National Biological Assessment and Criteria Workshop

Advancing State and Tribal Programs

Coeur d'Alene, Idaho
31 March – 4 April, 2003

LAKES 101

Defining Reference Conditions with Sediment Cores

Presented by

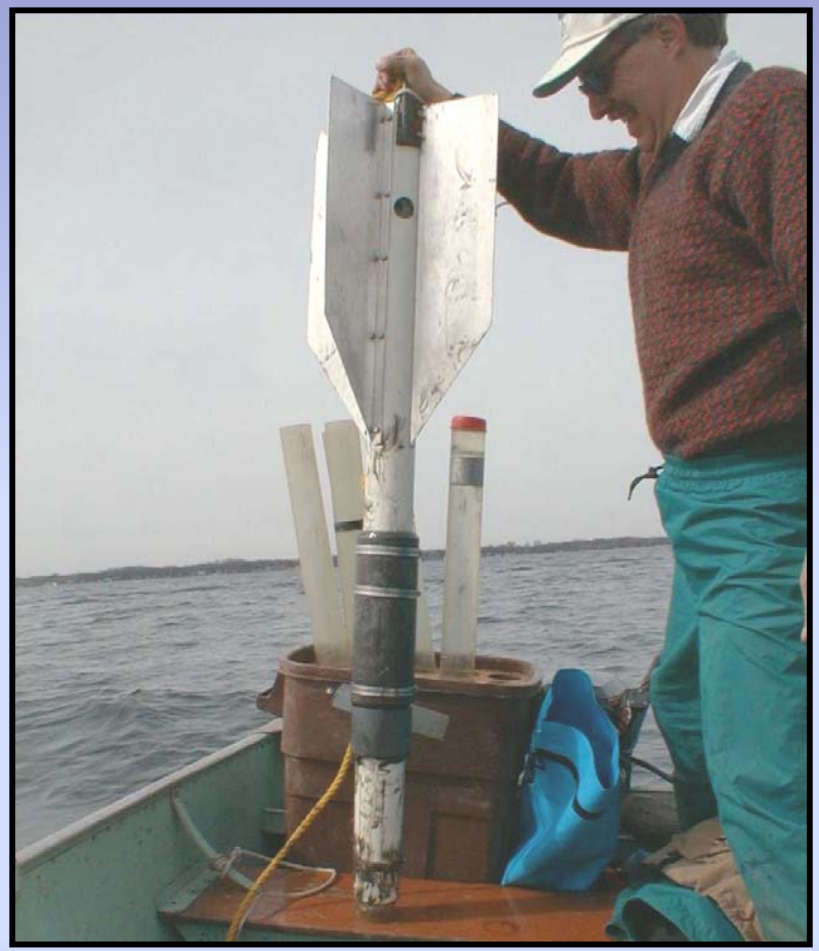
Paul Garrison
Wisconsin Department of Natural Resources


MERCURY
8.0
MERCURY
8.0

WHY TAKE SEDIMENT CORES?

- Lack of long-term data.
- Lack of suitable reference conditions.
- How has the water quality of my lake changed?

HOW DO YOU COLLECT SEDIMENT CORES?



Gravity Corer

Piston Corer

CORE COLLECTION

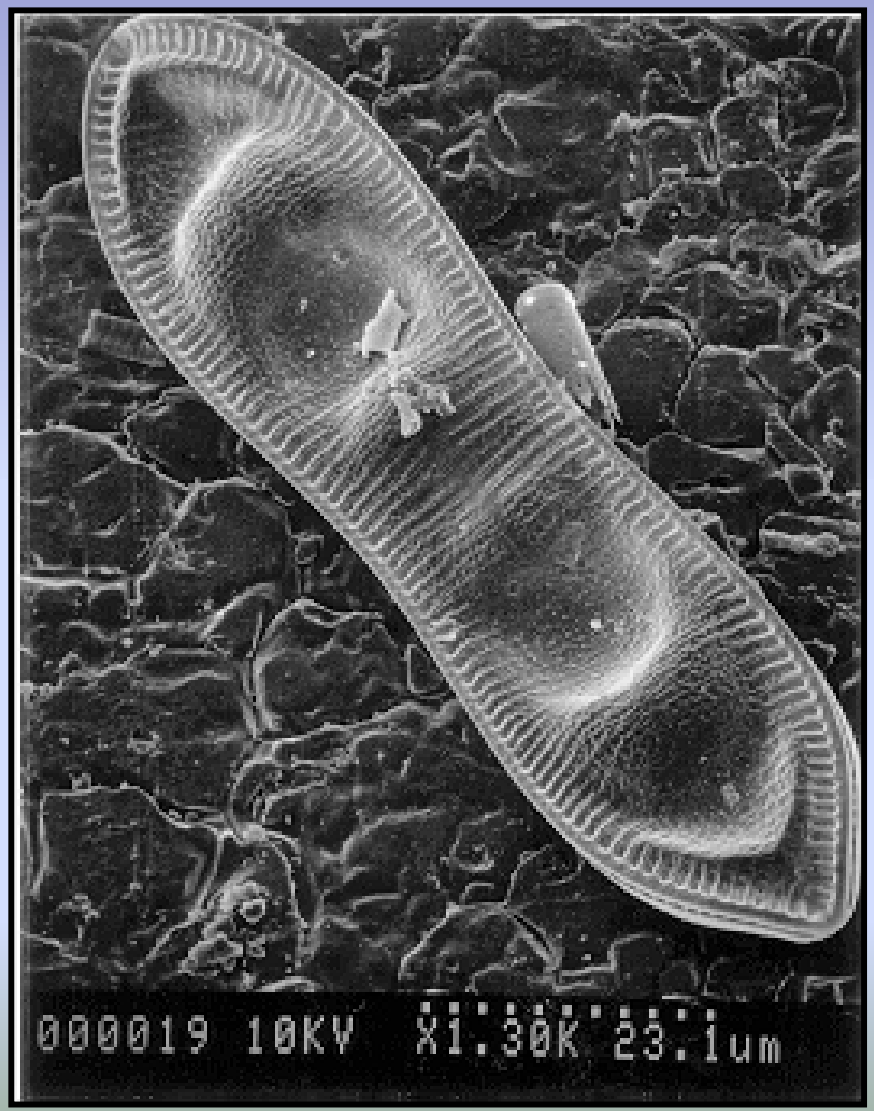
- **Where do you collect a core?**
  - Generally in deep area of the lake or reservoir where the bottom is broad and flat
- **When do you collect a core?**
  - Can be done any time of the year when access is best

