

US EPA ARCHIVE DOCUMENT



The 2007 National Lakes Assessment

Approach to Data Analysis and Preliminary Results

Neil Kamman
on detail to
USEPA Office of Water
Monitoring Branch

New England Association of Environmental Biologists
3-19-2009



Goals of Lakes Survey

- **Report on the condition of the Nation's Lakes**
 - Statistically valid design that represents the condition of all lakes
 - Regional and national estimates of the condition of lakes, option for State-scale estimates
 - Use consistent sampling and analysis procedures to ensure the results can be compared across the country
- **Promote State and Tribal capacity for monitoring and assessment**
- **Promote collaboration across jurisdictional boundaries in the assessment of water quality**

Survey Design Objectives

- Report on the proportion of lakes ($\pm 5\%$) in the conterminous U.S. that exceed a threshold of concern using selected indicators with 95% confidence
- Report on the proportion of lakes ($\pm 15\%$) in a specific eco-region grouping that exceed a threshold of concern using selected indicators with 95% confidence
- Indicators measured represent biological condition, recreational use, and trophic status
- Report on changes in lakes from National Eutrophication Study

Map of Survey Lakes





Today's update

- Describe process of data analysis
- Provide an honest assessment of progress to date
- Describe the difficulties involved in an analysis of this magnitude
- Preliminary results by indicator
- Schedule for issuance of the report

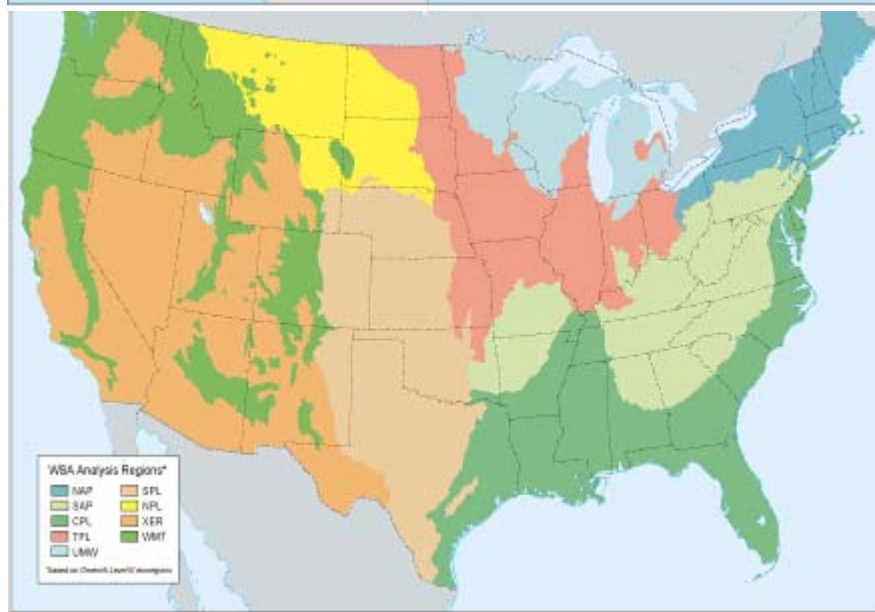
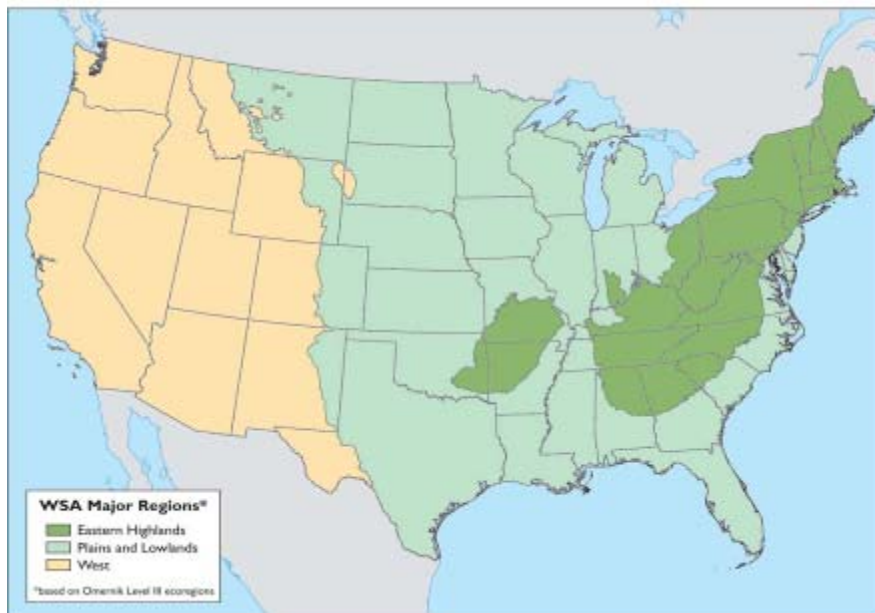


Elements of the assessment

- Reporting regions
- Extent of waters
- Selecting reference sites
- Evaluation of indicators
- Calculation of probability estimates

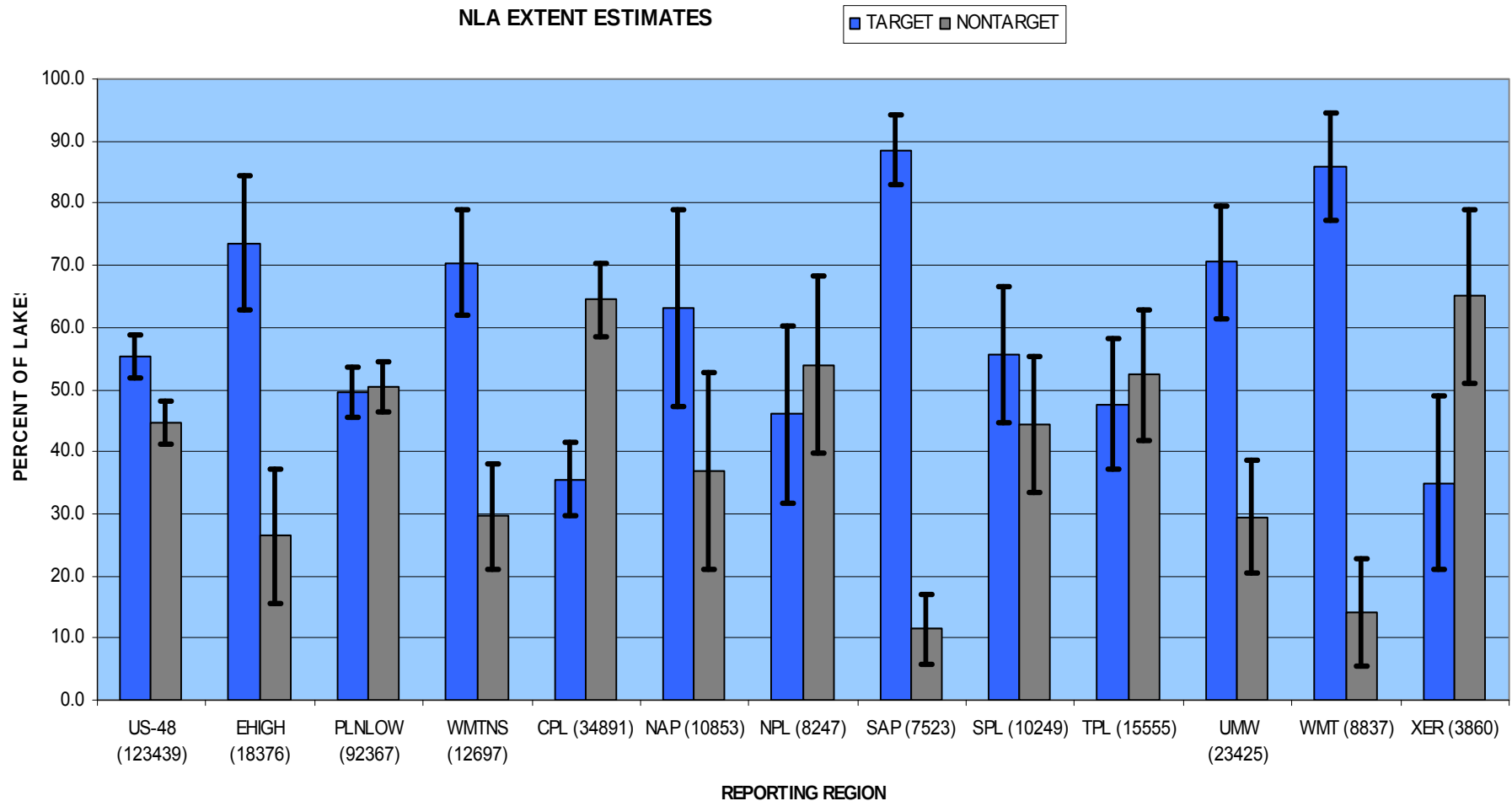
Indicator areas

Indicators	Indicators we will discuss
Phys. habitat	✓
Water Quality	✓
Phytoplankton	✓
Zooplankton	✓
Sed. diatoms	✓
Microcystin	✓
Enterococci	✓
Mercury	☐



