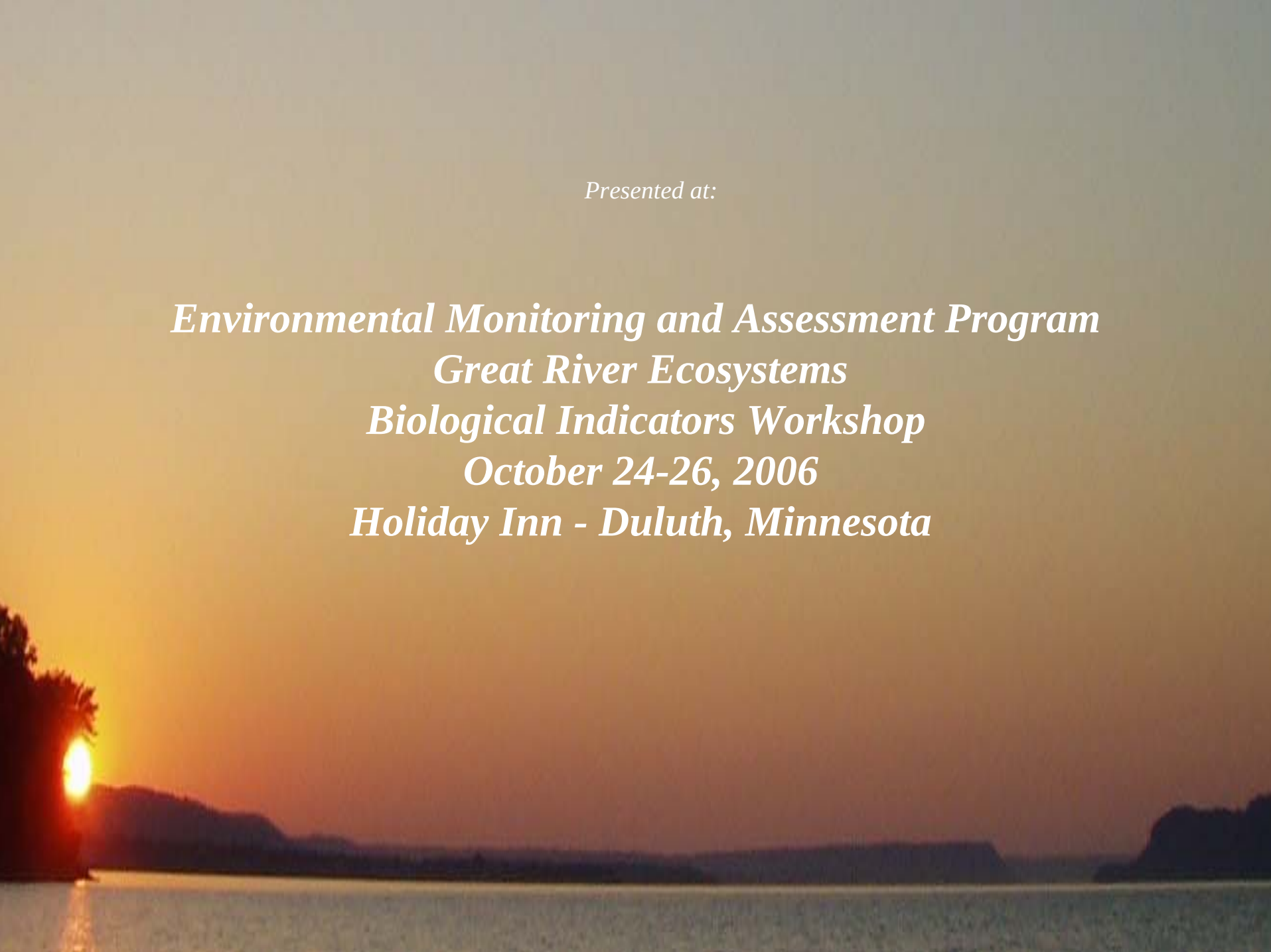


Presented at:

Environmental Monitoring and Assessment Program
Great River Ecosystems
Biological Indicators Workshop
October 24-26, 2006
Holiday Inn - Duluth, Minnesota

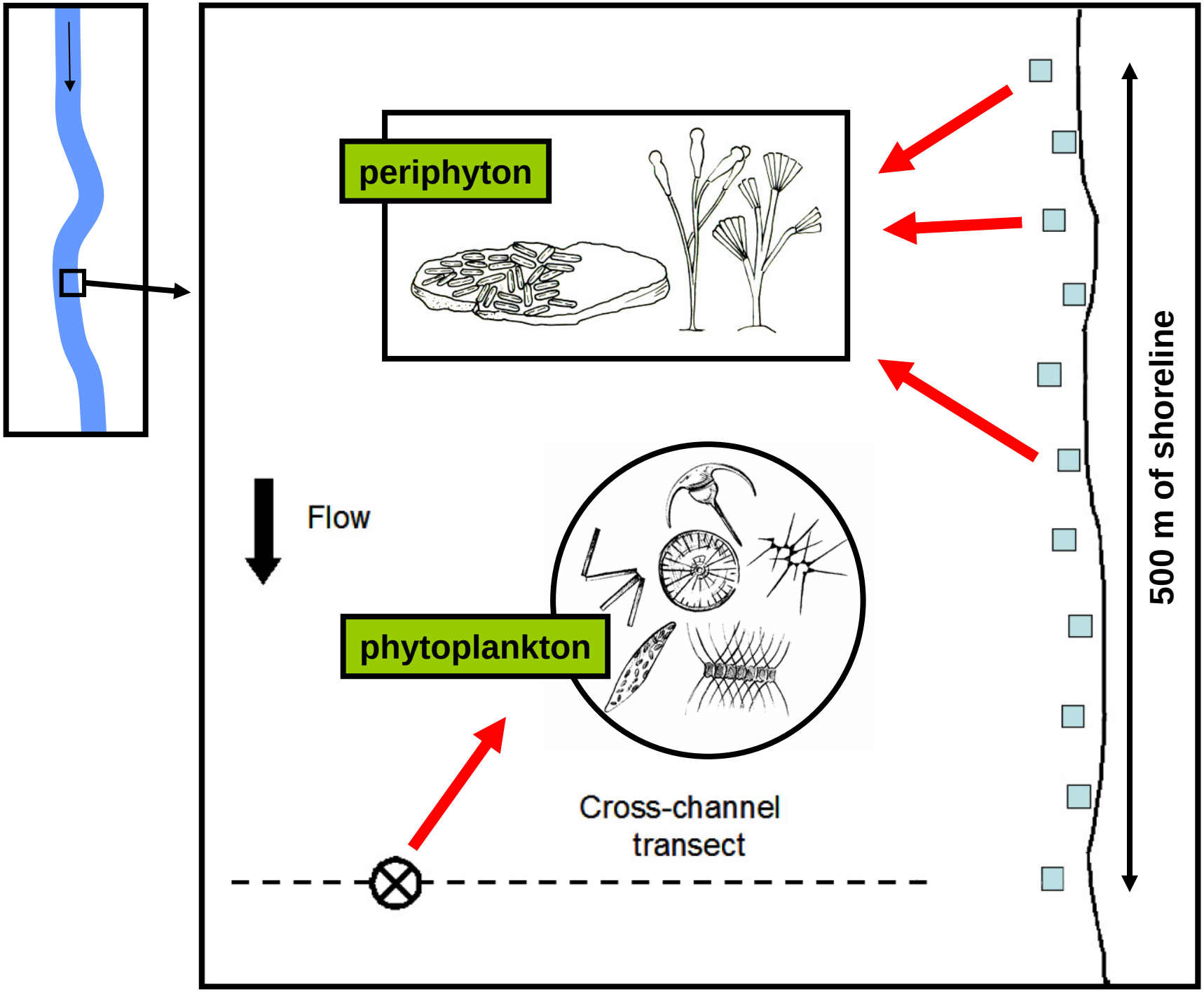
An early look at algal indicators for the Great Rivers

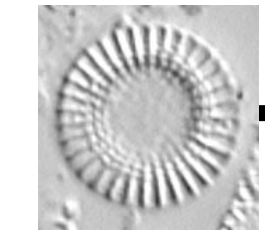
U. Minnesota, Natural Resources Research Institute
Euan Reavie, Amy Kireta, Lucinda Johnson, Elaine Ruzycki, Tom Hollenhorst, Rich Axler

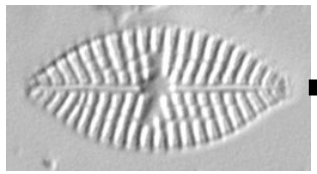
National Health and Environmental Effects Research Laboratory (NHEERL, EPA)
Brian Hill, Dave Bolgrien