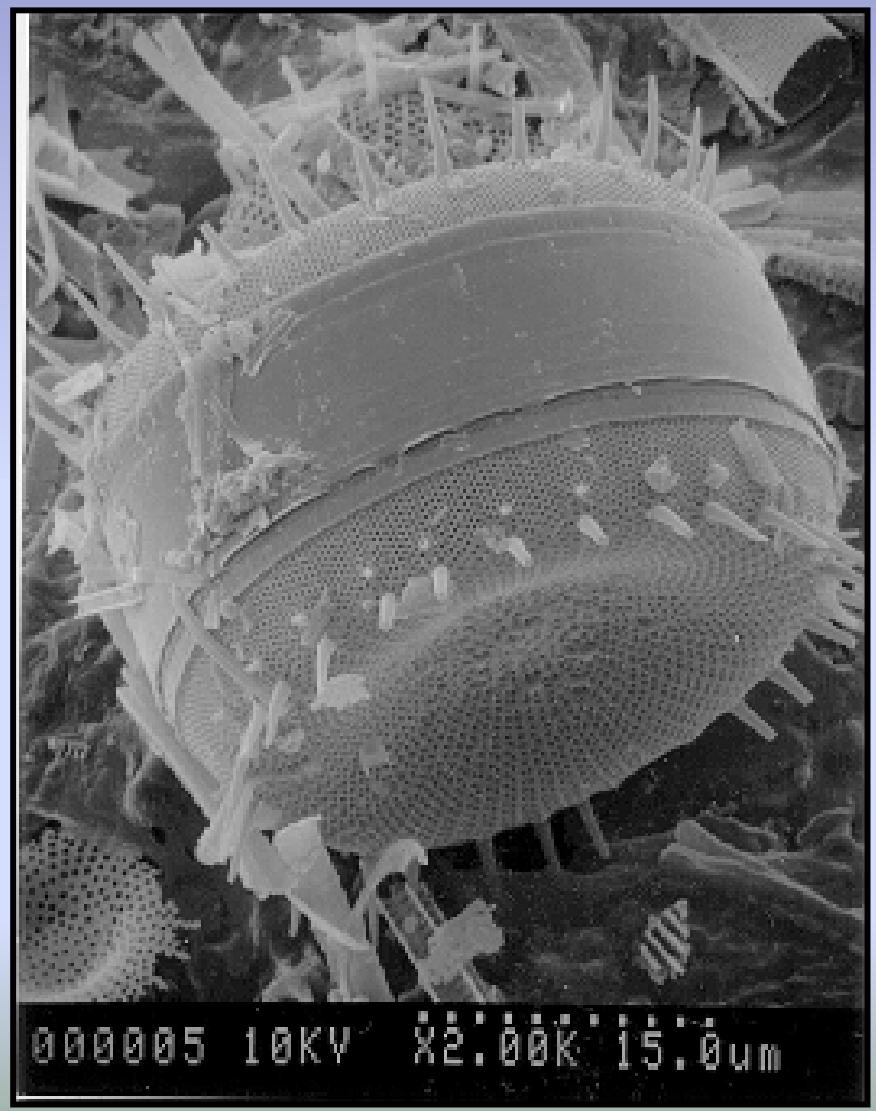
WHAT TYPE OF CORE?

- **Full Core**
  - Core depth should be deep enough so it includes time period prior to impact.
  - Complete core is sectioned and archived
  - Provides much more information about overall trends and specifics regarding timing of changes
- **Top/Bottom Core**
  - Only surface sample and pre-impact depth is kept.
  - Depth of bottom sample estimated from other cores in region, stratigraphic marker, e.g. color change, change in texture.
  - Much less expensive and provides a snapshot of changes

WHAT ARE DIATOMS?

DIATOMS





WHY USE DIATOMS?

- **QUANTITATIVE & QUALITATIVE**
  - Changes in nutrients
  - Changes in pH
  - Changes in macrophytes
- **TECHNIQUES**
  - Multivariate statistics
    - Weighted averaging

COMMON DIATOM SPECIES

REFERENCE

- *Cyclotella michiganiana*
- *C. atomus*
- *C. comensis*
- *Aulacoseira ambigua*
- *A. subarctica*