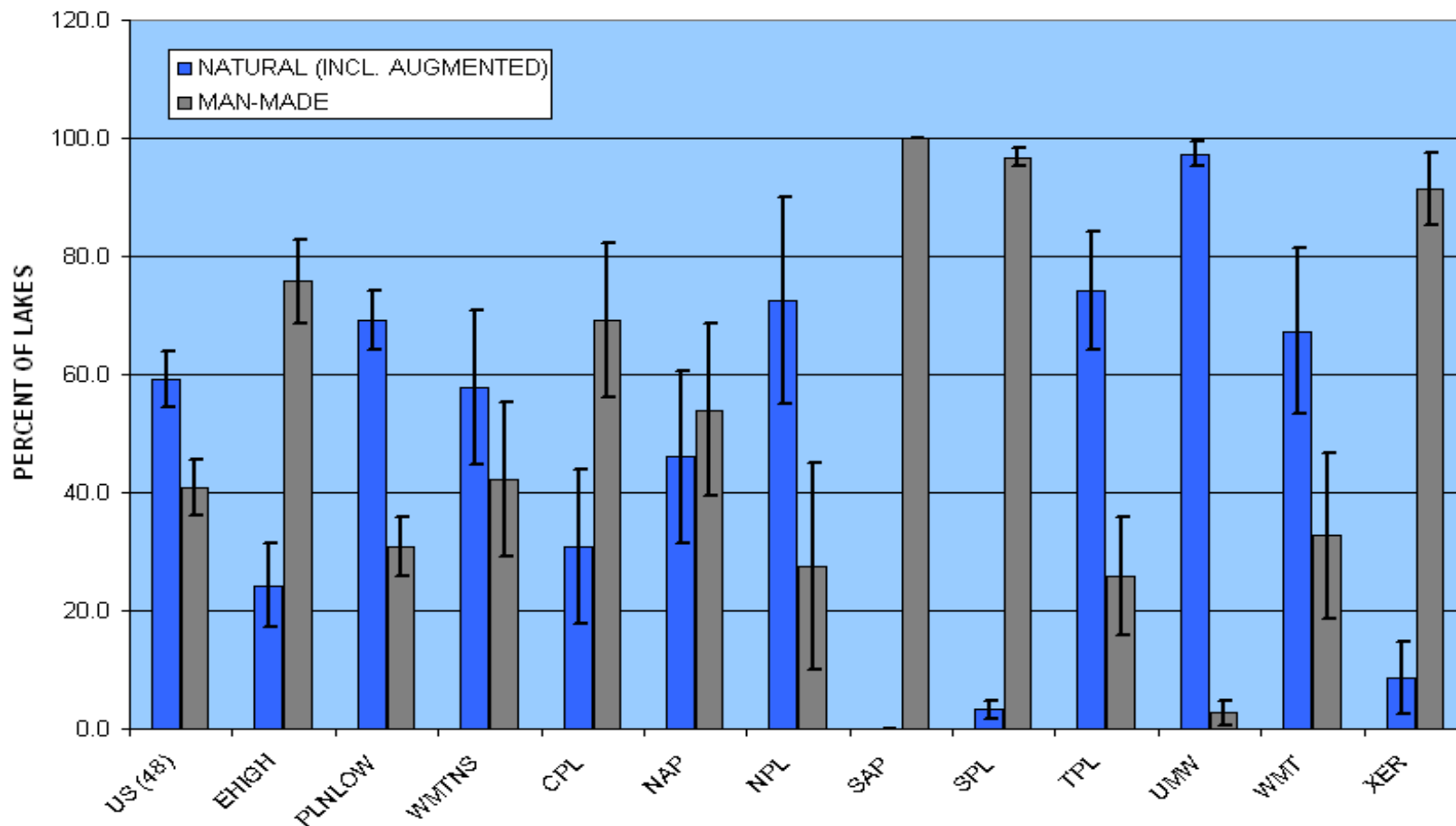
- Three reporting strata:
 - Lower 48
 - Aggregated level II ecoregions
 - Aggregated level III ecoregions
- Reporting regions are *not* the same as analysis regions.

Extent of lakes



Total estimated count of lakes in parentheses

Lakes v. reservoirs



See prior slide for estimated count of lakes

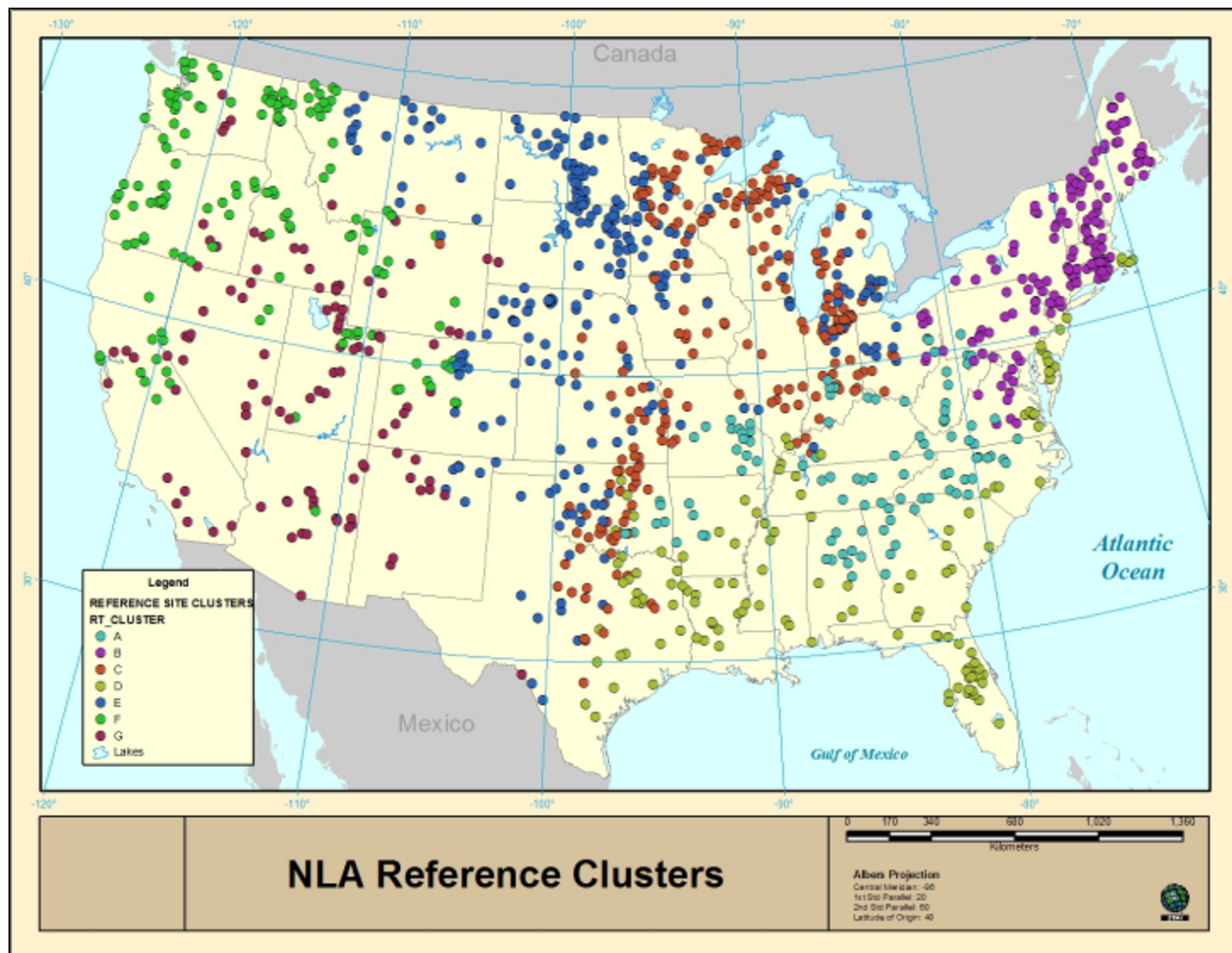
Selecting reference lakes

- The generic process:
 - 1) classify lake types;
 - 2) identify least-disturbed conditions by class.
- The principal constraint is sample size $\geq$ 20 sites/analysis area are needed to compute percentiles to define good / fair / poor thresholds.