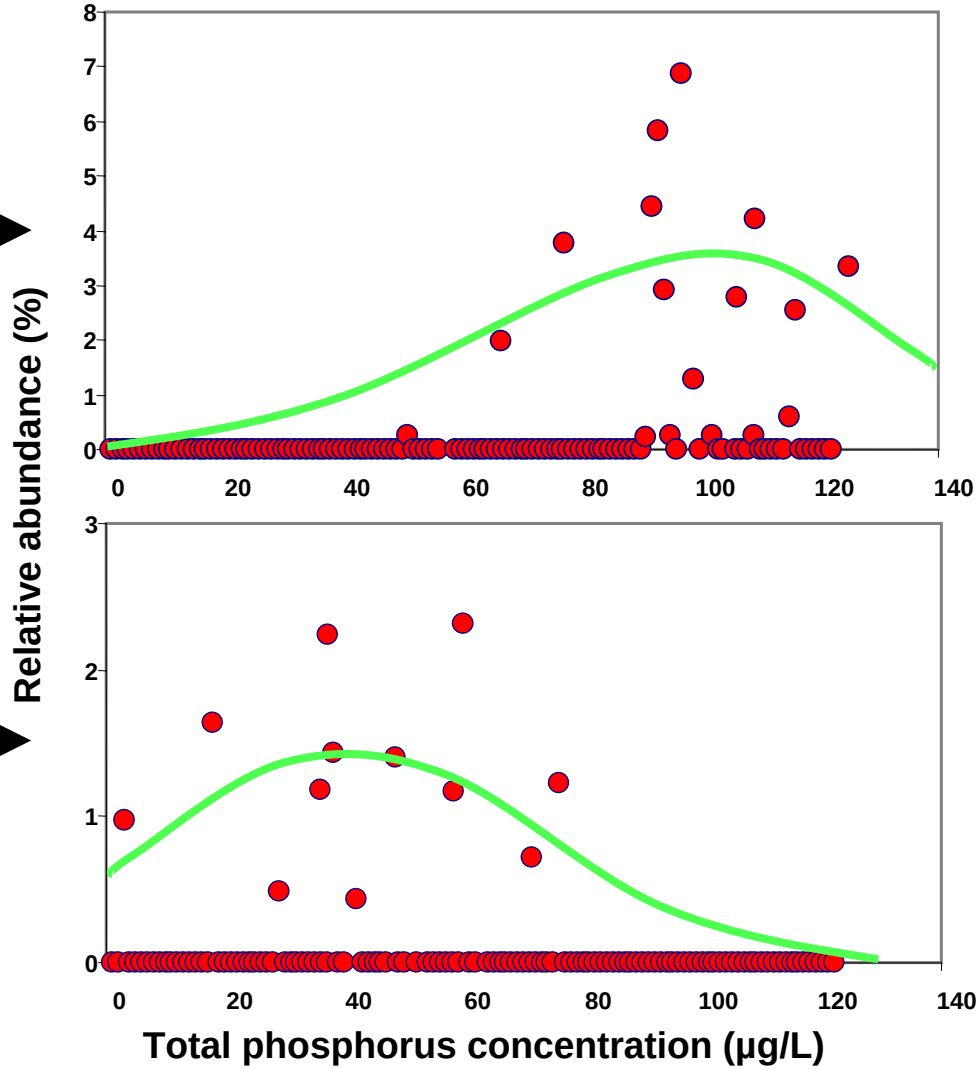
John Carroll U.
Gerald Sgro

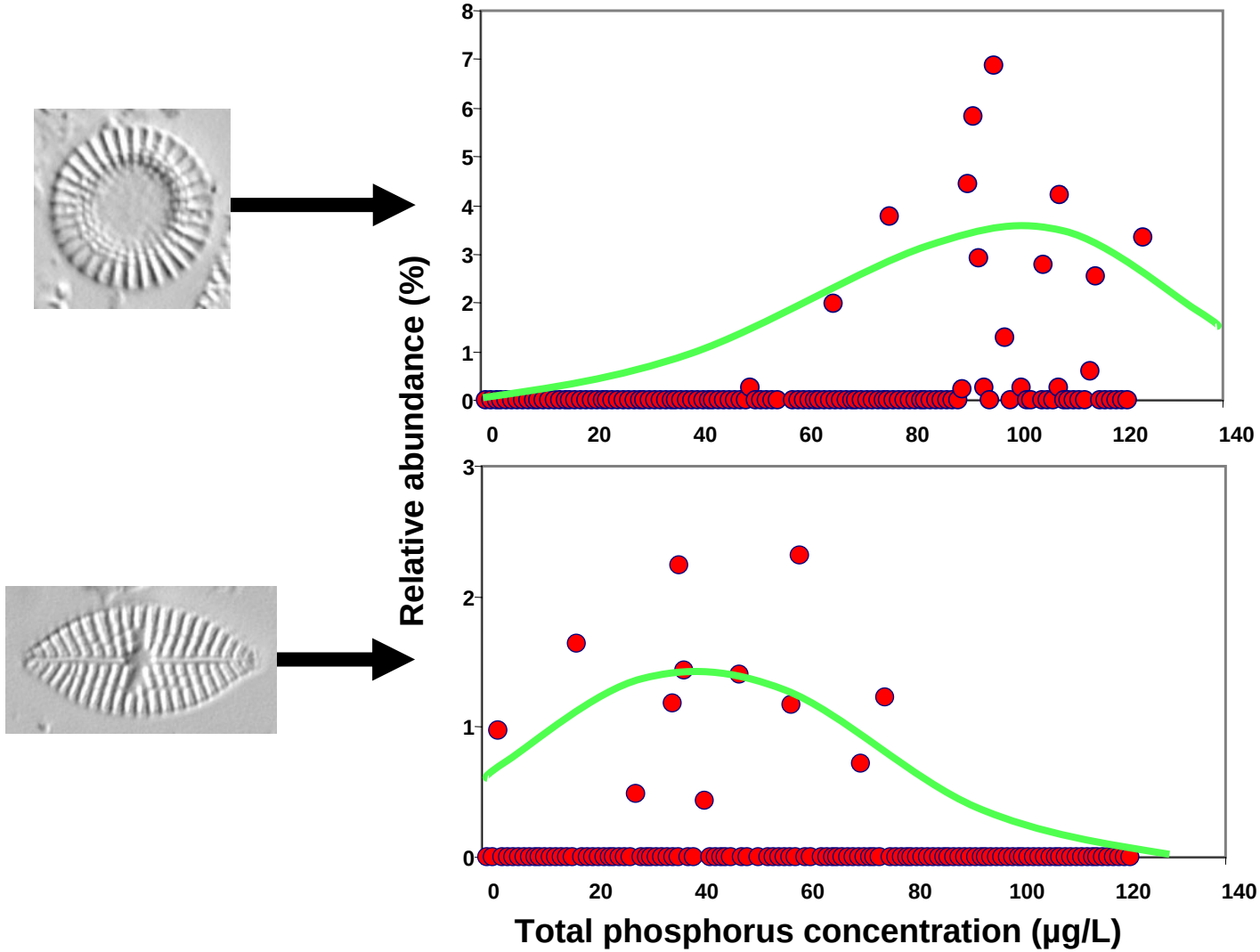
Bio-Limno, Canada
Mike Agbeti


periphyton
Flow
phytoplankton
Cross-channel
transect
500 m of shoreline






Relative abundance (%)
8
7
6
5
4
3
2
1
0
0
20
40
60
80
100
120
140
3
2
1
0
0
20
40
60
80
100
120
140
Total phosphorus concentration (µg/L)


Relative abundance (%)
8
7
6
5
4
3
2
1
0
0
20
40
60
80
100
120
140
3
2
1
0
0
20
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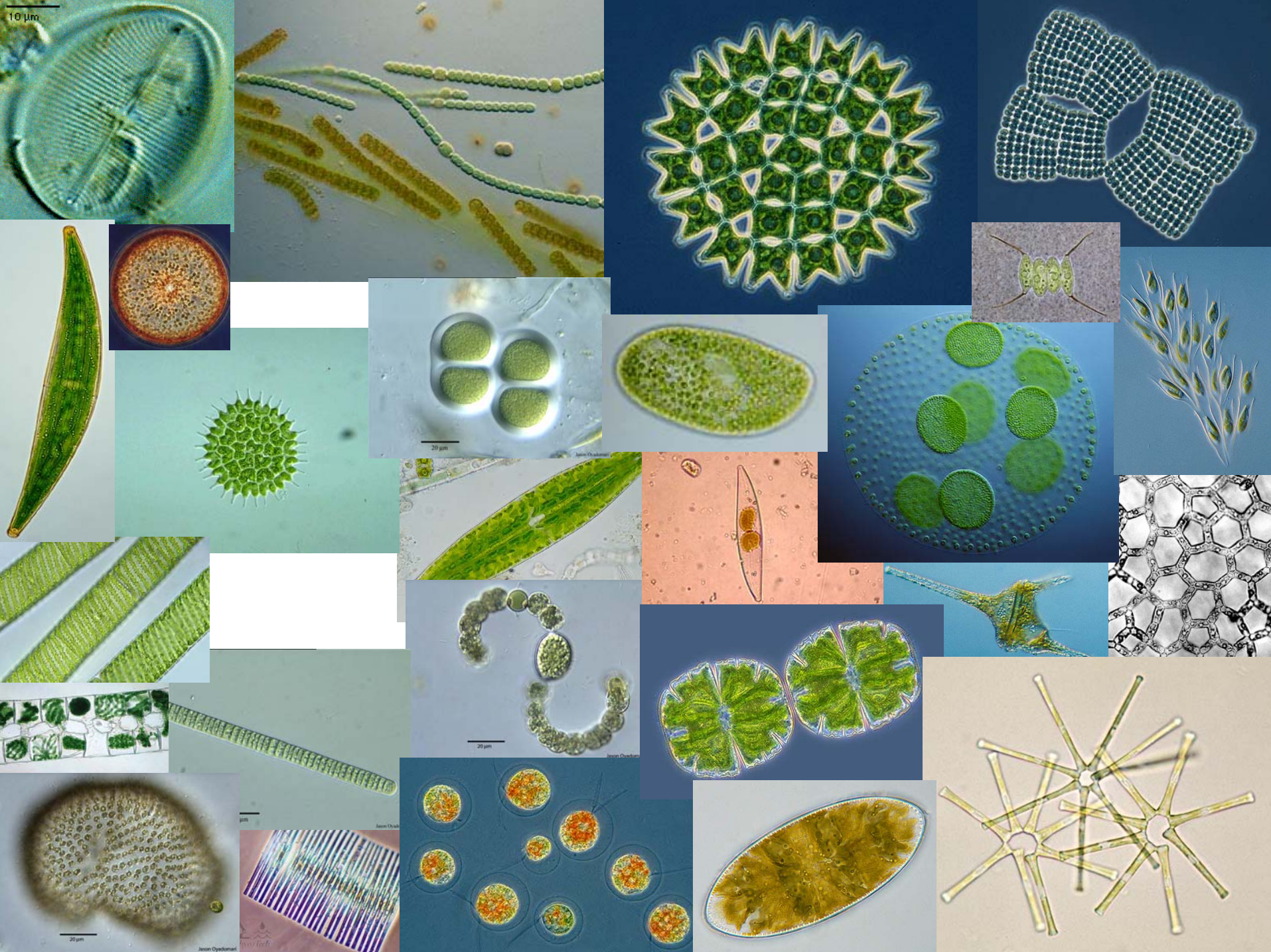
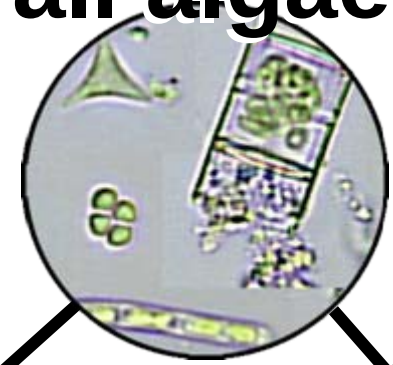
60
80
100
120
140
Total phosphorus concentration (µg/L)


