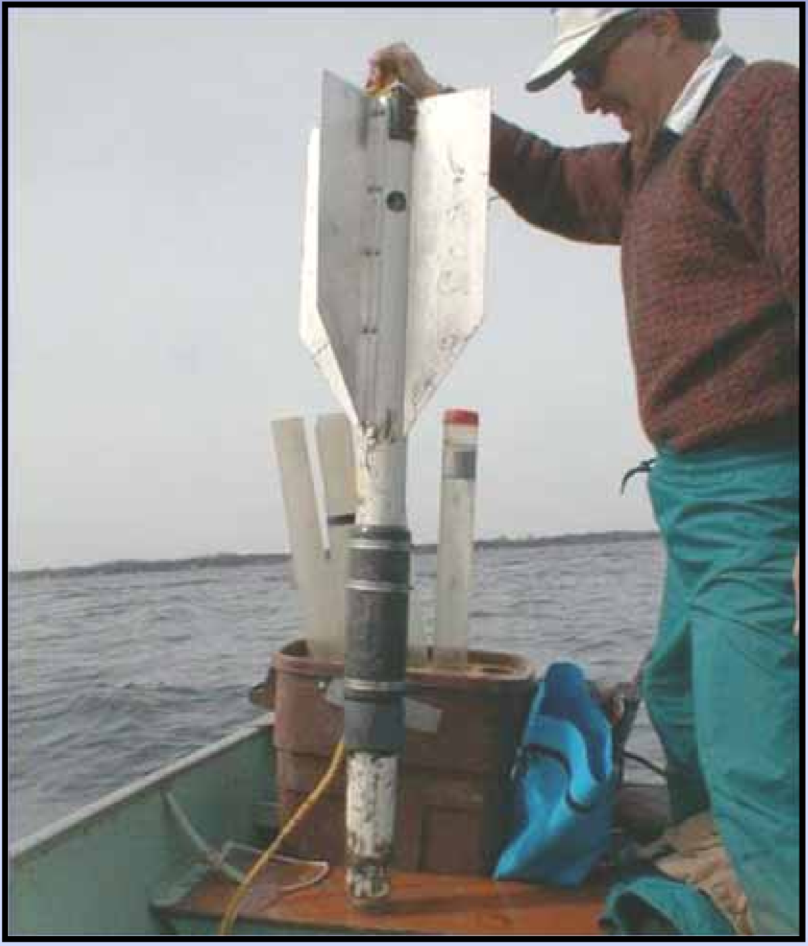
REVEALING A LAKE'S HISTORY IN ITS SEDIMENTS

Paul Garrison

Onterra, LLC
Lake Management Planning

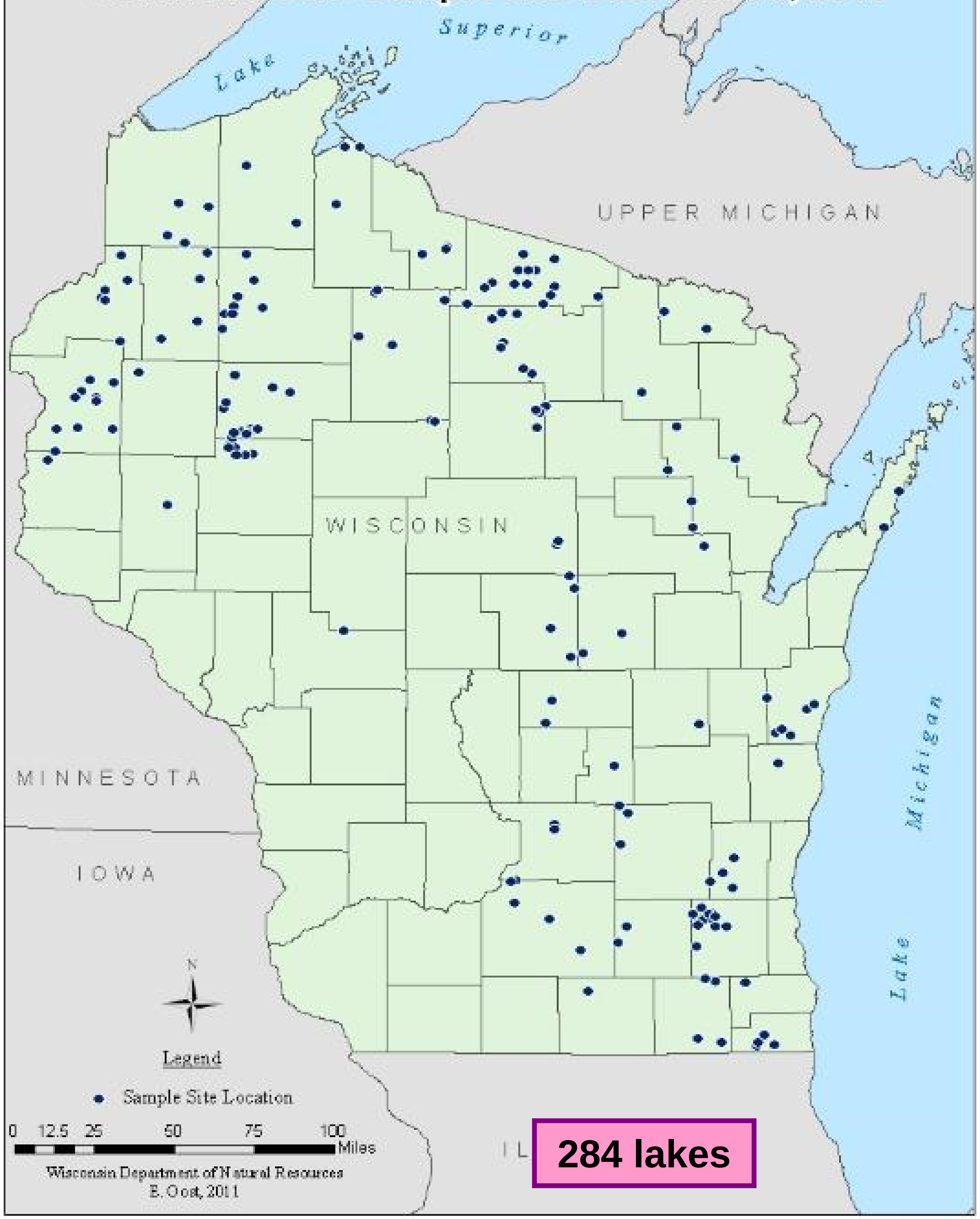
HOW DO YOU COLLECT SEDIMENT CORES?



Gravity Corer

Piston Corer

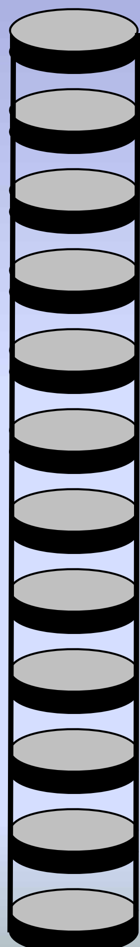
Sediment Core Sample Site Distribution, 2011