Classification

our approach

- At the national scale, how do you define lake class?
- Begin with level II Ecoregions
- Use cluster analysis to identify lakes that are similar based on major geographic factors that will influence lake WQ
 - elevation, area, depth, shoreline development, precipitation, temperature, longitude, latitude, and calcium
- Iterative process seeking clusters that describe lake types



Identifying least disturbed lakes

our approach

- TP
- TN
- CL
- SO₄
- Turb
- ANC (given DOC)
- Euphotic Zone DO
- Shoreline disturbed by Ag
- Shoreline disturbed by non-Ag
- SD – Intensity and extent

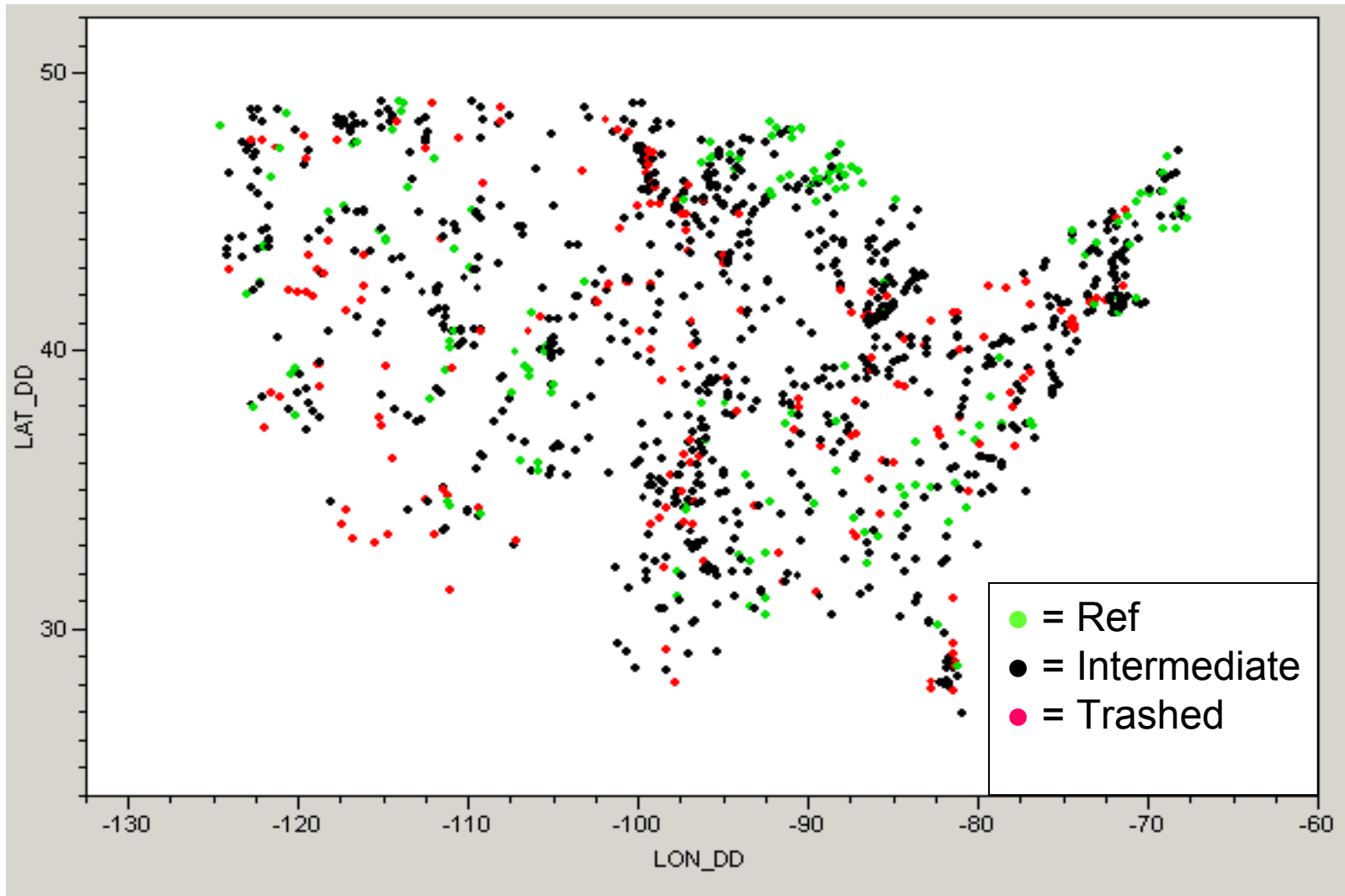
	TP (ppb)	TN (ppm)	CL (μeq)
A	12 / 100	400 / 1500	200 / 10,000
B	10 / 100	300 / 1500	250 / 10,000
C ^{1,2}	15 / 125	500 / 1500	250 / 10,000
C ^{1,3}	50 / 125	750 / 1500	250 / 10,000
D ¹	75 / 750	750 / 2500	NA / 2000
E ¹	100 / 500	1500 / 5000	600 / 10,000
F	10 / 100	300 / 1500	250 / 10,000
G	50 / 250	750 / 1500	500 / 10,000

Pass all = ref

Fail one = trashed

	Phosphorus	Nitrogen	Chloride	Sulfate	Turbidity	Acid rain (& DOC < 5)	Dissolved oxygen	Agriculture disturbance	Nonagricultural disturbance	Disturbance intensity	Number of lakes classified
	PIL	NIL	CL	SO ₄	TURB	ANC DOC	DO ELP	ROSNAG	ROSNONG	ROSNEXIA	
A	12 / 100	400 / 1500	200 / 10,000	400 / 1000	5 / 50	<50 / <0	>4 / <3	0 / 05	06 / 080	05 / 085	17 / 23
B	10 / 100	300 / 1500	250 / 10,000	250 / 1000	2 / 50	<50 / <0	>4 / <3	0 / 05	05 / 075	04 / 085	30 / 21
C ^{1,2}	15 / 125	500 / 1500	250 / 10,000	250 / 1000	5 / 50	<50 / <0	>4 / <3	0 / 03	06 / 08	05 / 085	30 / 25
C ^{1,3}	50 / 125	750 / 1500	250 / 10,000	NA / 1000	10 / 50	<50 / <0	>4 / <3	0 / 03	06 / 08	05 / 085	
D ¹	75 / 750	750 / 2500	NA / 2000	250 / 1000	10 / 50	<50 / <0	>4 / <2	0 / 05	06 / 075	06 / 085	19 / 18
E ¹	100 / 500	1500 / 5000	600 / 10,000	1500 / 10000	10 / 50	<50 / <0	>4 / <3	01 / 05	06 / 075	06 / 085	24 / 51
F	10 / 100	300 / 1500	250 / 10,000	250 / 1000	2 / 50	NA / <0	>4 / <3	0 / 05	05 / 075	04 / 085	40 / 12
G	50 / 250	750 / 1500	500 / 10,000	500 / 4000	10 / 50	NA / <0	>4 / <3	01 / 05	05 / 075	05 / 085	10 / 35

Reference lakes



Dimensions of physical habitat

- Riparian Vegetation Structure & Cover
- Human Landuse & Disturbances
- Bank Characteristics & Level Fluctuations
- Surface Scums
- Substrate -- Bottom & Shoreline
- Littoral Aquatic Macrophytes
- Fish Cover

Stressors /
Characteristics

Responses



EMAP Lake Habitat Metrics and Precision

Habitat Metric

Depth 10m from Shore (m)

Lake Level Fluctuation (m)

Surface Scums (% of Littoral)

Shore Substrate Size (mean)

Bottom Substrate Size (mean)

Riparian Canopy Presence (%)

Dock & Boat Presence (% Shore)

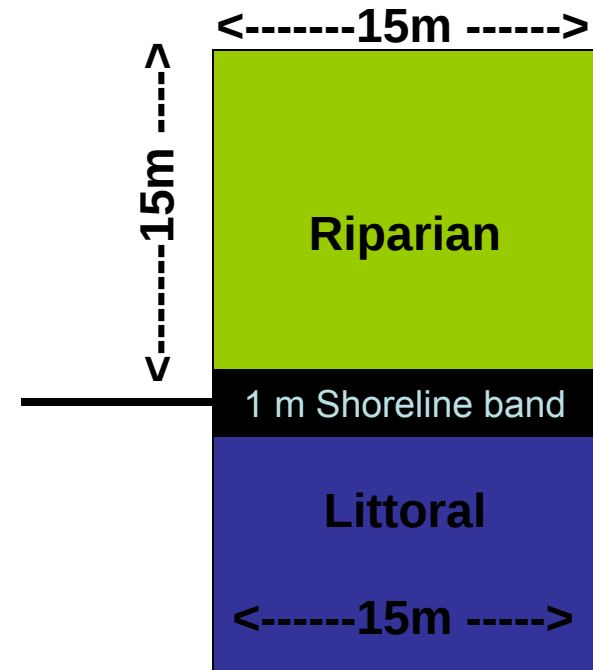
Fish Cover (Sum of all types)

Shoreline Disturbance (proximity-wt'd index)

