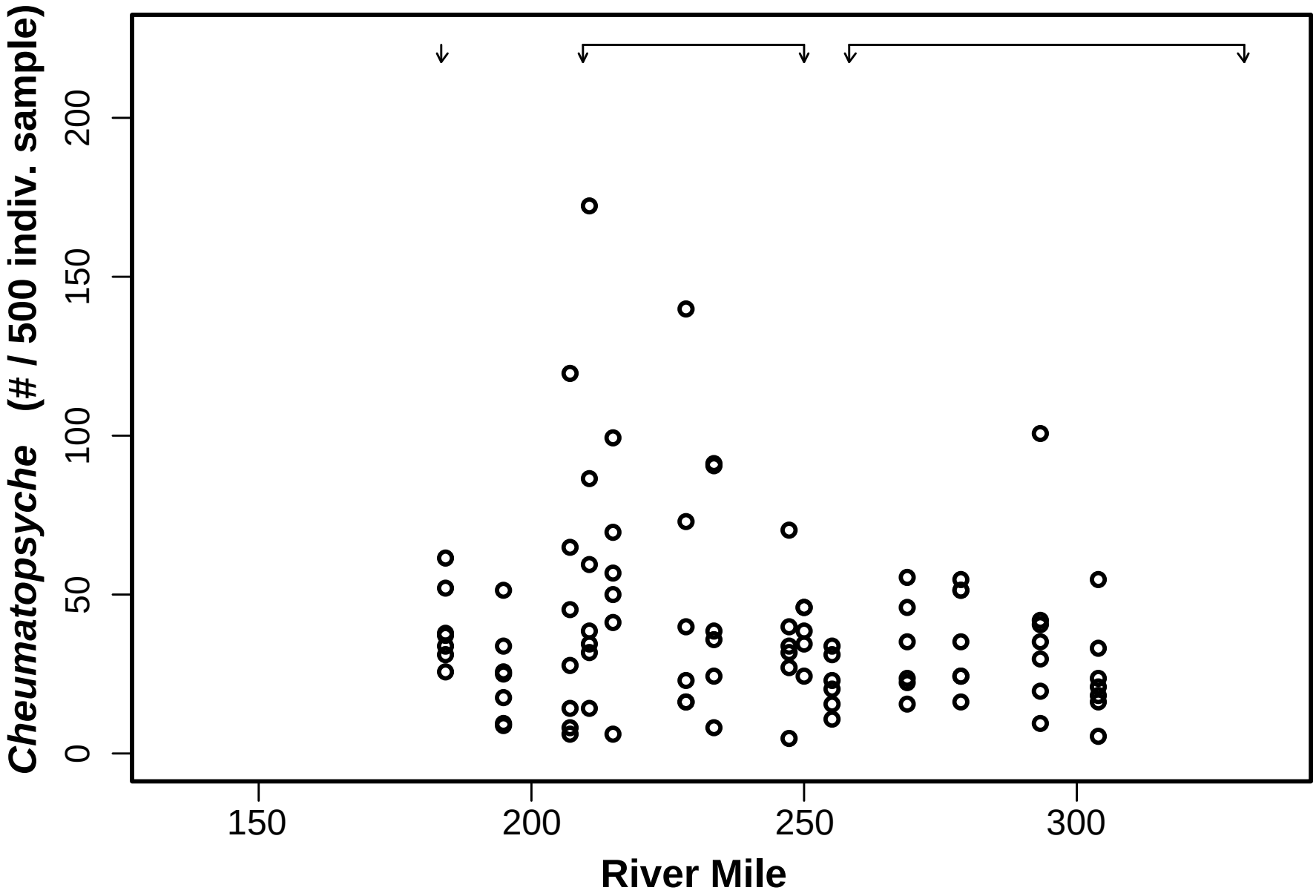
Longitudinal Change: Biotic Index



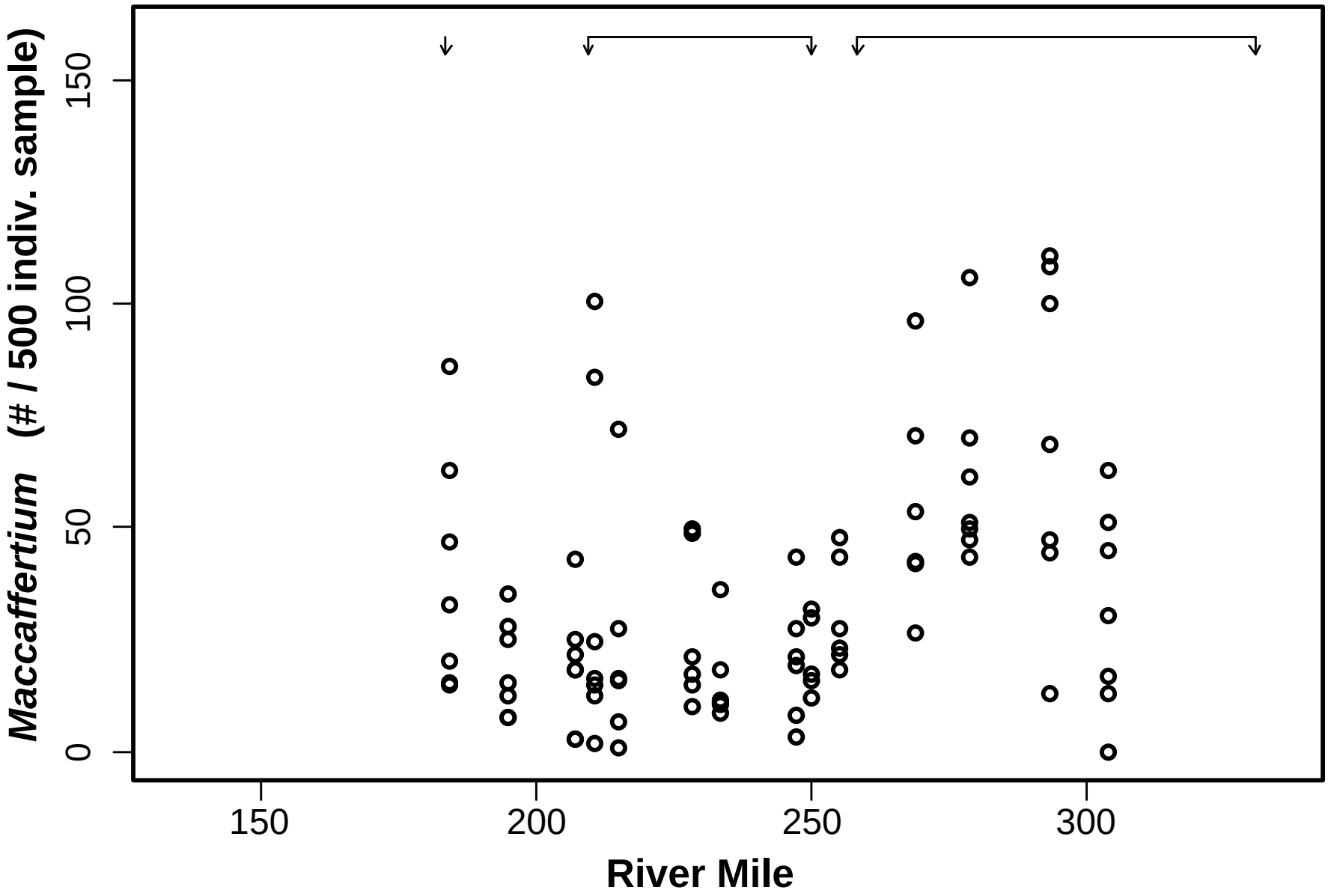
Community Composition: Top 12 Taxa

	Taxon	Group	Ave. Abund.	Rank (median)
➡	*Cheumatopsyche*	Trichop	10%	#1
	Hydropsyche	Trichop	7%	#2
➡	*Maccaffertium*	Ephem	7%	#3
	* Hydrobiidae	Snail	5%	#20
➡	*Stenelmis*	Coleop	5%	#4
	Isonychia	Ephem	5%	#5
➡	* *Protoptila*	Trichop	4%	#21
➡	*Chimarra*	Trichop	4%	#6
	Baetis	Ephem	4%	#8
	Plauditus	Ephem	4%	#7
	Acentrella	Ephem	3%	#15
	* *Leucrocuta*	Ephem	3%	#9
	Other Taxa	-	41%	-