10 µm
20 µm
20 µm
20 µm

Algae indicators: our choice of datasets

all algae

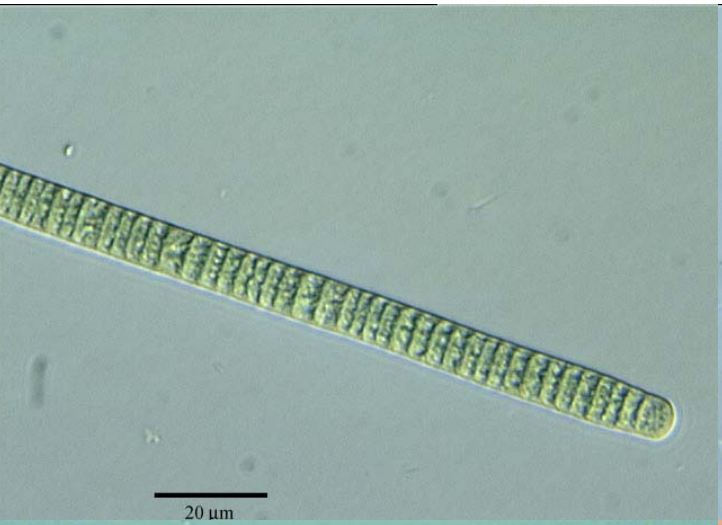


- absolute abundance
- % abundance

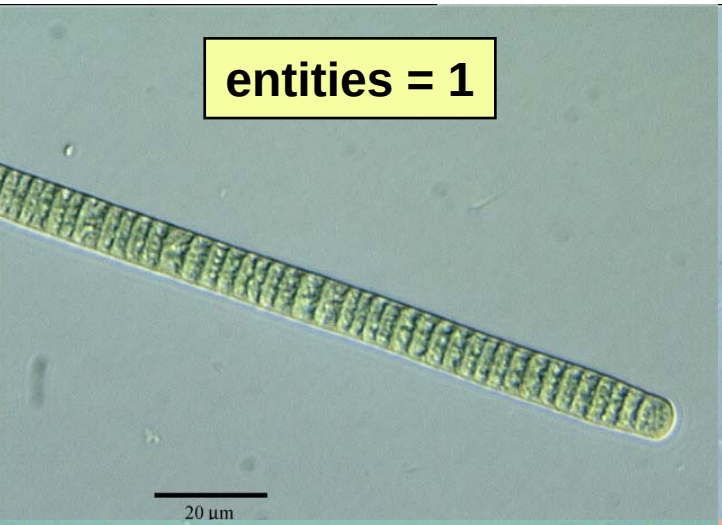
diatoms

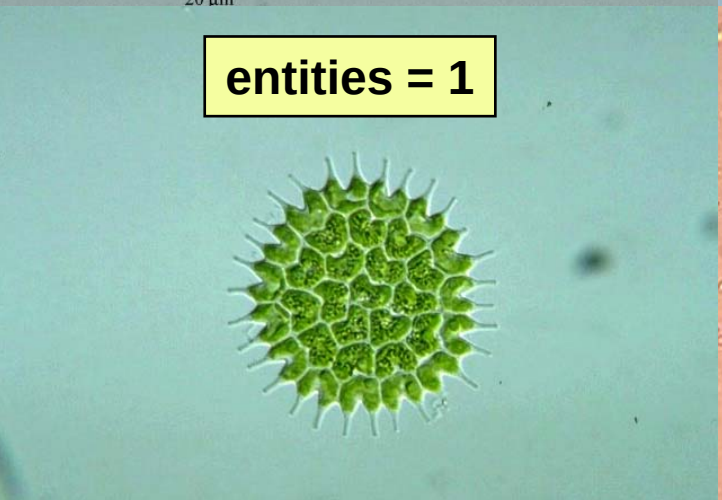
- absolute abundance
- % abundance

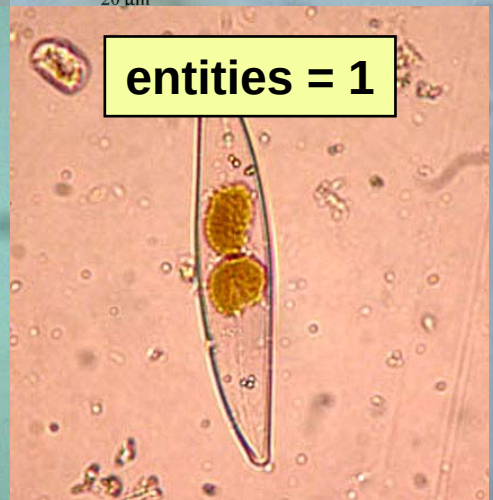
Counting algae



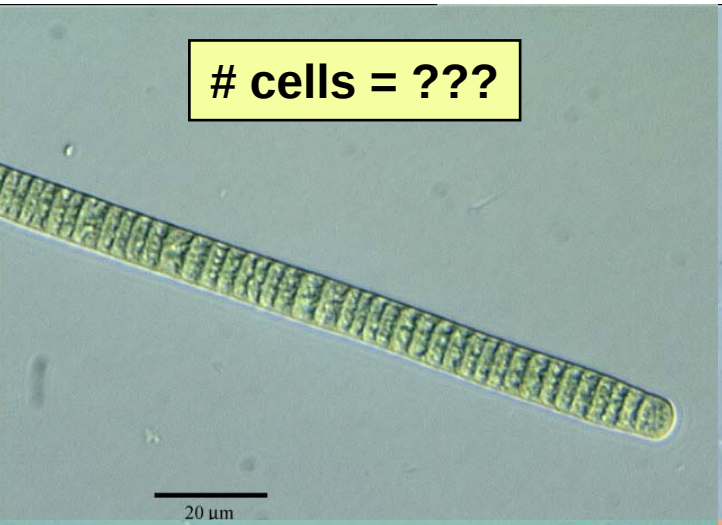
Counting algae (number of entities)

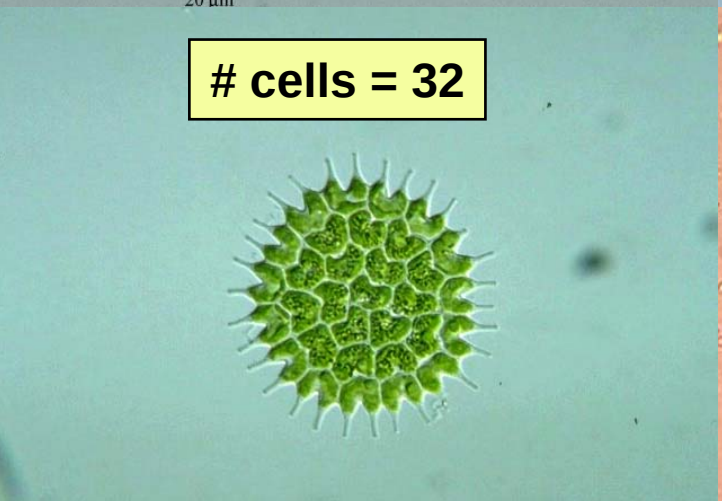


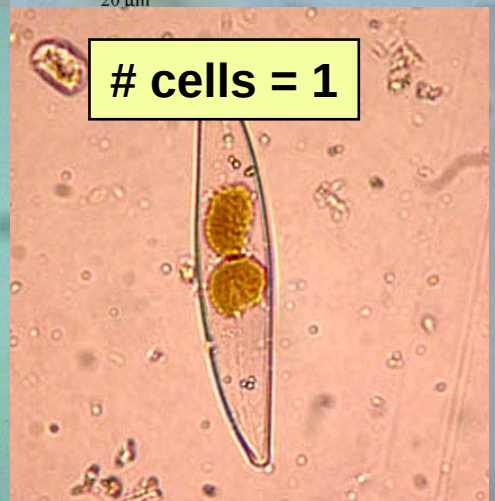


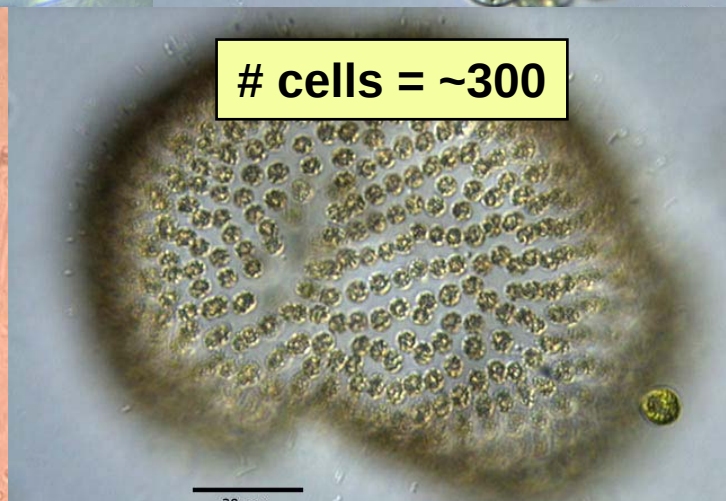


Counting algae (number of cells)