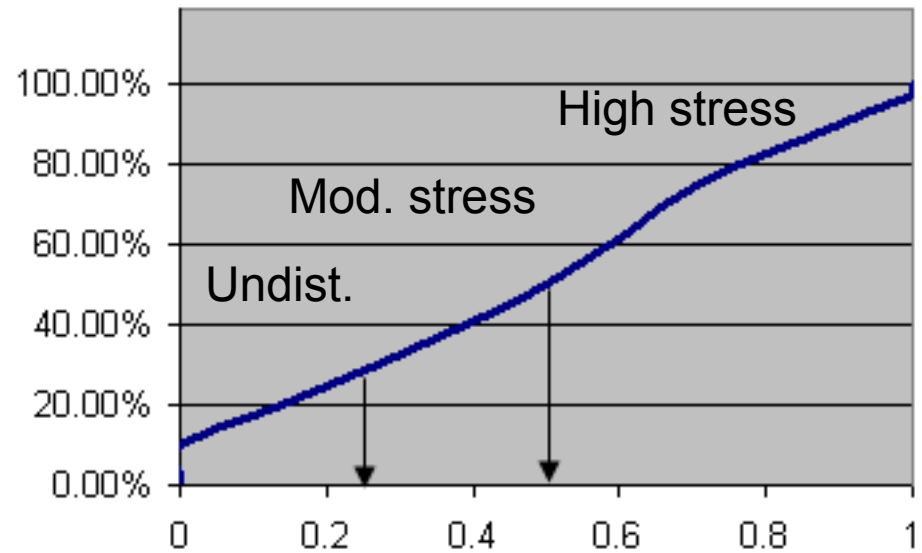
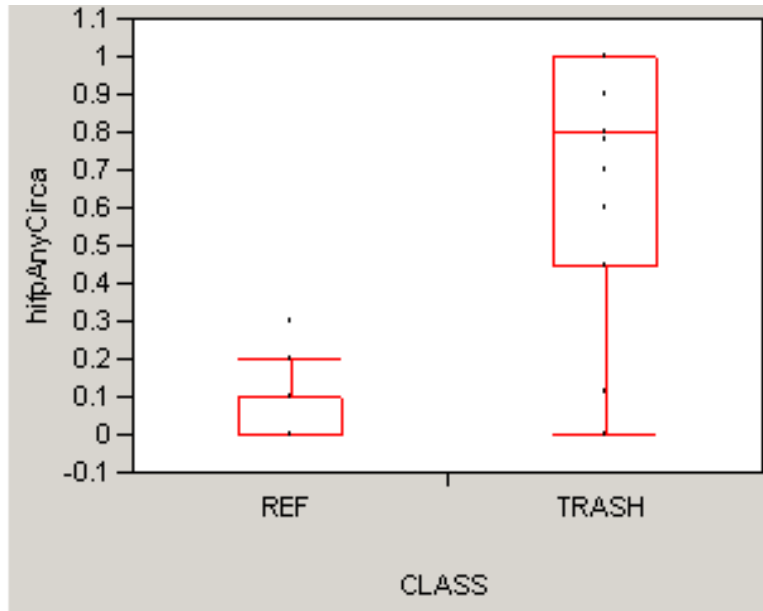
Composite - Riparian Alteration Index

Composite - Shoreline Fish Cover Quality Index

Composite - Riparian & Littoral Quality Index

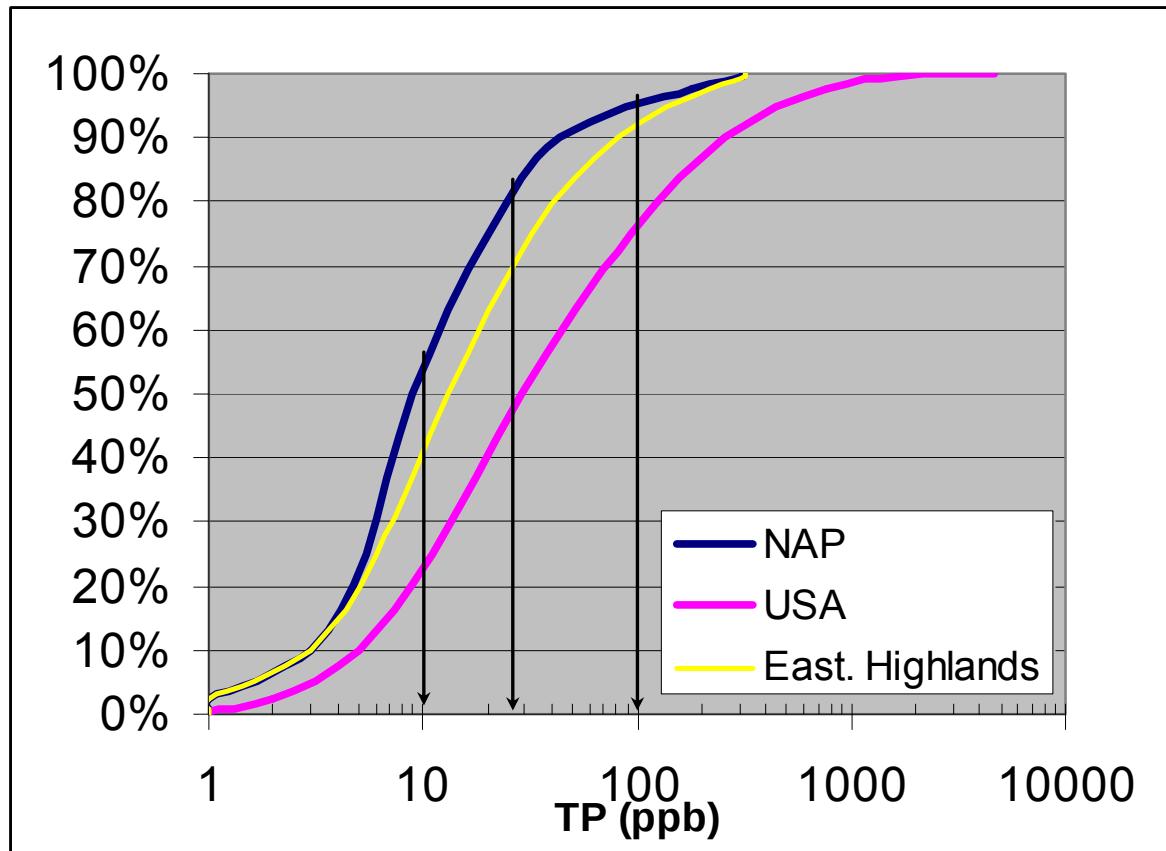


Example of Phab analysis NAP

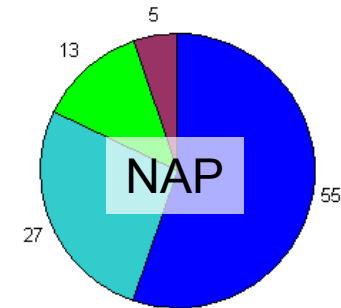


Relative percent of disturbed shoreline
(thresholds from Whittier et al., 2002)

Water Quality – Trophic State



Percent of lakes in trophic categories by region.
(total estimated count of lakes on slide 9)

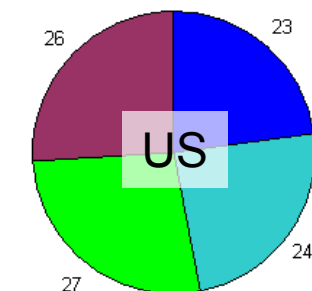
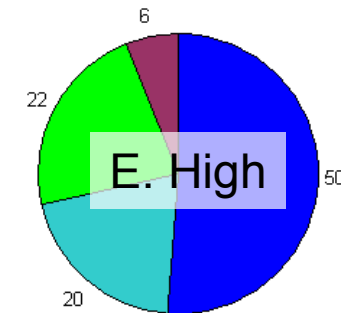