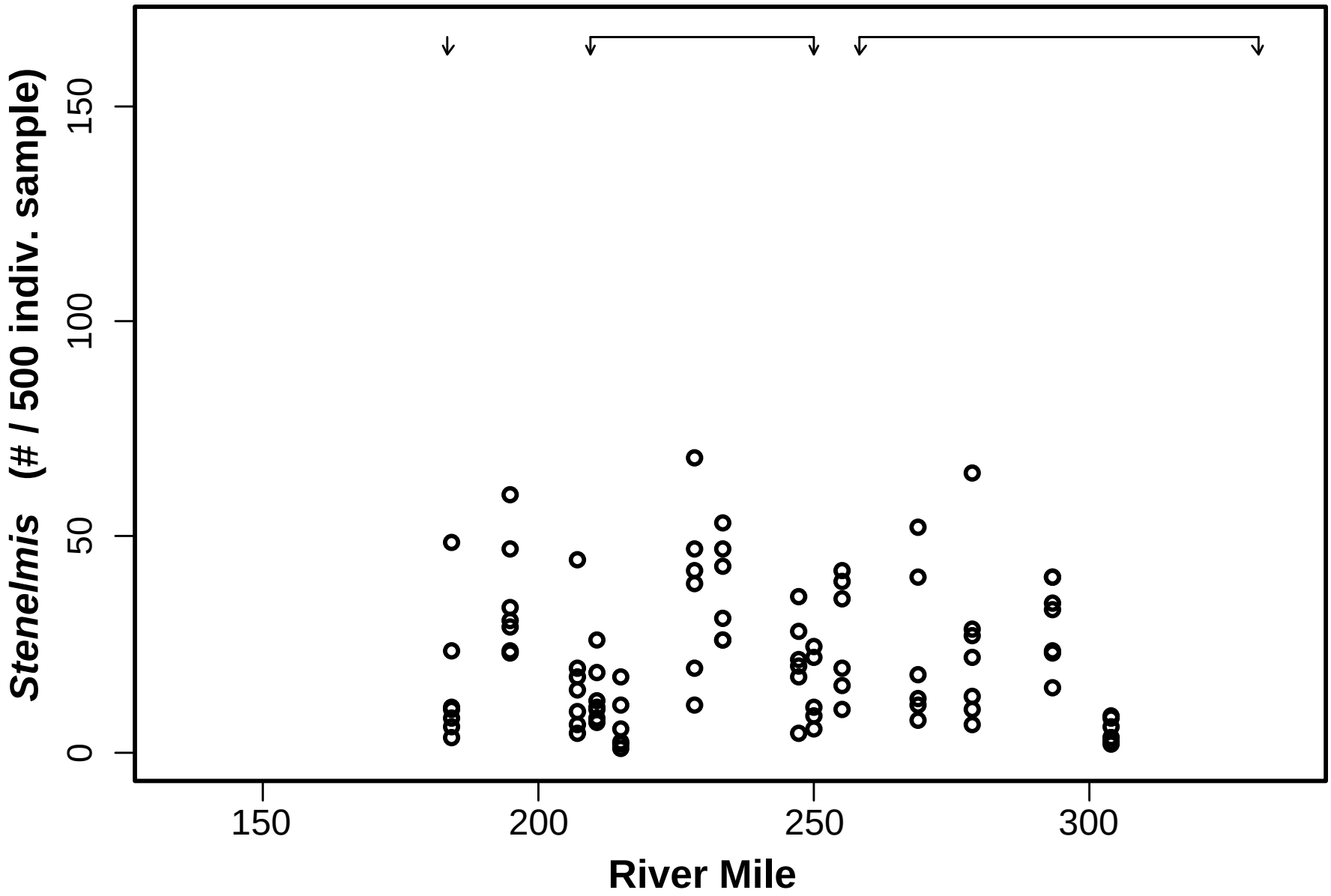
Cheumatopsyche (1st @ 10%)



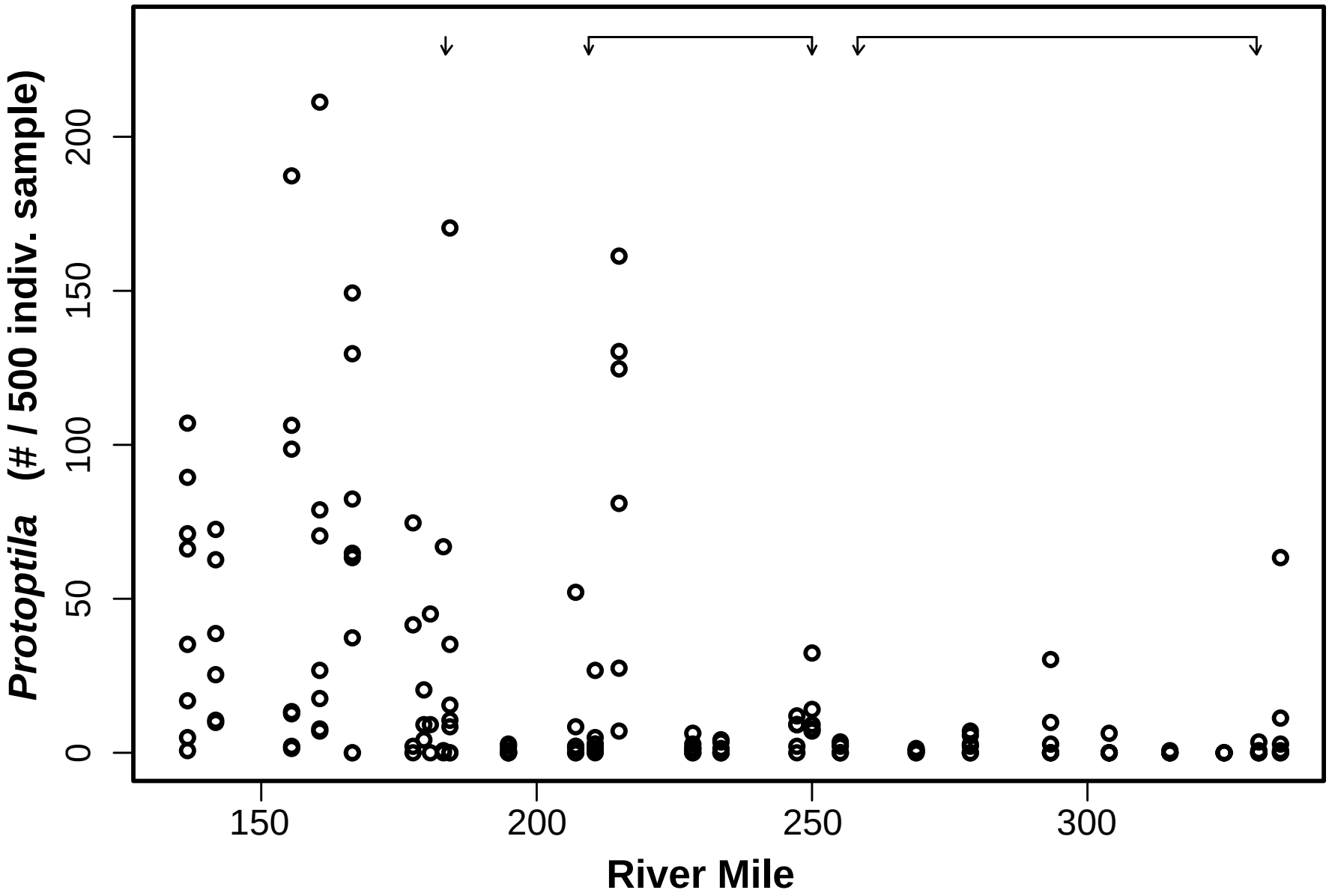
Maccaffertium (3rd @ 7%)



