

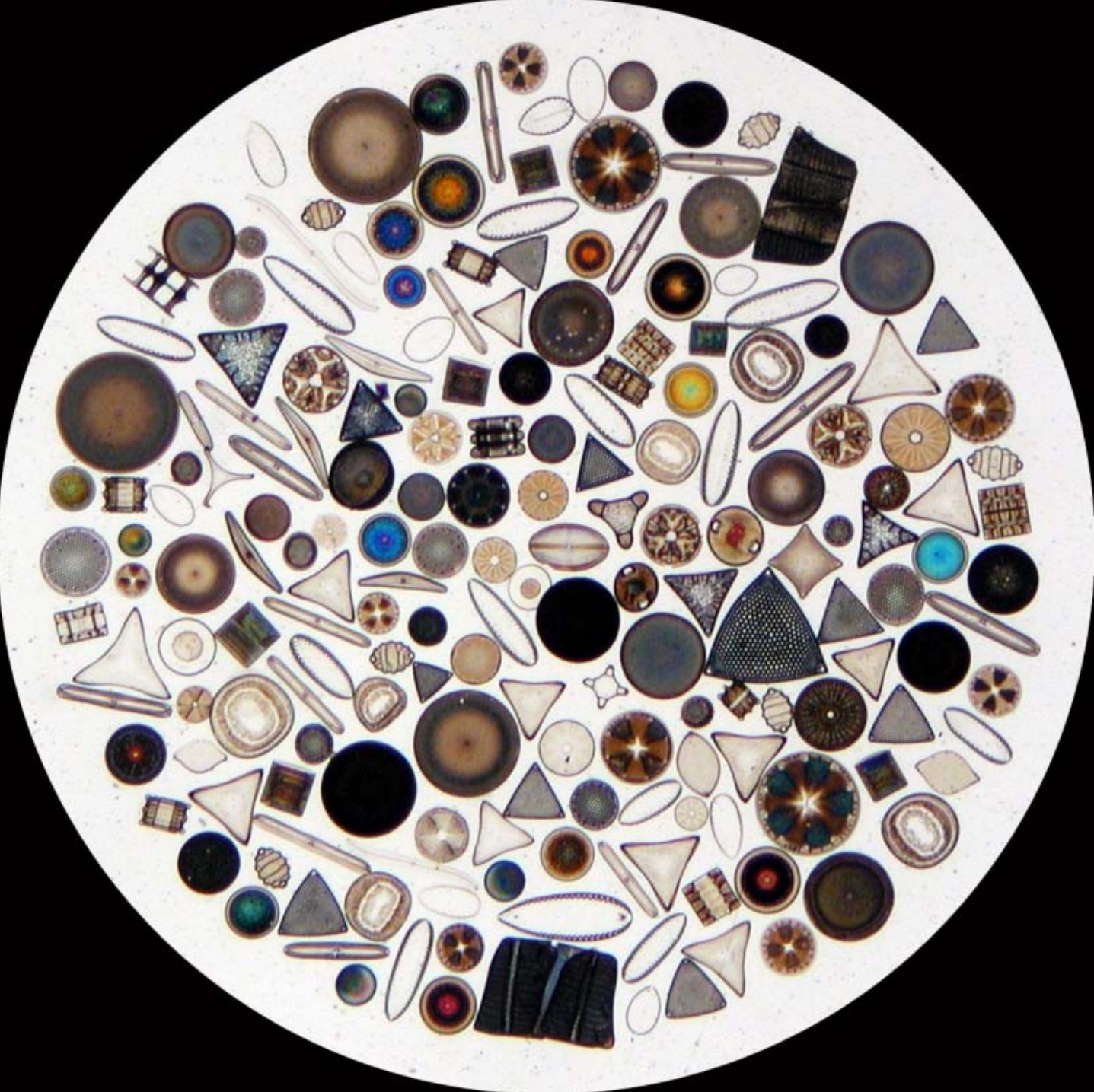
Diatoms as Water Quality  
Indicators:  
New Jersey Rivers and Streams

Don Charles

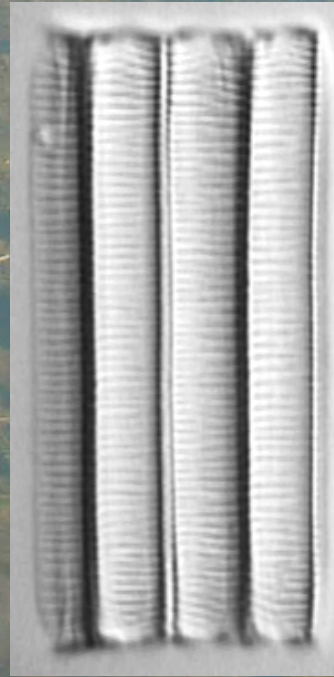
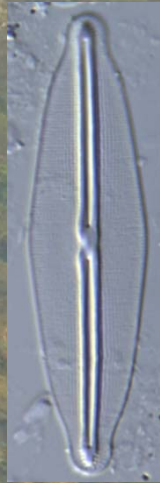
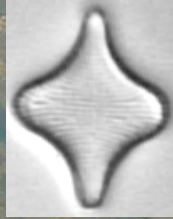
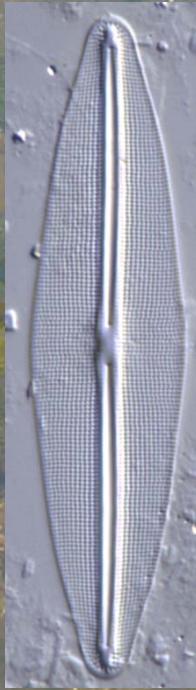
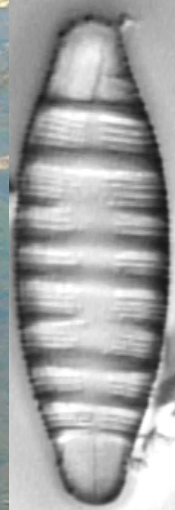
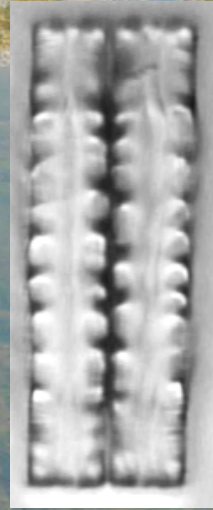
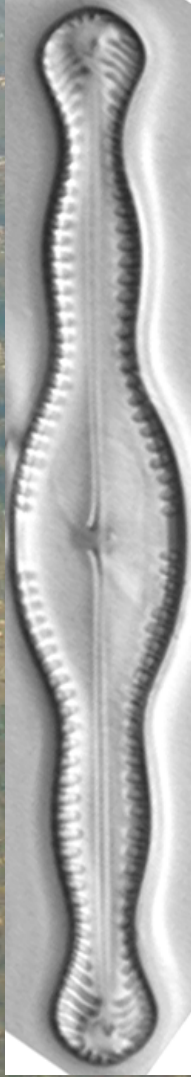
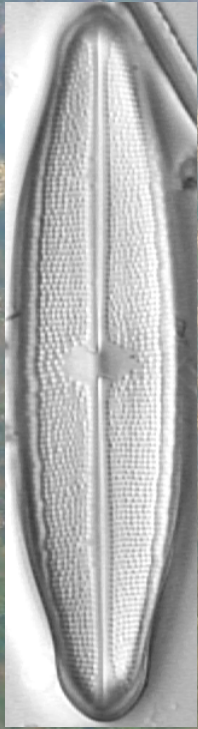
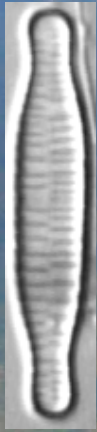
Patrick Center for Environmental Research  
Academy of Natural Sciences  
Philadelphia, PA

# Questions / Outline

- What are diatoms? Why are they good indicators?
- How do you do the work? - field, lab, development and application of indicators
- New Jersey diatom research
  - Nutrient indicators
  - Impairment indicators (BCG)



# Diatoms







Diatoms on *Cladophora*

# Advantages of Diatoms as Ecological Indicators

- | Important ecosystem components
- | Widely distributed in many habitats
- | Siliceous remains preserve well
- | Identifiable to lowest taxonomic level
- | Many taxa / Large number of individuals
- | Strong correlations with environmental characteristics / Sensitive to stress
- | Rapid response to change / Diagnostic
- | Efficient storage of representative assemblages

Northern NJ

Sample substrate : rocks

Karin  
Ponader







Southern New Jersey  
Sampling Substrate:  
Diatometer and  
Sand / silt

# Diatoms

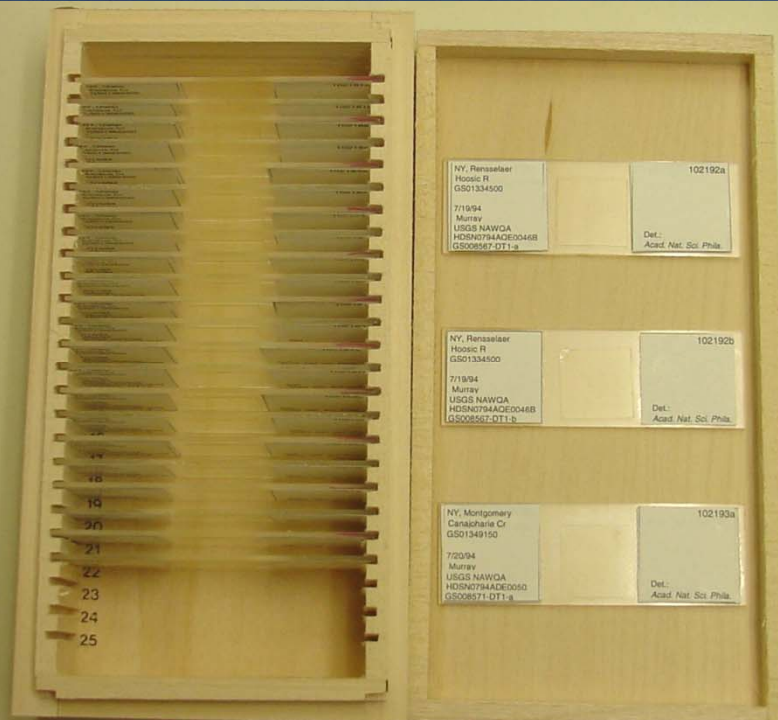
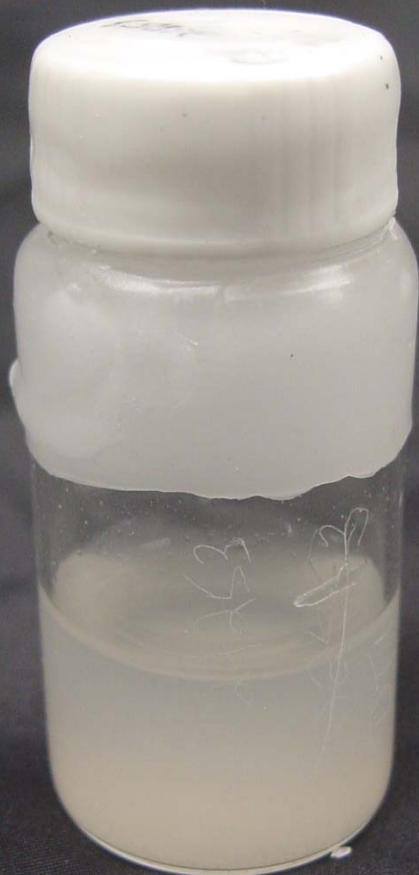