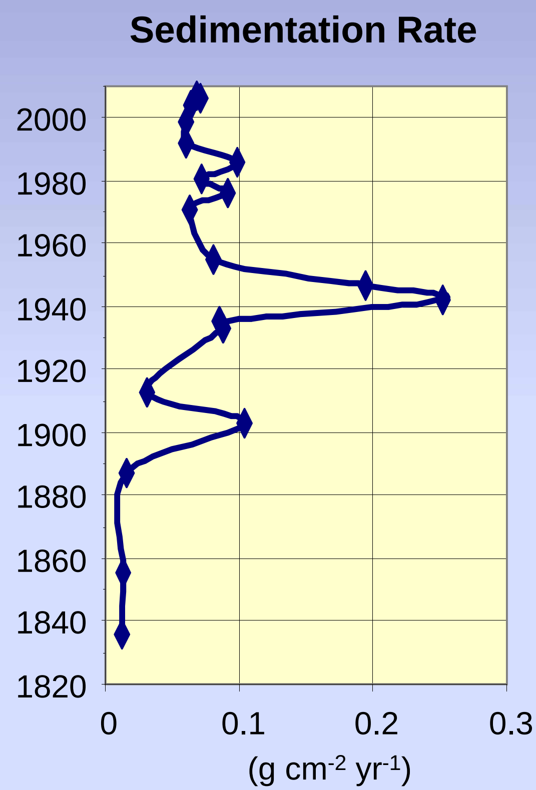


284 lakes

Types of Cores

Full core



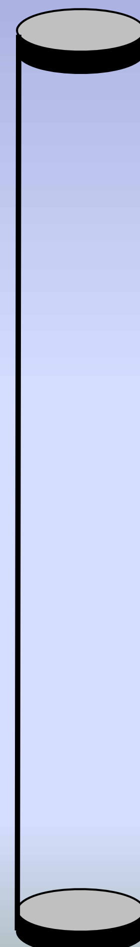


Geochemistry

Diatom community

Top/Bottom

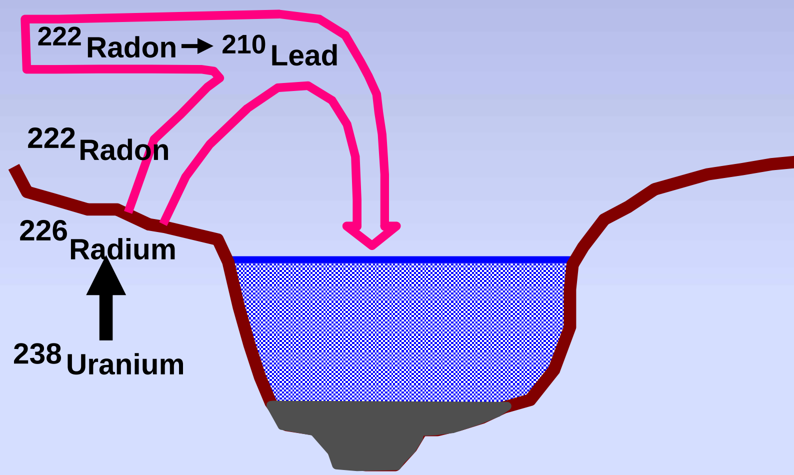
Modern



Diatom community

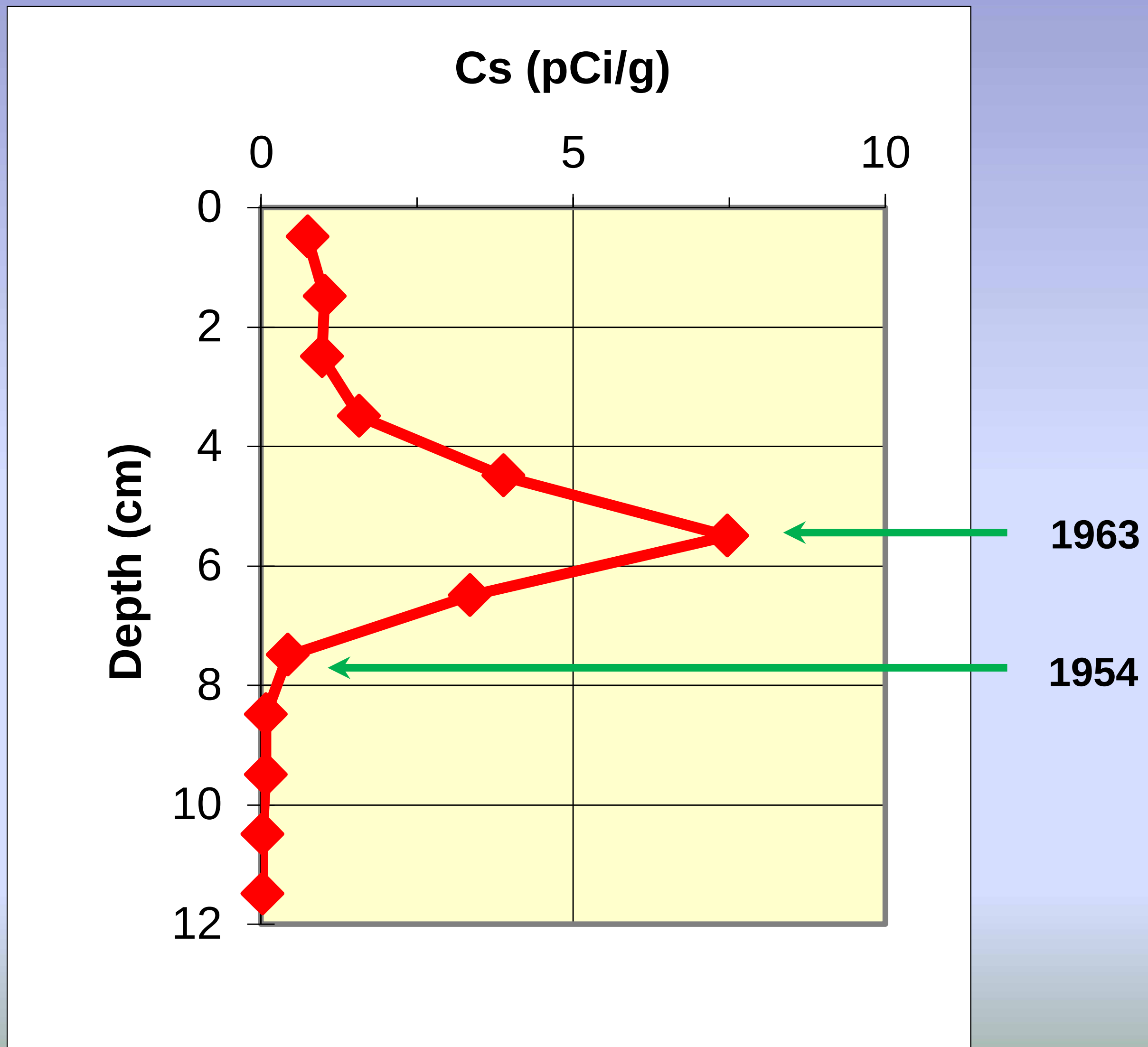
Reference

Lead-210 Dating

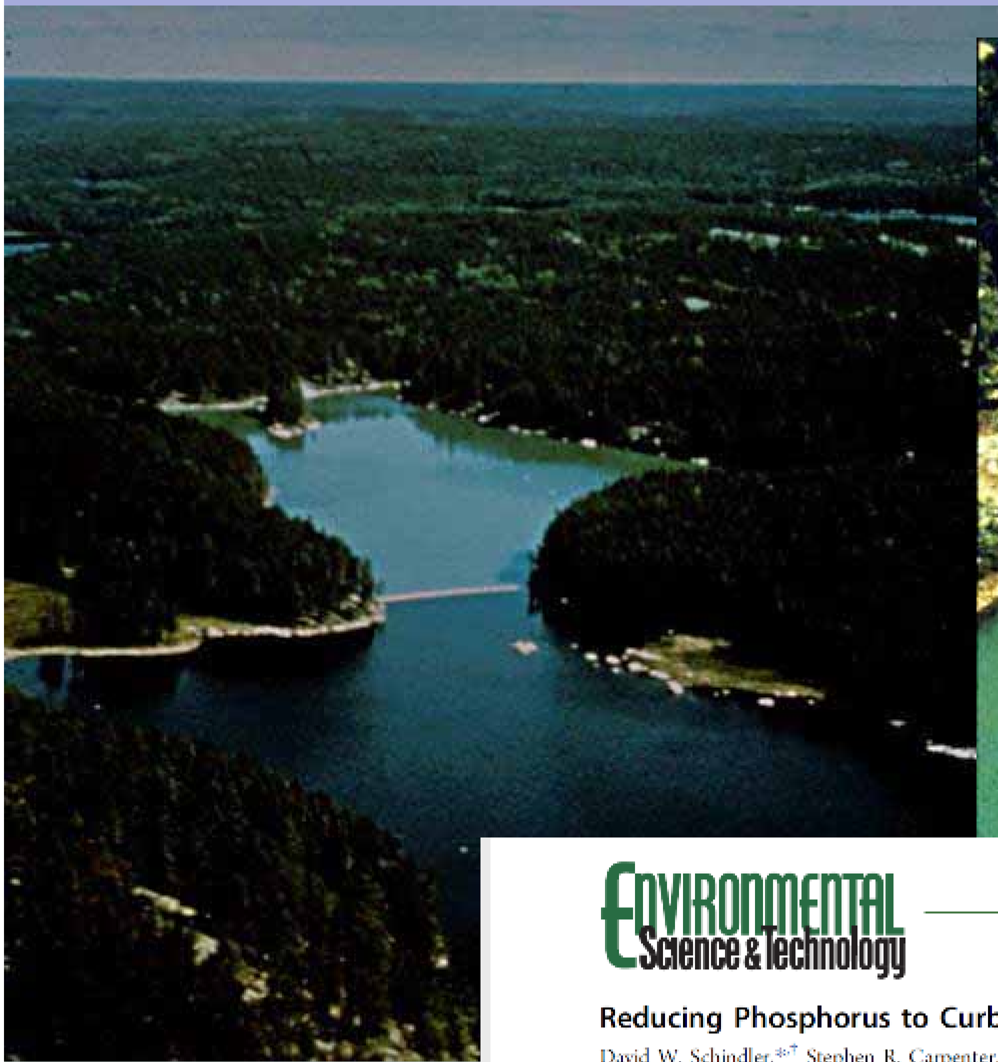


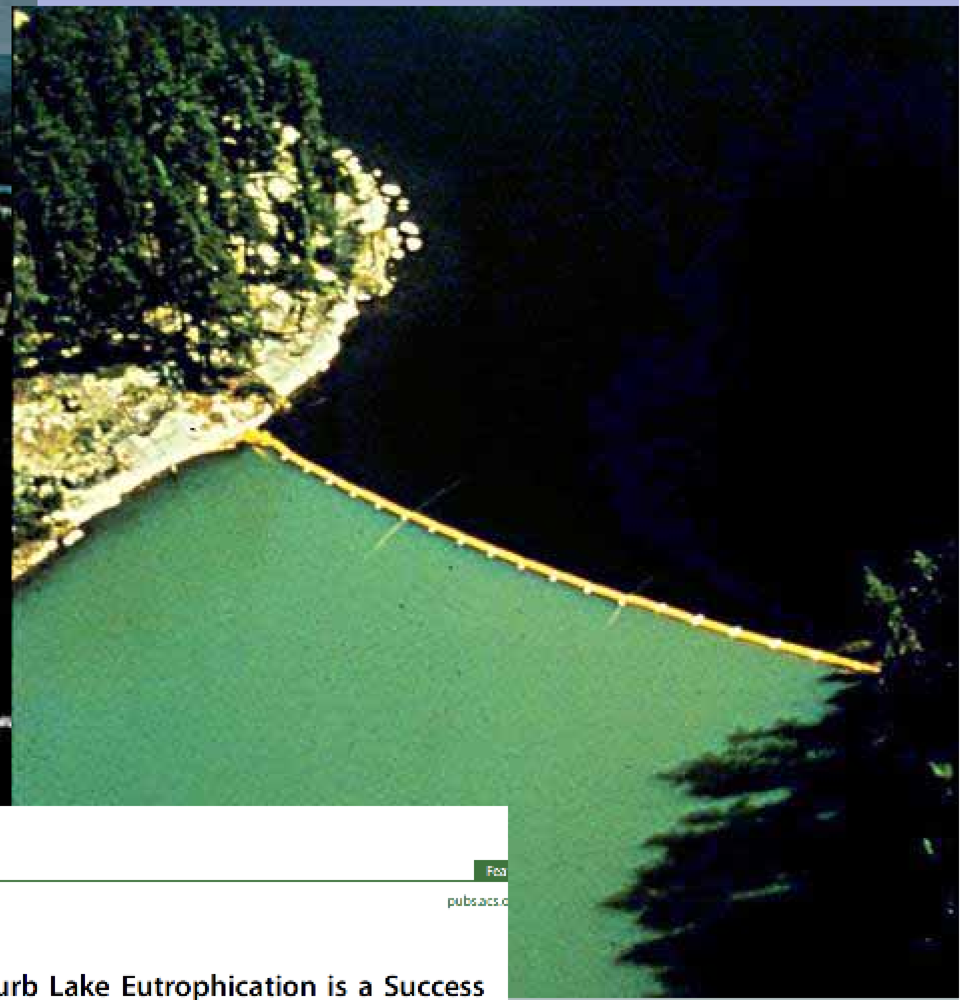
HALF LIVES	
^{226}Radium	1024 yr
^{222}Radon	3.8 days