Oligo

Meso

Eutro

HyperEut

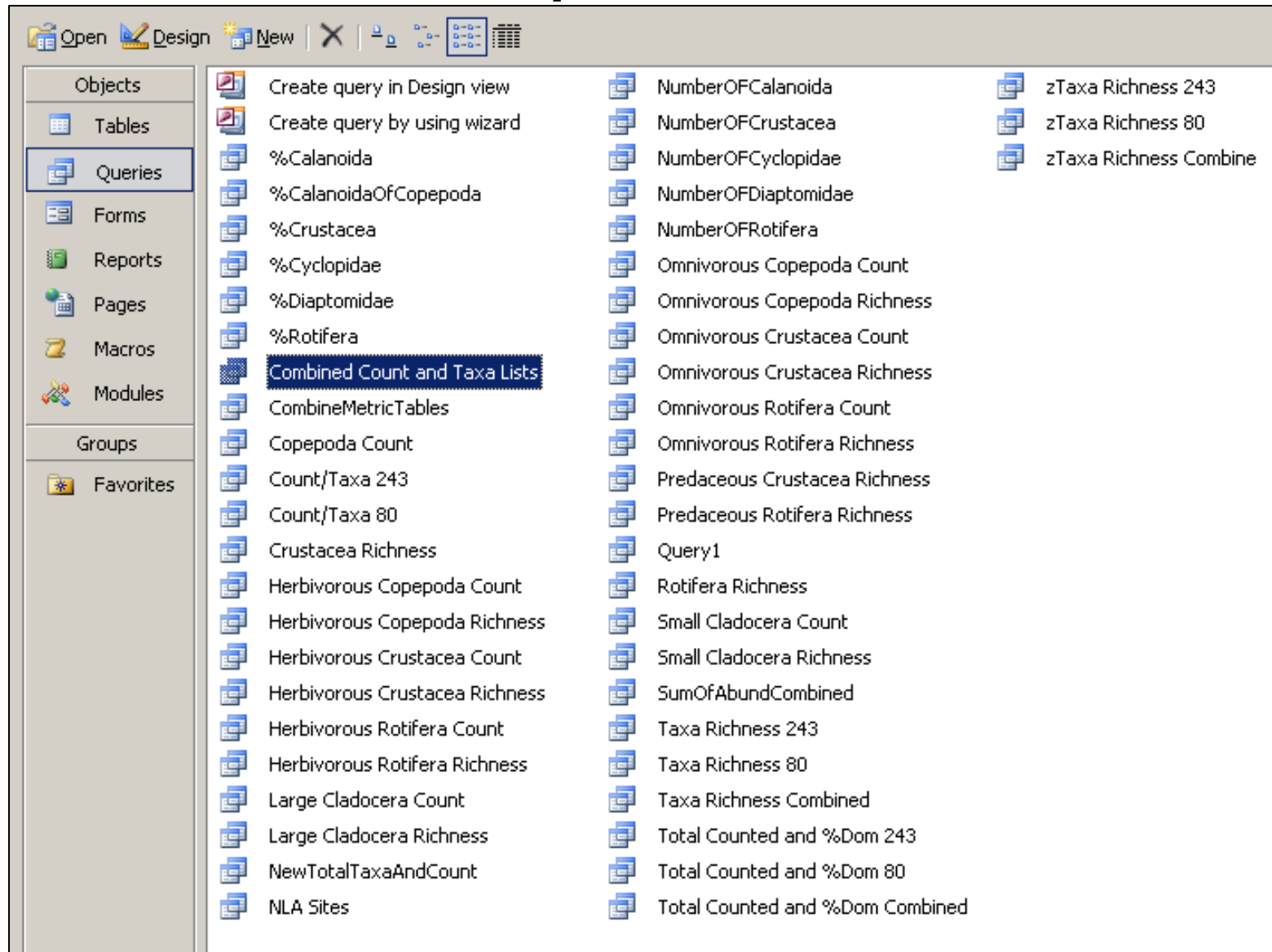


Bioindices – Zooplankton and Phytoplankton

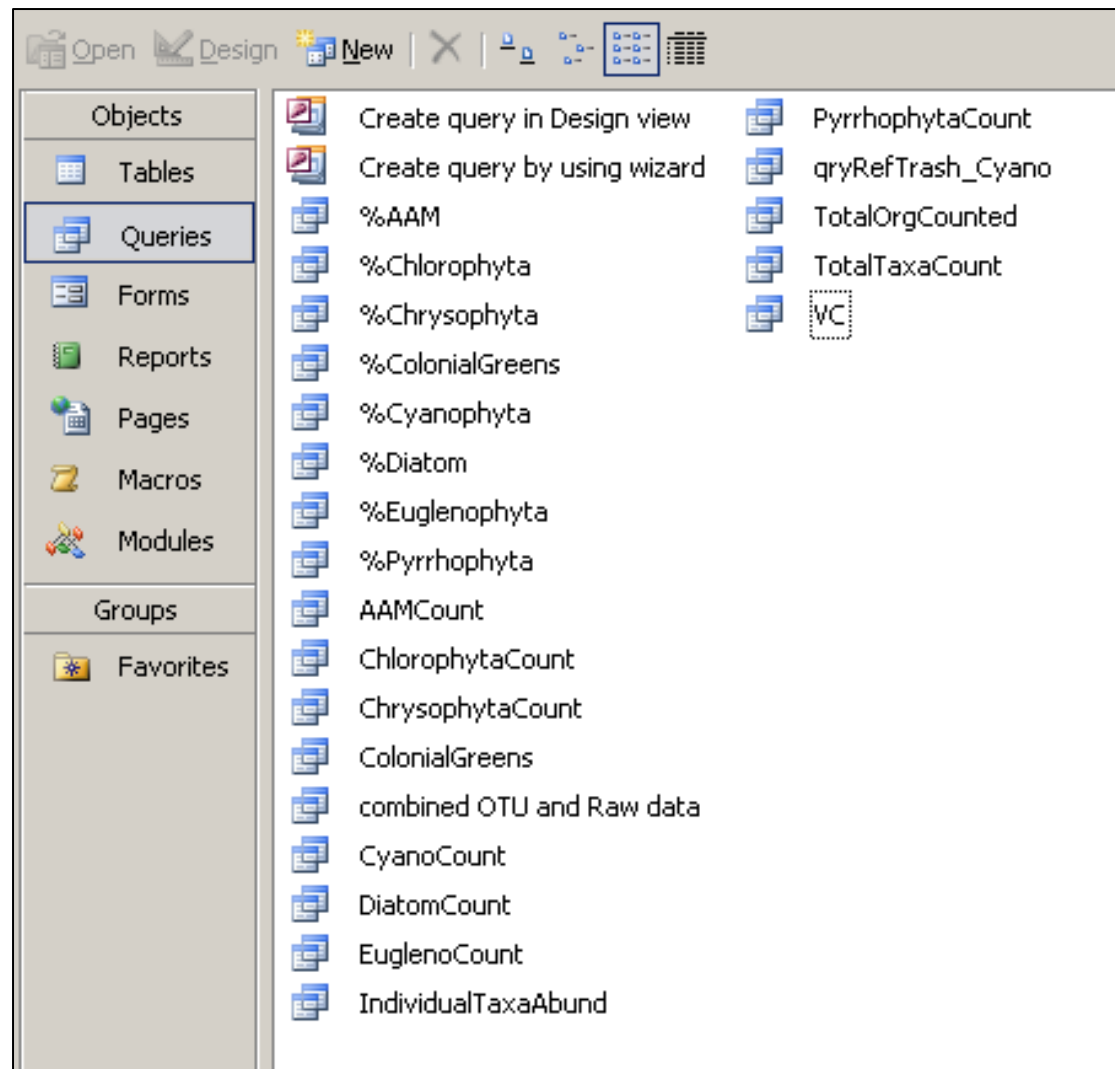
- IBI's are being developed for each indicator
- Considering mixing indicators:
 - E.g. % cladocerans where %cyanobacteria > 25
- O/E modeling is also being done on Zoop (1st), possibly phytoplankton