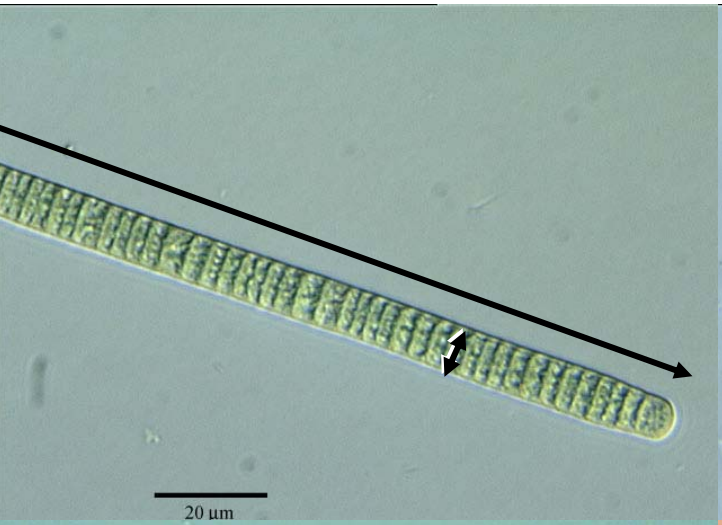


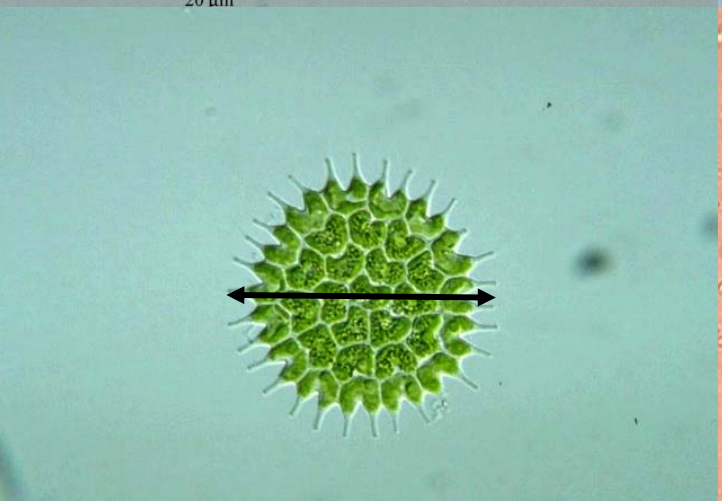


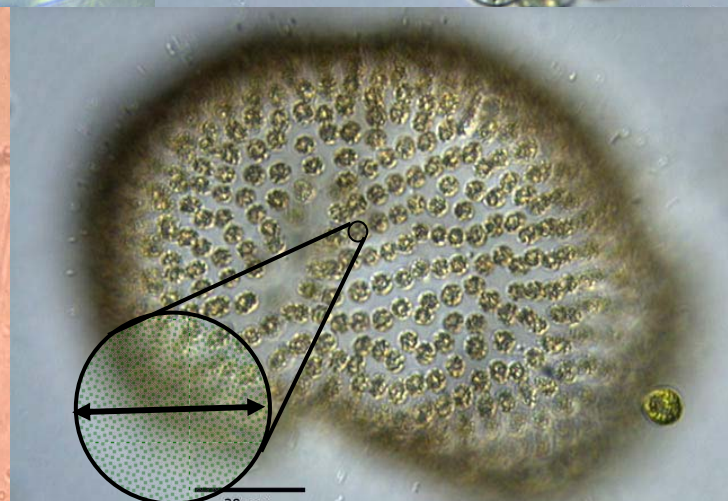




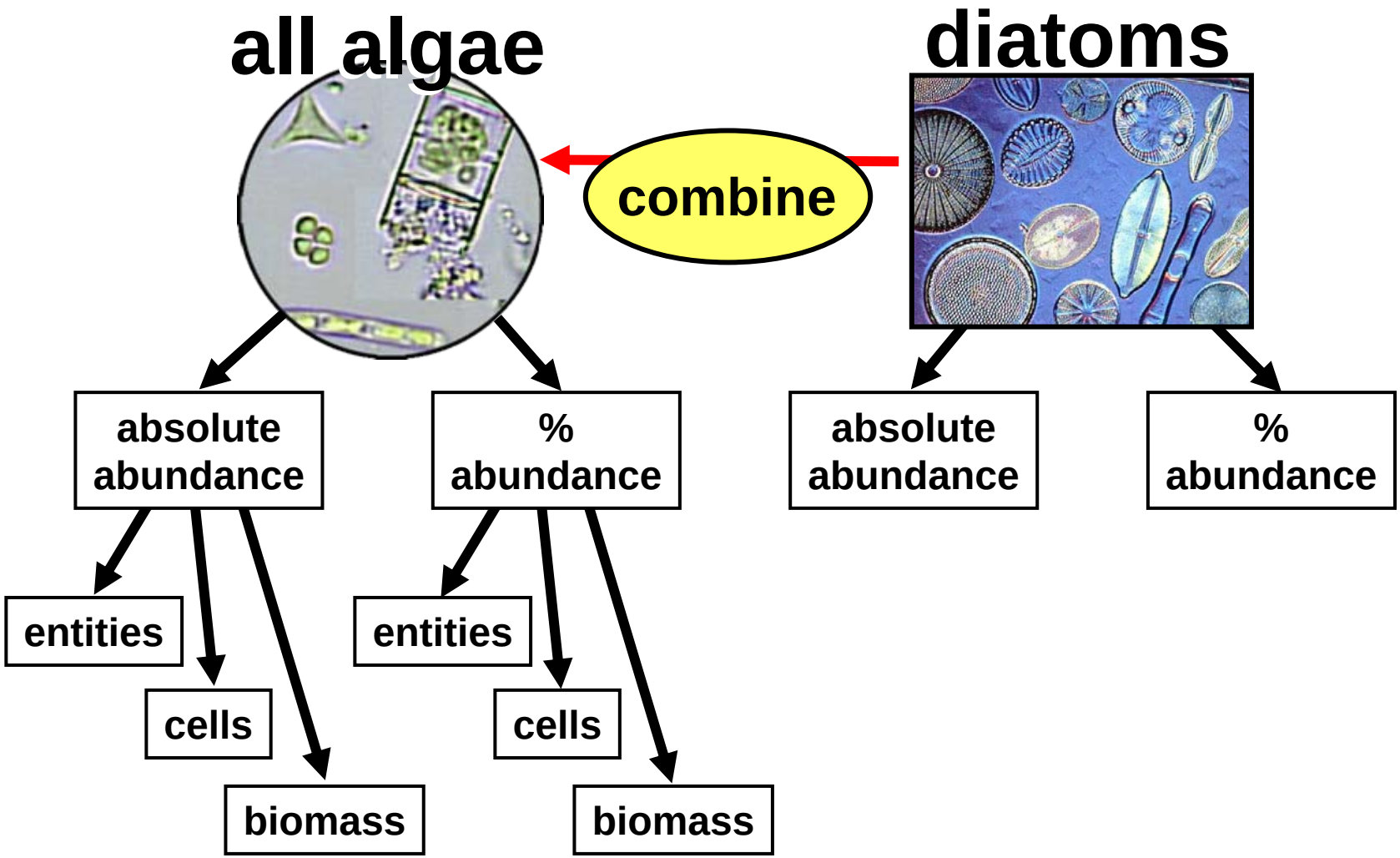
Greatest Axial Linear Dimension (GALD)