^{210}Lead	22.26 yr

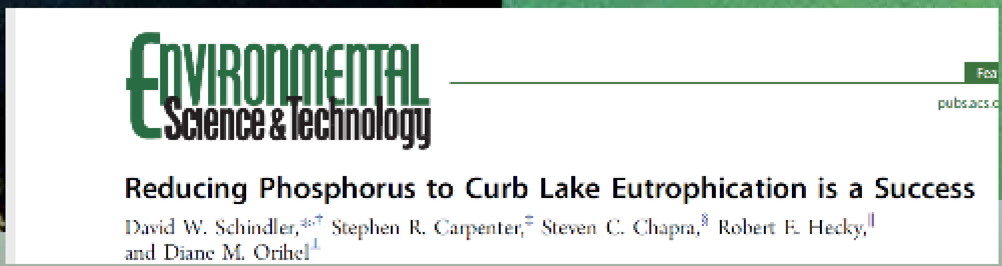
FALLOUT FROM ATMOSPHERIC BOMB TESTING



WHY DO WE CARE ABOUT PHOSPHORUS?



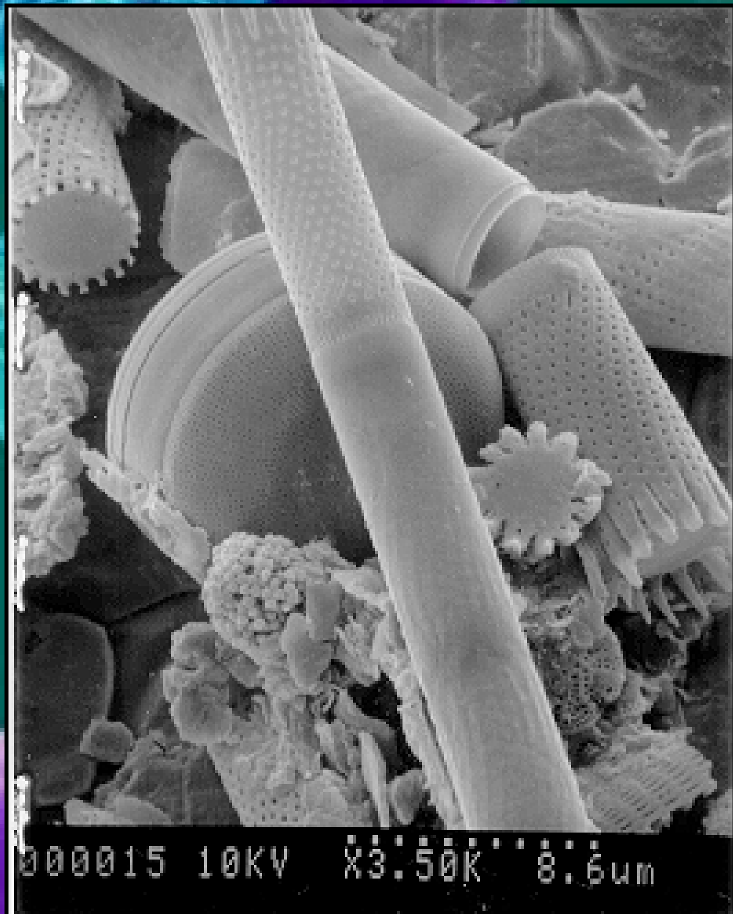


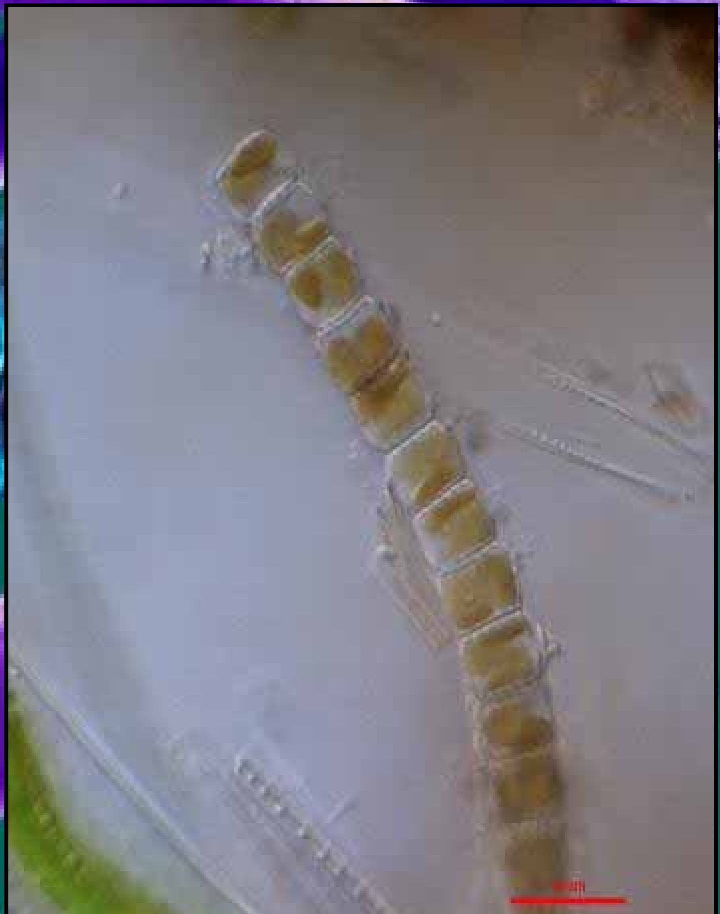

Environmental Science & Technology

Reducing Phosphorus to Curb Lake Eutrophication is a Success

David W. Schindler,[*,†] Stephen R. Carpenter,[‡] Steven C. Chapra,[§] Robert E. Hecky,[‖] and Diane M. Orihel[⊥]