Zoop Metrics

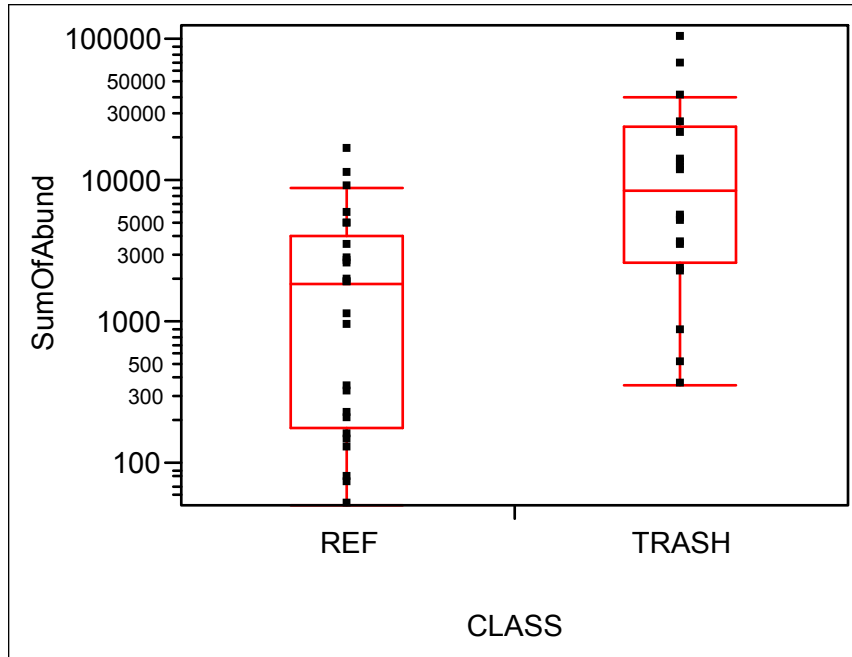


Phyto metrics

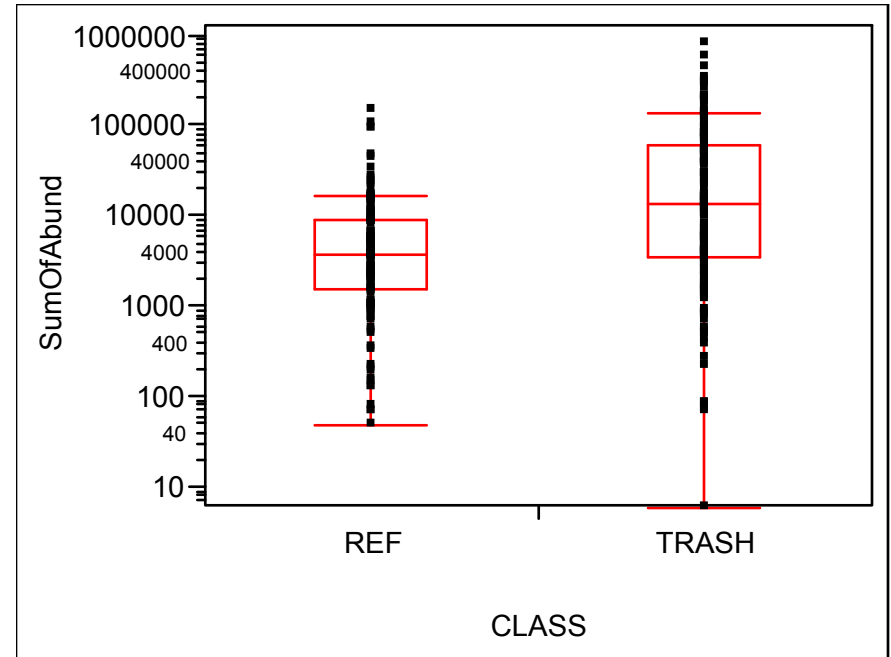


Phytoplankton metric example

Lakes in NAP (cluster B)

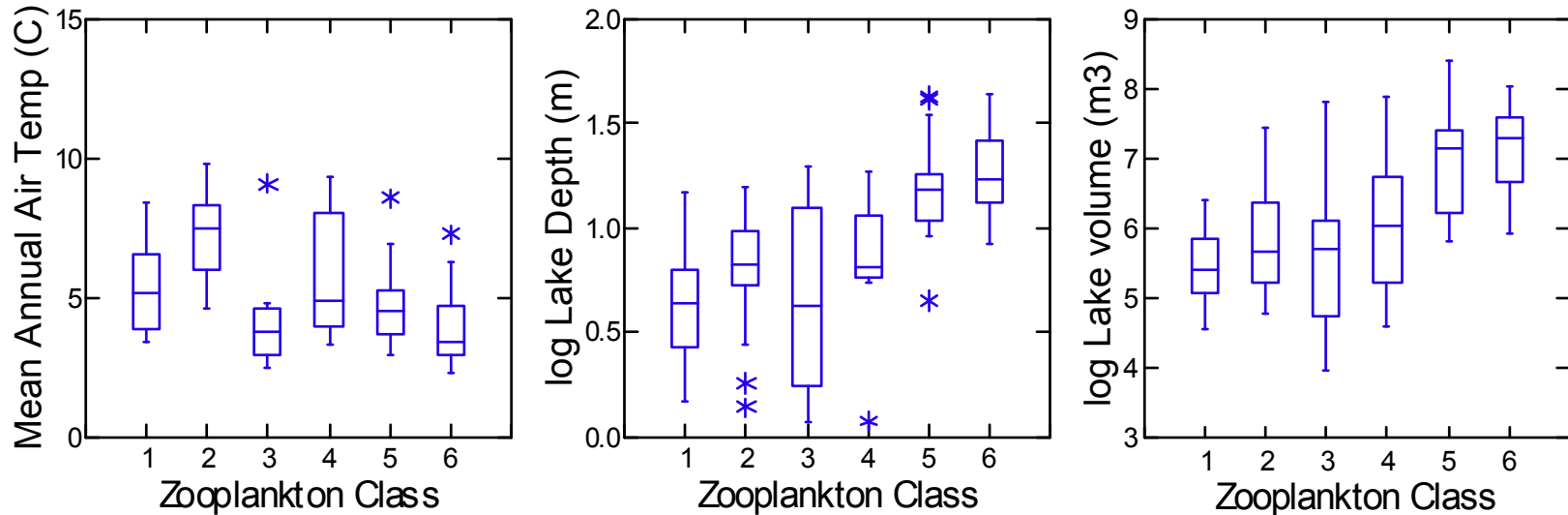


All lakes



Total abundance – Aphanazominon, Anabaena, Microcystin

O/E major environmental associations with reference lake groups (NE lakes)



Indicator

Precision

Responsiveness

Sensitivity

Zooplankton O/E

0.14

0.74

77

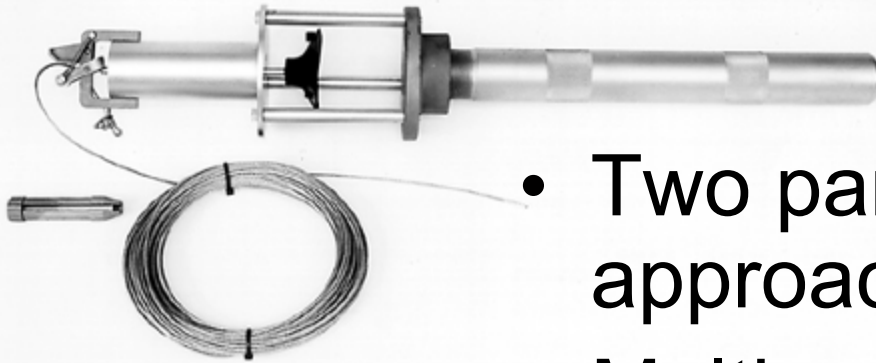
Zooplankton MMI

0.17

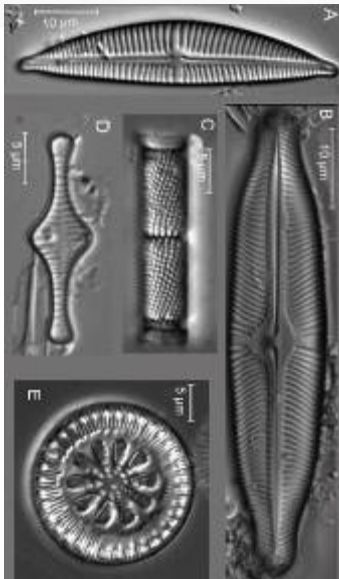
0.81

63

Sediment diatoms



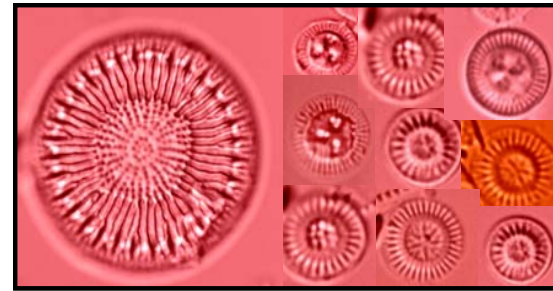
- Two parallel approaches
- Multimetric index development (determine biointegrity)
- Diatom inference modeling (predict env. condx from diatoms)