NY, Rensselaer  
Hoosic R  
GS01334500

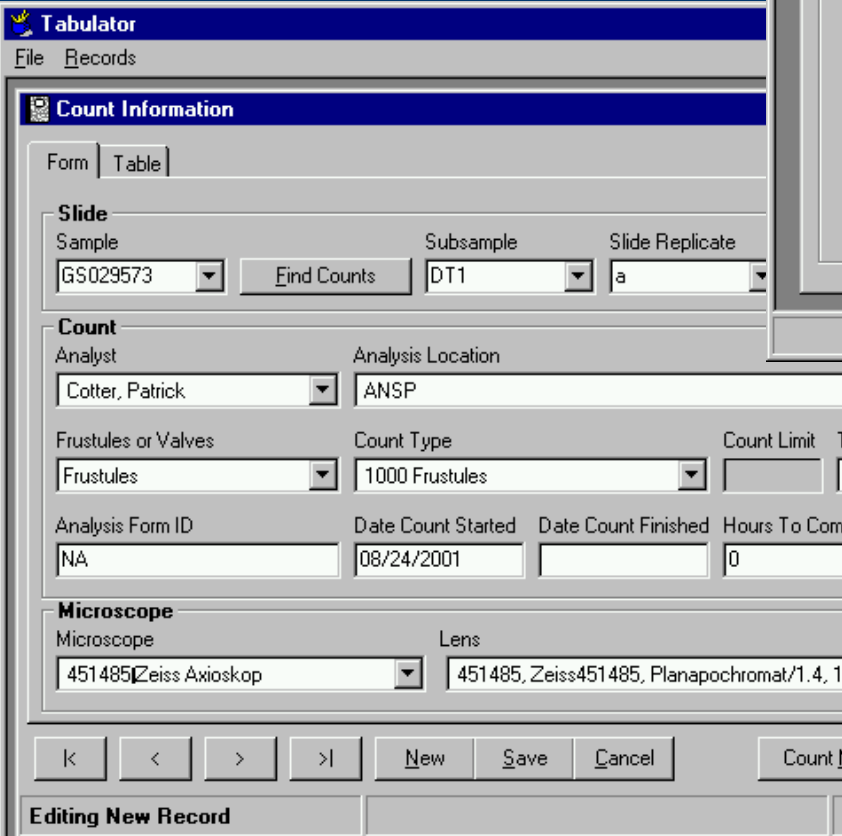
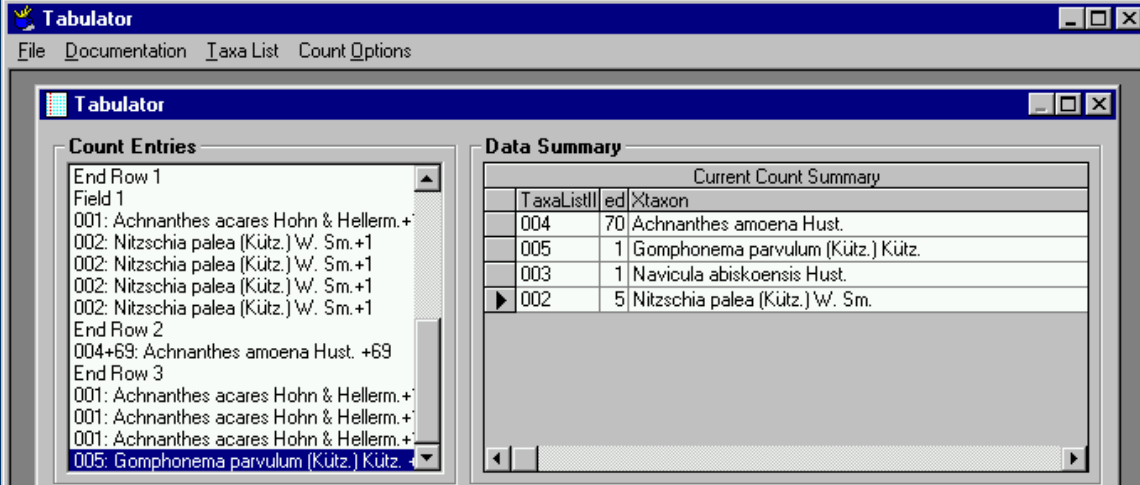
7/19/94  
Murray  
USGS NAWQA  
HDSN0794AQE0046B  
GS008567-DT1-b

102192b

Det.:  
*Acad. Nat. Sci. Phila.*



# “Tabulator” program for entering diatom counts and documentation information



# North American Diatom Ecological Database - NADED

Phycology Section, Patrick Center For Environmental Research - ANSP

## Diatom Count Report

Water Body: Assumpink Creek      Site Location ID: NJAN0118      Sample Label: NJ\_118\_1  
Sample ID: NJ000009      Client Sample ID: AN0118  
Date Sample Collected: 10/3/00      Count Finished: 3/6/01  
Subsample ID: DT1      Slide Replicate ID: 1      Count Replicate ID: 1  
Counted by: Karin C Ponader (KCP)      Sample Type:

Master NADED Number	Taxon Name	Percent	Count
2015	<i>Achnanthes lanceolata</i> (Bréb. in Kütz.) Grun.	0.83	5
2224	<i>Achnanthes lanceolata</i> subsp. frequentissima Lange-Bert.	1.67	10
2026	<i>Achnanthes pusilla</i> (Grun.) DeT.	0.67	4
2132	<i>Achnanthes subhudsonis</i> var. krauselii Chohn.	3.33	20
12001	<i>Caloneis bacillum</i> (Grun.) Cl.	1.17	7
20012	<i>Cyclotella pseudostelligera</i> Hust.	0.33	2
<b>37197</b>	<b><i>Gomphonema kobayasii</i> Kociolek &amp; Kingston</b>	<b>29.50</b>	<b>177</b>
37010	<i>Gomphonema parvulum</i> (Kütz.) Kütz.	1.00	6
<b>130001</b>	<b><i>Luticola goeppertiana</i> (Bleisch in Rabh.) Mann</b>	<b>7.50</b>	<b>45</b>
44073	<i>Melosira varians</i> Ag.	0.17	1
46421	<i>Navicula agrestis</i> Hust.	0.17	1
46003	<i>Navicula arvensis</i> Hust.	0.33	2
46661	<i>Navicula capitatoradiata</i> Germain	0.17	1
<b>46023</b>	<b><i>Navicula gregaria</i> Donk.</b>	<b>8.00</b>	<b>48</b>
<b>46039</b>	<b><i>Navicula minima</i> Grun.</b>	<b>19.00</b>	<b>114</b>
46649	<i>Navicula recens</i> Lange-Bert.	0.33	2
46562	<i>Navicula subminuscula</i> Mang.	0.67	4
46400	<i>Navicula symmetrica</i> Patr.	0.33	2
48347	<i>Nitzschia acidoclinata</i> Lange-Bert.	0.50	3
48004	<i>Nitzschia amphibia</i> Grun.	3.83	23
48025	<i>Nitzschia palea</i> (Kütz.) W. Sm.	2.50	15
186008	<i>Psammothidium subatomoides</i> Hüst.) Bukht. et Round	1.17	7
57001	<i>Rhoicosphenia curvata</i> (Kütz.) Grun. ex Rabh.	0.67	4
<b>170014</b>	<b><i>Sellaphora seminulum</i> (Grun.) Mann</b>	<b>14.17</b>	<b>85</b>
66053	<i>Synedra delicatissima</i> var. angustissima Grun.	0.67	4
66018	<i>Synedra rumpens</i> var. familiaris (Kütz.) Hust.	1.33	8
Report Date: 4/9/01	Total Number of Taxa: 26	Total Number Counted:	600

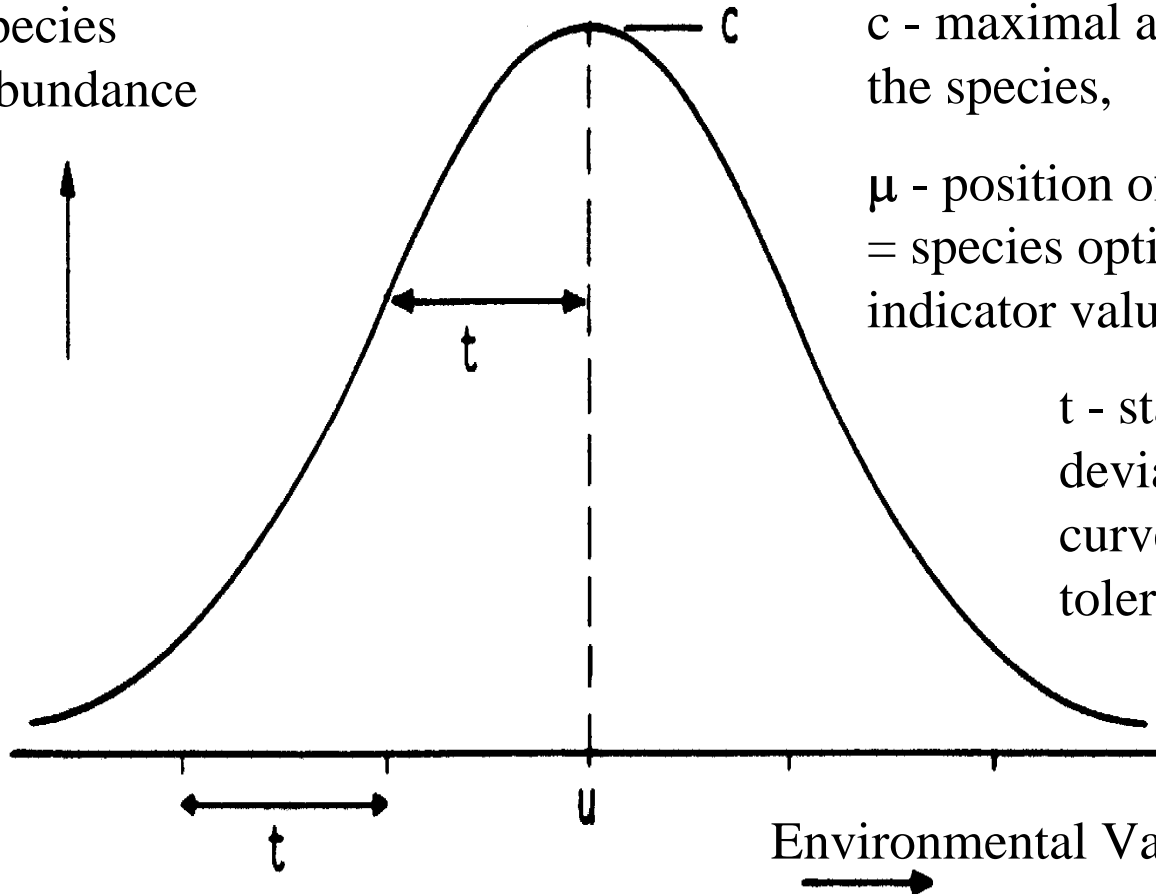
# Periphyton Metrics

- | Taxa richness / Diversity
- | Percent Similarity wrt reference conditions
- | Indicator taxa
- | Percent sensitive species
- | Pollution Index / Pollution Tolerance Index
- | Siltation Index (motile diatoms)
- | Multivariate approaches (e.g., CCA)
- | Autecological indices (e.g., prefer high nutrients)
- | Inference models (Weighted Averaging)