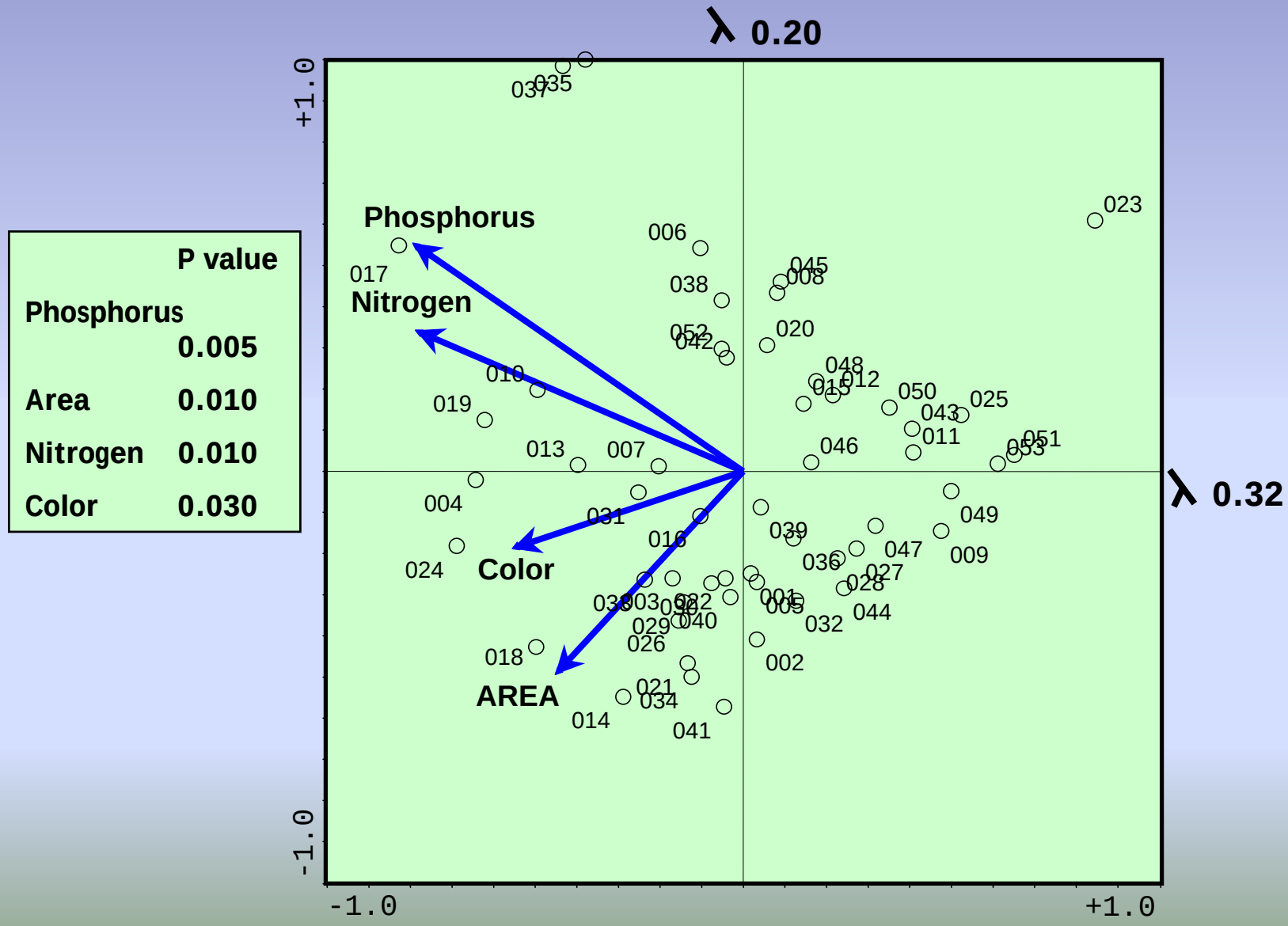
IMPACTED

- *Stephanodiscus medius*
- *S. hantzschii*
- *S. parvus*
- *S. minutulus*
- *Aulacoseira ambigua*
- *A. granulata*
- *A. italica*
- *Cyclostephanos dubius*
- *C. invisitatus*
- ***Fragilaria crotonensis***
- ***Asterionella formosa***

Statistical Analyses

- **Canonical Correspondence Analysis (CCA)**
  - Determine variables that can be reliably inferred
- **Weighted Averaging**
  - Infer historical levels
    - Phosphorus, pH, chloride, etc