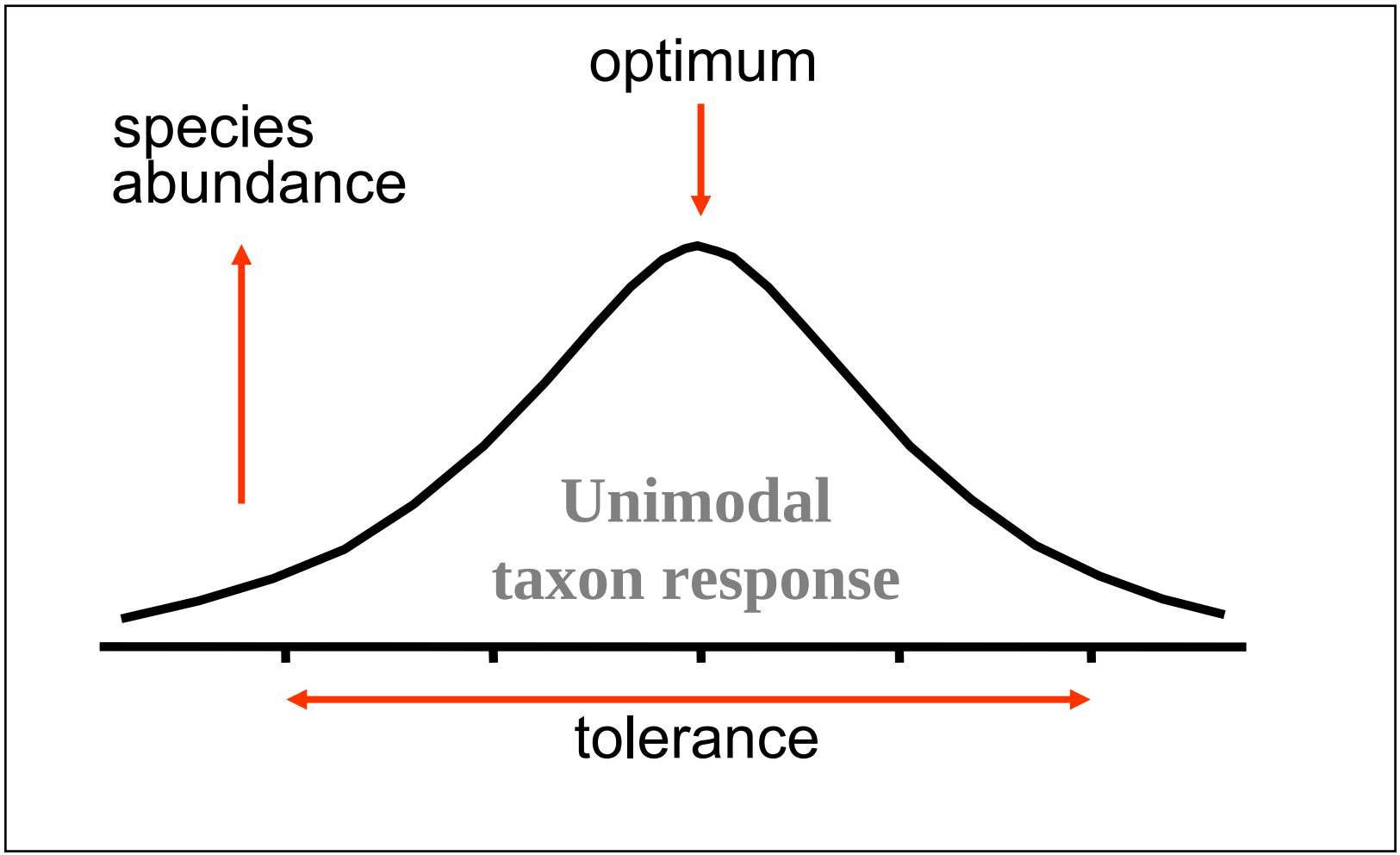


Algae indicators: our choice of datasets



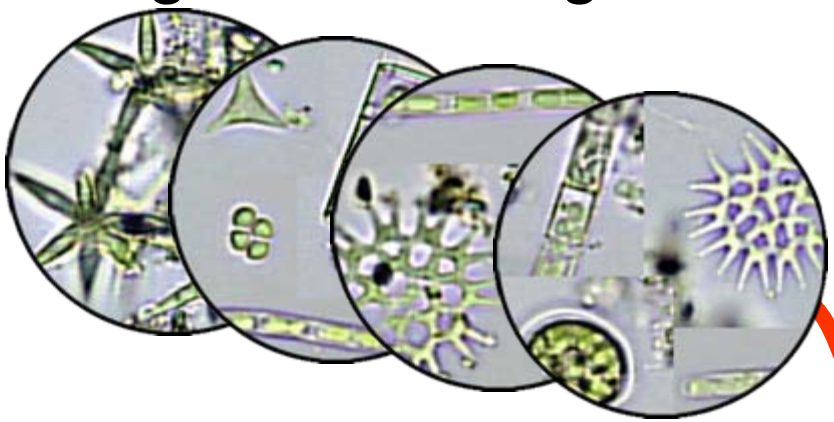
possible datasets = 28

Quantifying species-environment relationships

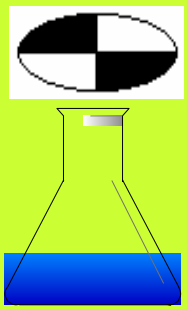


Algae model construction

Algal Assemblages

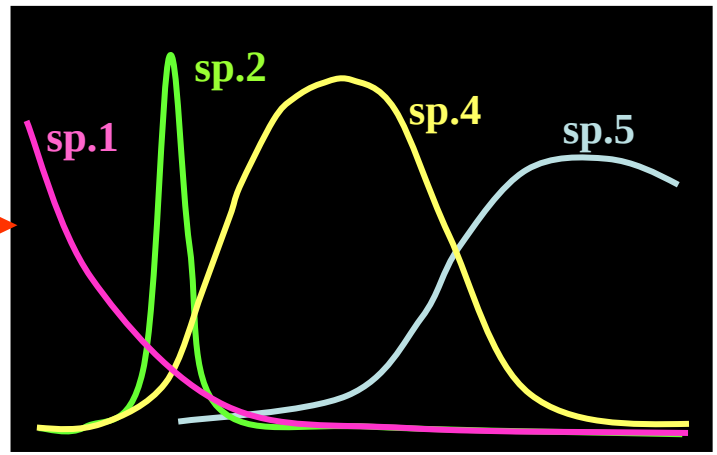


Environmental Data

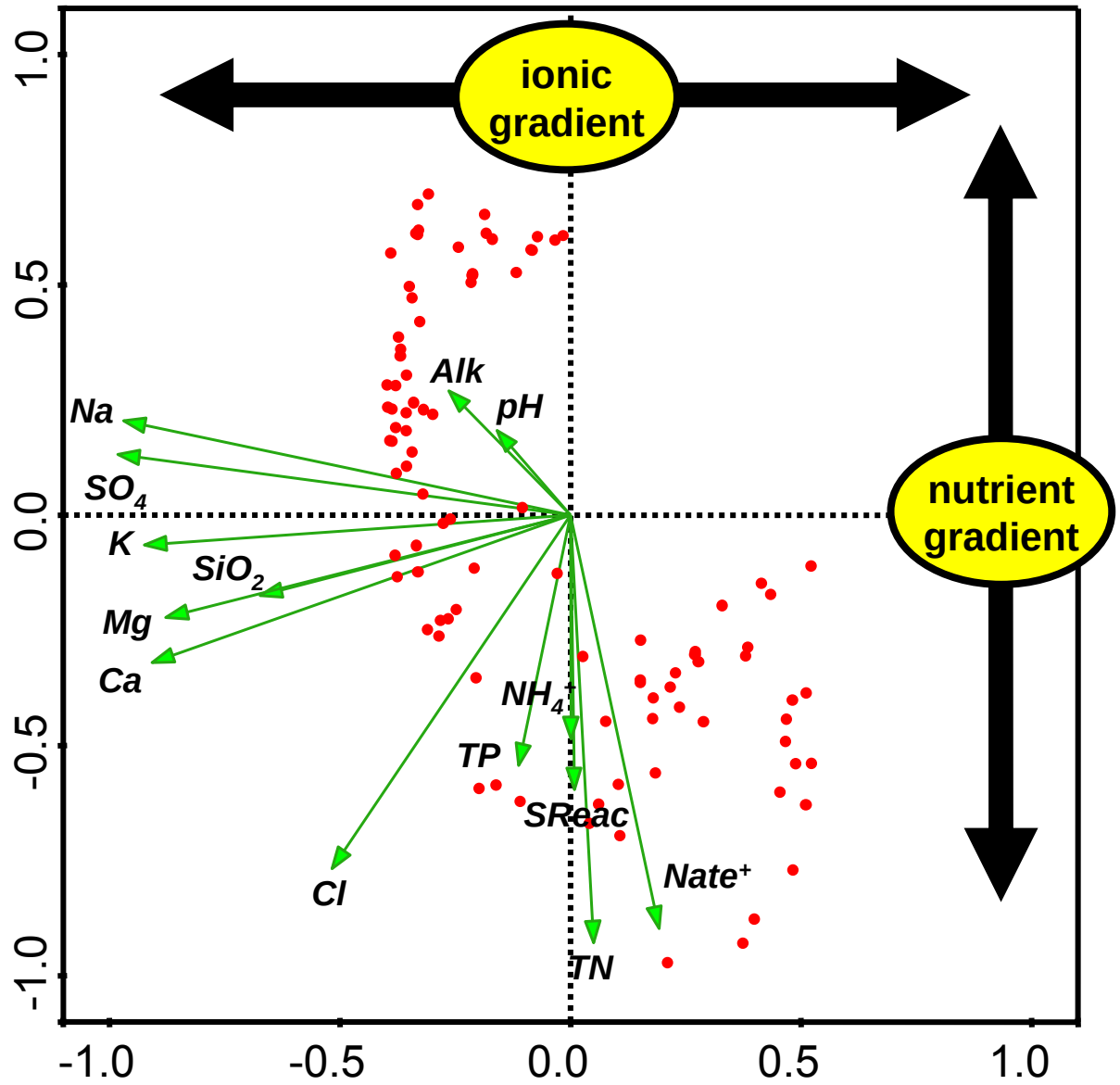


Surface area
Depth
Development
Total phosphorus
Total nitrogen
Chlorophyll *a*
Suspended solids, etc…