# Diatoms as indicators of environmental conditions: What is a species indicator value?

## Gaussian response curve:

Species  
Abundance

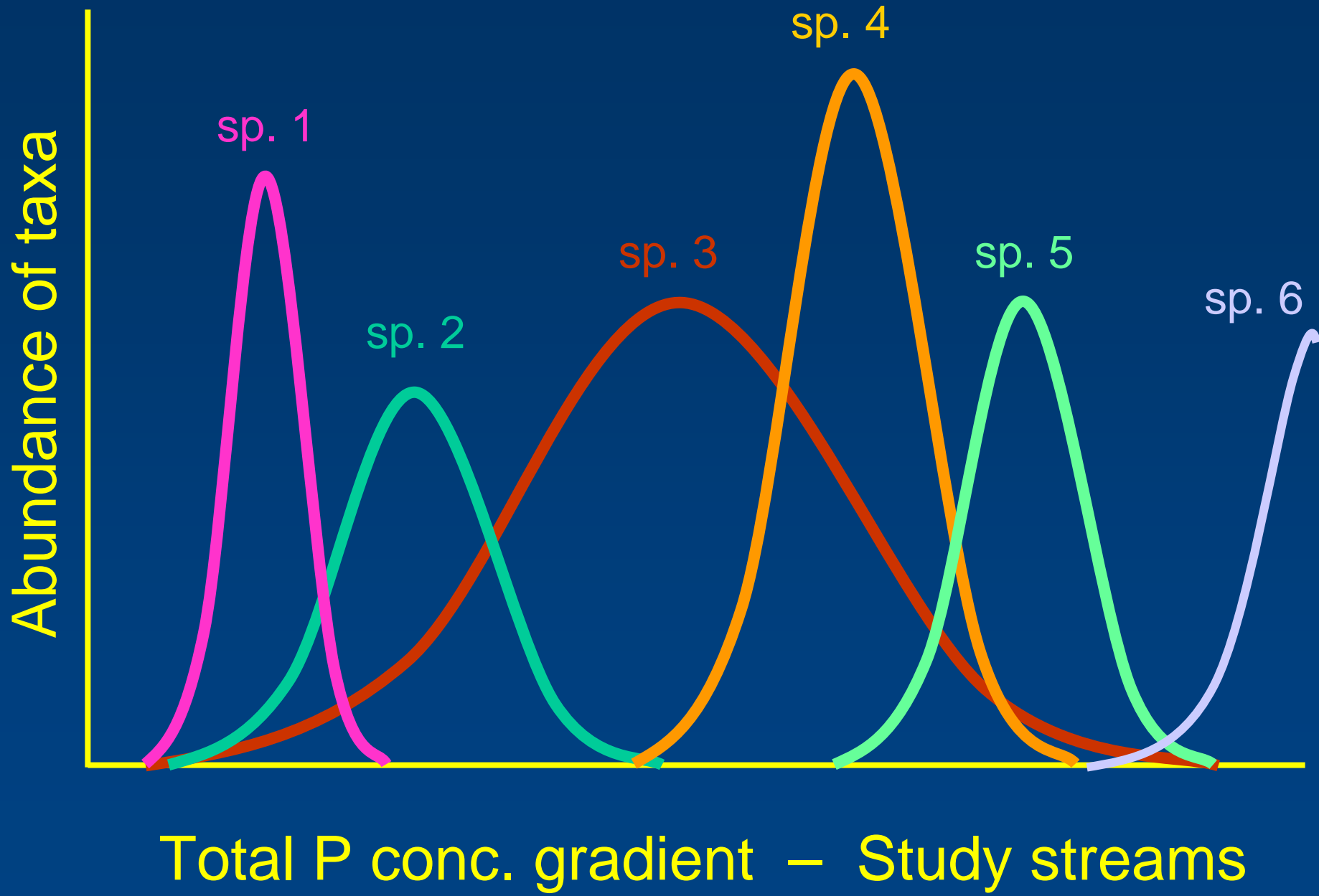


$c$  - maximal abundance of  
the species,

$\mu$  - position of the mode  
= species optimum, or  
indicator value

$t$  - standard  
deviation of the  
curve, or species  
tolerance

Environmental Variable

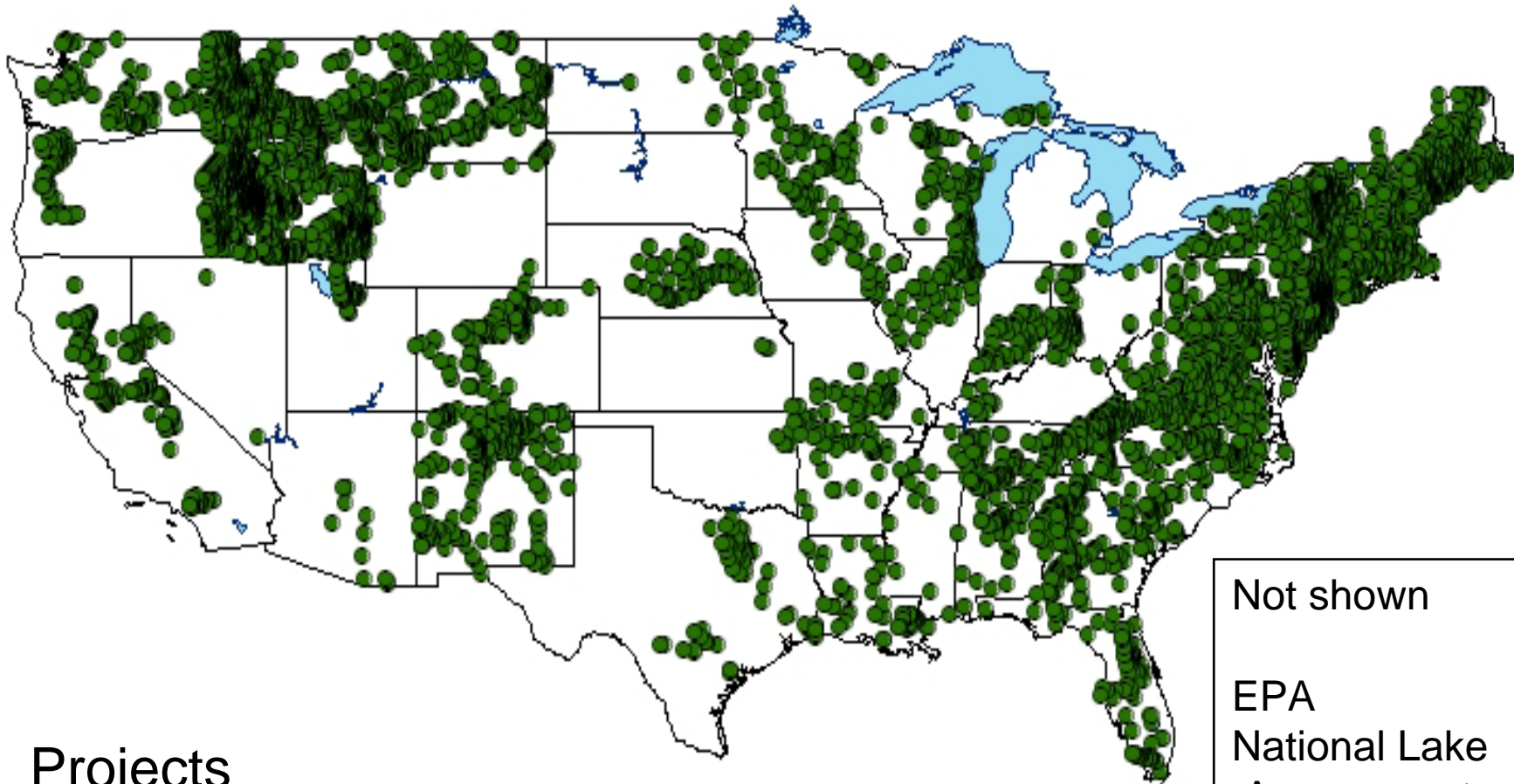




Ruth Patrick



# Diatom Sample Sites – ANSP Database

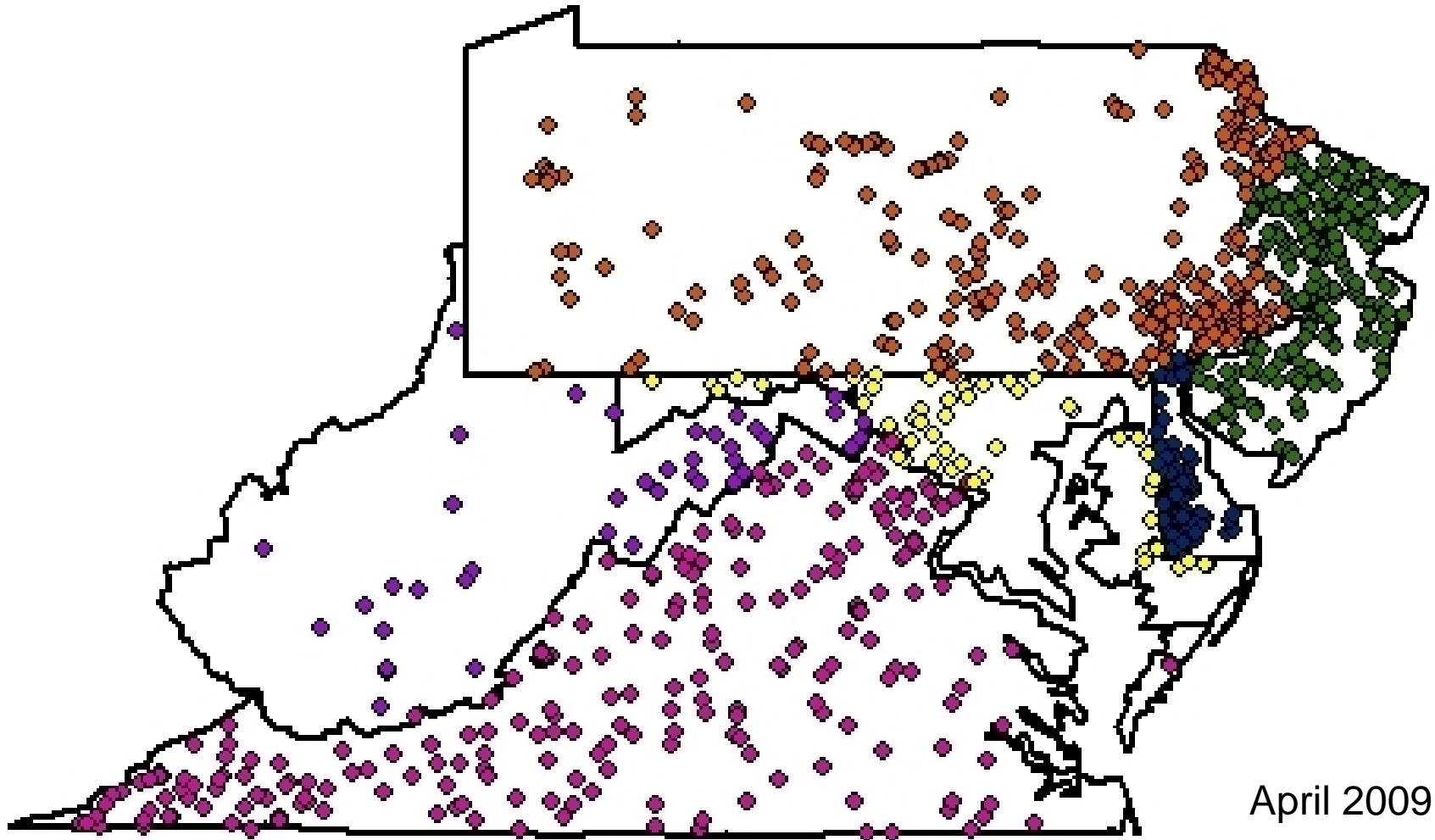


## Projects

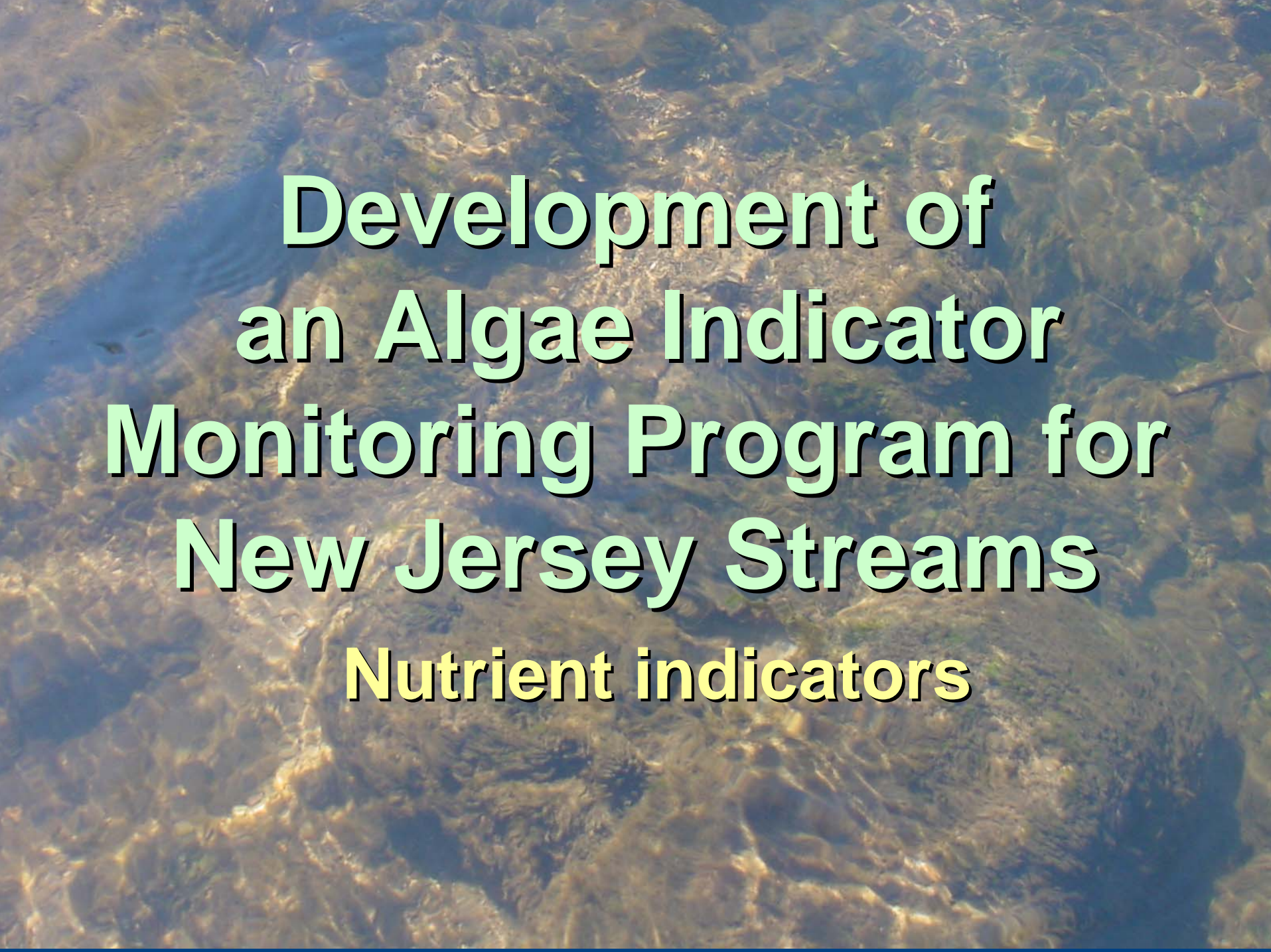
USGS National Water Quality Assessment (NAWQA)  
States: DE, ID, ME, MD, MT, NM, NY, NJ, VA  
ANSP River studies (R. Patrick)

Not shown
EPA National Lake Assessment
National River and Stream Assessment

# ANSP Diatom Study Sites in and near the Chesapeake Watershed



April 2009

