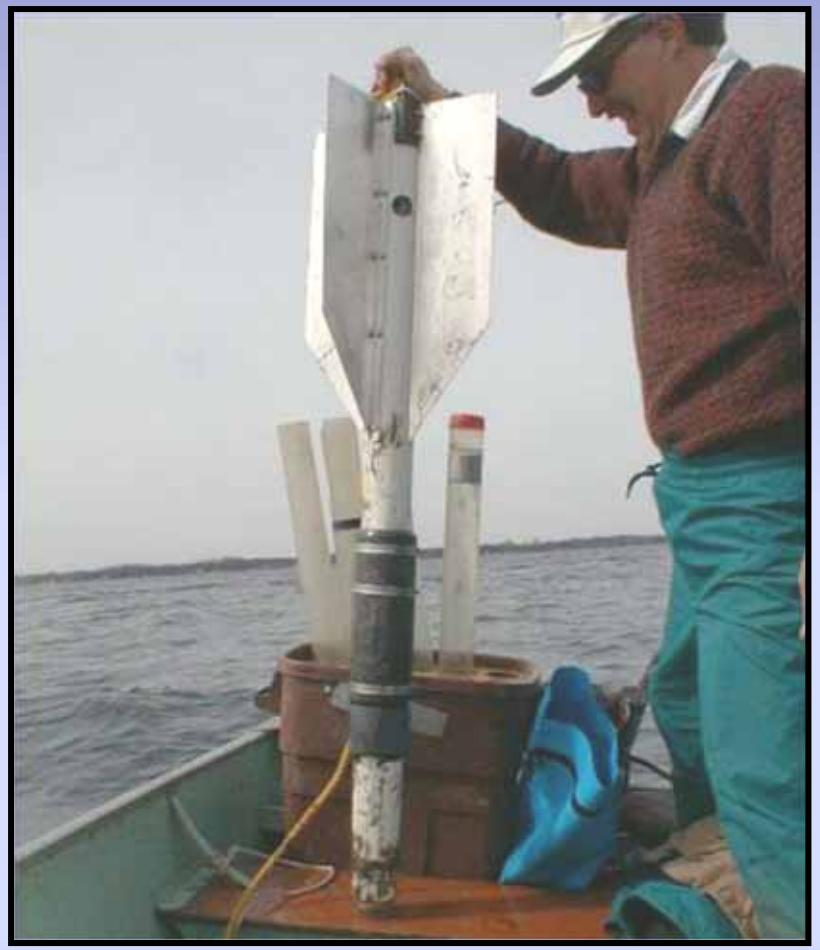
REVEALING A LAKE'S HISTORY IN ITS SEDIMENTS