DIATOMS





SHORELAND DEVELOPMENT

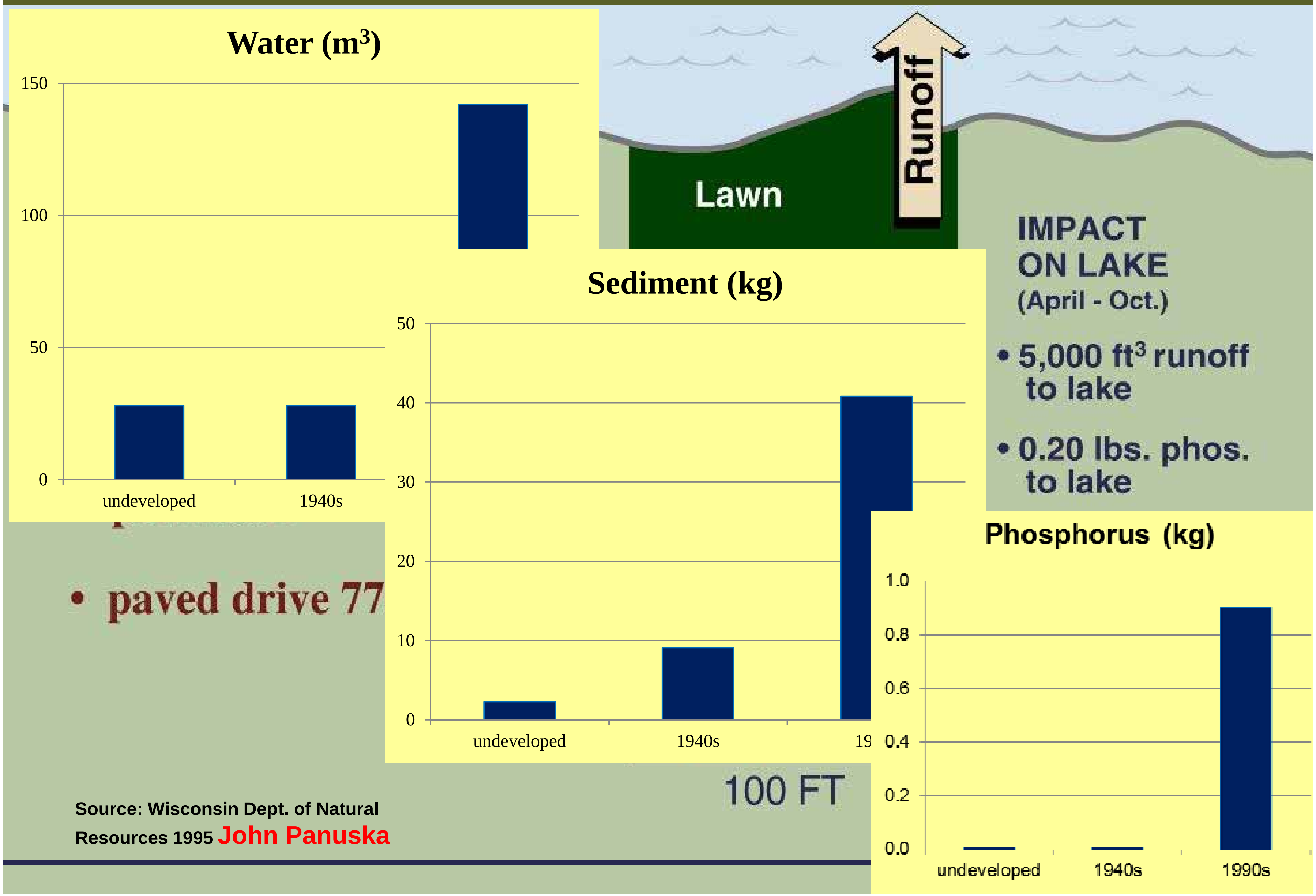
1940s

Today

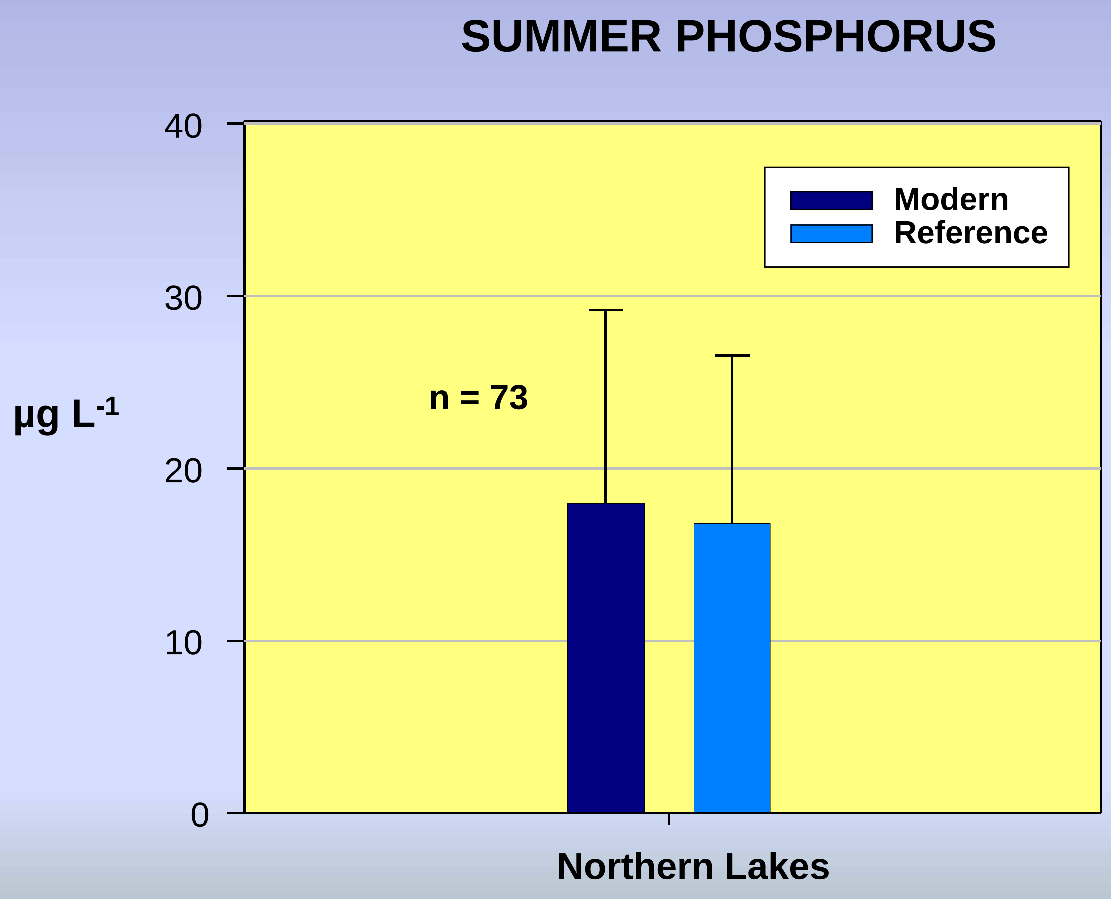
circa 1940

2009

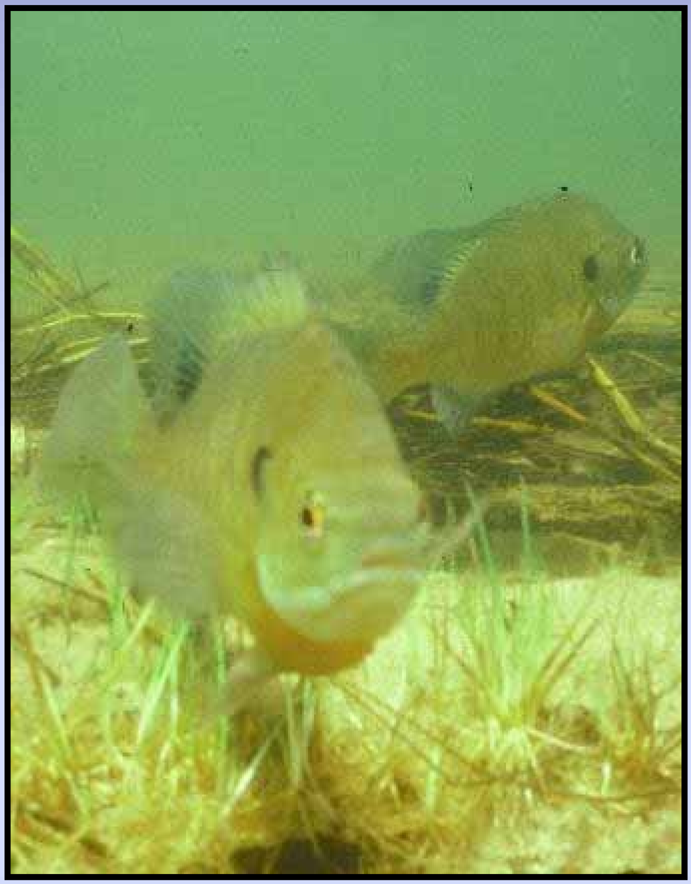
1990s development – Apr.-Oct. phosphorus/sediment runoff model