An aerial photograph of a stream with dense, green, filamentous algae growing in the water. The water is a deep blue-green color, and the algae appears as a thick, textured layer covering the stream bed. The text is overlaid on the image.

**Development of  
an Algae Indicator  
Monitoring Program for  
New Jersey Streams**

**Nutrient indicators**

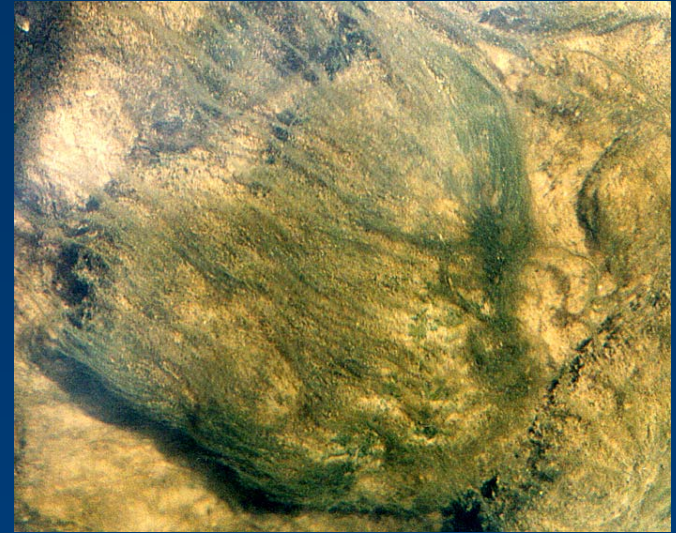
- **Problem:** Excess algal biomass and community change
- **Cause:** Nutrient (P and N) from sewage treatment plants, industries, agriculture, fertilizer, urban runoff
- **Solution:** Nutrient standards to limit inputs



# Algal indicators of nutrient conditions

## New Jersey needs:

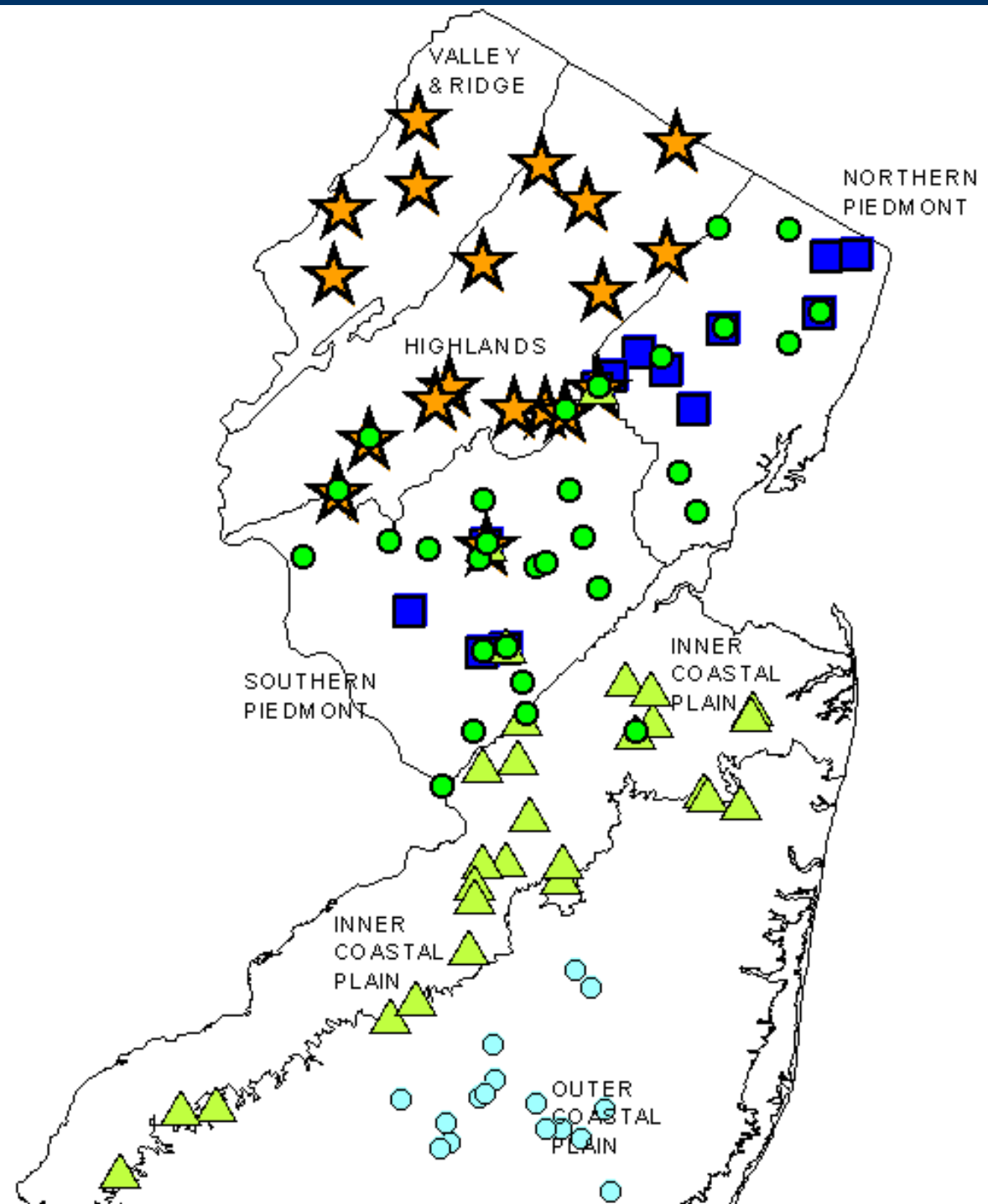
- Monitoring and regulatory tools
- Accurately characterize nutrient enrichment and biological response
  - determine impairment
  - diagnose cause of impairment
- Consistent with State nutrient criteria