Taxon Responses

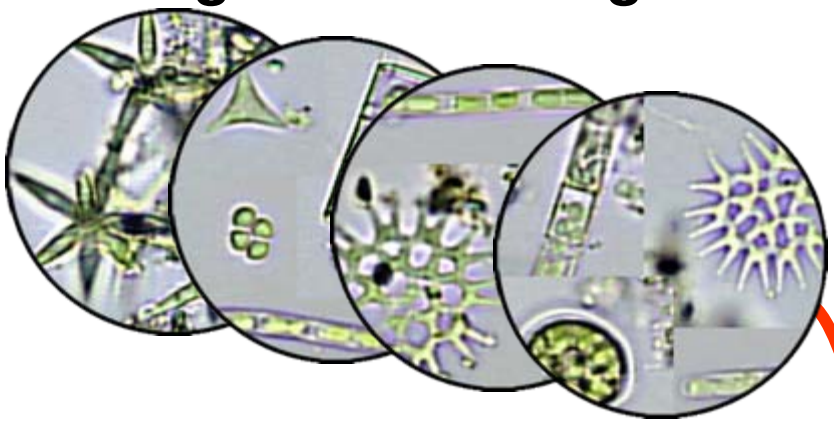


Water Quality PCA



Algae model construction

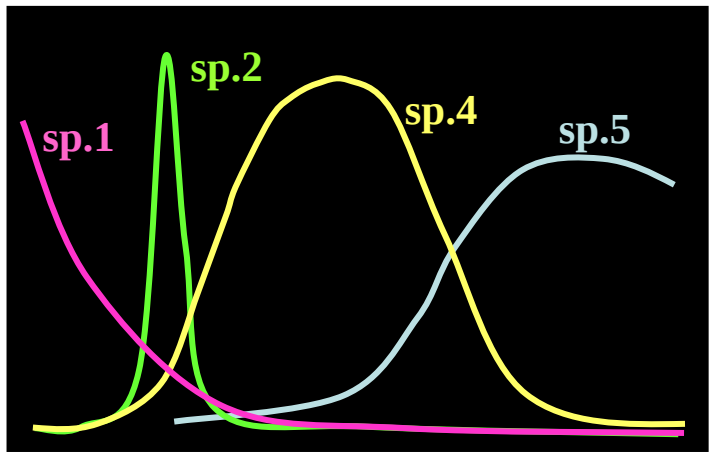
Algal Assemblages

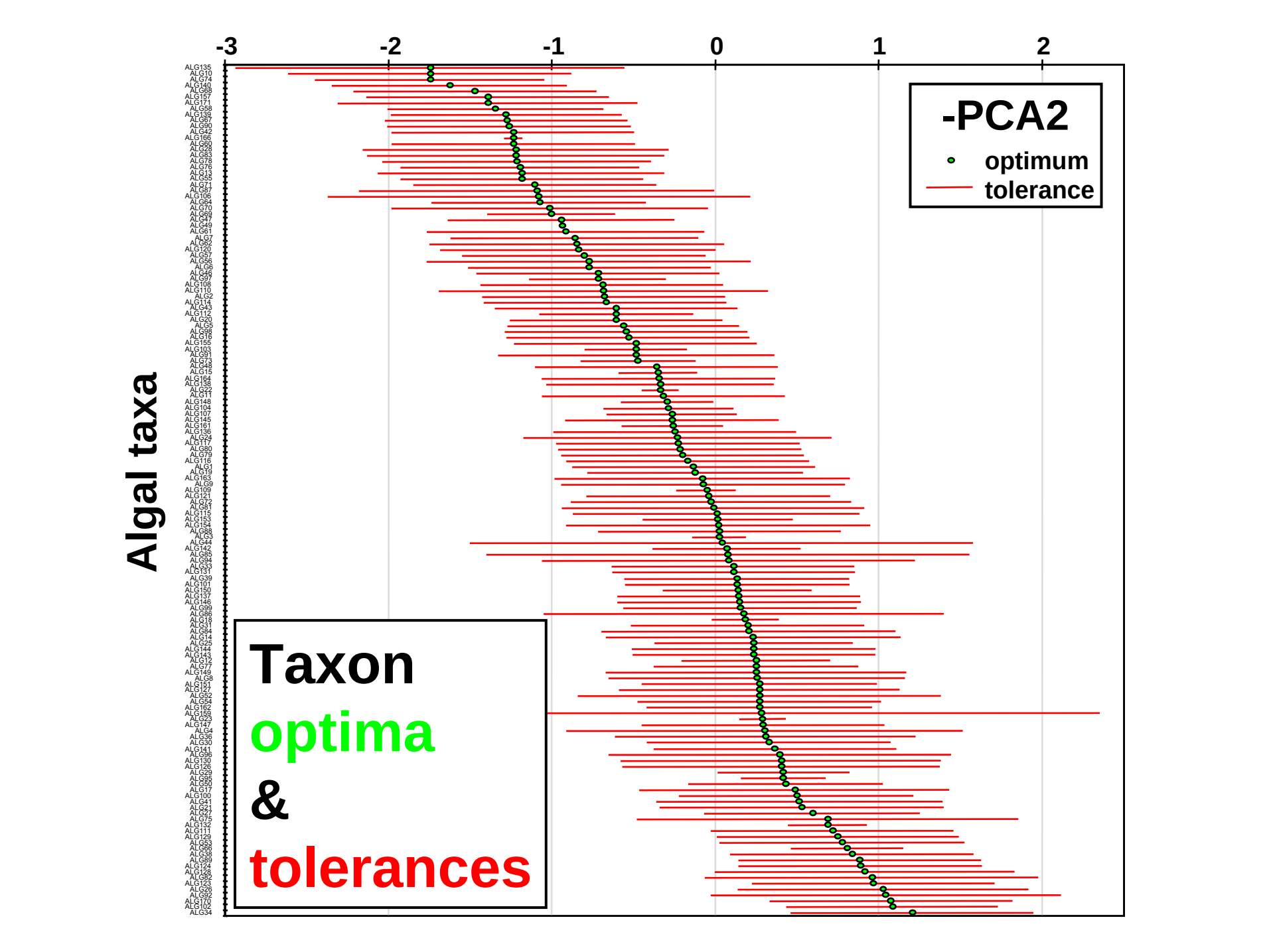


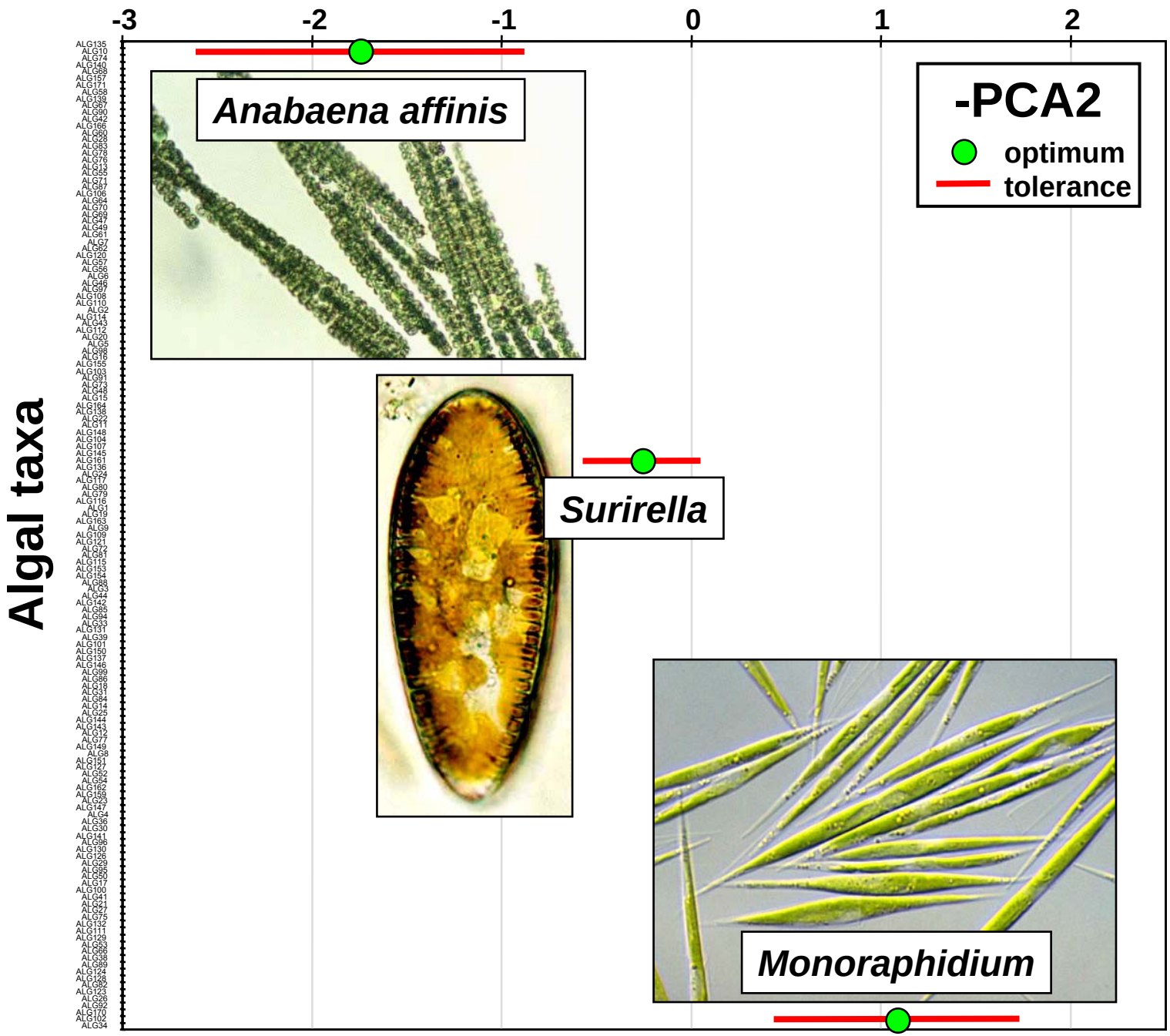
Environmental Data

PCA2 (nutrients)

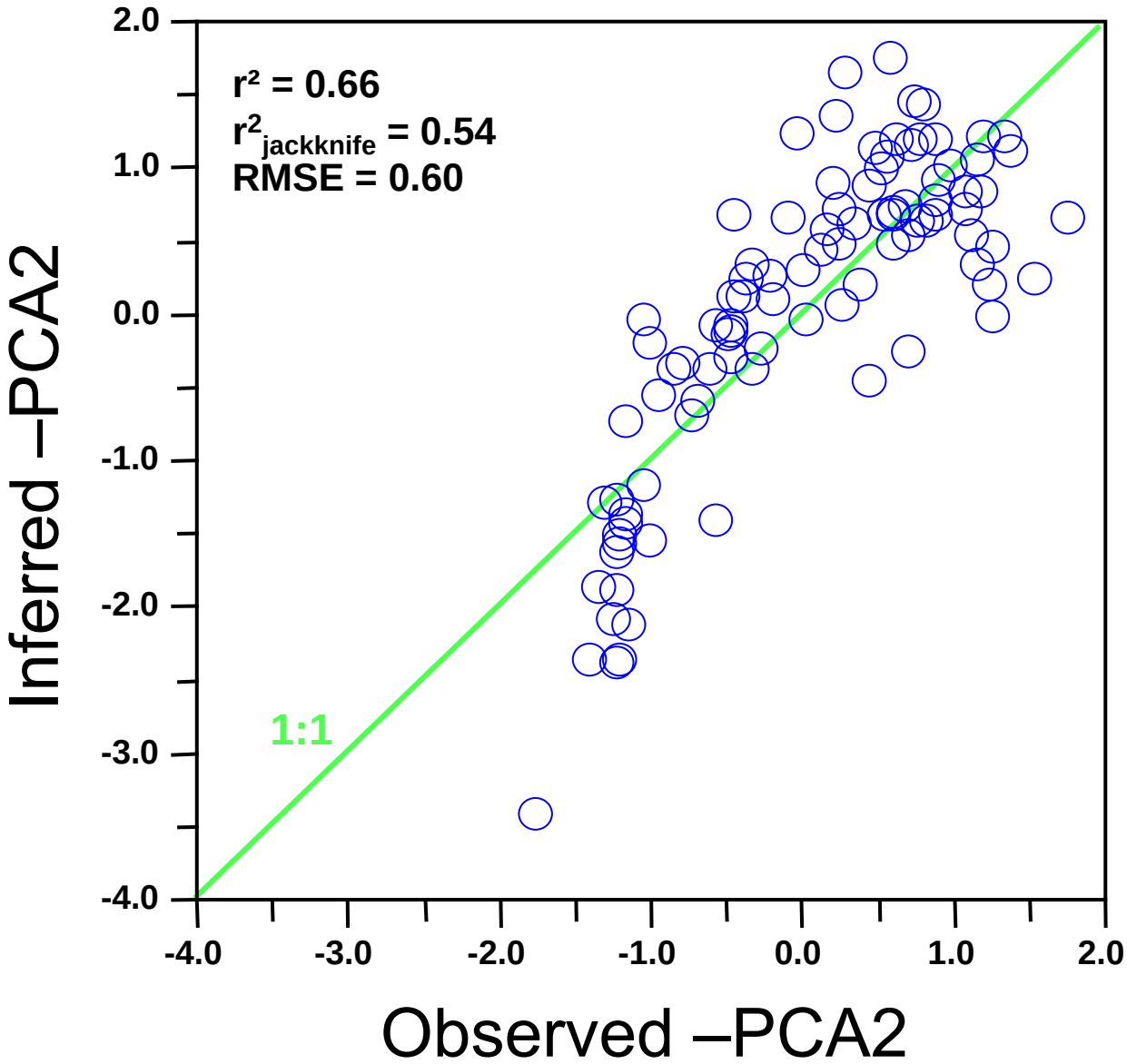
Taxon Responses



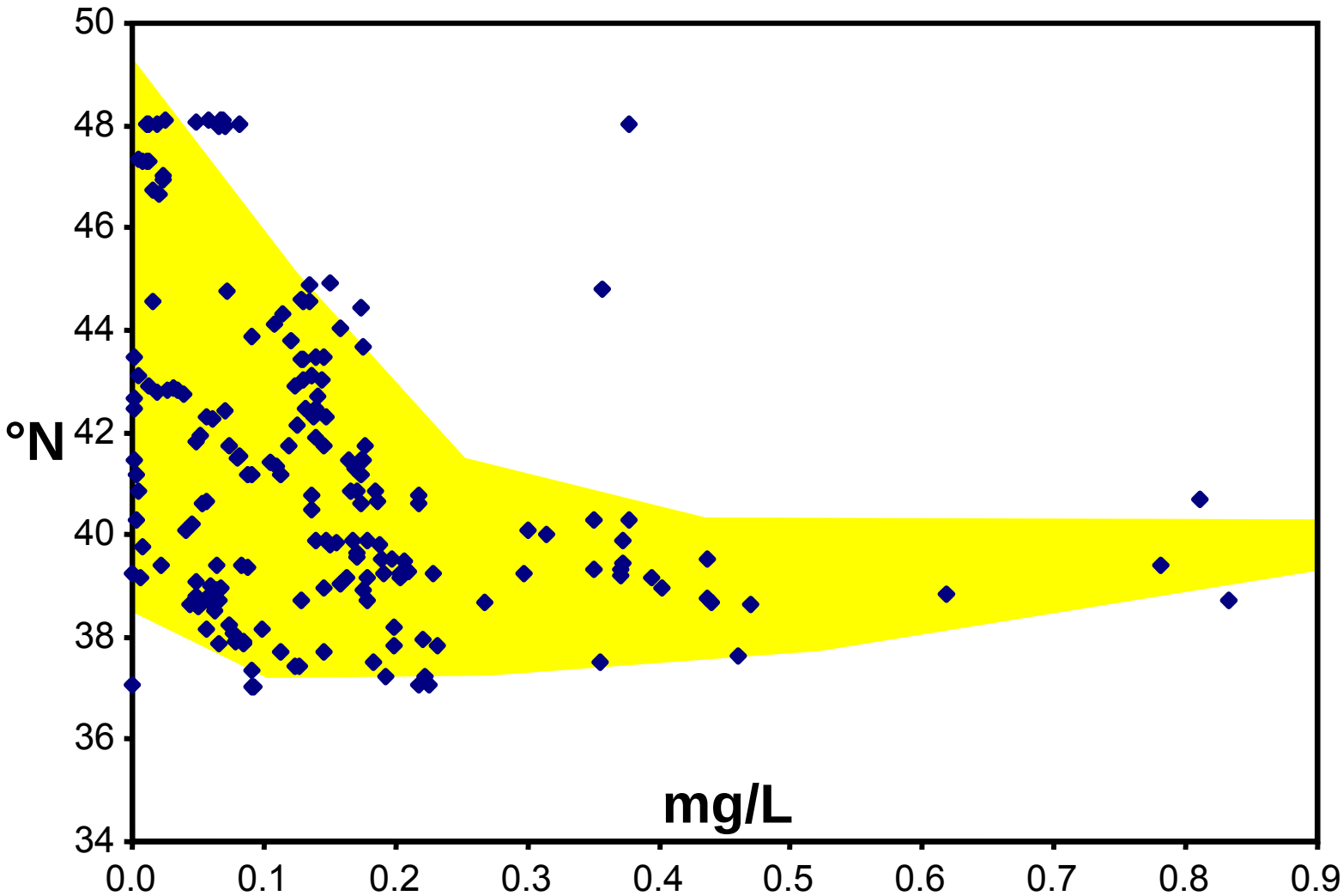

-3
-2
-1
0
1
2
-PCA2
optimum
tolerance
Algal taxa
Taxon
optima
&
tolerances


-3
-2
-1
0
1
2
Algal taxa
-PCA2
optimum
tolerance
Anabaena affinis
Surirella
Monoraphidium