“Top-Bottom” Sediment Sampling Approach

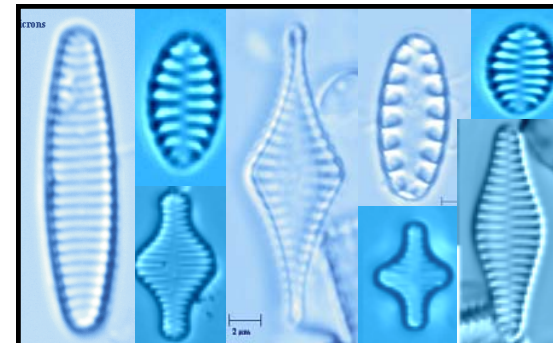
MMI to describe TOP

Deposited in recent lake environment

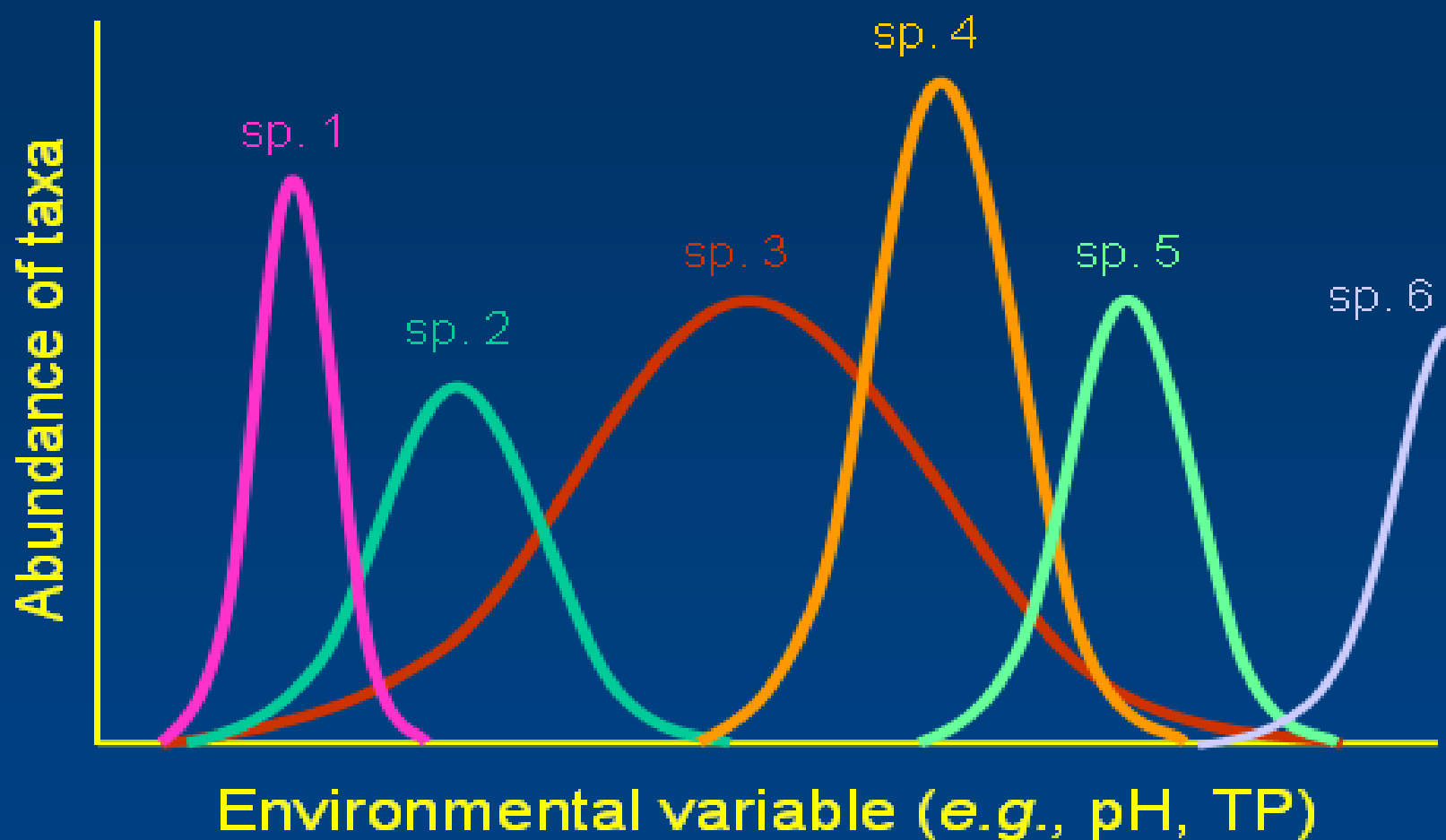


MMI to describe BOTTOM

Deposited in pre-industrial lake environment

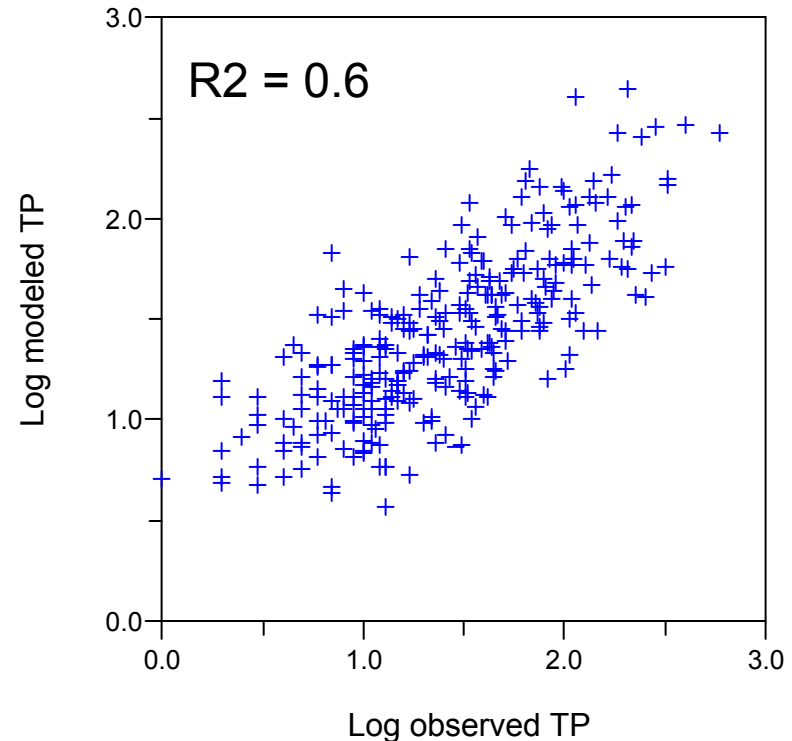
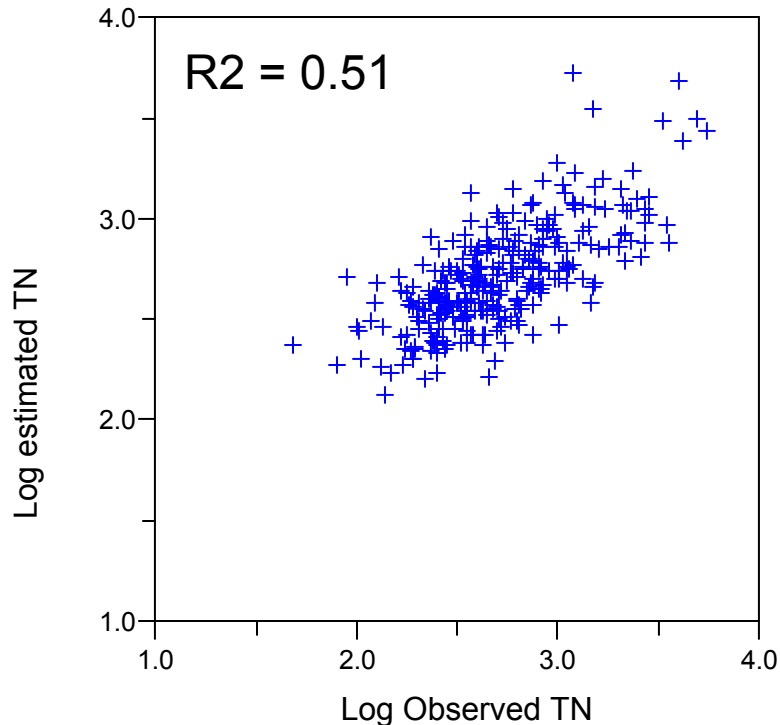


Transfer Functions



Transfer Functions

CPL, NAP, SAP



- Transfer functions hindcast historical conditions from bottom-core samples
- Computed using “WAPLS” for TP, TN, pH, DOC

Microcystin

- Most commonly measured cyanotoxin
- Indicator of recreational suitability
- Possible stressor of biological integrity



Microcystins Are Found Throughout the United States Especially in the Upper Midwest.

Concentration
(ppb MCLR
equivalents)

Study Lakes

Mean	3.0 (~ 1.0)
Median	0.52 (< 0.10)
Minimum	0.10 (< 0.10)
Maximum	230

1 Values outside parenthesis are summary statistics for detections only. Values inside parenthesis include non-detections in summary statistics.