# Study sites 2000 – 2004

Piedmont	28
Ridge & Val.	5
Highlands	12
Coastal Plain	34

Total:  
79 streams,  
13  
resampled





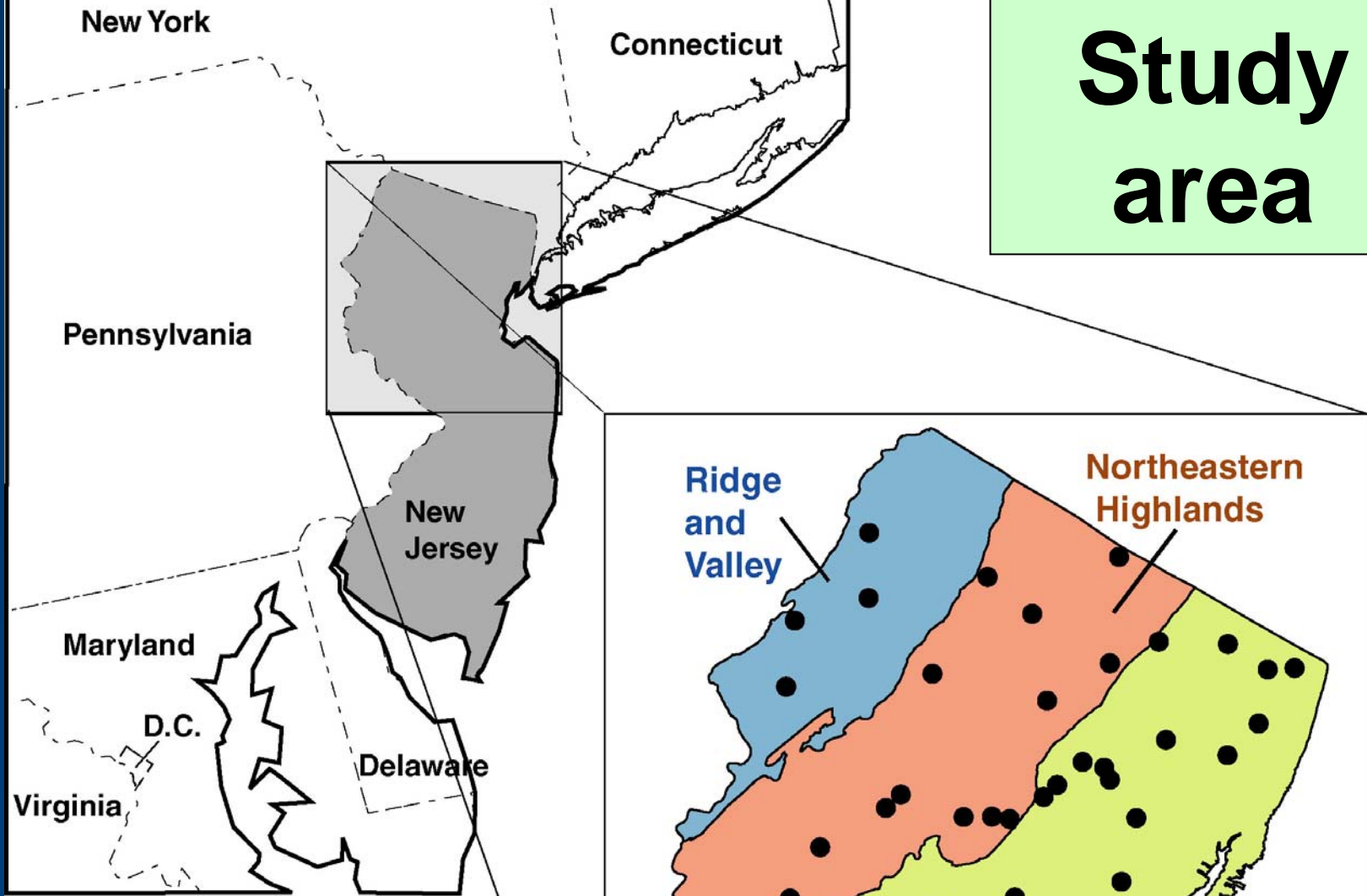




# Field sampling

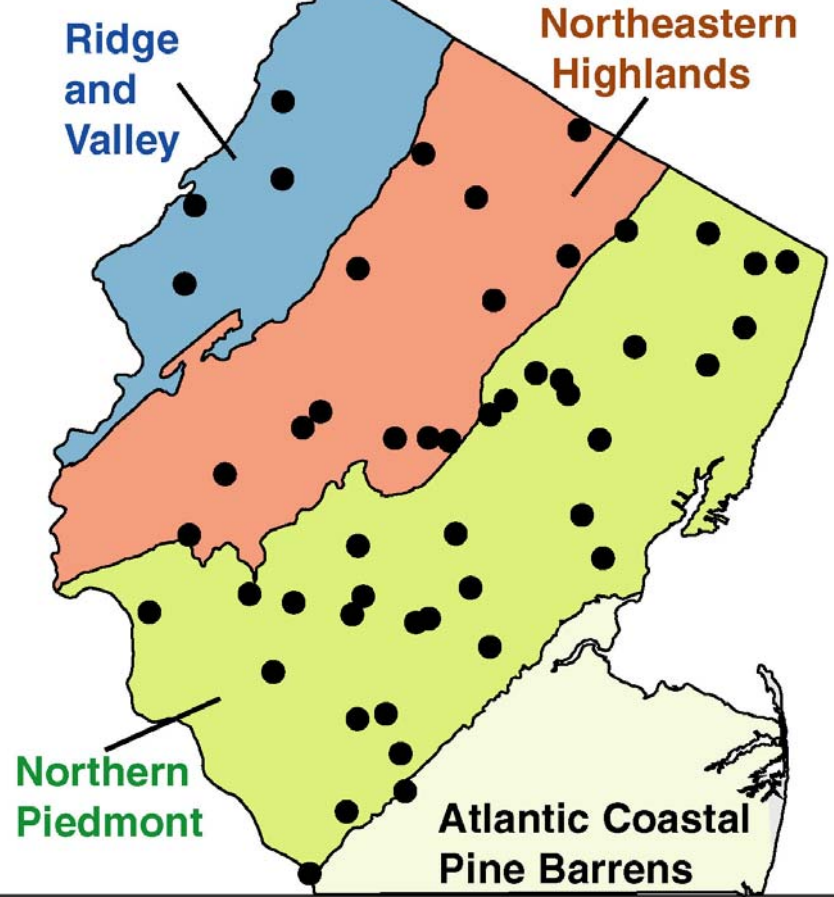
- Width, depth, velocity range
- Substrate, canopy cover
- Nutrients – several forms of N and P
- Composite algal sample for chl *a*, AFDM, and filamentous algae taxa
- Composite sample for diatom analysis
- Visual estimate of algal abundance along transects