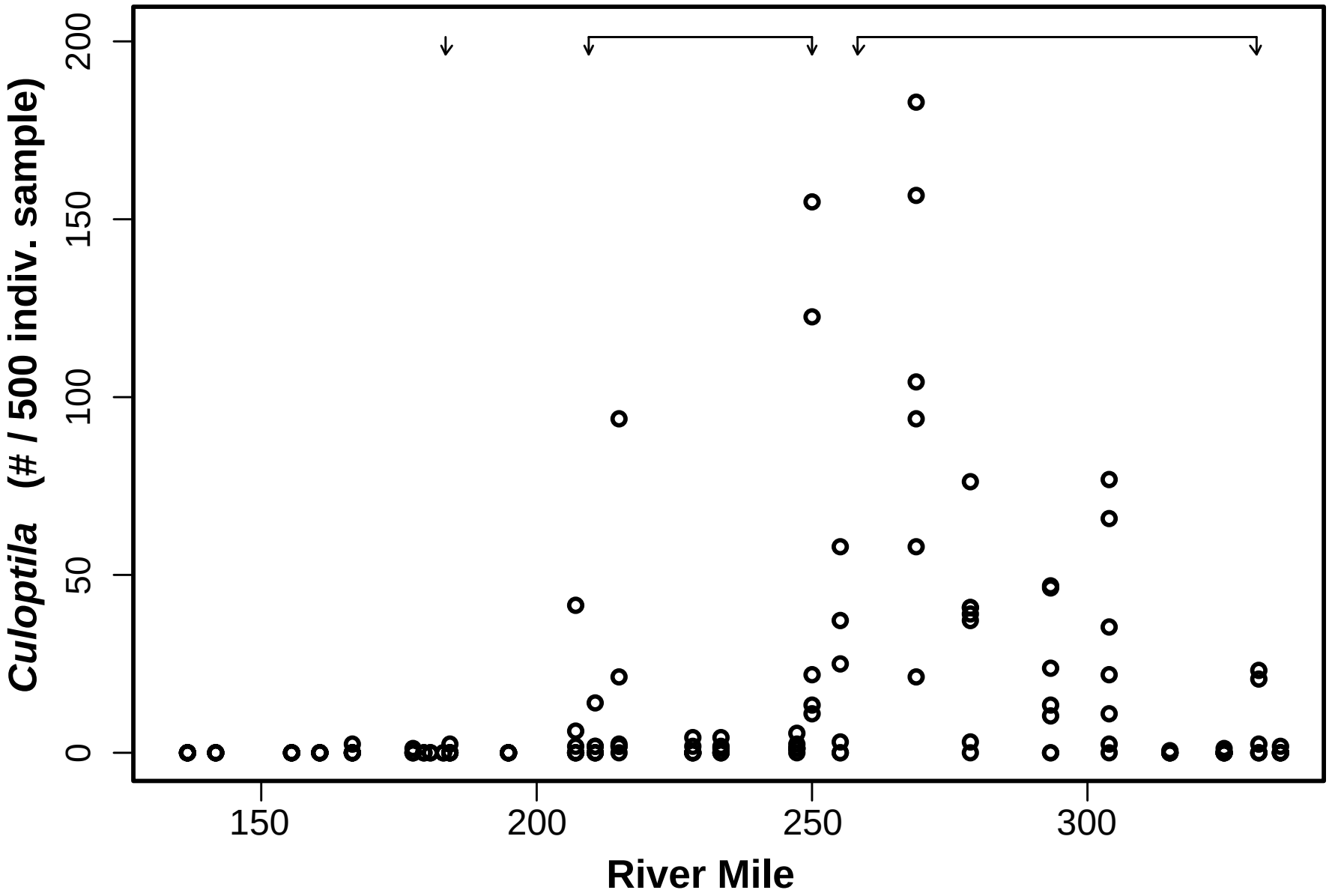
Stenelmis (5th @ 5%)



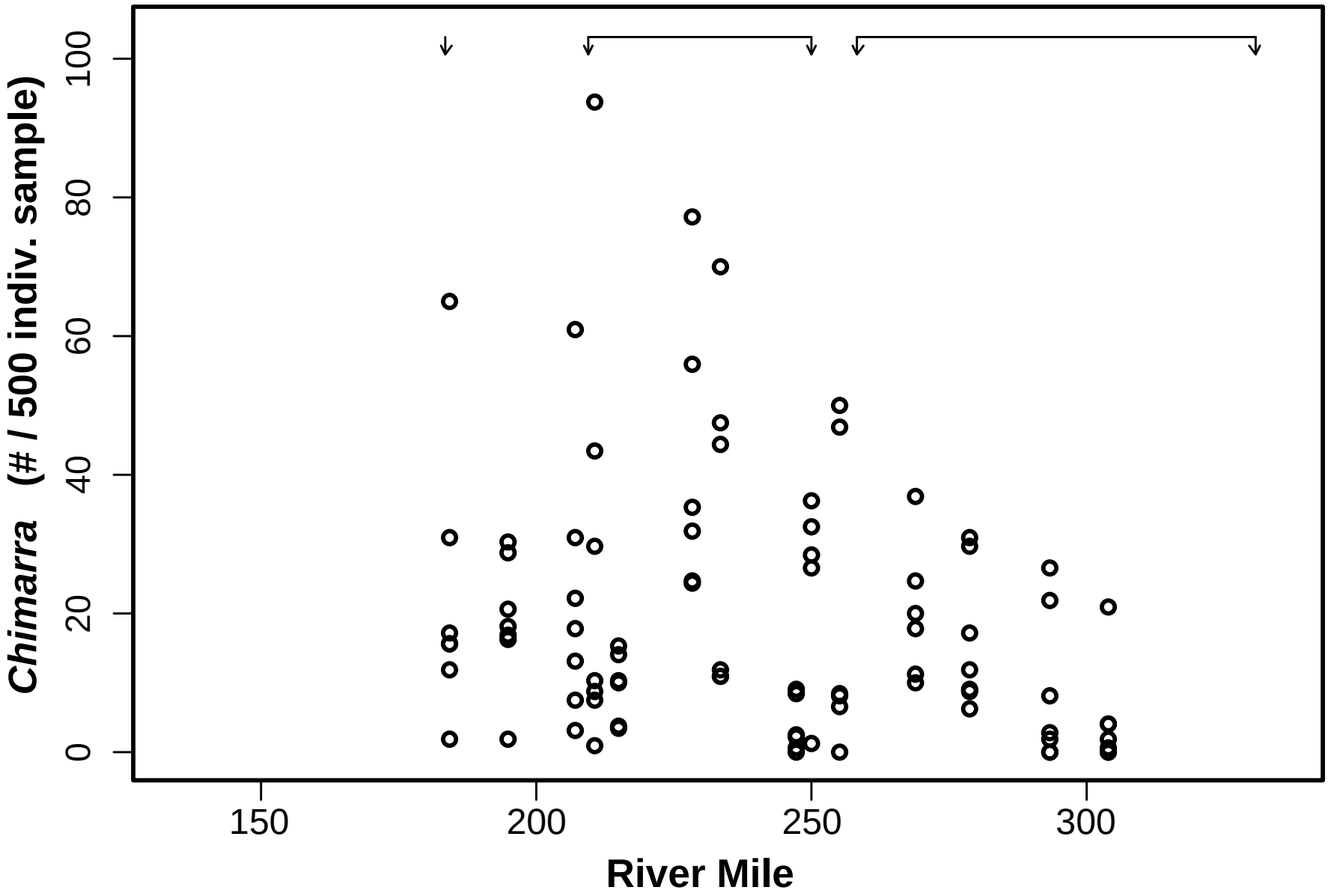
Protoptila (7th @ 4%)