Canonical Correspondence Analysis

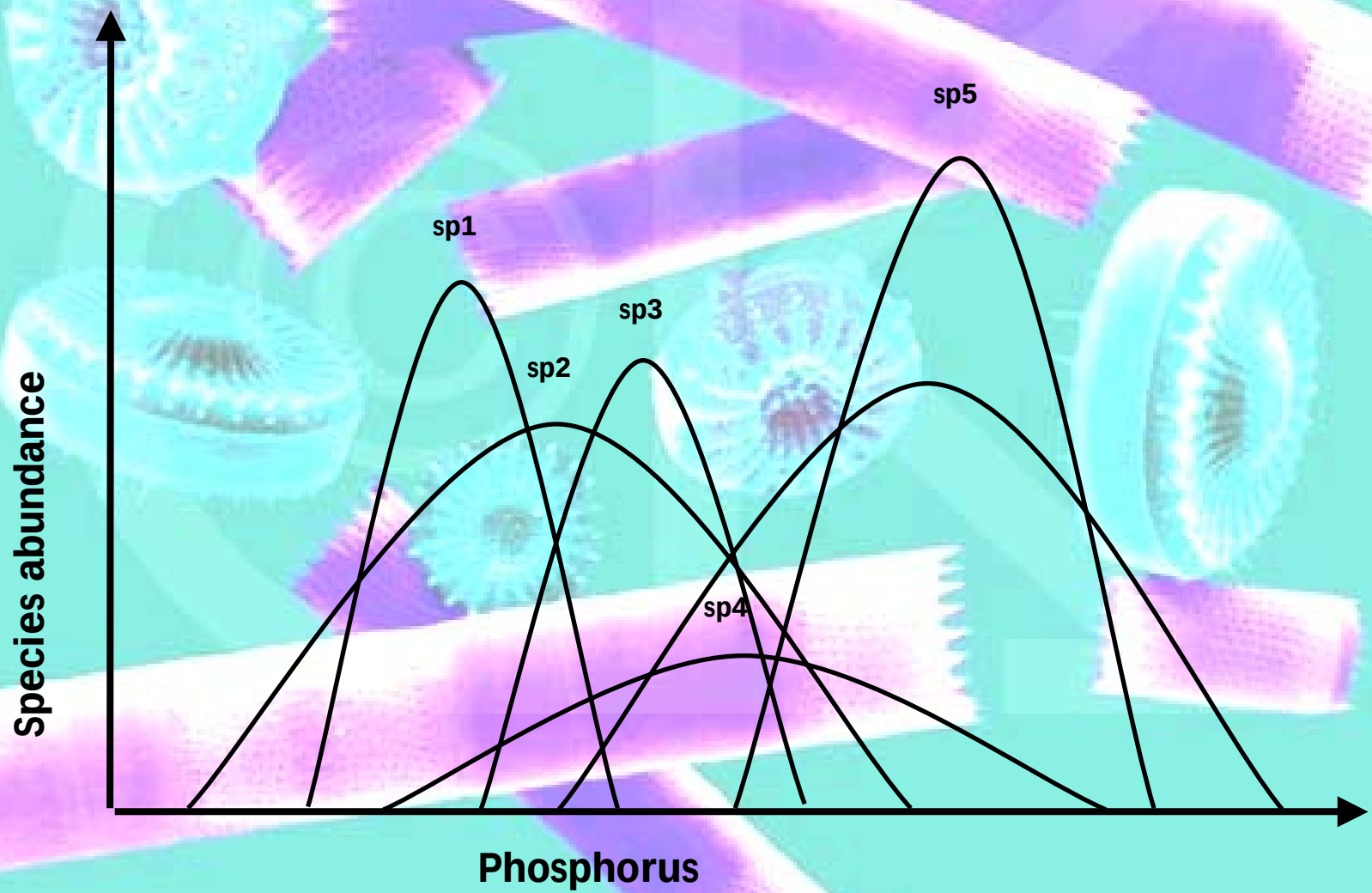


WEIGHTED AVERAGING

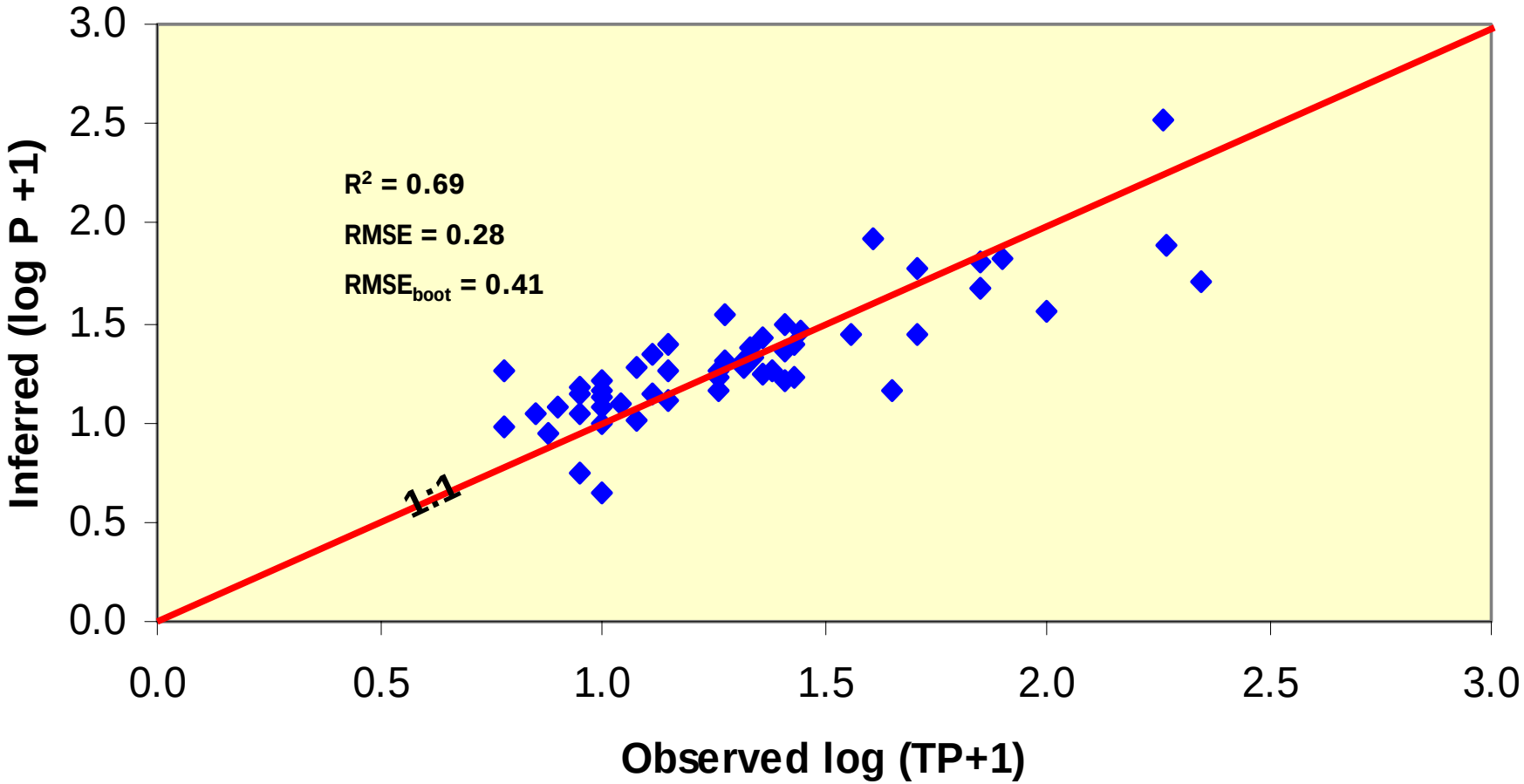
- Statistical model that allows the use of diatoms to estimate historical levels of variables of interest, e.g., P, pH, Cl, ANC, DOC