**% Overall Detections (with Reference
and Resampled Lakes:
32 % (401/1238)**

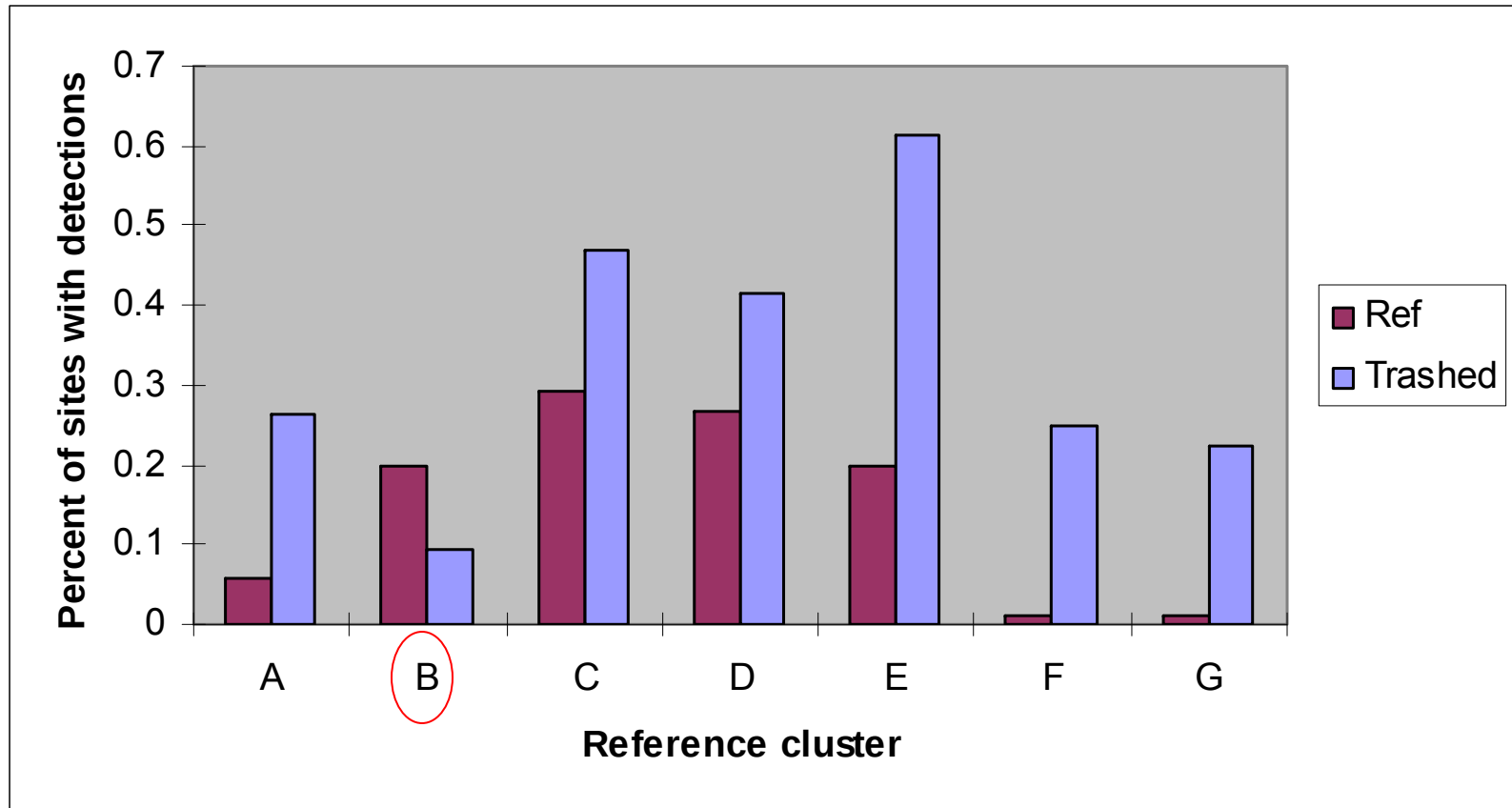
● No Detectable Microcystin
● Detectable Microcystin



Enterococci (by qPCR)

- New indicator of swimming suitability
- Still experimental in freshwaters
- Reporting approaches under evaluation:
 - *Reference approach*
 - *Threshold approach*
 - Stressor approach
 - Ranking of lakes.

Example of reference approach Enterococci





ID	Task Name
1	Grants allocation
2	Work with 106 partners
3	Prepare RFA for Supplemental Work
4	Pre-award negotiations
5	Grant awards
6	Prepare RFP for in-kind services
7	Task Order for in-kind support
8	
9	Prepare QAPP and SOPs
10	Complete definition of DQOs
11	Select indicators, protocols, methods
12	Prepare draft QAPP and SOPs
13	Review period
14	Finalize and distribute
15	
16	Field Support and Sampling
17	Site reconnaissance
18	Prepare field guidance / sheets
19	Training
20	Conduct field work
21	Laboratory audits
22	
23	Data Analysis and report
24	Data intake and management
25	Conduct data analyses
26	Workshop with basic results
27	Workshop with full results
28	Write report

Timeline to completion

- Despite perceived (and real) delays, we are not far off track
- Analysis is proceeding with the goal of producing preliminary condition estimates by the Chicago Lakes Conference
- Condition estimates will not be presented until they achieve final form
- Data are being made available to states as they become available.



Report preparation

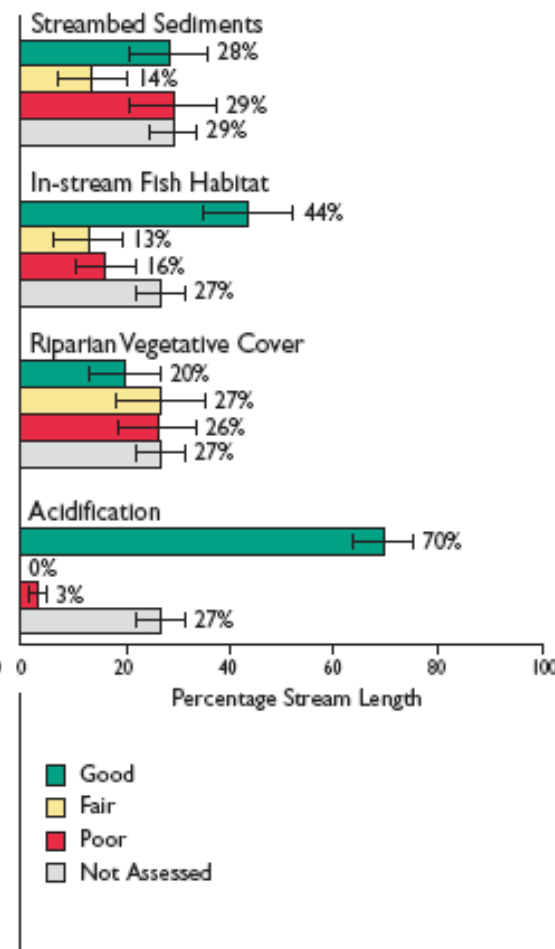
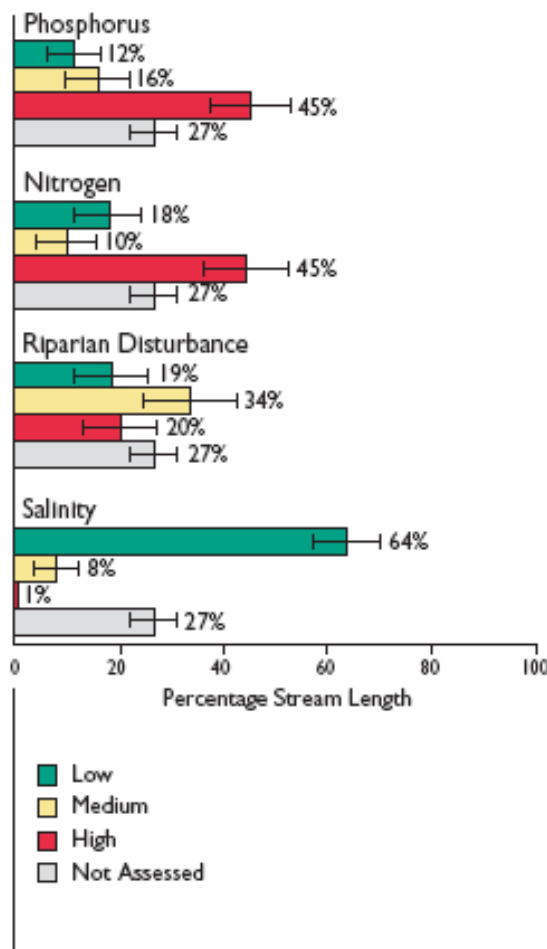
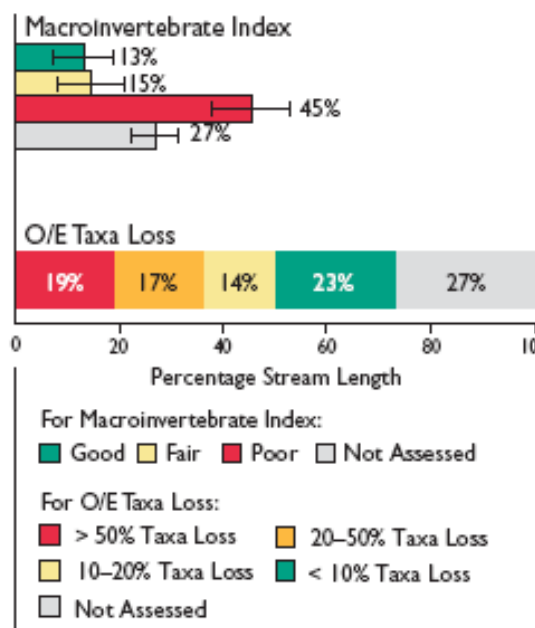
- Outline of report and front-end of text is drafted
- Target is to have State review draft for mid May
- Peer review draft to follow for end of June.

Report structure

Blending WSA and the Coastal Assessment



Northern Appalachians Ecoregion
97,913 miles





Need more info?

Neil Kamman
103 S. Main 10N
Waterbury, VT 05671-0408

820 241-3795
Kamman.neil@epa.gov