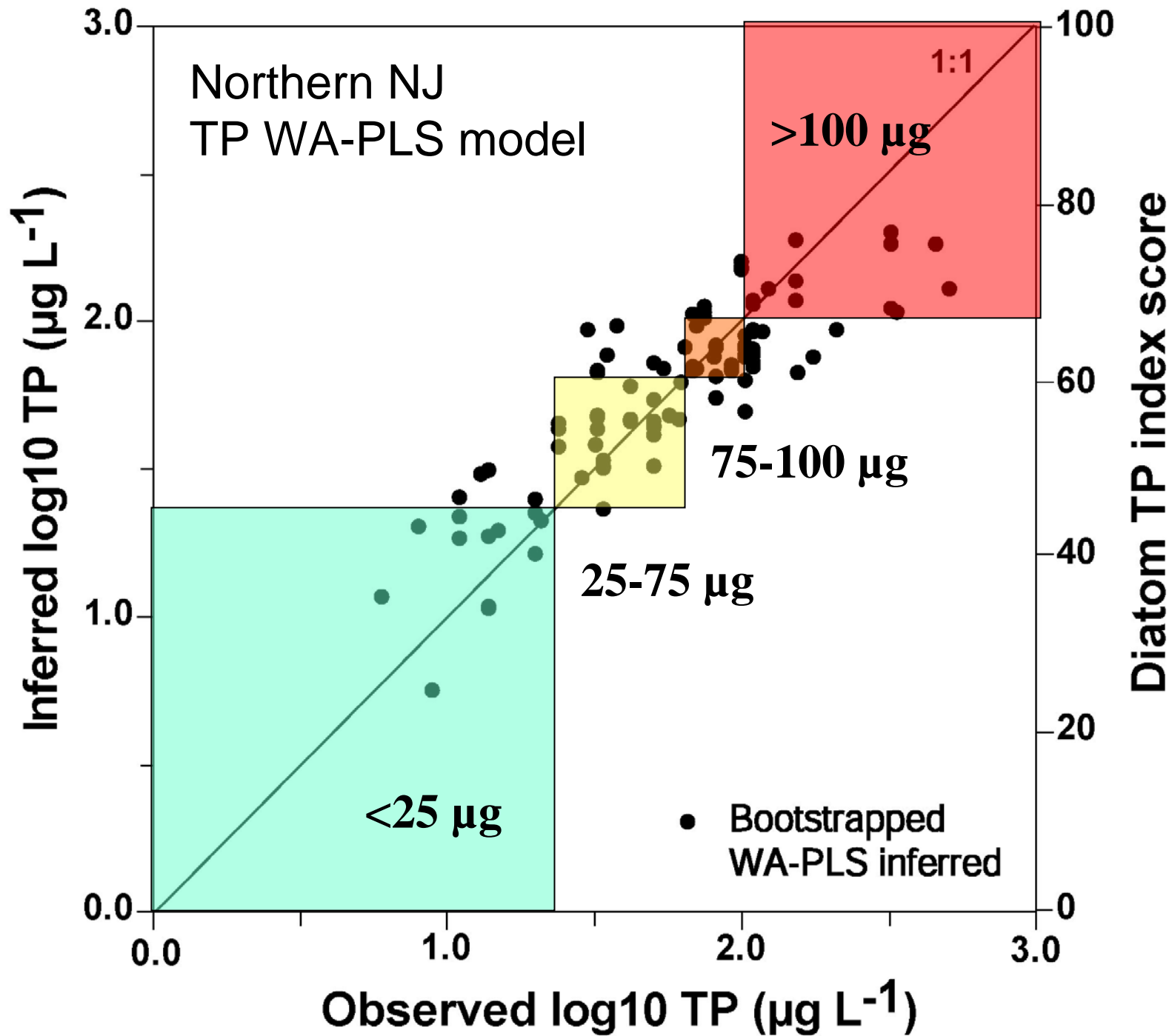
# Study area



**45 sites**

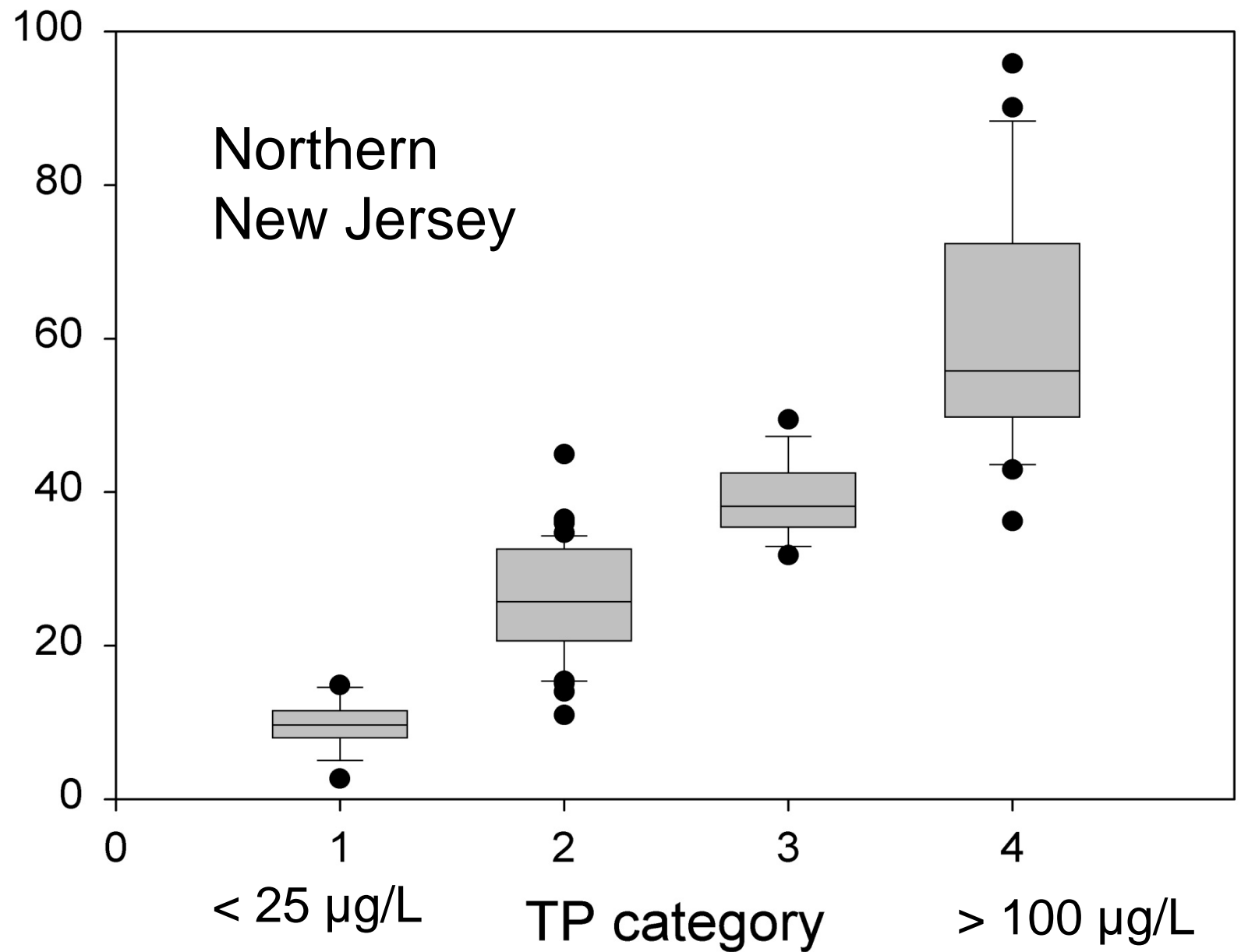
**101 samples**



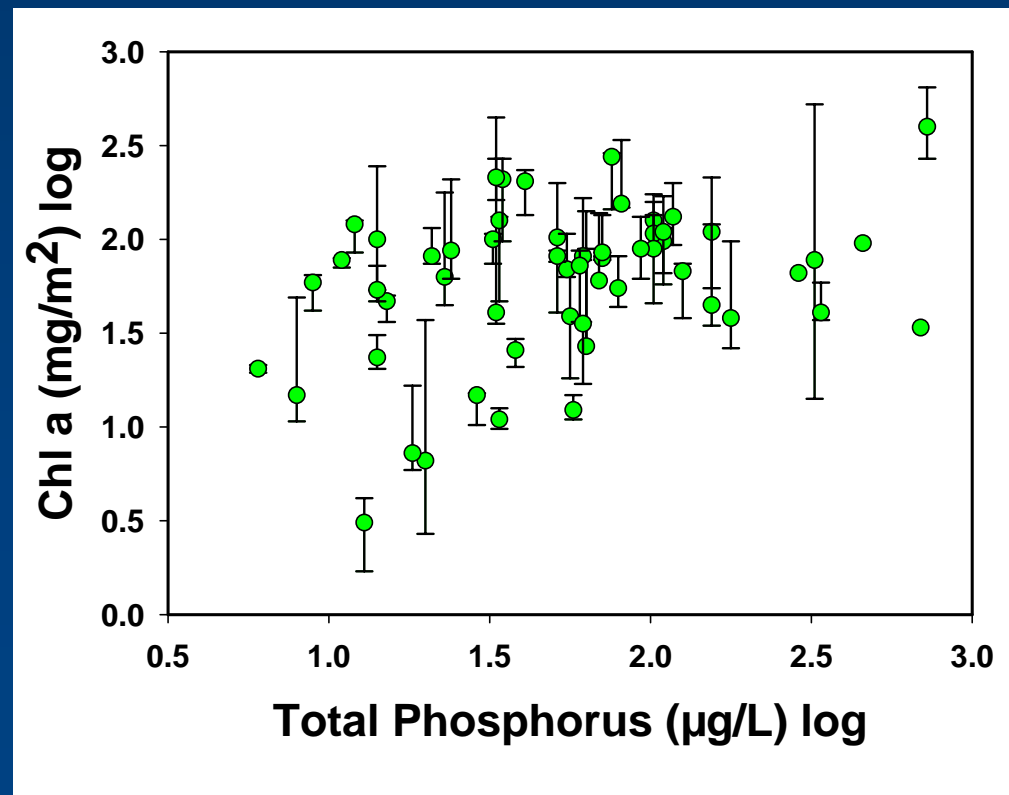
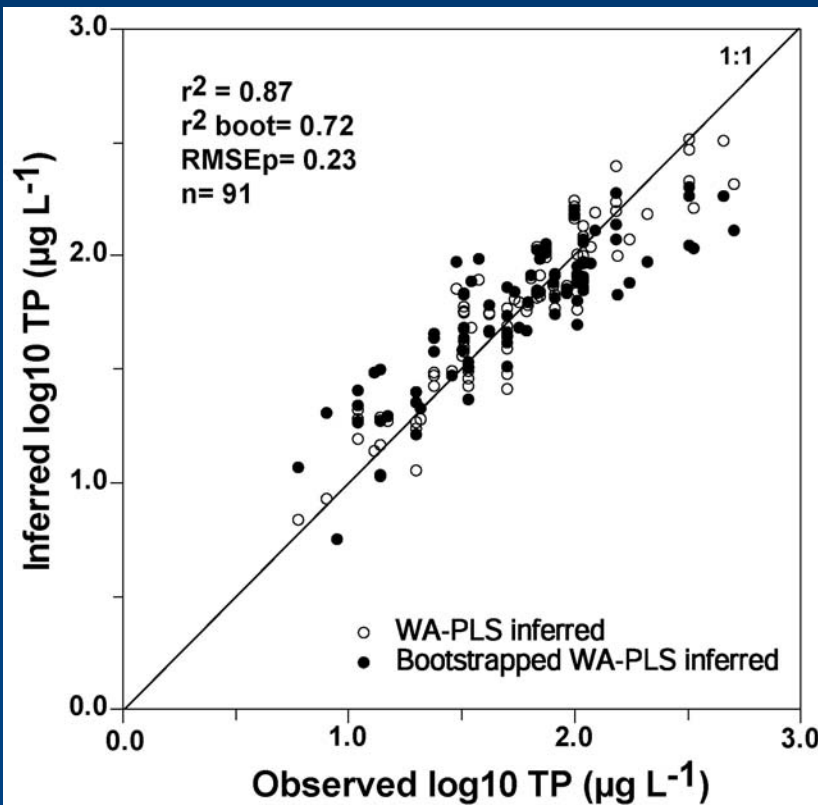