CHANGE IN PHOSPHORUS



Shift in the ratio of isoetids to elodeids



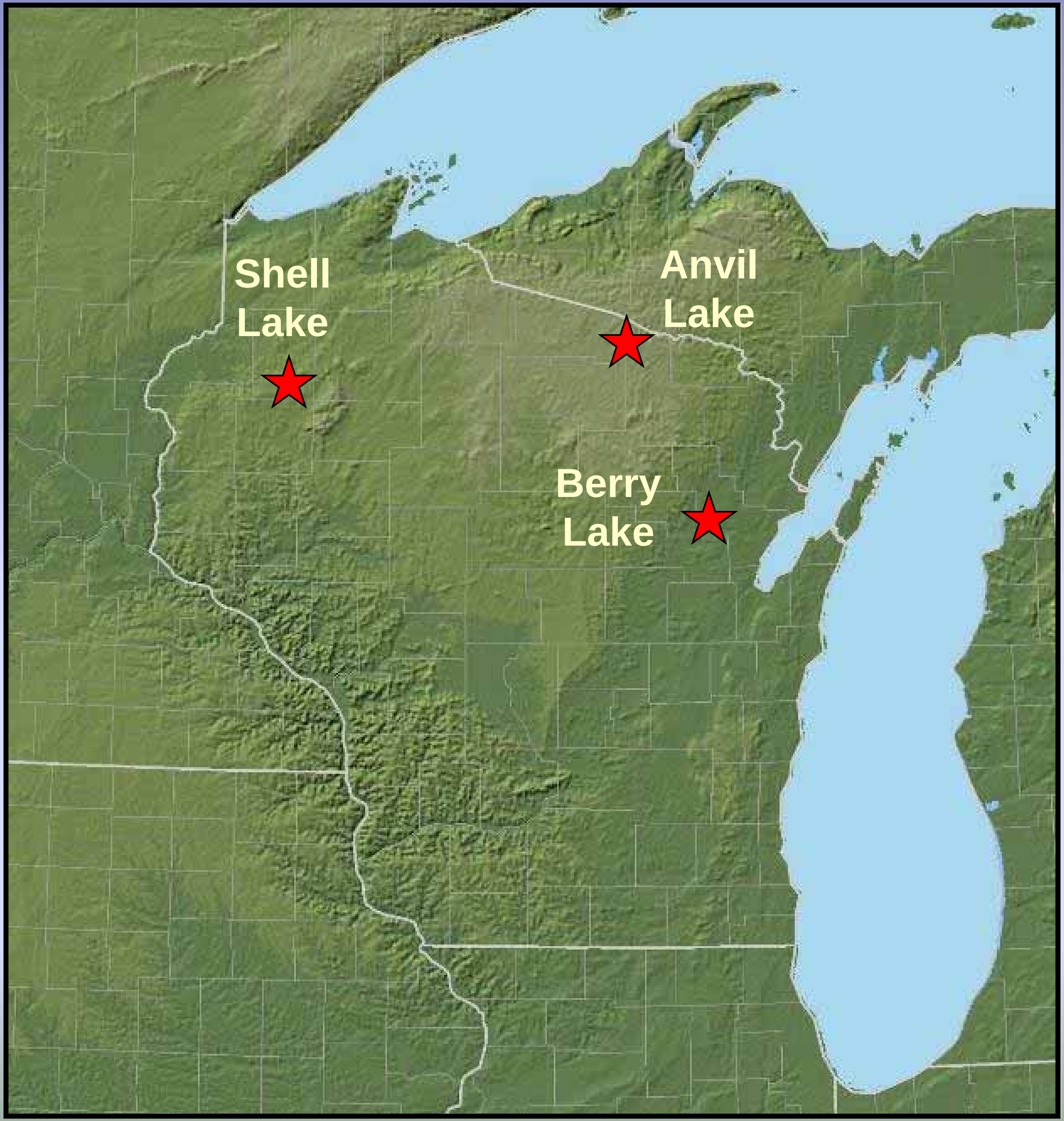
1930s: 50/50

2000s: 30/70

Susan Borman and Ray Newman-U. of Minnesota

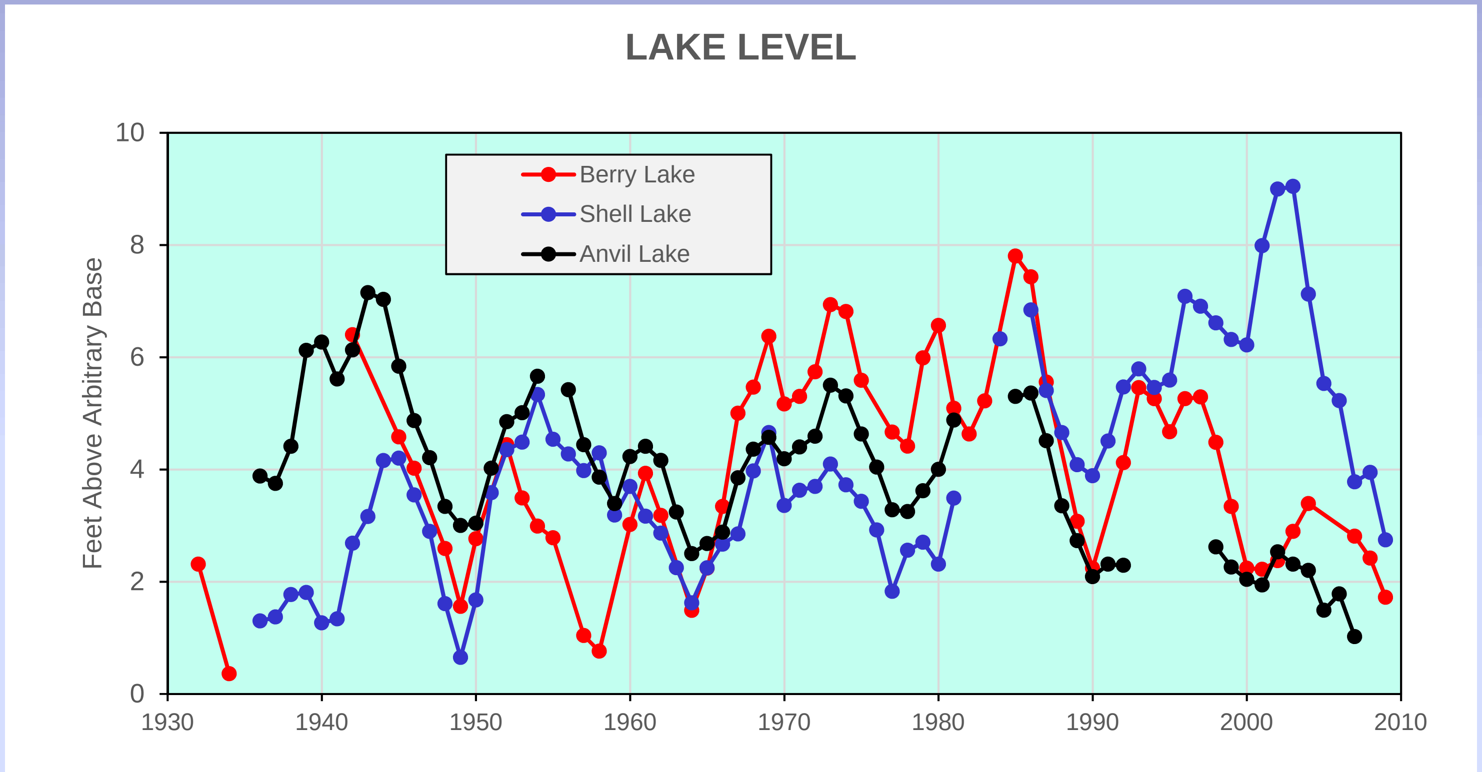
HABITAT CHANGE

LAKE LEVEL CHANGES