Model Testing



Latitude vs. phosphorus



Multimetric index

Example candidate metrics

Functional

- ♥Natural log Shannon-Weaver
- ♥Proportion most dominant taxon
- ♥Proportion motile
- ♥Proportion planktonic
- ♥Saprobic Index
- ♥Trophic Index

Taxonomic

- ♣Proportion *Stephanodiscus*
- ♣Proportion *Achnanthidium minutissimum*
- ♣Proportion *Staurosira/Staurosirella/Pseudostaurosira*
- ♣Proportion *Anabaena*
- ♣Proportion *Monoraphidium*

DI Cl (log (mg/L + 1))

% araphid
% monoraphid
% biraphid

% *Martyana*
% *Eunotia*
% *A. minutissimum* complex
% *Cocconeis*

% *Psammothidium*
% *Rossithidium*

% *Navicula*
% *Geissleria*
% *Hippodonta*

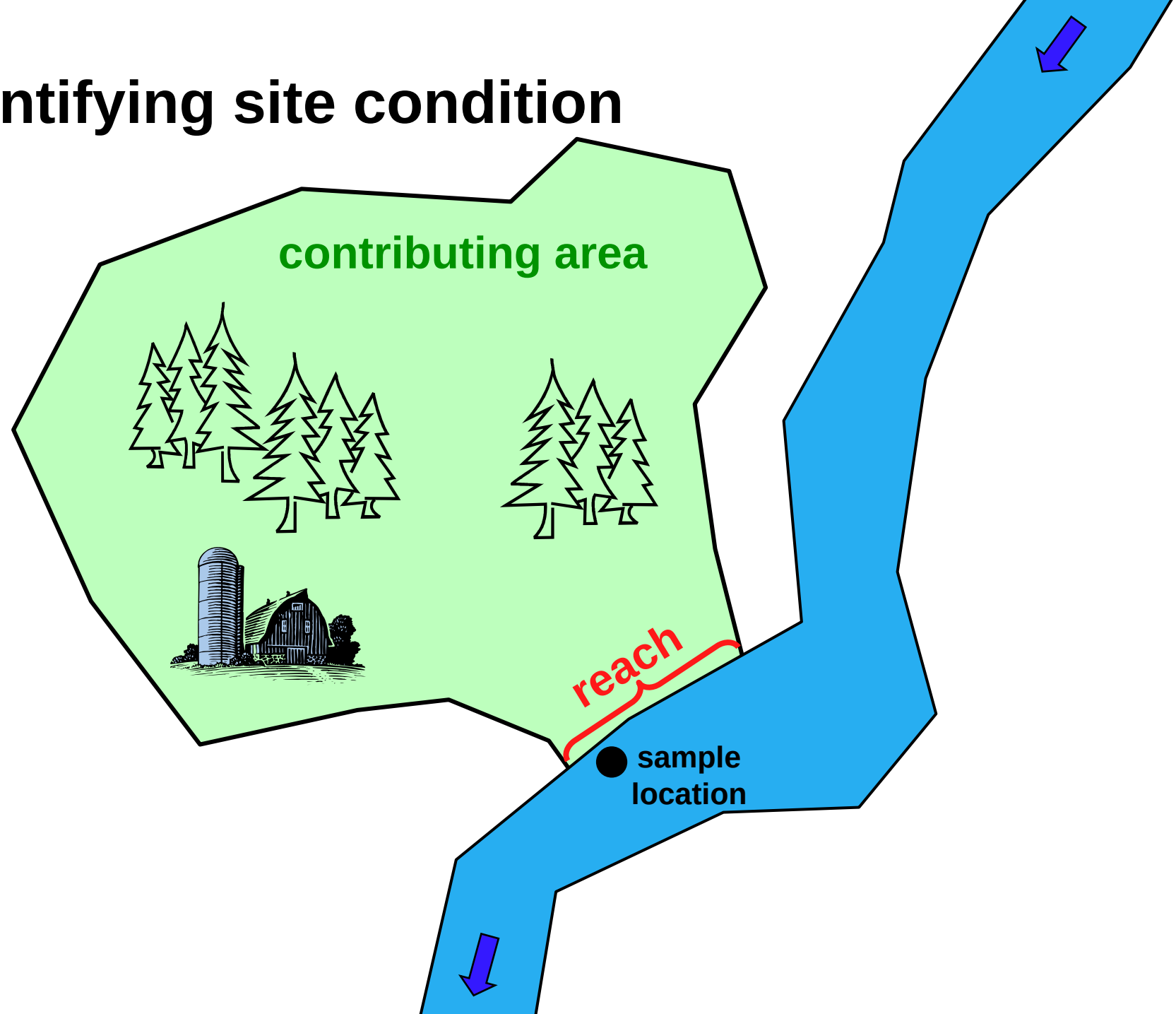
% *Amphora*

Eliminate redundant and unimportant metrics

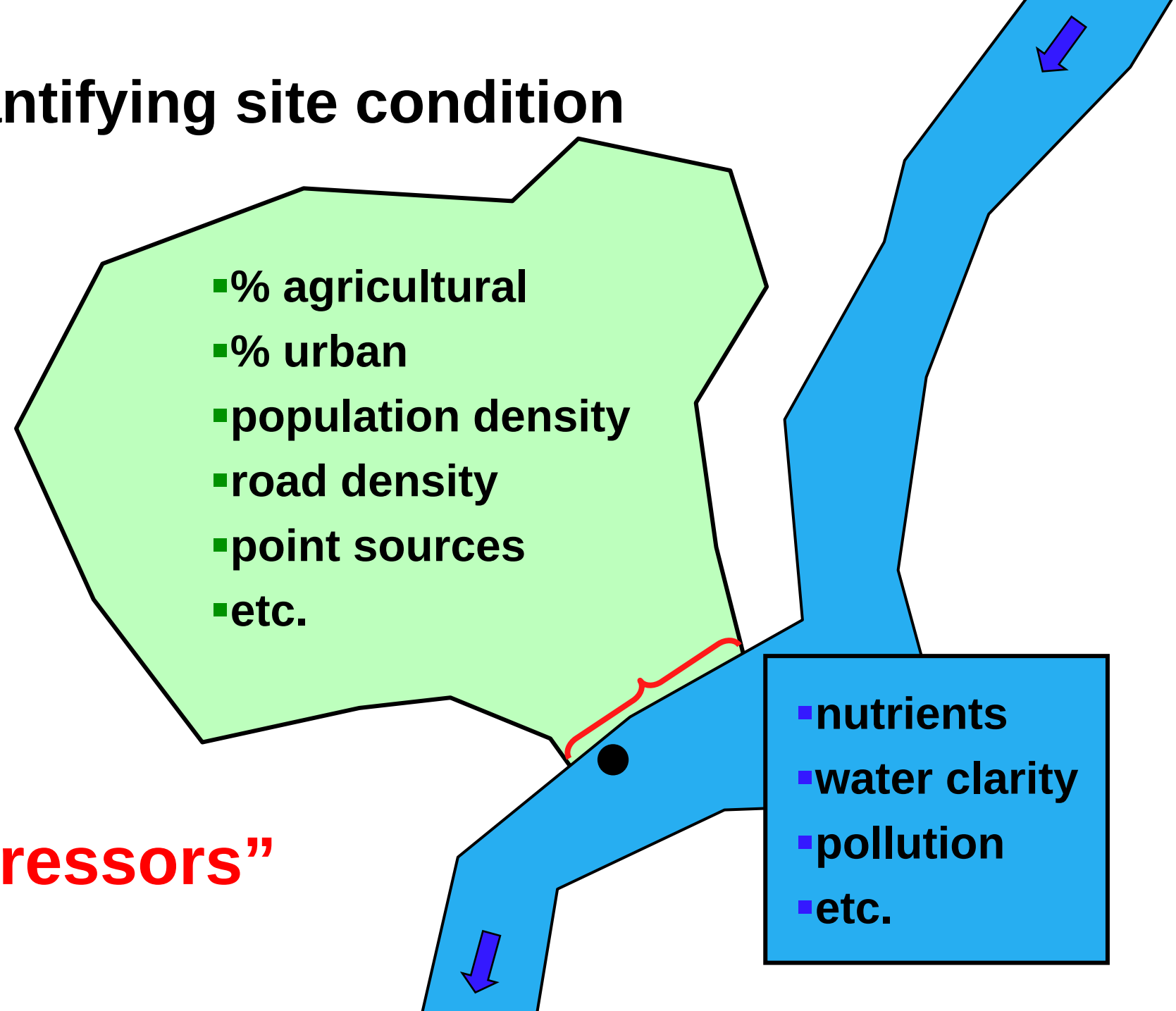
DI Cl (log (mg/L + 1))
% araphid
% monoraphid
% biraphid
% *Martyana*
% *Eunotia*
% *A. minut*. complex
% *Cocconeis*
% *Psammothidium*
% *Rossithidium*
% *Navicula*
% *Geissleria*
% *Hippodonta*
% *Amphora*

How well do these metrics track stressors?

Quantifying site condition

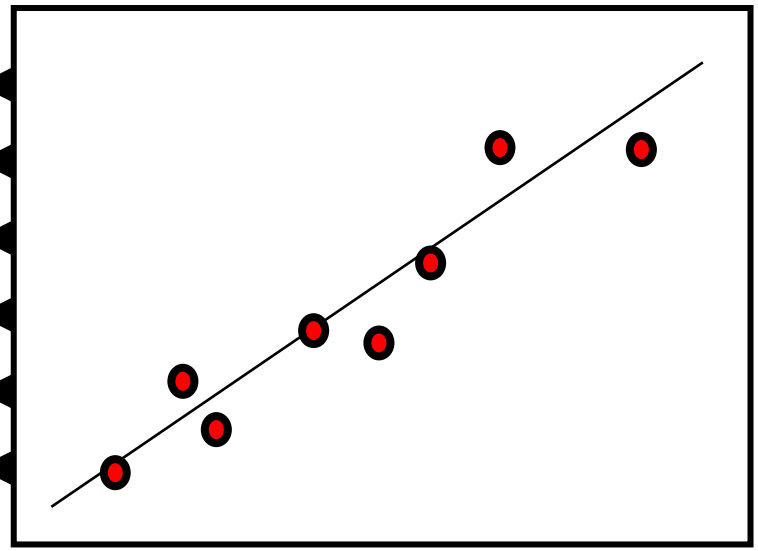


Quantifying site condition



“stressors”