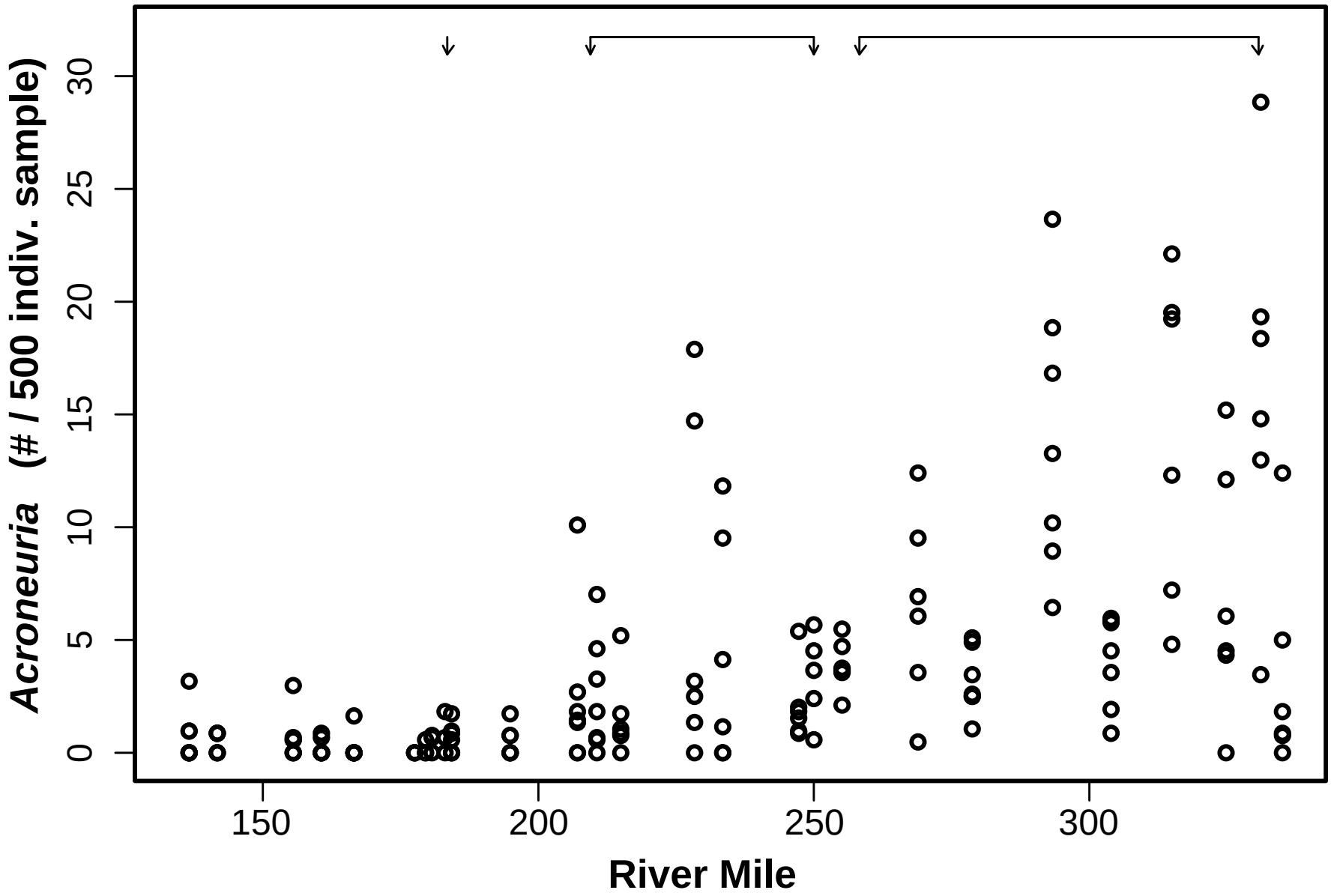
Culoptila (16th @ 2%)