- Usually done with program WACALIB

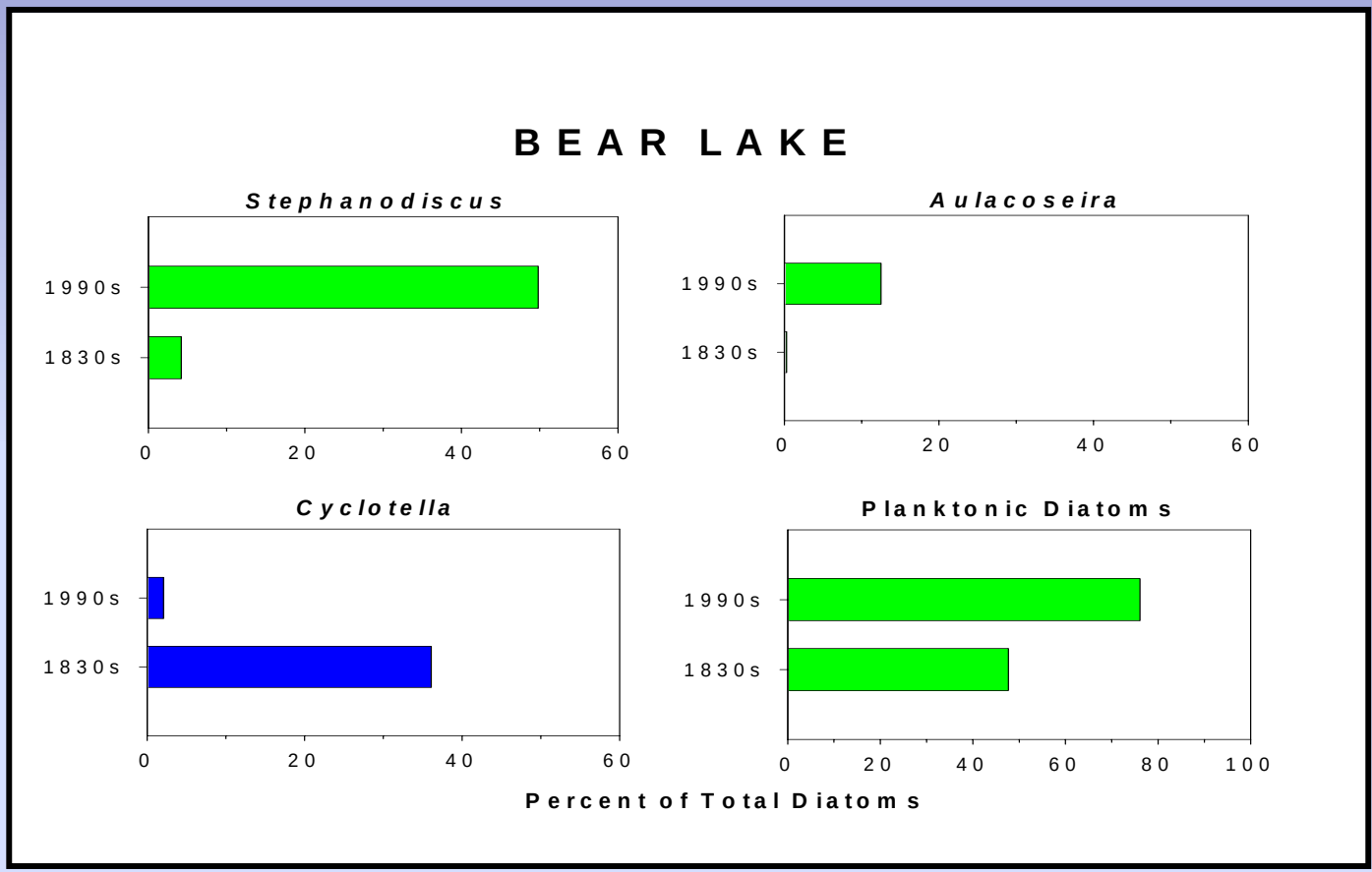
WEIGHTED AVERAGING



Weighted Average -- Tolerance

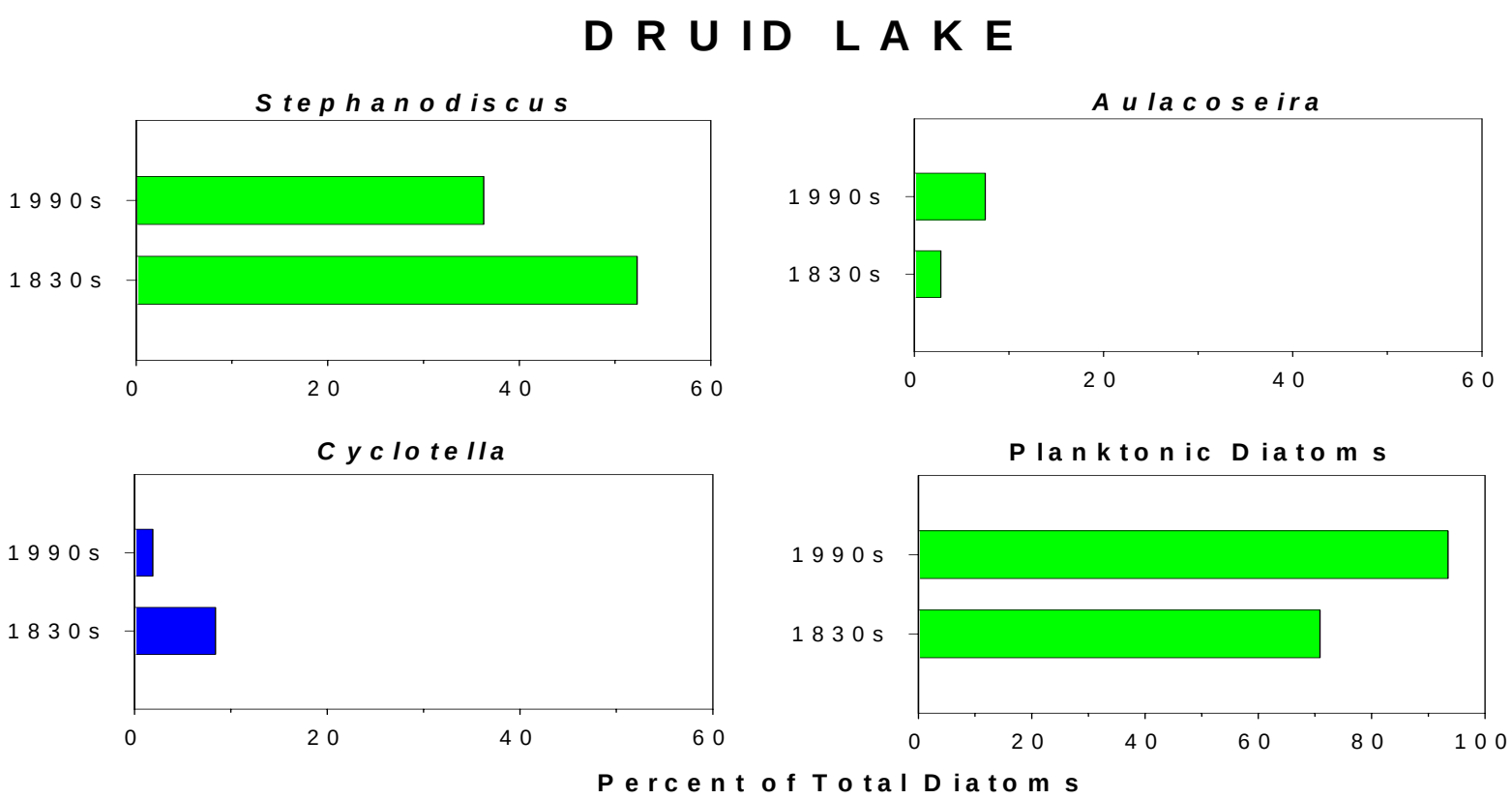


CASE STUDIES
Phosphorus

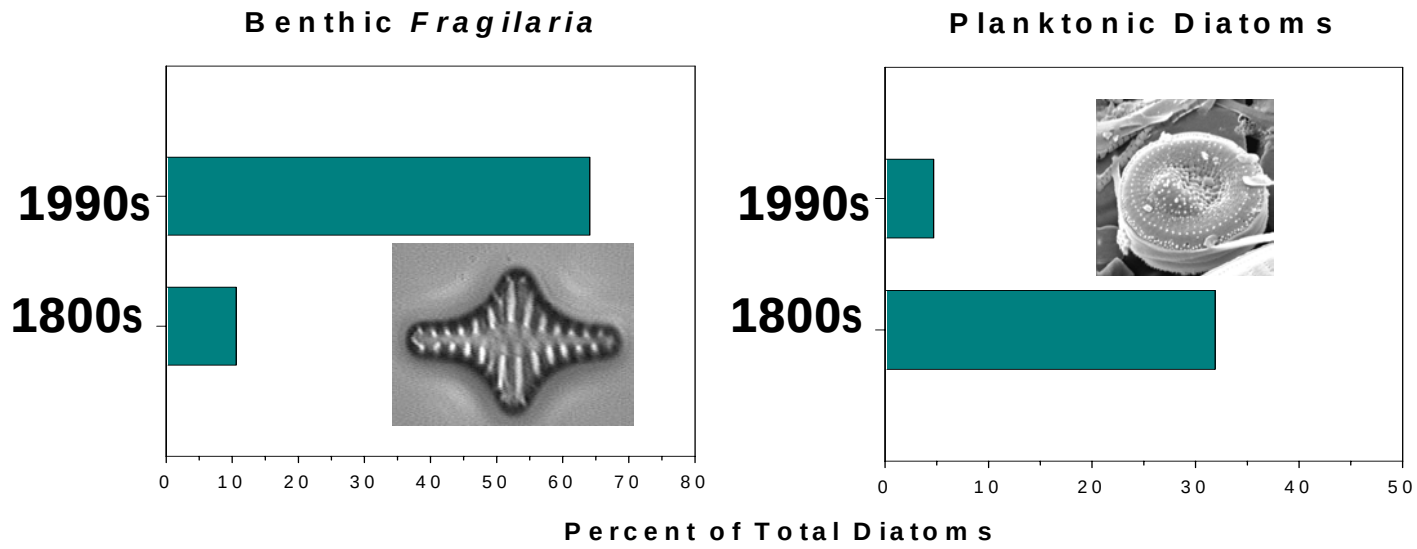