Correlation with “stress” variables



Y

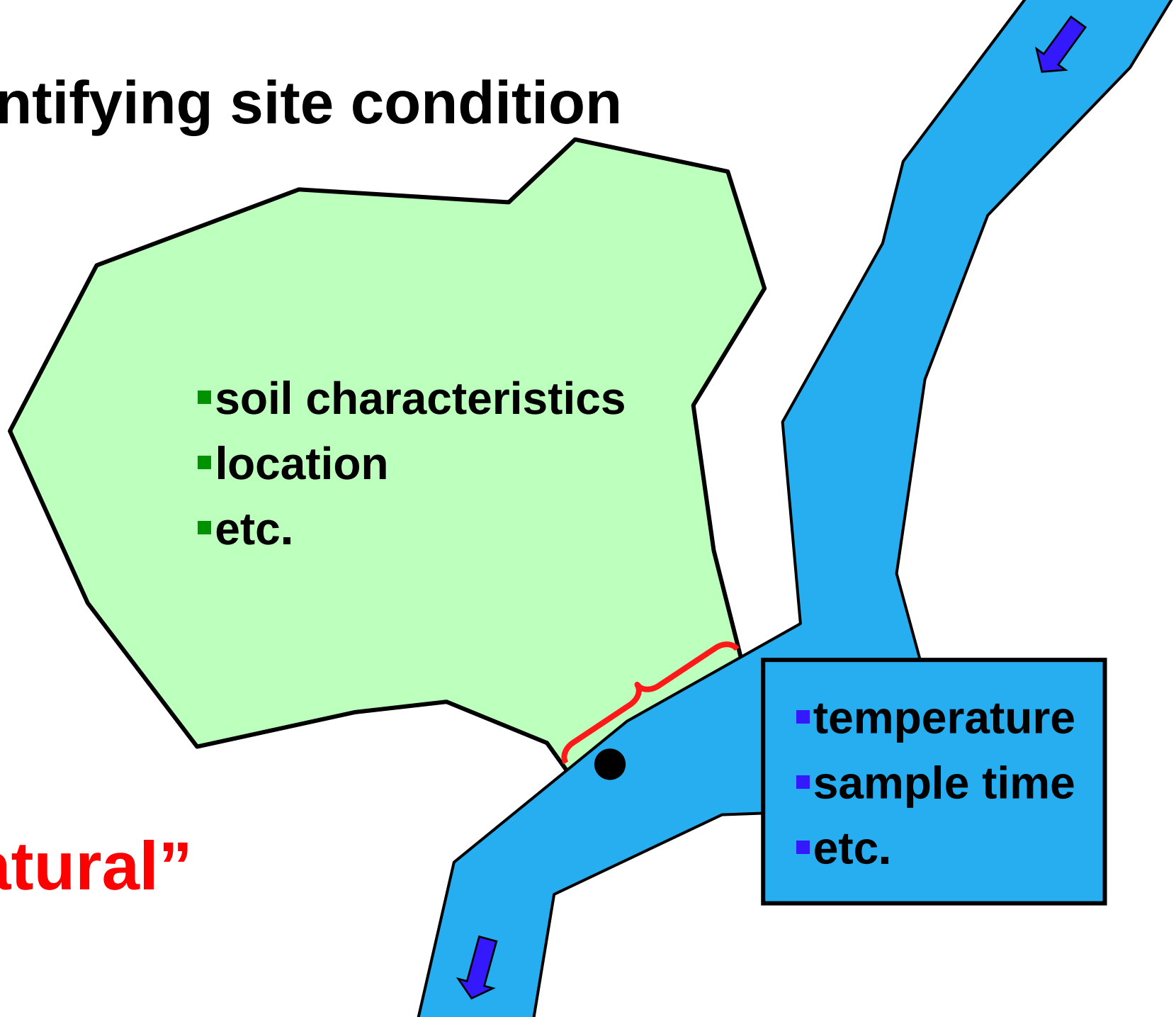
conductivity
nutrients
suspended solids
human activities
% urbanization
% agriculture

X

DI Cl (log (mg/L + 1))
% araphid
% monoraphid
% biraphid
% *Martyana*
% *Eunotia*
% *A. minut*. complex
% *Cocconeis*
% *Psammothidium*
% *Rossithidium*
% *Navicula*
% *Geissleria*
% *Hippodonta*
% *Amphora*

Identify important and useful metrics for inclusion in multimetric development

Quantifying site condition



"natural"

Multimetric calculation

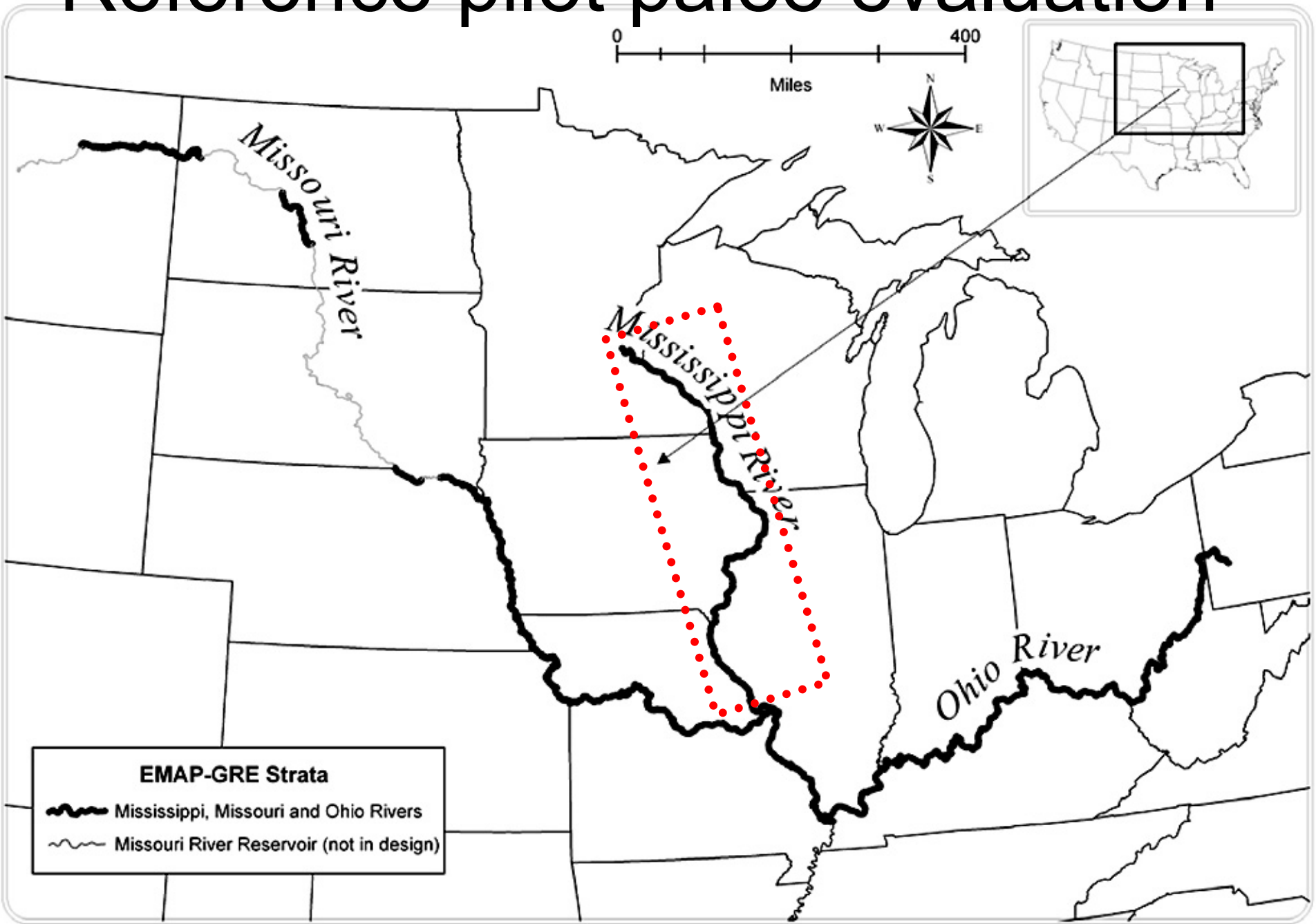
$$G = \sum_{n=1}^{14} \left(M_n\right) \times \left(w_n\right)$$

multimetric score

metric score

weight

Reference pilot paleo evaluation



We need cores.

We need cores.

Top/bottom sediment analysis

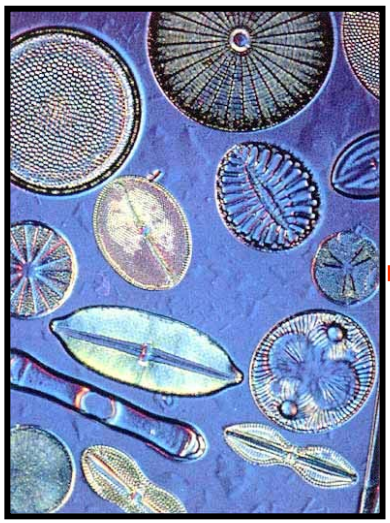
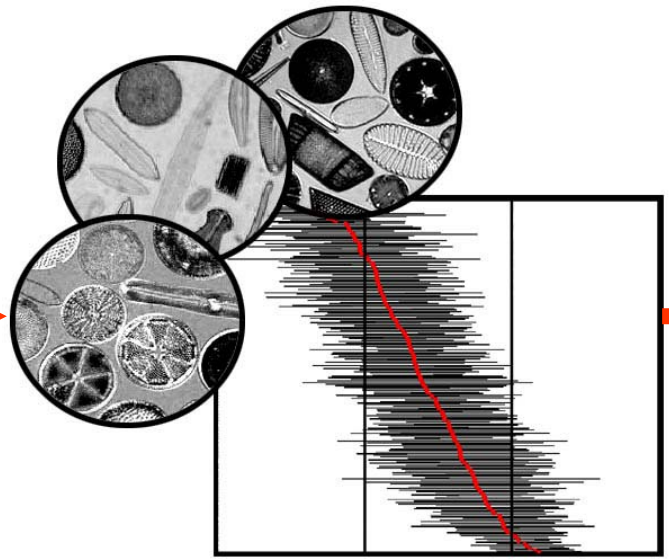
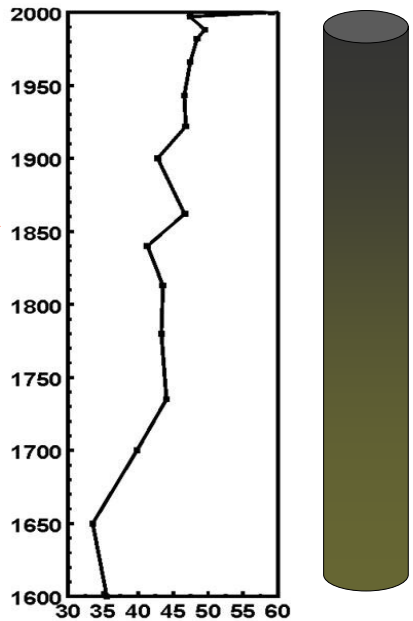
Surface sediments: contain microfossils deposited during the last few years. Assemblages reflect modern conditions.

Bottom sediments: contain microfossils deposited prior to human impacts. Assemblages reflect ‘natural’ background conditions.

Application of an indicator model

fossil assemblage

transfer function (indicator model)

inferred limnological data

Background condition
Nutrient load
Suspended solids
Stochastic events
etc.