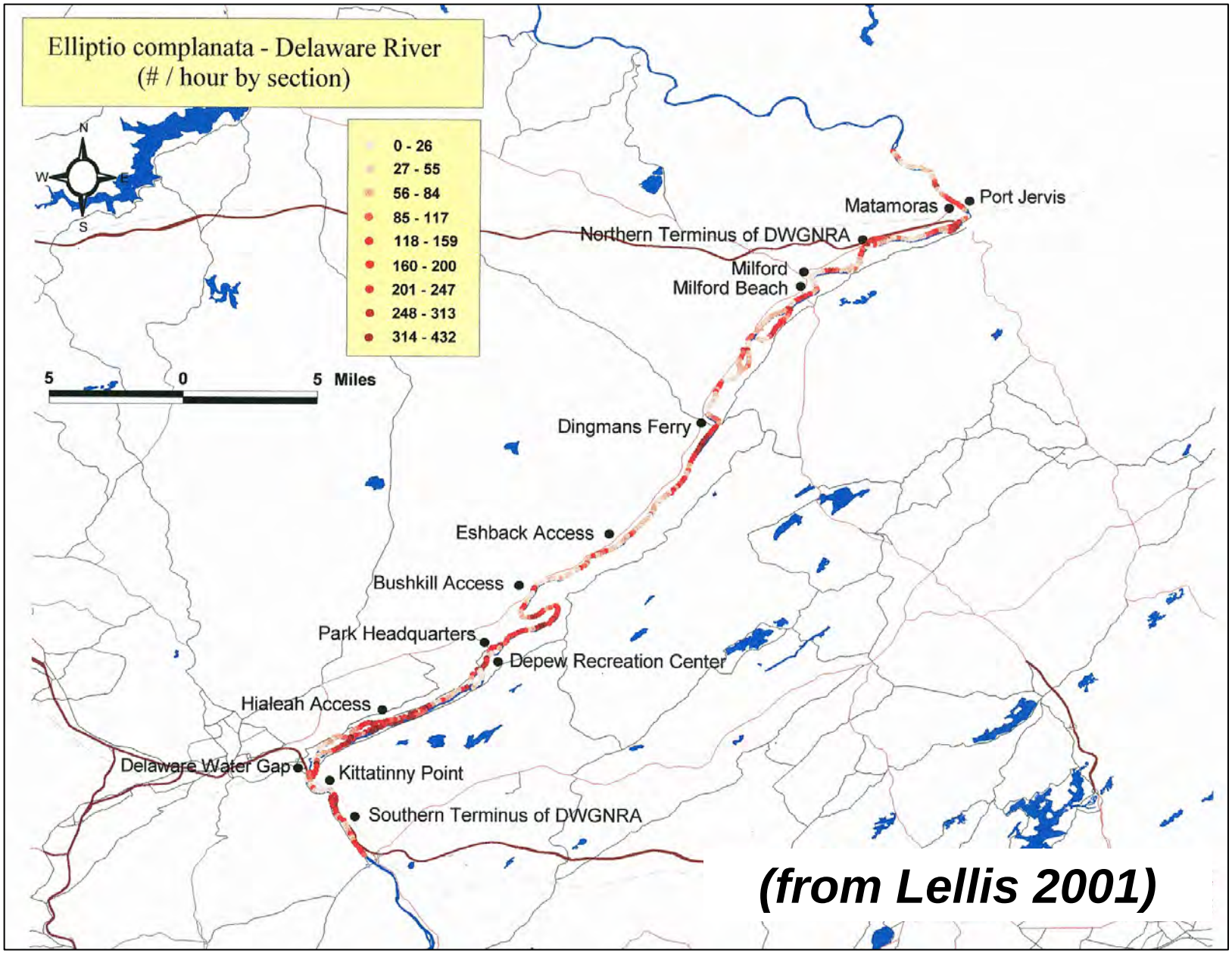
Chimarra (8th @ 4%)



Acroneuria (top predator; ~1%)