Paul Garrison

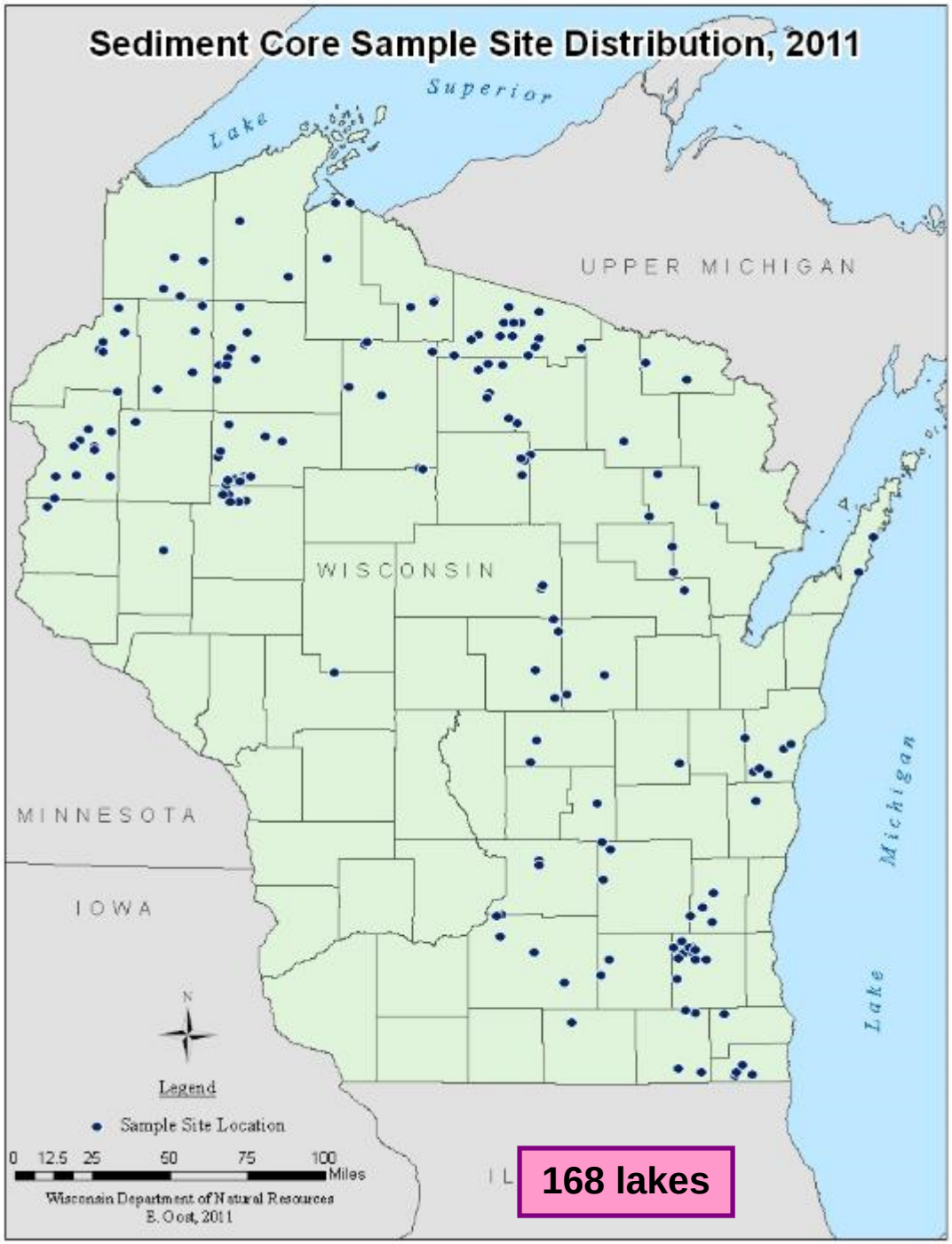
Onterra LLC
Lake Management Planning

HOW DO YOU COLLECT SEDIMENT CORES?