Diatom Phosphorus Index

Northern  
New Jersey



# Relationship between total phosphorus and diatom taxa composition is stronger than with chlorophyll a



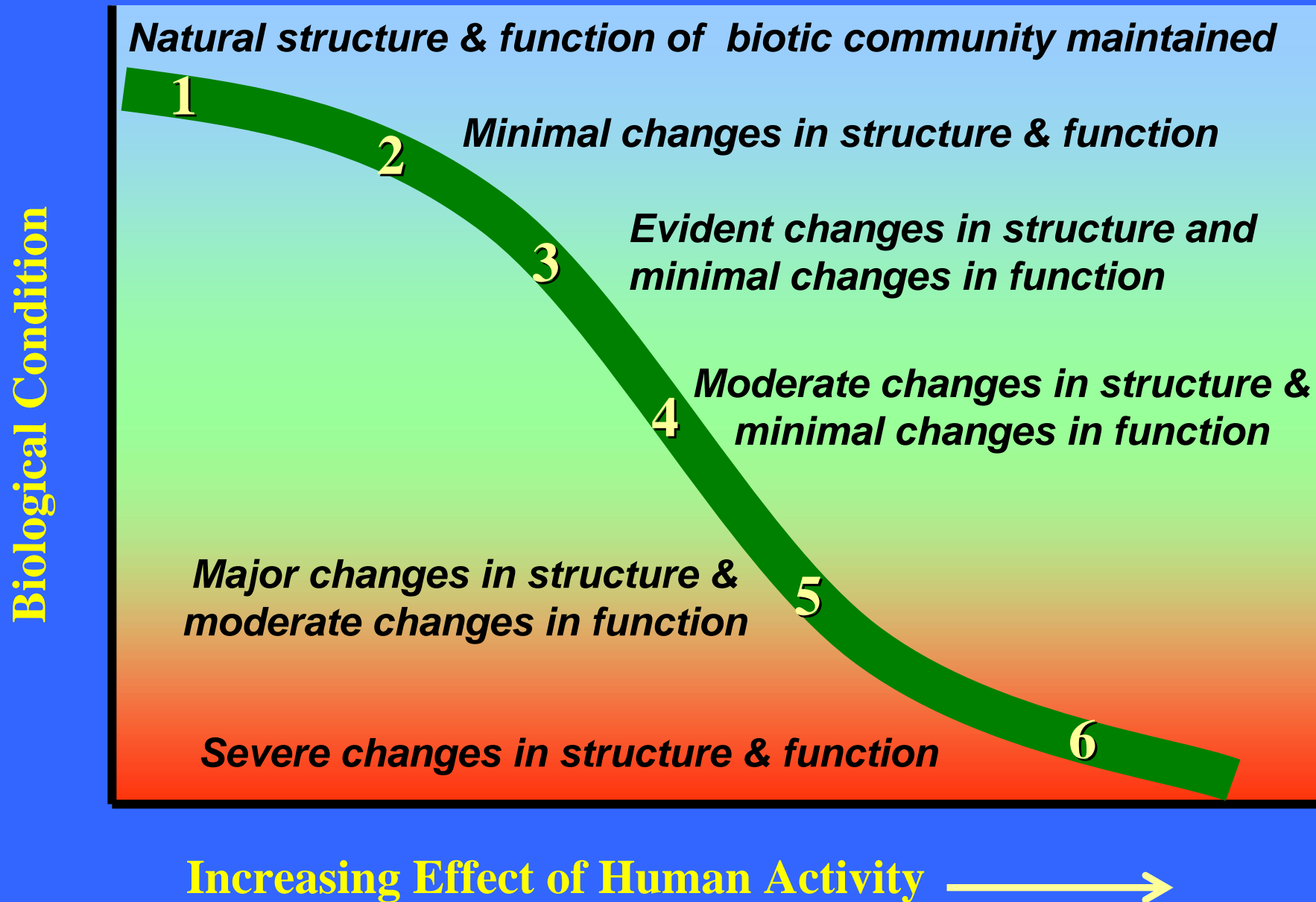
# New Jersey Diatom TALU

## Using the Biological Condition Gradient Approach

**Patrick Center for Environmental Research,  
Academy of Natural Sciences of Philadelphia**

**New Jersey Department of Environmental Protection  
Trenton, NJ**

# The Biological Condition Gradient – Concept



# Diatom TALU Approach

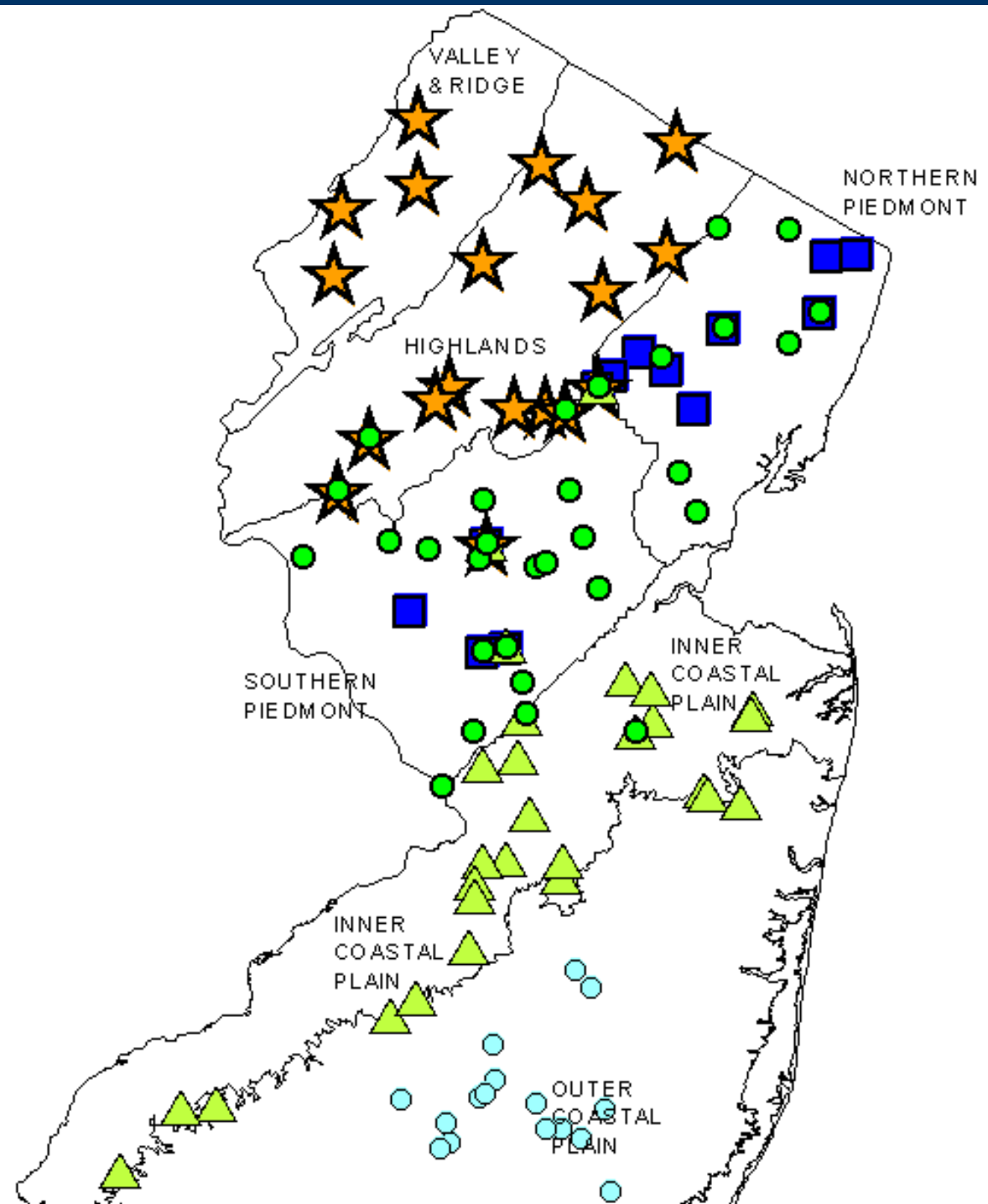
- Examine variation in natural characteristics; basis for classification?
- Define stressor gradients
- Develop autecological data; assign taxa to Biological Condition Gradient (BCG) attributes
- Workshop of diatom experts to assign sites to BCG categories and review taxa attributes
- Develop rules for using % taxa in BCG's to assign sites; BCG cat's, and nutrient criteria