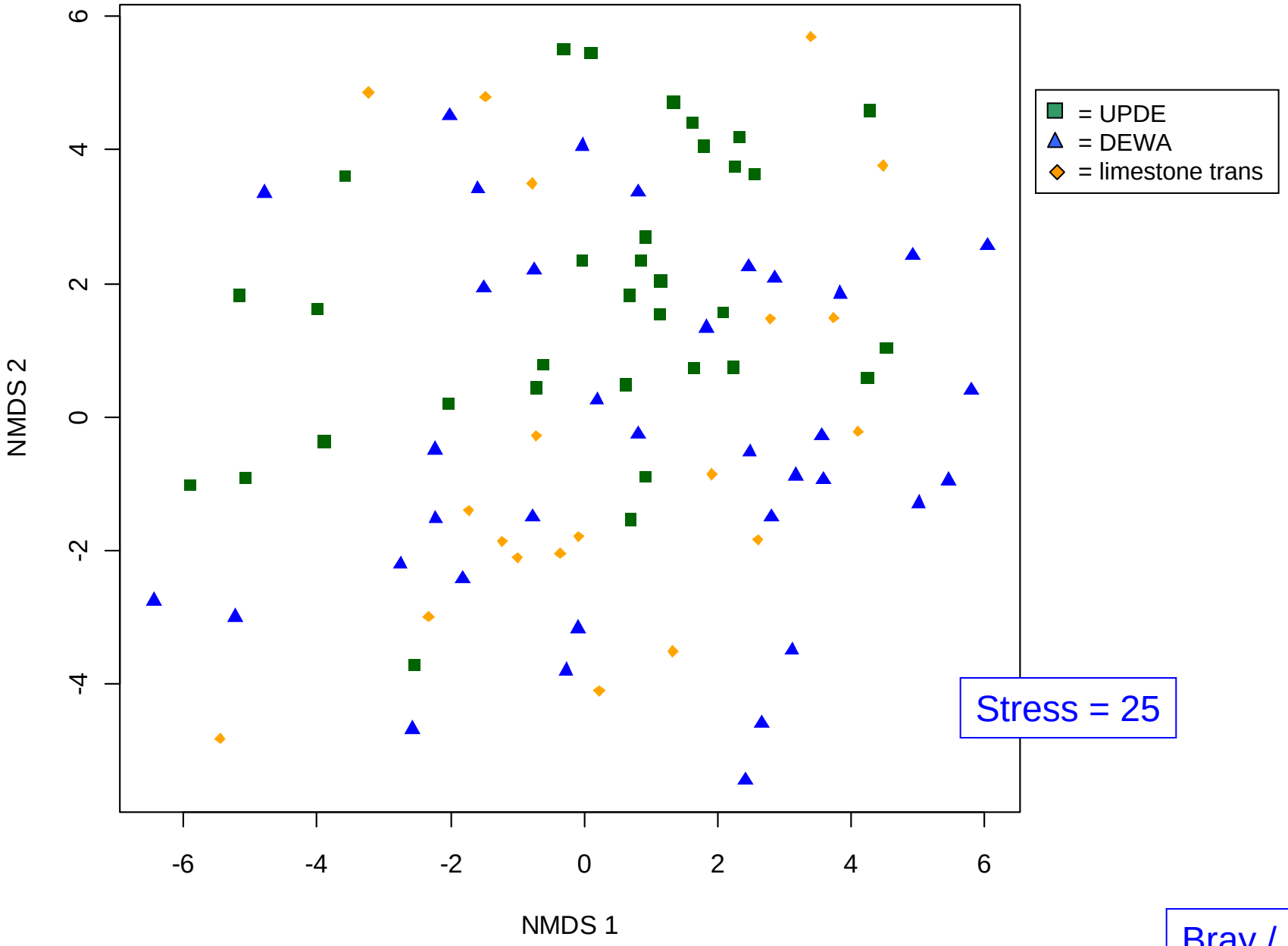


Freshwater Mussels: 8 species, density ~ 10 / m^2



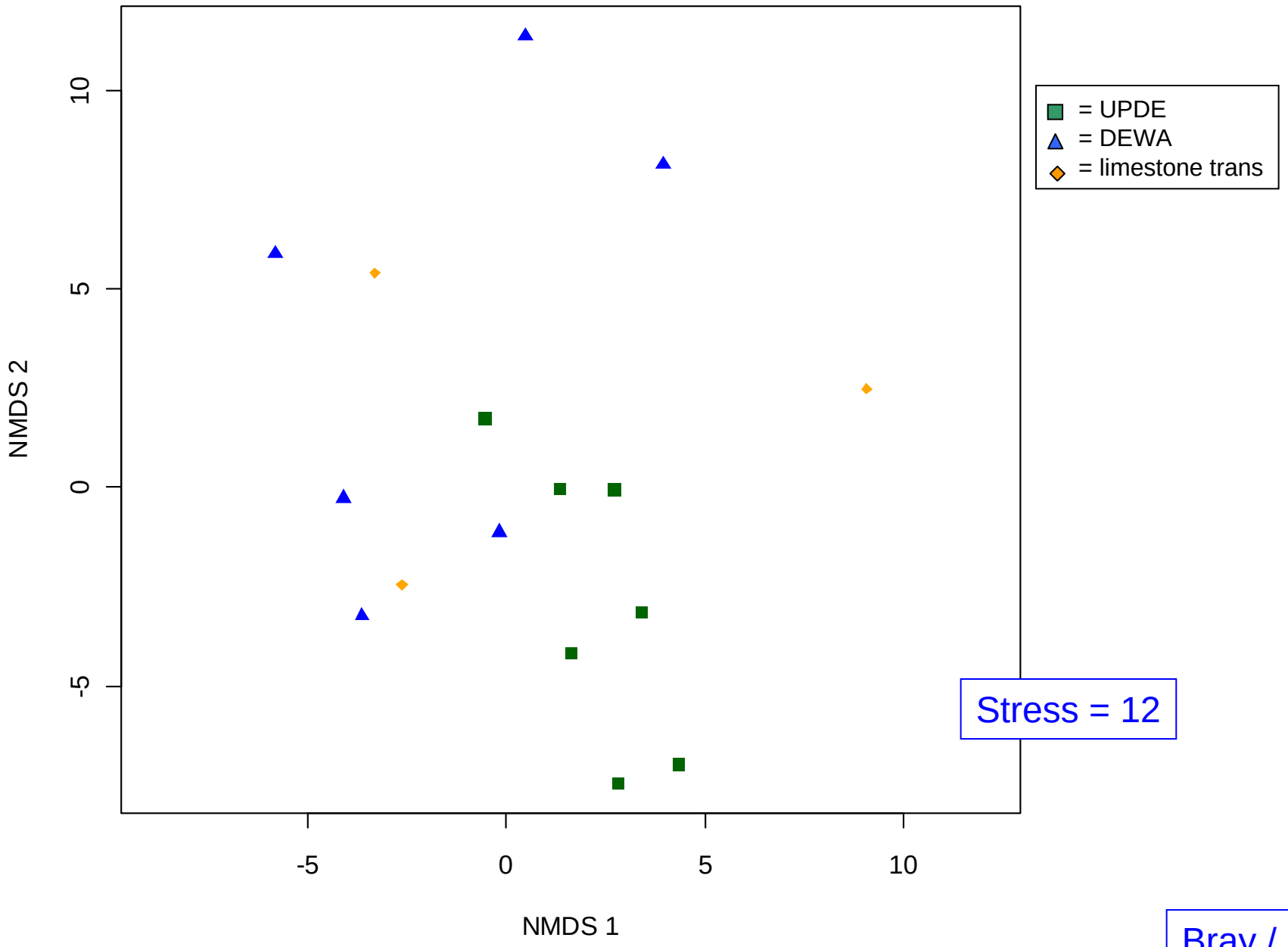
(from Lellis 2001)

NMDS Ordination: All Years, Reference Sites



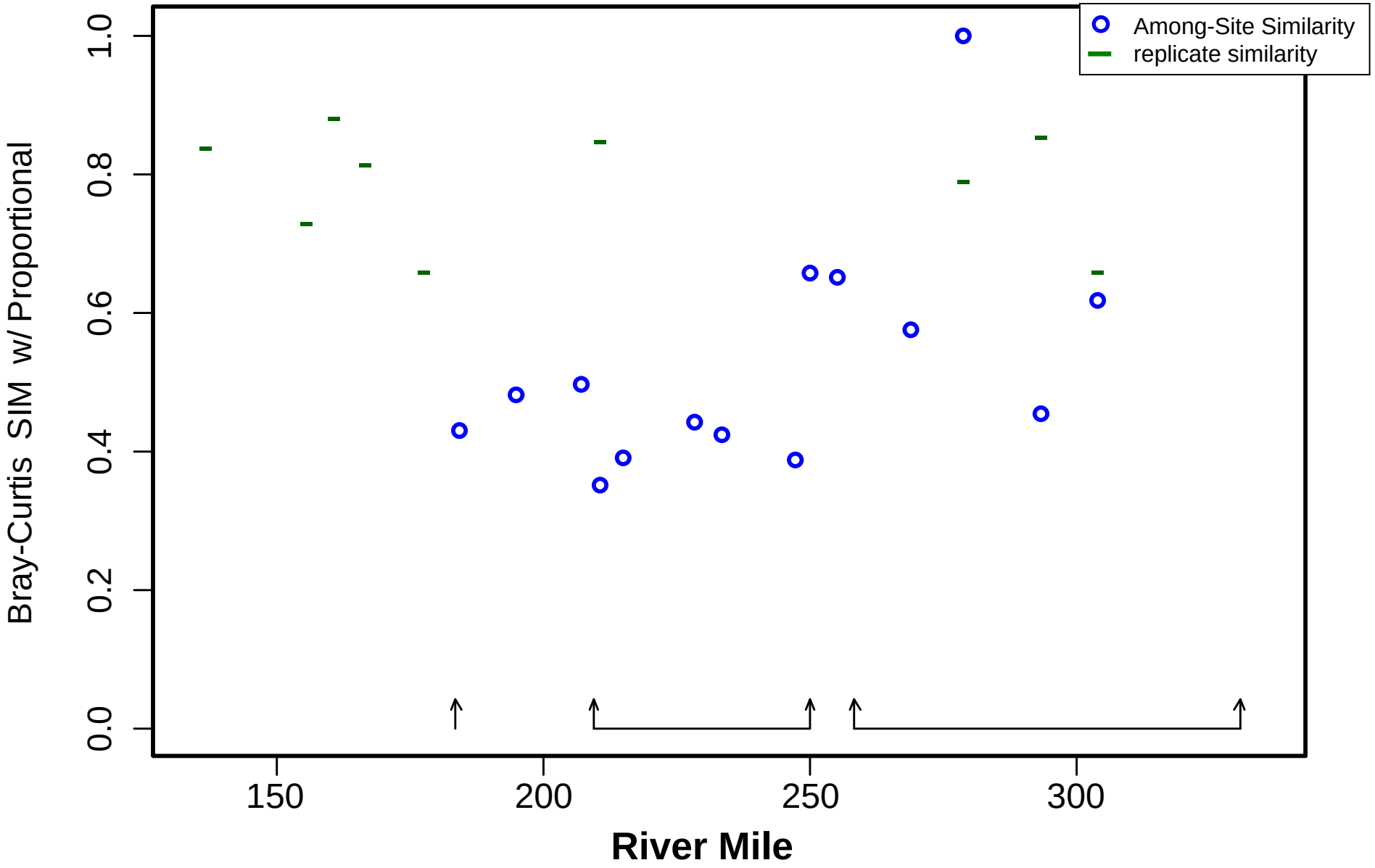
Bray / prop

NMDS Ordination: 2008 Reference Sites



Bray / prop

2008 Auto-Similarity (RM 279 Origin)



Question: Do longitudinal changes along the Delaware River require different "reference" standards?

- Metrics: suggestive, but inconclusive
- Species: dominants stable but some turnover among less common
- Multivariate: weak structure

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- Multivariate: weak structure

Decision: **Use a single reference designation**
(interim) **for 200 miles of river**

Issue #2: How To Measure Ecological Impacts?