Seepage Lakes

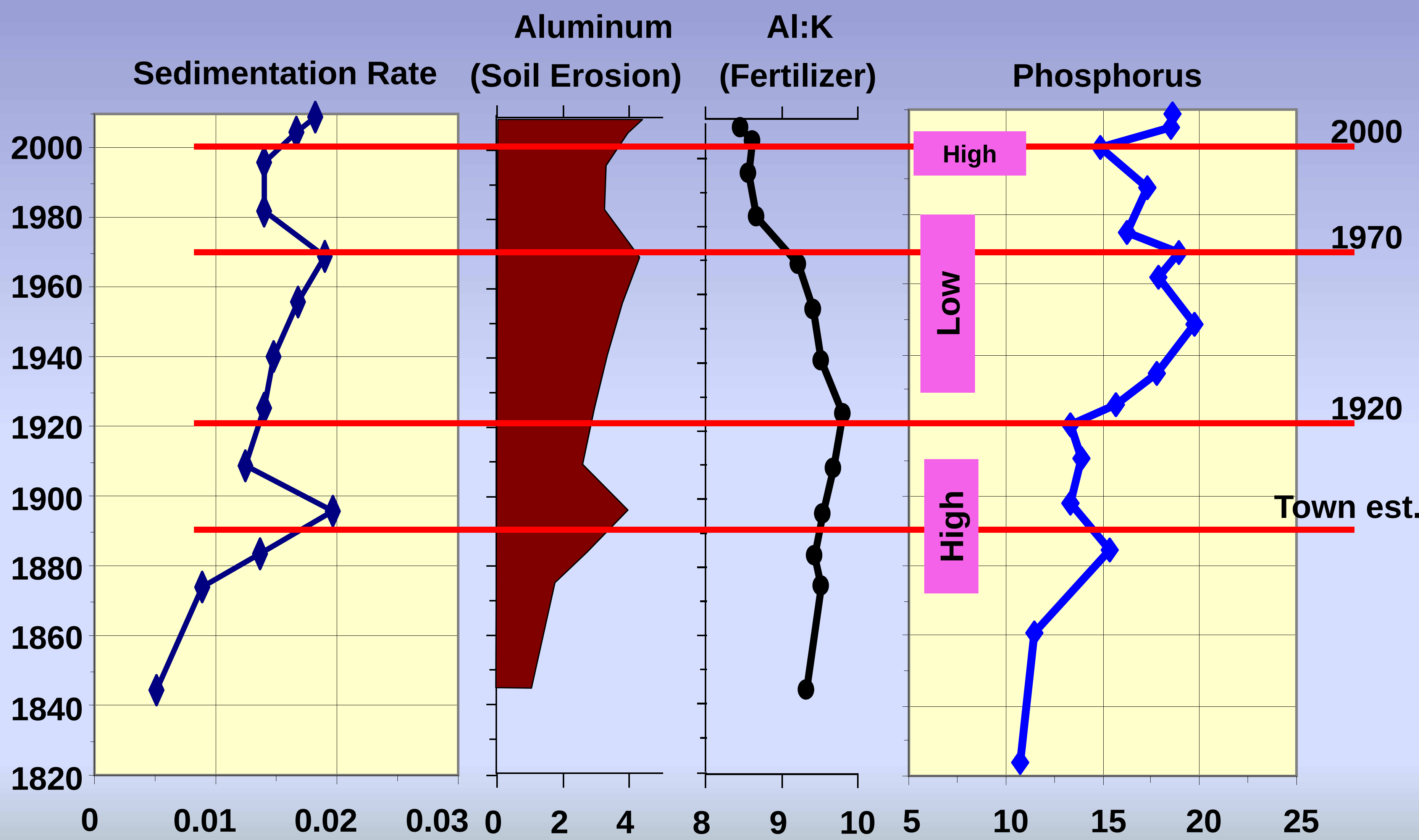
Maximum Depth
27-35 ft



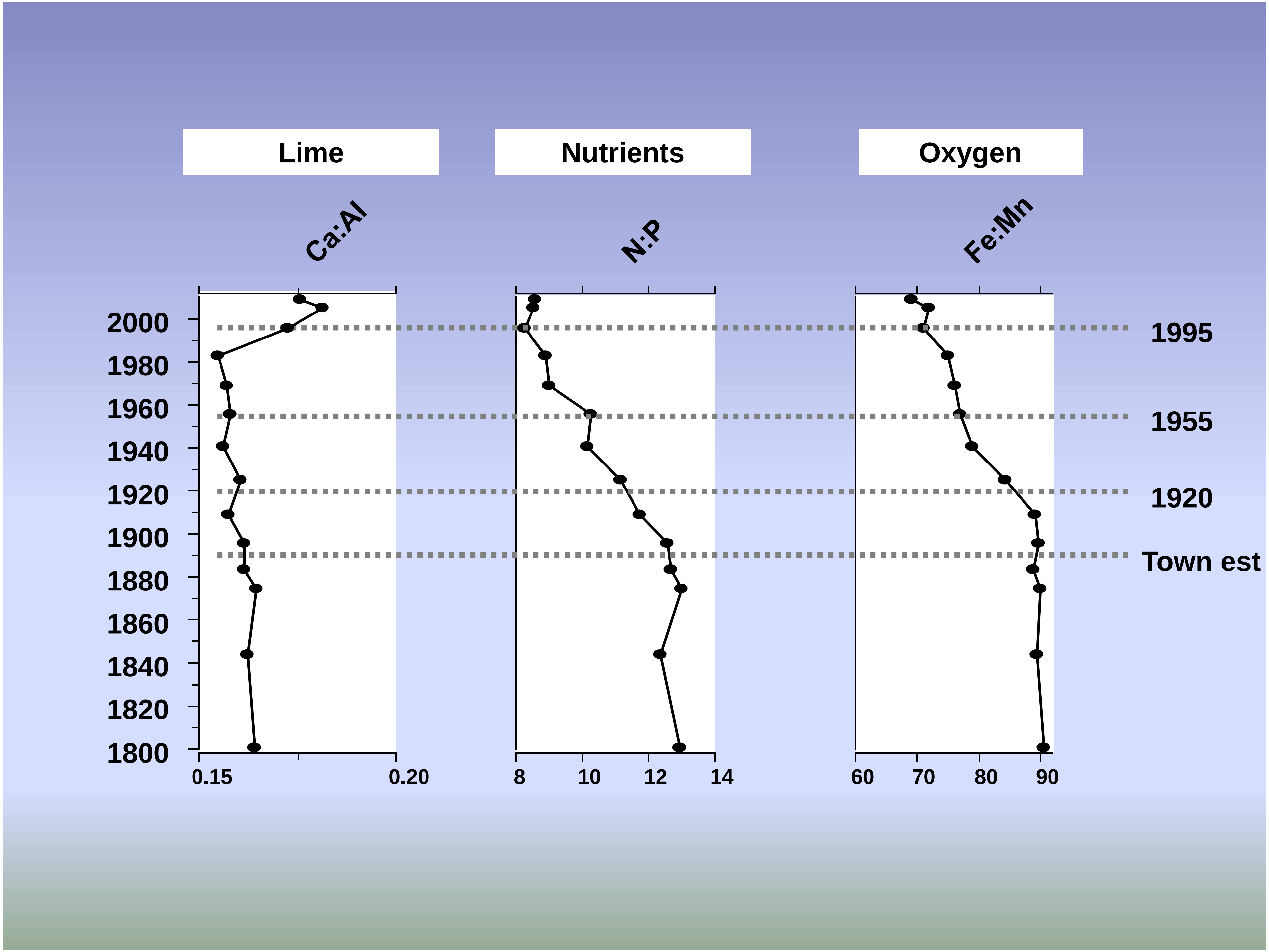
LAKE LEVEL
Berry Lake
Shell Lake
Anvil Lake
Feet Above Arbitrary Base
0
2
4
6
8
10
1930
1940
1950
1960
1970
1980
1990
2000
2010