Increase of high phosphorus diatoms (green); P increase of 25 µg L^{-1}

CASE STUDIES
Naturally Eutrophic Lake

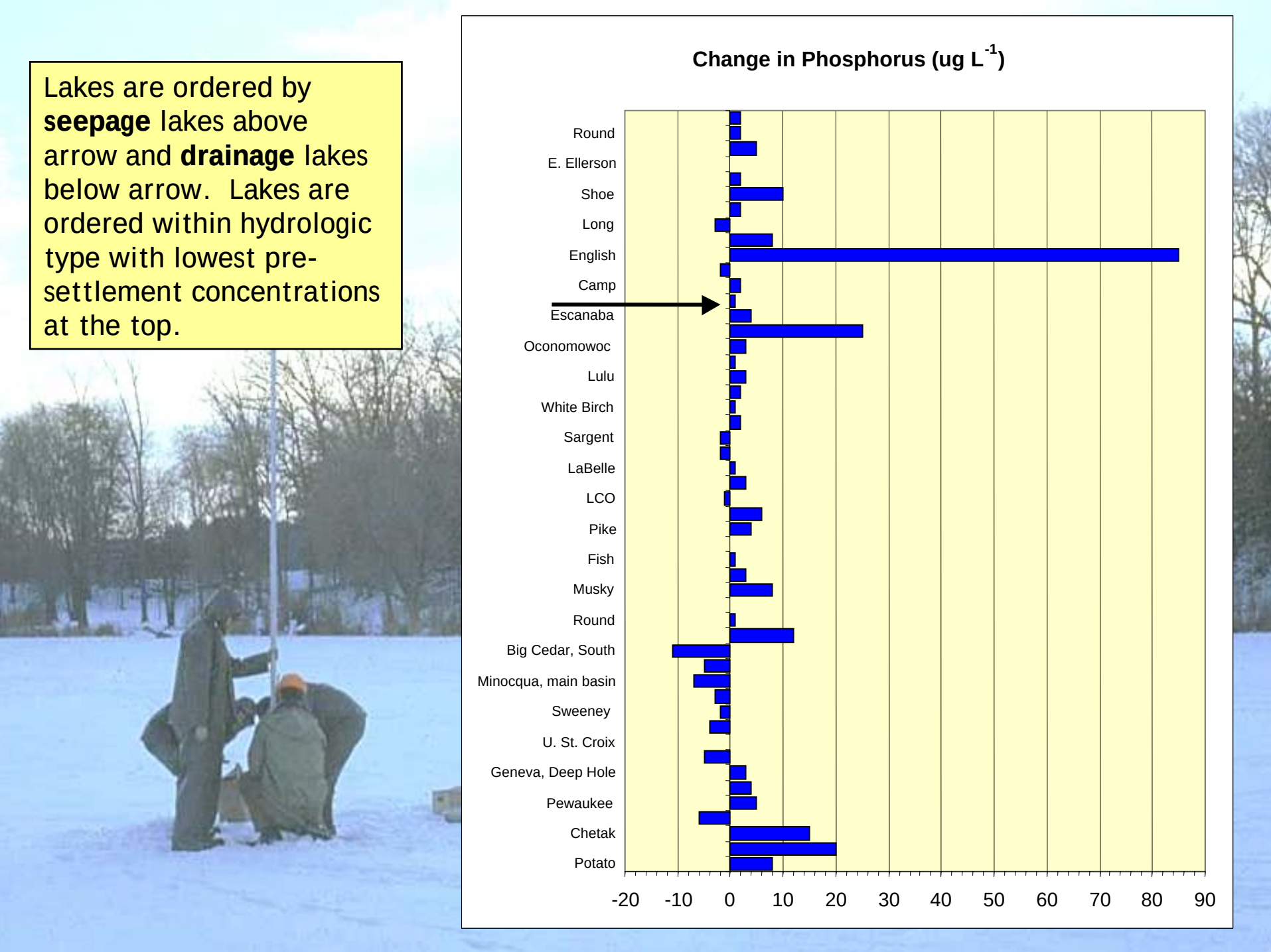


CASE STUDIES
Macrophytes & P

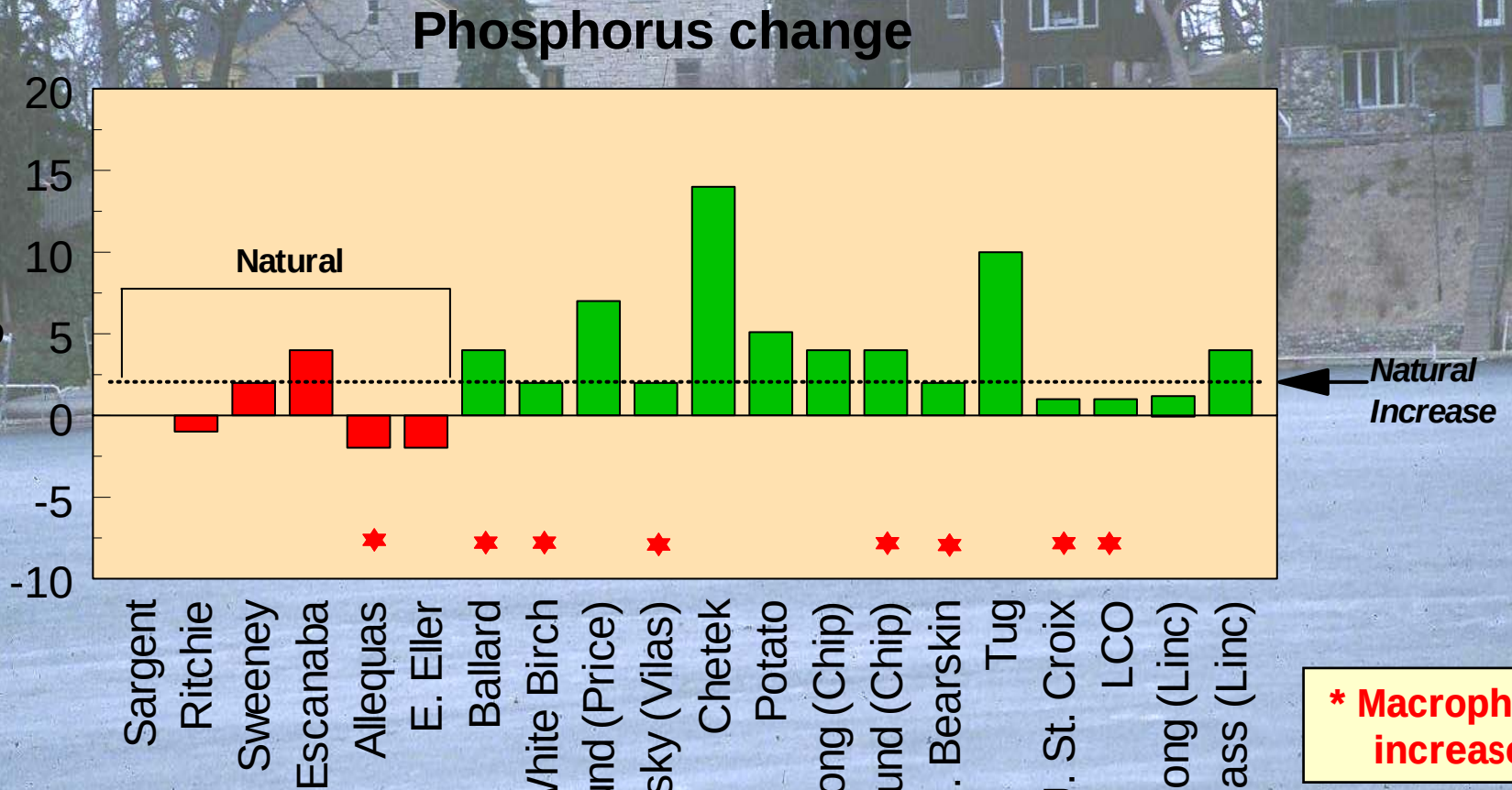


More macrophytes and phosphorus increase of 1 µg L^{-1}

Lakes are ordered by **seepage** lakes above arrow and **drainage** lakes below arrow. Lakes are ordered within hydrologic type with lowest pre-settlement concentrations at the top.