- **Use proven measures in the region**

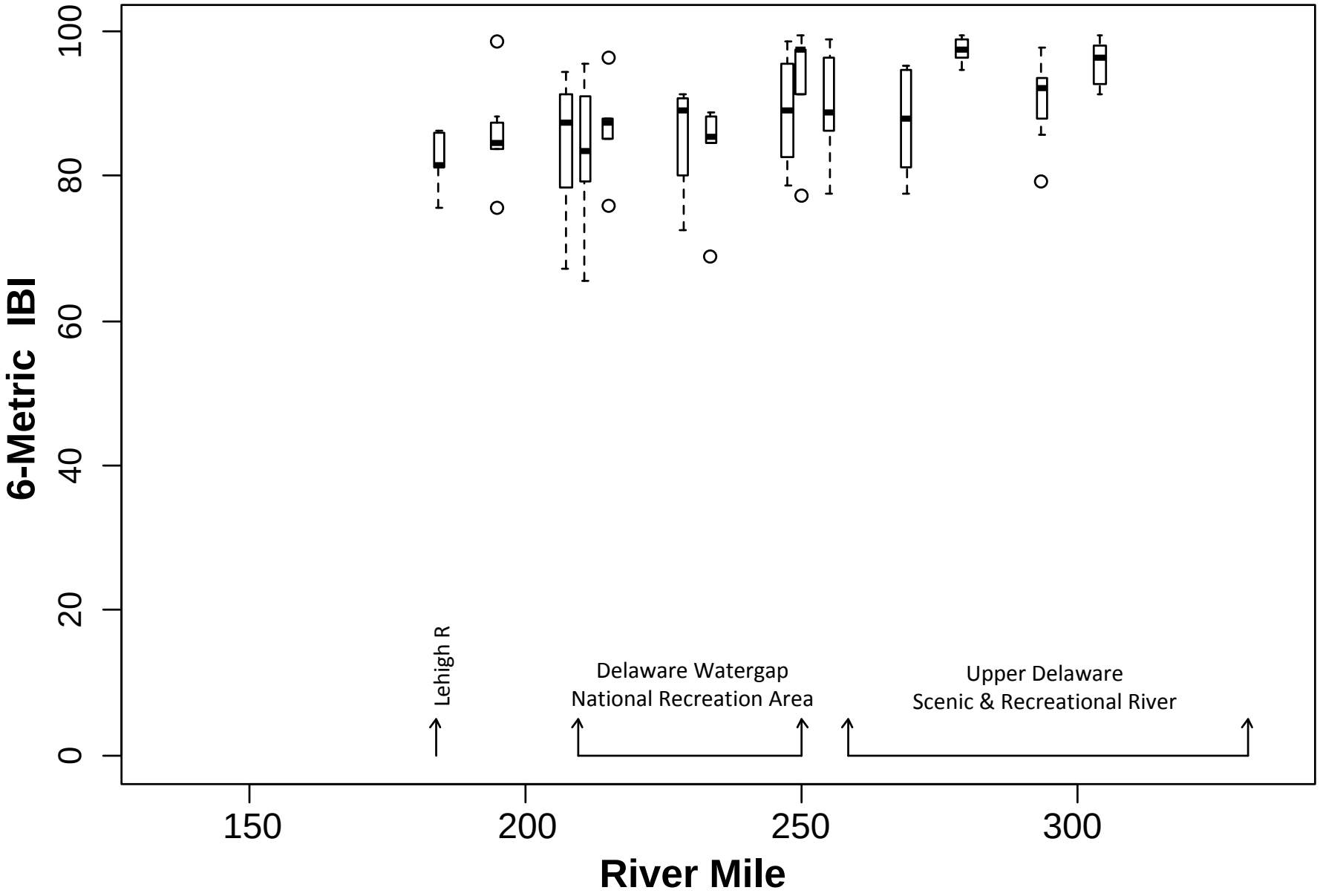
  ⇨ "Signal" established by the states

- **But select among them based on Delaware performance**

  ⇨ "Noise" quantified for Delaware data

- **Result: 6-metric IBI**
  - → Richness (rarefied)
  - → EPT Richness (rarefied)
  - → Shannon-Wiener Diversity
  - → Biotic Index (Hilsenhoff)
  - → % Intolerant Richness (0,1,2)
  - → Scraper Richness

IBI Performance at Reference Sites



Issue #3: How To Define "Too Much" Ecological Change?

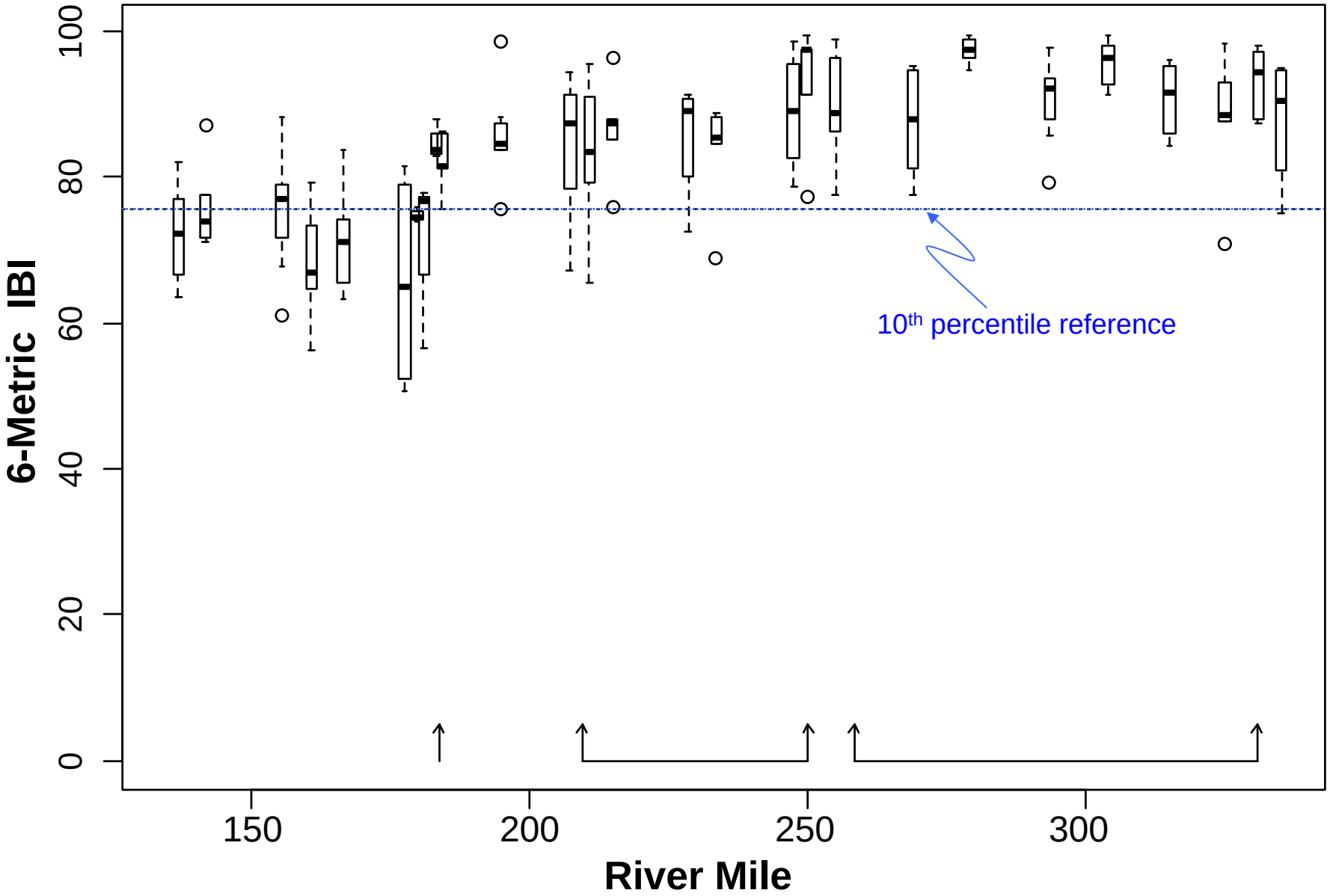
Options

- Draw from state or national thresholds
- Derive from an understanding of ecological system
- Expert workshop (e.g., TALU)
- Empirical based on data variability