SHELL LAKE

SHELL LAKE

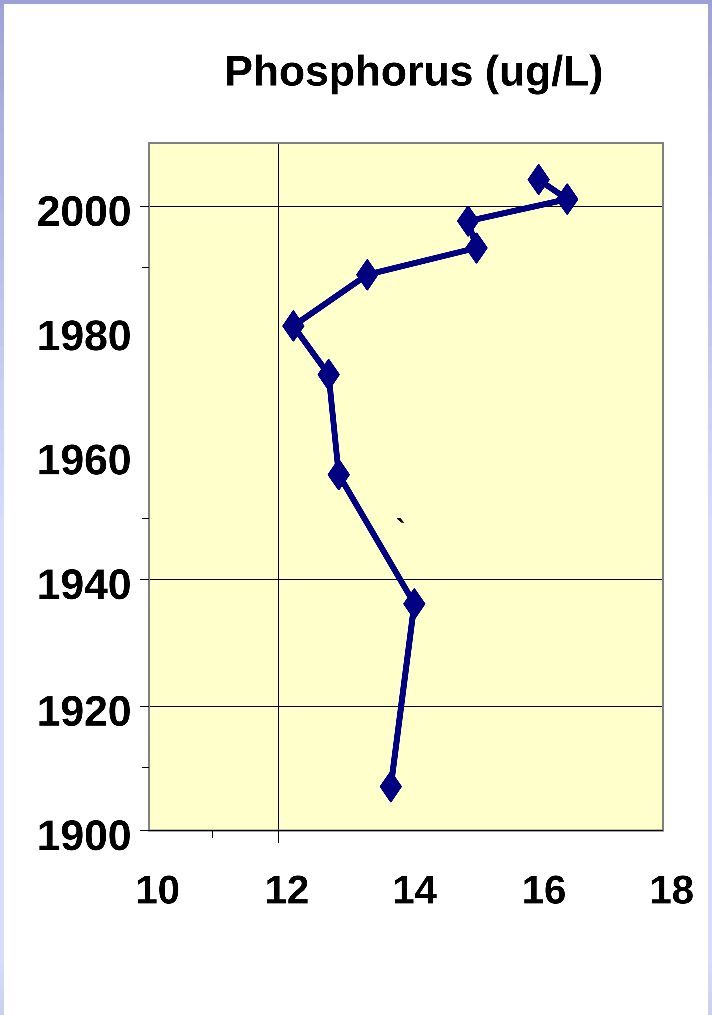


Sedimentation Rate
Aluminum
(Soil Erosion)
Al:K
(Fertilizer)
Phosphorus
High
Low
High
2000
1970
1920
Town est.
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
0
0.01
0.02
0.03
0
2
4
8
9
10
5
10
15
20
25

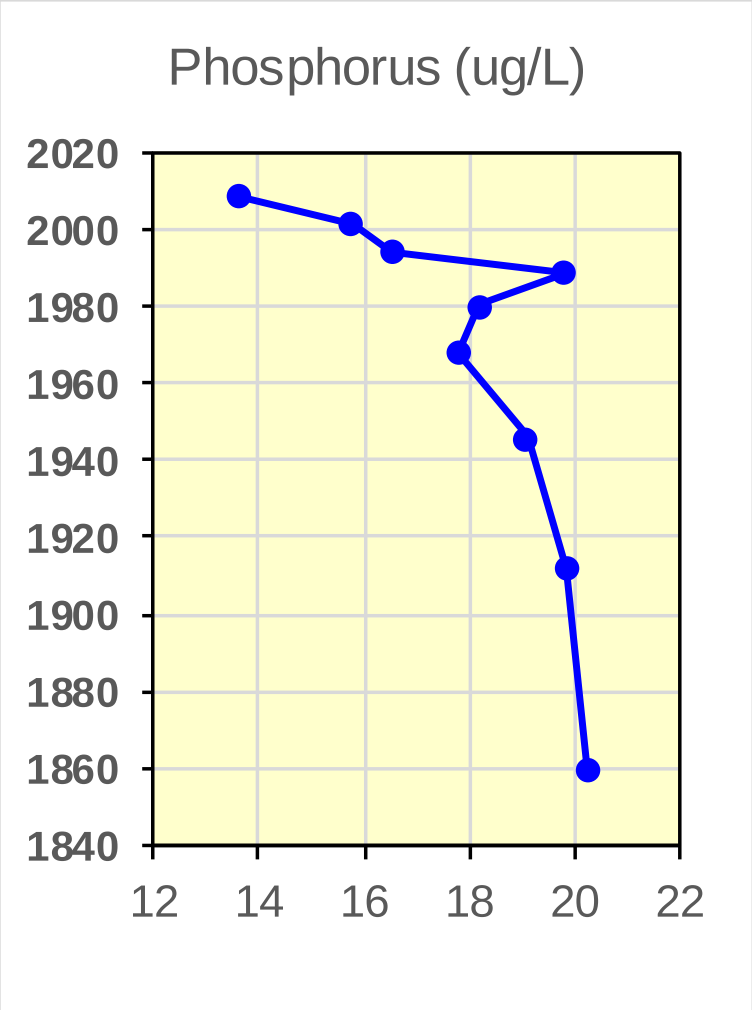


Lime
Nutrients
Oxygen
Ca:Al
N:P
Fe:Mn
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
1800
0.15
0.20
8
10
12
14
60
70
80
90
1995
1955
1920
Town est