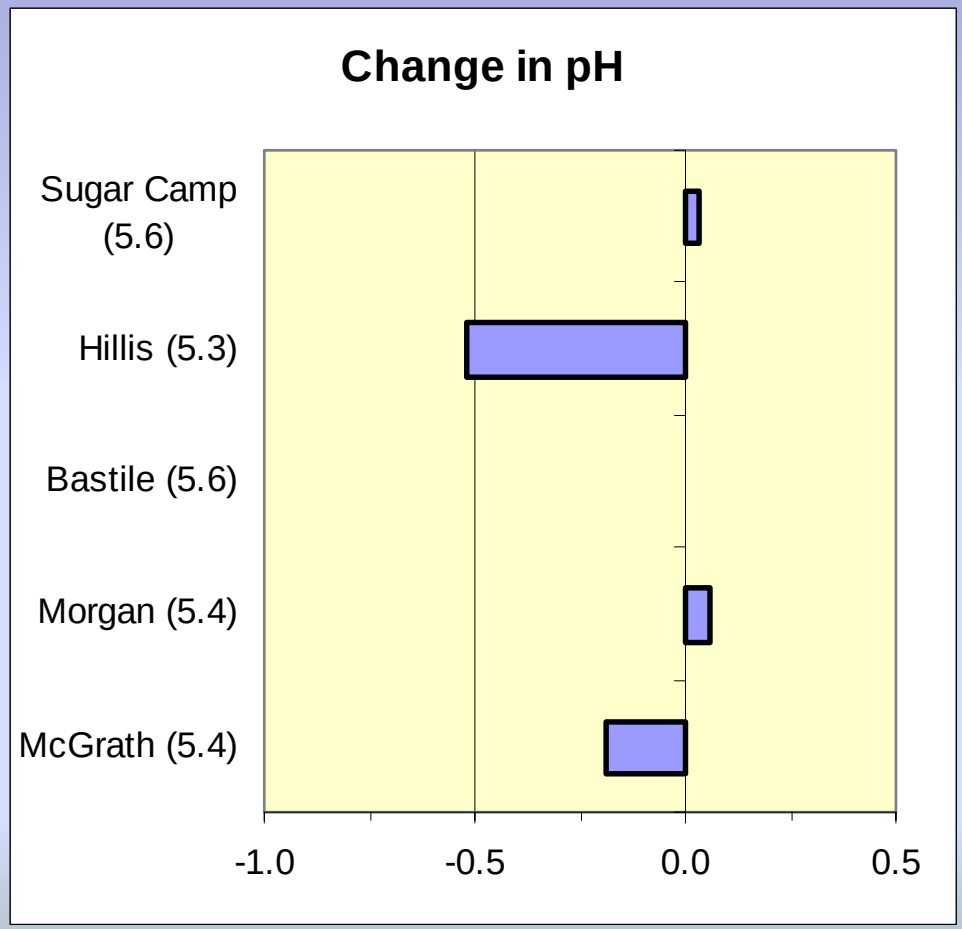
Shoreline Development



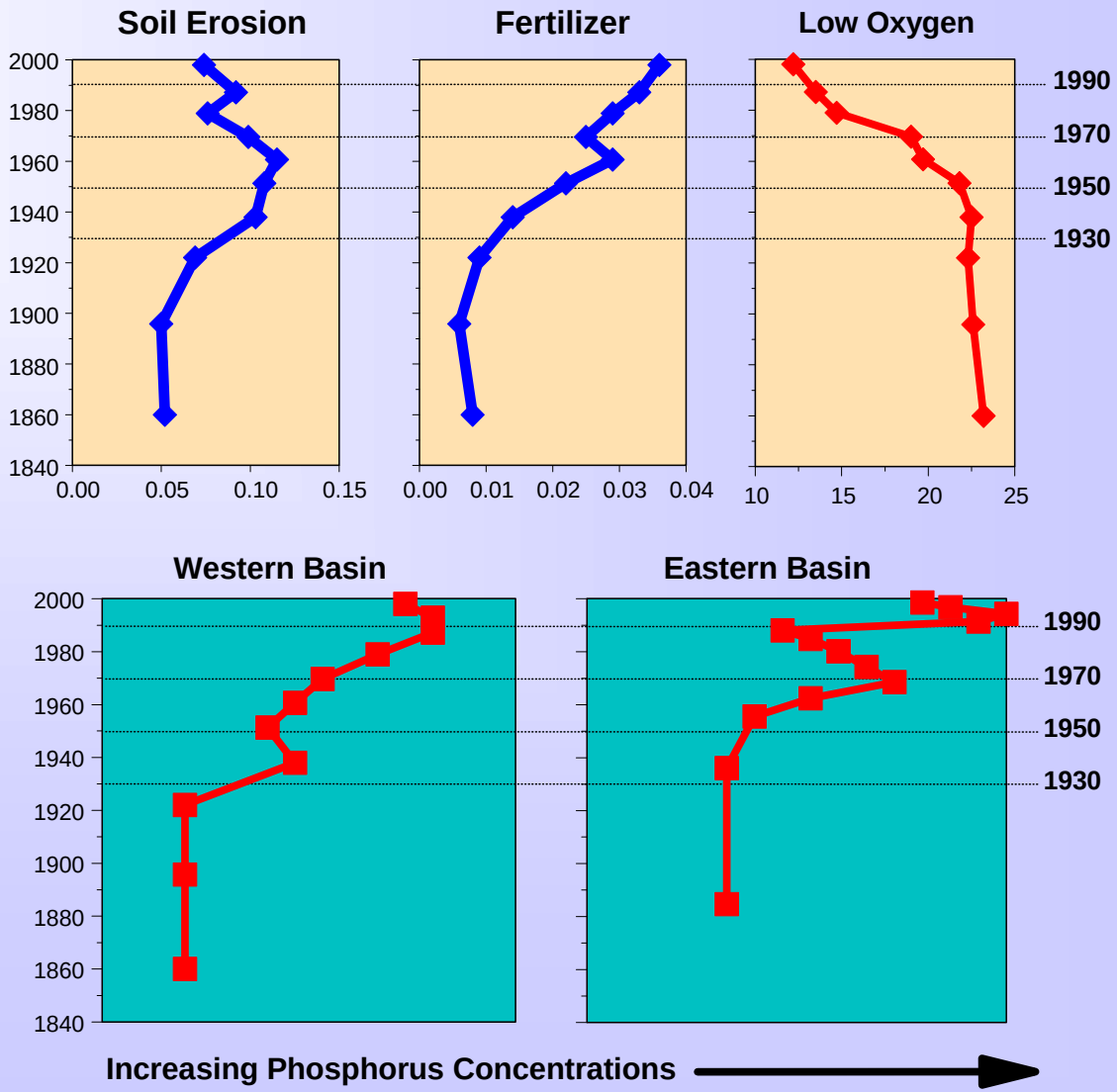
* Macrophyte increase

CASE STUDIES

pH



HISTORY IN THE MUCKING



STRENGTHS AND WEAKNESSES OF TOP/BOTTOM SAMPLING

- **STRENGTHS**
  - –Relatively inexpensive
  - –Many lakes can be examined in a short time
- **WEAKNESSES**
  - –Requires fair degree of taxonomic knowledge
  - –Bottom samples may not be representative of typical pre-impact conditions, e.g. drought
  - –Some important diatoms taxa have wide range of environmental optima, especially in shallow lakes