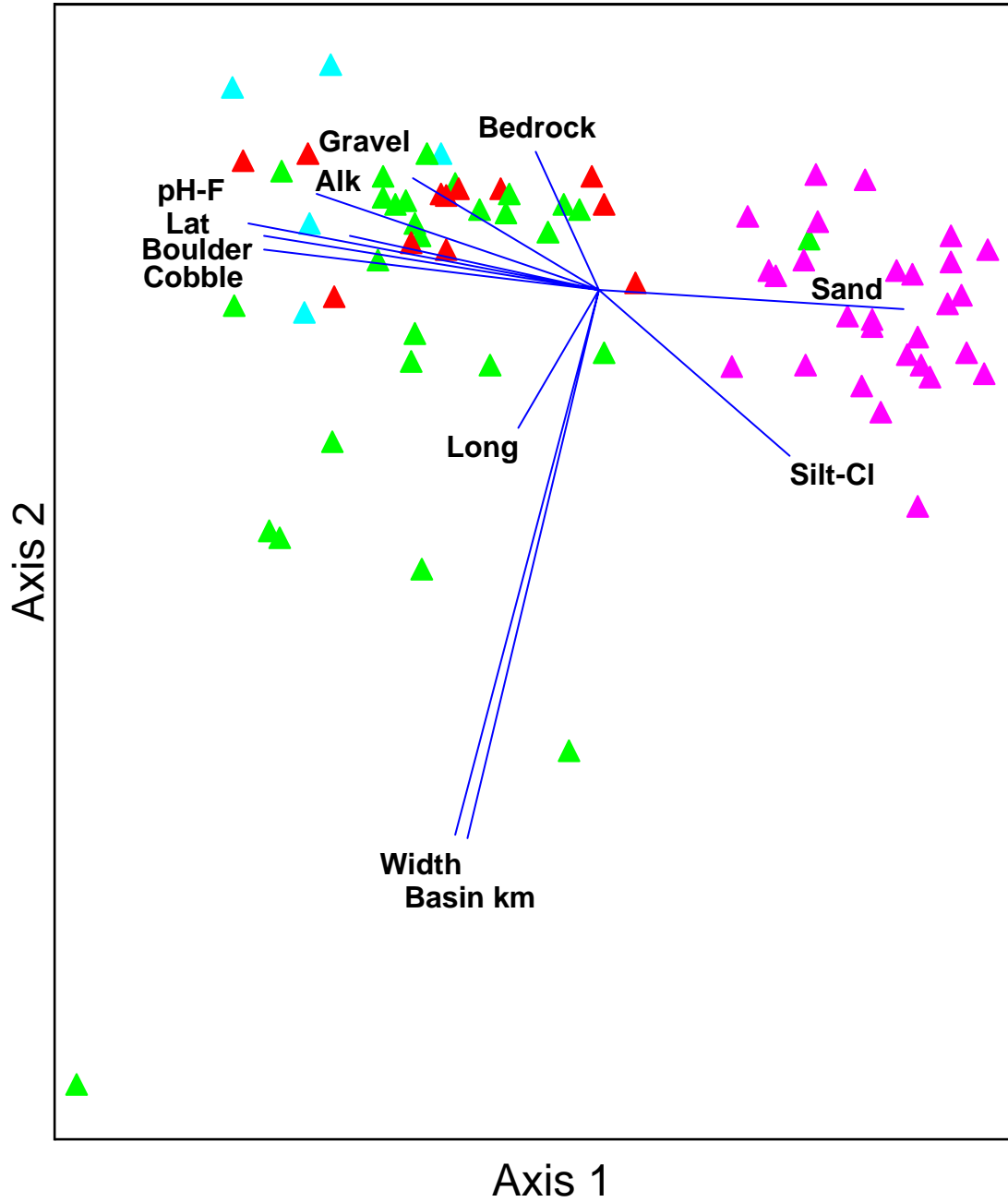
# Study sites 2000 – 2004

Piedmont	28
Ridge & Val.	5
Highlands	12
Coastal Plain	34

Total:  
79 streams,  
13  
resampled



PCA AMNET 7 NatChars data not trans 27June09

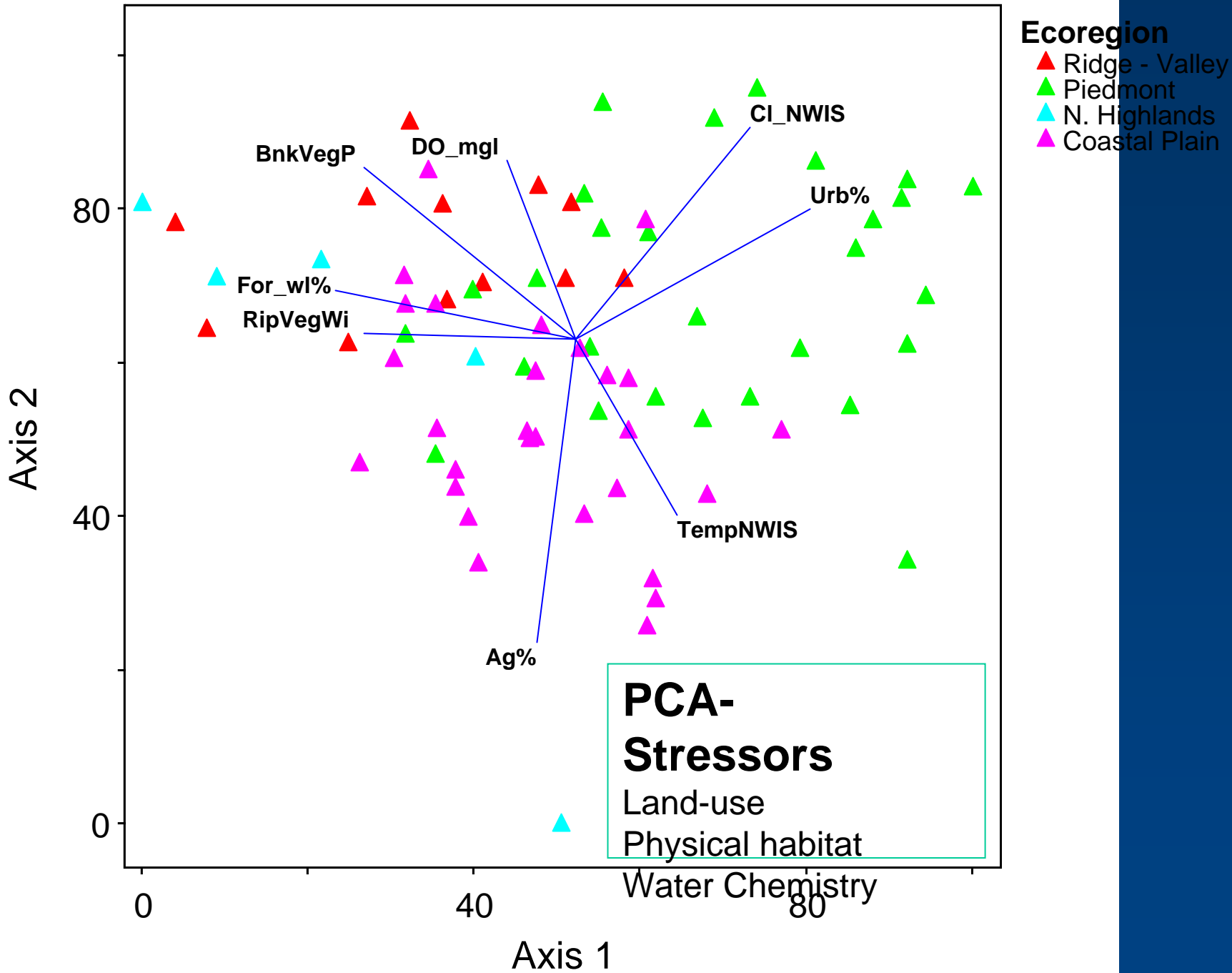


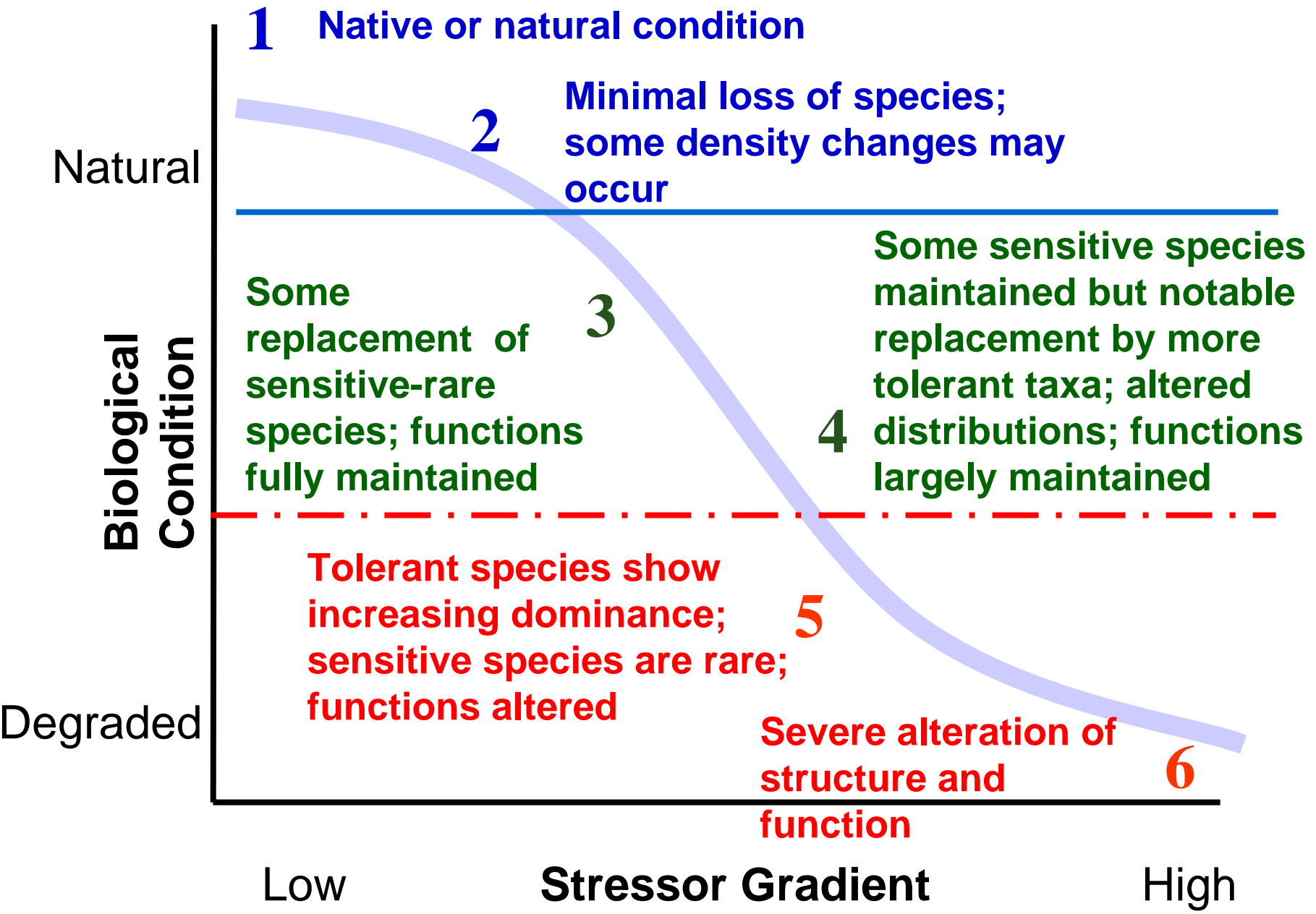
Ecoregion

- ▲ Highlands
- ▲ Piedmont
- ▲ Ridge-Valley
- ▲ Coastal Plain

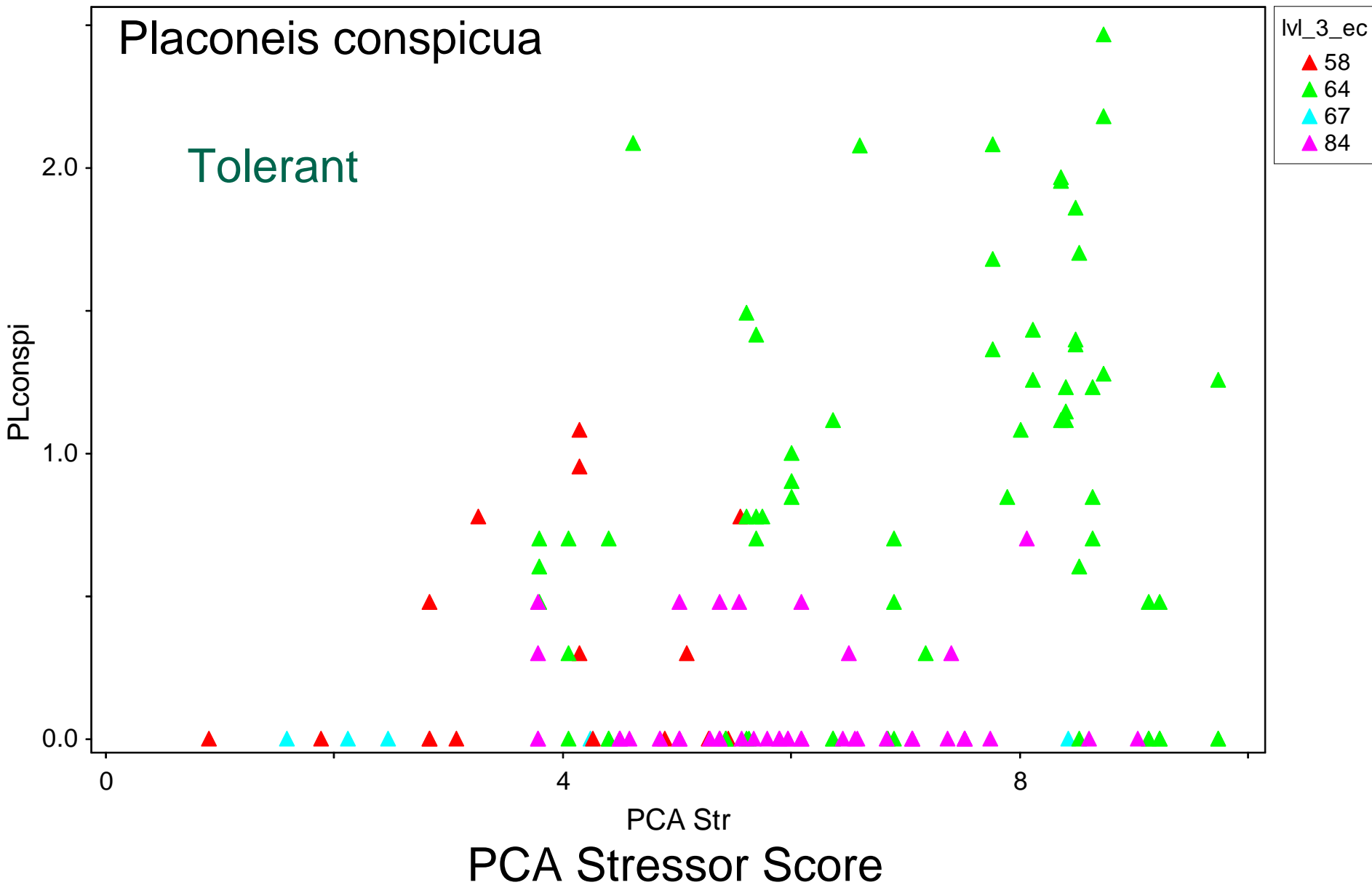
Classification of sites

Natural characteristics

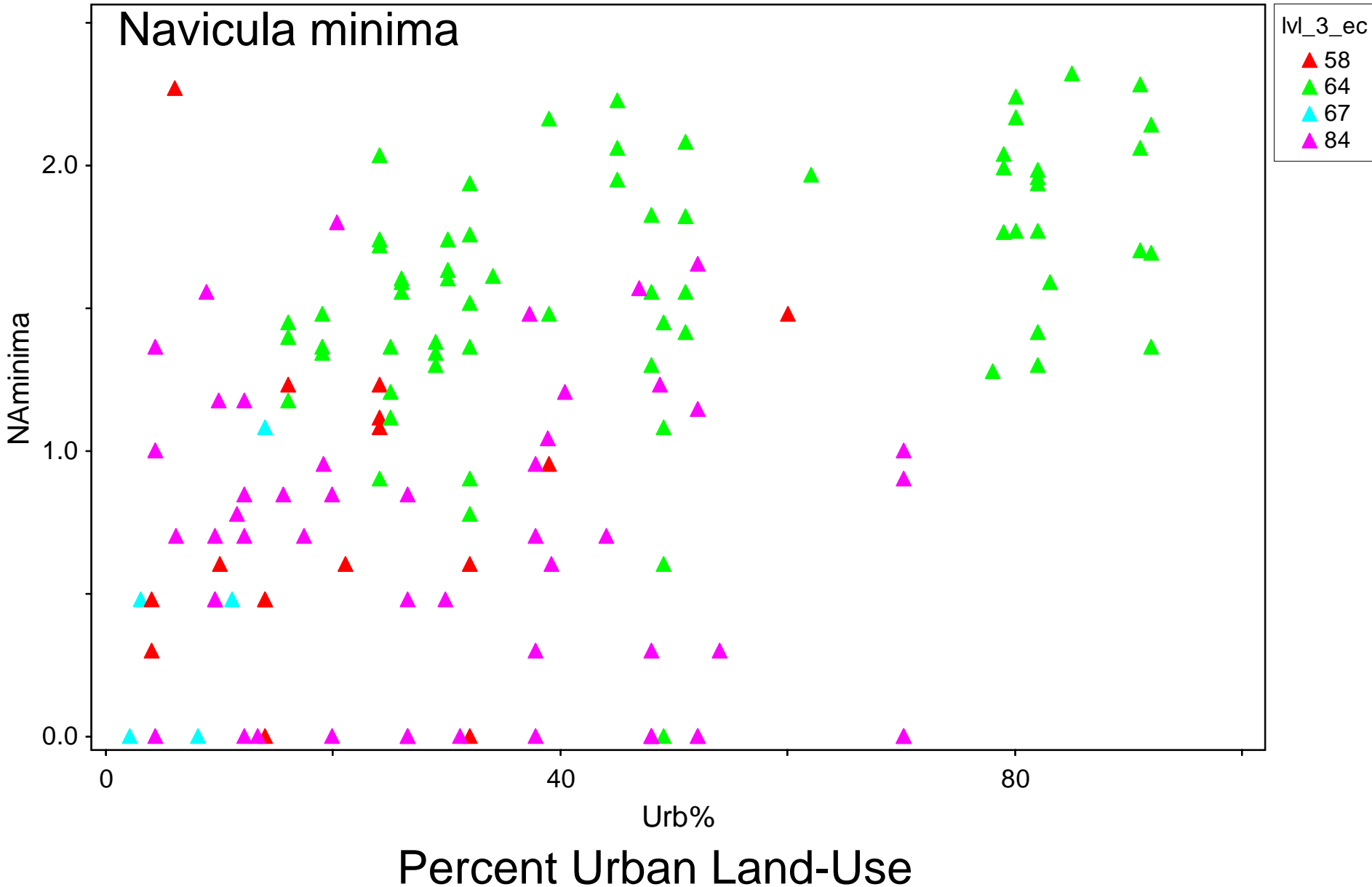




NJ TALU taxa vs stressors - 140 diatom samples



NJ TALU taxa vs stressors - 140 diatom samples



# New Jersey Diatom TALU Workshop – Aug 2009



## Diatom Experts

Rex Lowe  
Kalina Manoylov  
Jan Stevenson  
Jerry Sgro  
Hunter Carrick  
Dean DeNicola  
Marina Potapova

## Facilitator

Jeroen Gerritsen

# Contributors

## ANSP

- Karin Ponader
- Diane Winter
- Marina Potapova
- David Velinsky
- Andrew Tuccillo

## NJ DEP and others

- Tom Belton
- Tom Varnum
- Kevin Berry
- John Kennon
- Bob Limbeck





From PEARL Website, Queen's Univ.

# **Acknowledgements:**

**Research funded by the NJ  
Department of Environmental  
Protection (NJ DEP)**

**Many thanks to Tom Belton and other NJ DEP staff and PCER staff Josh Collins, Dan Mellott, Erin Hagan, Mike Hoffmann, Eduardo Morales, Marina Potapova, Kathleen Sprouffske and Diane Winter, Andrew Tuccillo, and many others.**

End