Bioassessment Methodology

Threshold: 10th percentile of reference samples for 2001-2006 data

Decision Rule: 30% of samples from 2007-2009 below Threshold



Conclusions

Reference Designation

- Use the Delaware as a “reference” for itself
- Apply a single standard for 200 miles of non-tidal river

Ecological Change

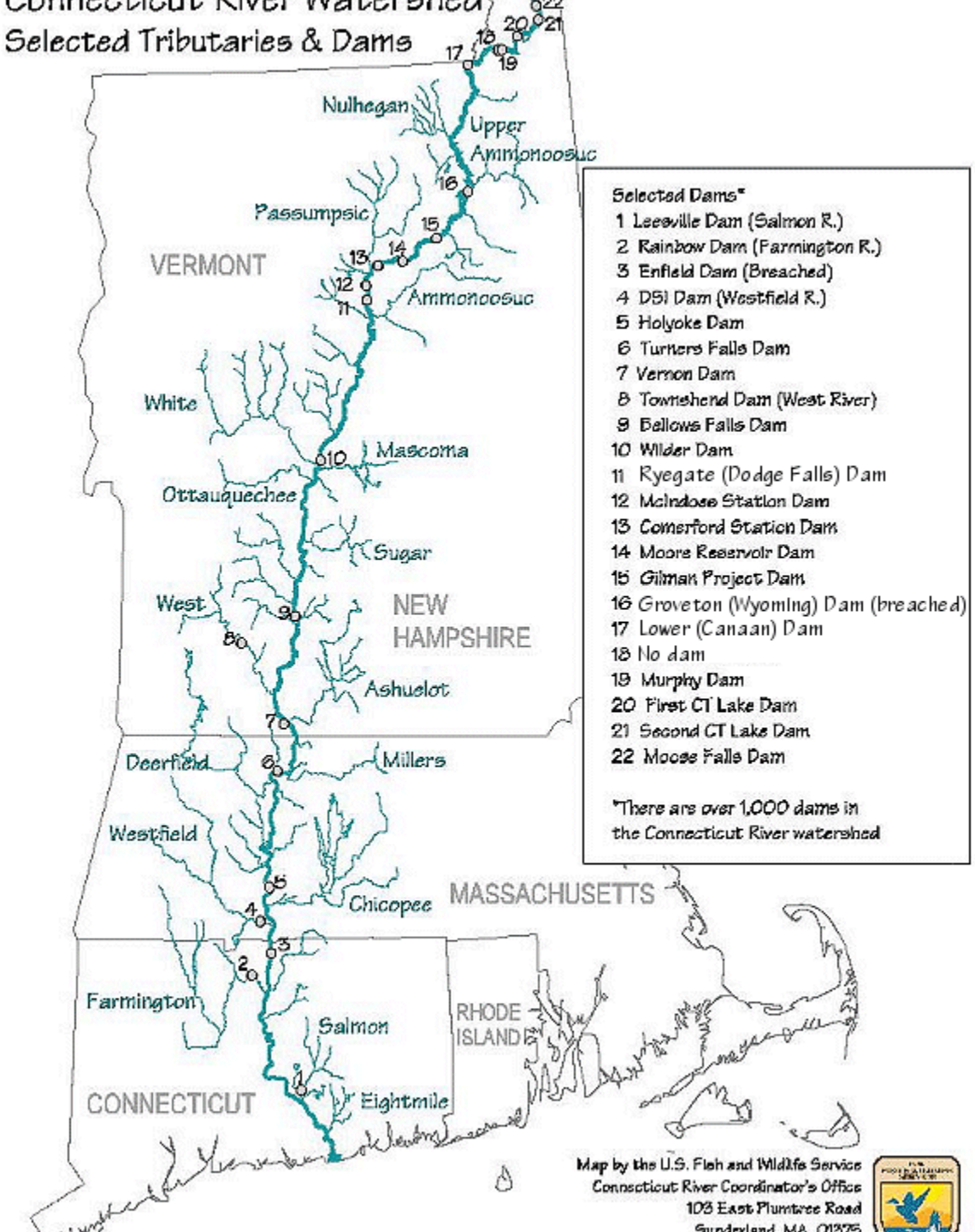
- Draw from States’ experience, but tailored to the Delaware

Impairment Threshold

- 3-fold increase in the frequency of “poor” samples

Acknowledgements

- Bob Limbeck & Geoff Smith (DRBC)
- Joe Flotemersch & Karen Blocksom (USEPA-ORD)
- Maggie Passmore (USEPA-R3)
- Al Korndoerfer (NJDEP) & Bio Subcommittee
- DRBC Summer Interns & DRBC Staff
- USEPA for funding


Connecticut River Watershed
Selected Tributaries & Dams
Nulhegan
Upper Ammonoosuc
Passumpsic
VERMONT
Ammonoosuc
White
Mascoma
Ottauquechee
Sugar
West
NEW HAMPSHIRE
Ashuelot
Deerfield
Millers
Westfield
Chicopee
MASSACHUSETTS
Farmington
Salmon
RHODE ISLAND
CONNECTICUT
Eightmile
Selected Dams*
1 Leeeville Dam (Salmon R.)
2 Rainbow Dam (Farmington R.)
3 Enfield Dam (Breached)
4 D51 Dam (Westfield R.)
5 Holyoke Dam
6 Turners Falls Dam
7 Vernon Dam
8 Townshend Dam (West River)
9 Bellows Falls Dam
10 Wilder Dam
11 Ryegate (Dodge Falls) Dam
12 McIndoes Station Dam
13 Comerford Station Dam
14 Moore Reservoir Dam
15 Gilman Project Dam
16 Groveton (Wyoming) Dam (breached)
17 Lower (Canaan) Dam
18 No dam
19 Murphy Dam
20 First CT Lake Dam
21 Second CT Lake Dam
22 Moose Falls Dam
*There are over 1,000 dams in the Connecticut River watershed
Map by the U.S. Fish and Wildlife Service
Connecticut River Coordinator's Office
103 East Plumtree Road

Reservoir Influence: *Didymo & Cymbella*

Category	Metric	PA	NJ	NY
Structure	Richness	Y	Y	Y
	EPT Richness	Y	Y	Y
	Ephemeroptera Richness	Y		
	Trichoptera Richness	Y		
	Invertebrate Richness			
Composition	EPT % Abundance		Y	
	Shannon-Wiener Diversity	Y		Y
	Dominance-3		Y	Y
Tolerance	Biotic Index (Hilsenhoff)	Y	Y	Y
	Beck's Index	Y	Y	
	Intolerant % Richness			
	Intolerant % Abundance	Y		
	Tolerant % Richness			
	Tolerant % Abundance	Y		
Functional	Scraper Richness		Y	