Berry Lake



Anvil Lake



ANVIL LAKE

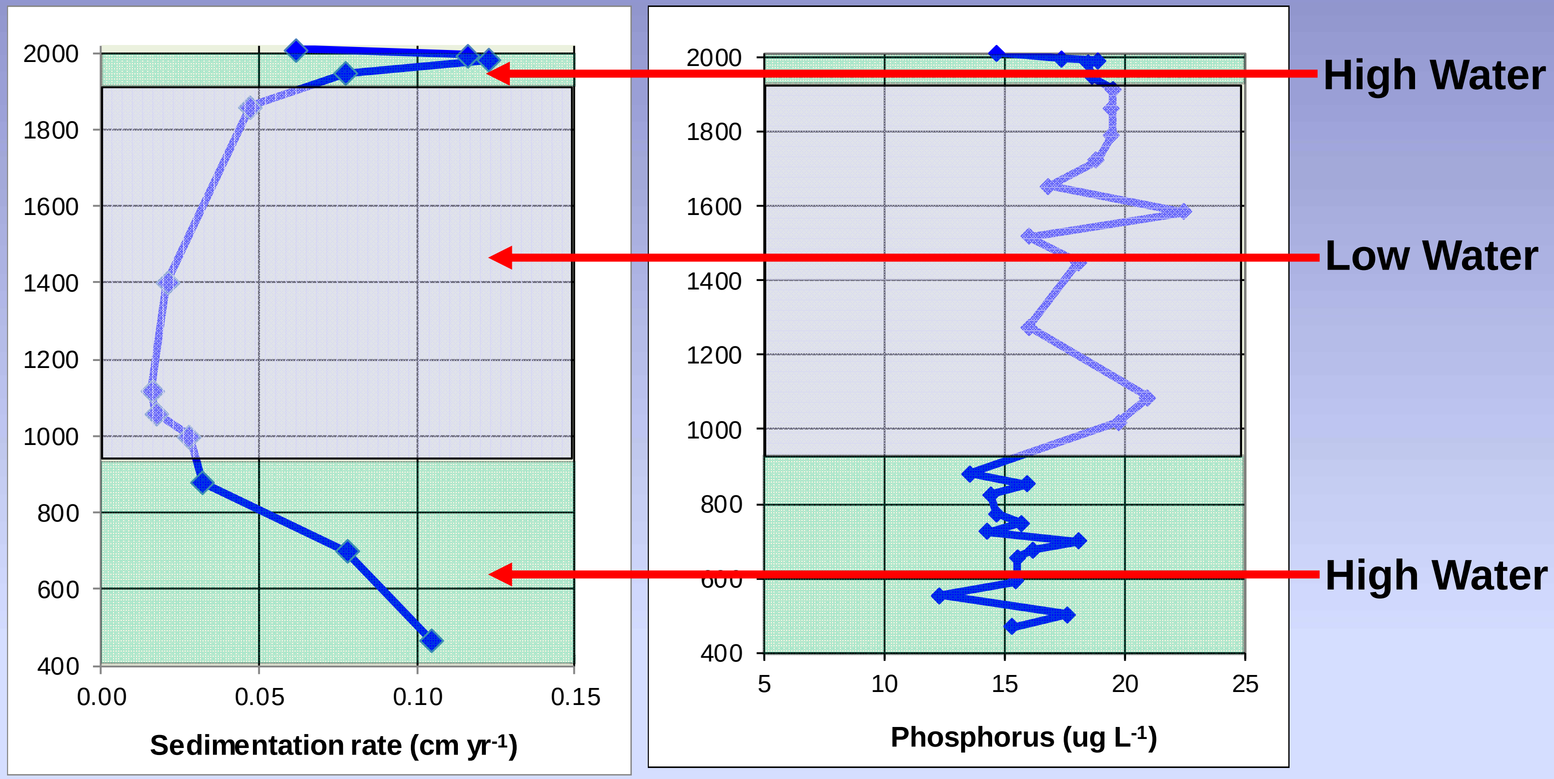
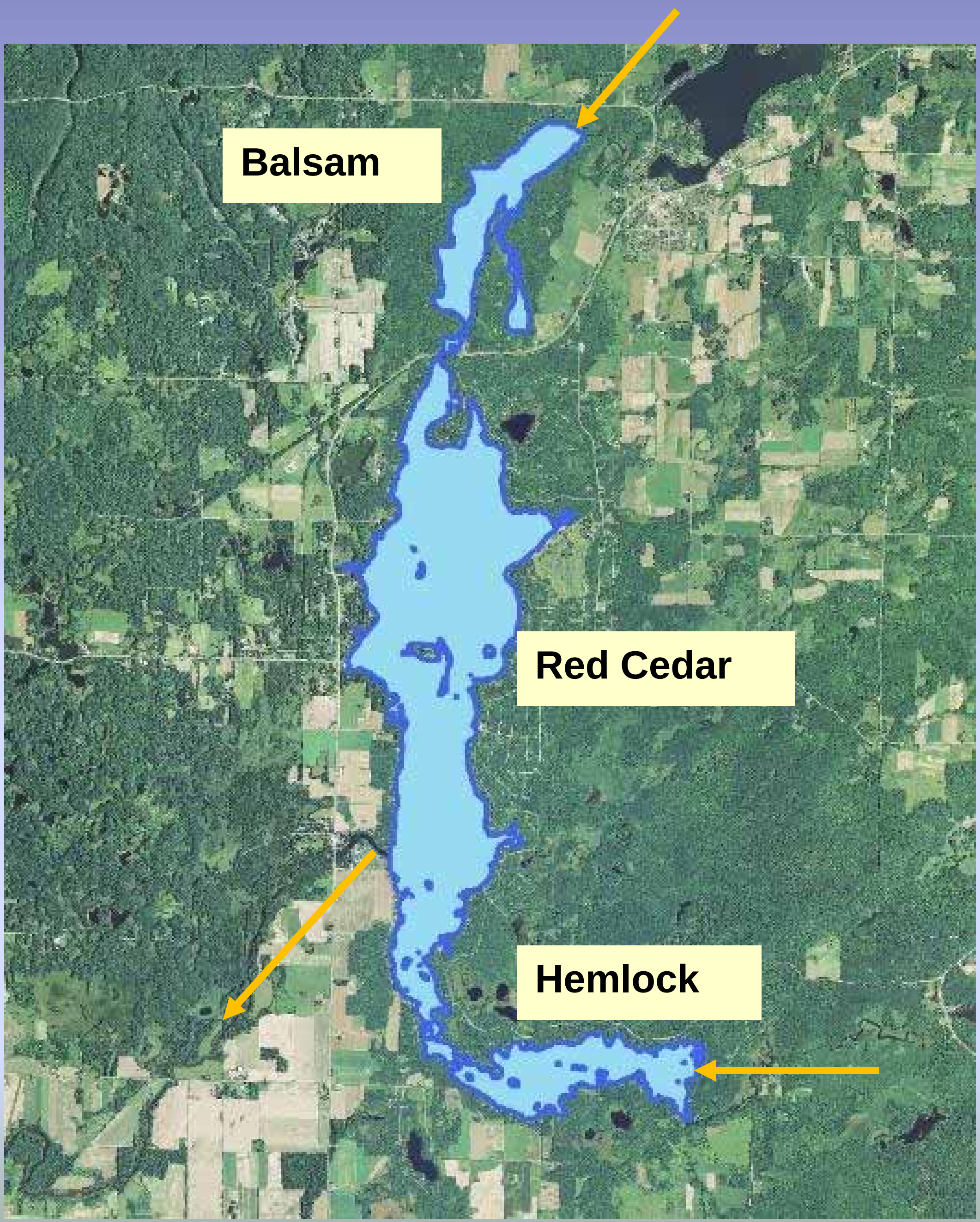
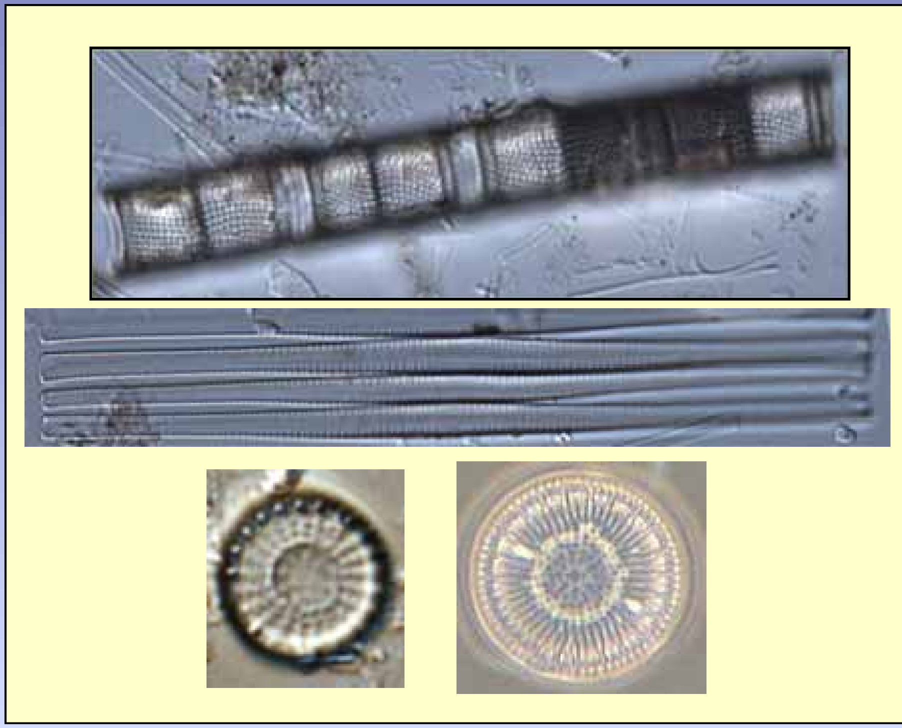


Table 3.2-1. Summary of lake condition inferred from the diatom community.

Period	Trends	Mean TP concentration (µg/L)
I	Higher water levels, higher P	17.2
II	Lower water levels, higher P	18.4
III	Higher water levels, Lower P	13.9


Red
Cedar
Lakes


Balsam
Red Cedar
Hemlock



CONCLUSIONS

- The lakes are naturally mesotrophic with historical phosphorus concentrations of 20-25 µg L^{-1}. The present day concentration in Red Cedar Lake is about 23 µg L^{-1} while it is about 33 L^{-1} in the other two lakes.

- The increase in P has been less in Red Cedar Lake because the other lakes are assimilating some of the phosphorus.

- The upstream lakes are also assimilating nitrogen and at a higher rate than phosphorus.

- The extent of the aquatic plant community has changed little.

SUMMARY

- Sediment cores reveal if changes have occurred in the lake's water quality
  - Some lakes have been seriously degraded as a result of activities in the watershed
  - Some lakes are naturally eutrophic and have always had algal problems

- Sediment cores are an excellent means to establish phosphorus goals for lake management actions

- Full cores provide a detail history of changes that have occurred and what was the major cause of the changes

- Top/bottom cores provide a snapshot of how present day water quality compares with pre-settlement conditions

LAKETIDES

Winter 2007

Paleolimnology
History in the Mucking

Lake folks often get into lively discussions over what the lake used to be like...more plants, fewer plants, clear water, murky water... Is there any way to really know for sure? Well, the answer is yes! In fact we can have a good idea of what lakes used to be like hundreds of years ago with a science called Paleolimnology.

Winter 2008

Paleolimnology
A Reflection of Our History

An article in Lake Tides *(vol. 32, no. 1), "Paleolimnology: History in the Mucking," discussed how sediment cores are taken and utilized to understand past changes in lakes. This article will take us on a historical journey that links changes on the landscape with environmental impacts to our lakes, which are revealed in the lake sediments.*

on the land. The opening of the forest allowed large amounts of sediments and nutrients to be exported from the land to the water.

Major events in the history of our country, like World War II, had definite impacts on our lakes. World War II marked another period

Environmental Science and Technology Schindler et al. 2016 Vol. 50; pages: 8923-8929.