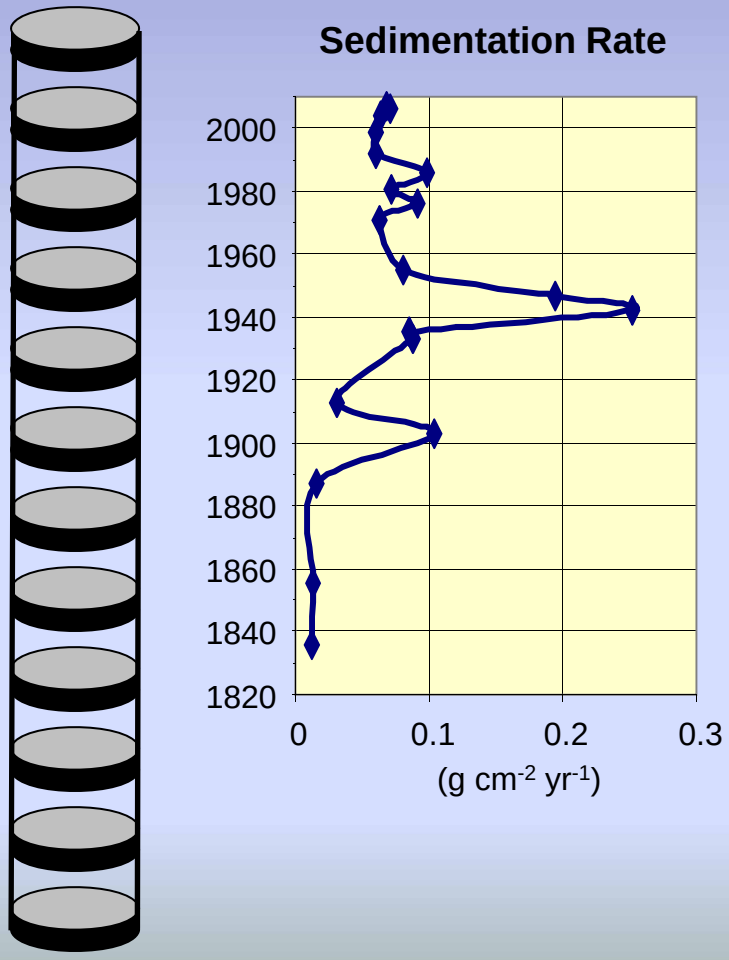
Gravity Corer

Piston Corer

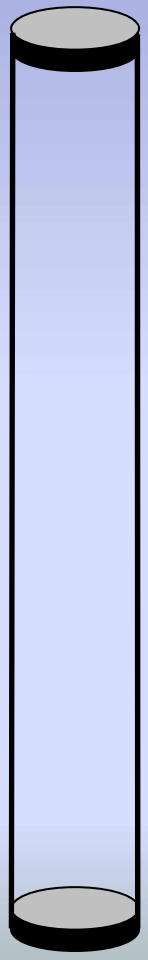

Sediment Core Sample Site Distribution, 2011
Lake Superior
UPPER MICHIGAN
WISCONSIN
MINNESOTA
IOWA
IL
Lake Michigan
N
Legend
Sample Site Location
0 12.5 25 50 75 100
Miles
Wisconsin Department of Natural Resources
E. Oost, 2011
168 lakes

Types of Cores

Full core



Top/Bottom



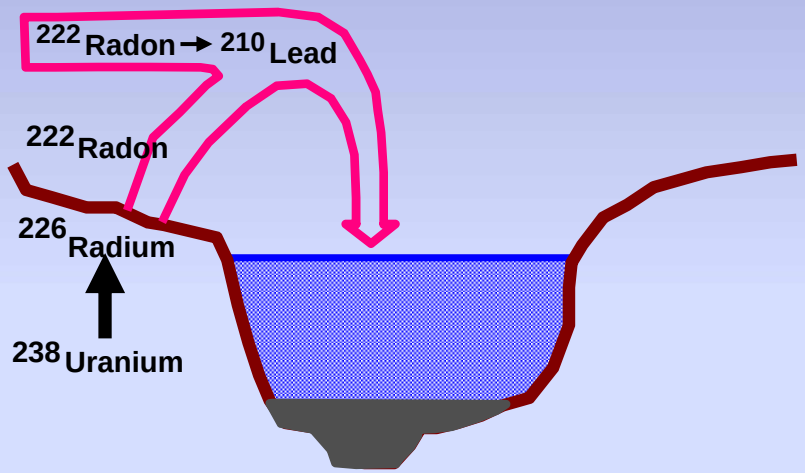
Modern

Reference

WHAT INFORMATION IS RECORDED IN THE SEDIMENTS?

- **Geochemistry**
  - **Nutrients** -- phosphorus, nitrogen
  - **Soil erosion**--aluminum, titantium
  - **Urbanization**--zinc, copper
  - **Synthetic fertilizer**--uranium, cadmium
  - **Anoxia**--iron, manganese
  - **Shoreland development**—calcium, potassium
- **Diatoms**
  - **Water quality history**
    - **nutrients**
    - **pH**
  - **General aquatic plant growth**
- **Blue-green algae**
- **Plant remains**
  - History of macrophytes

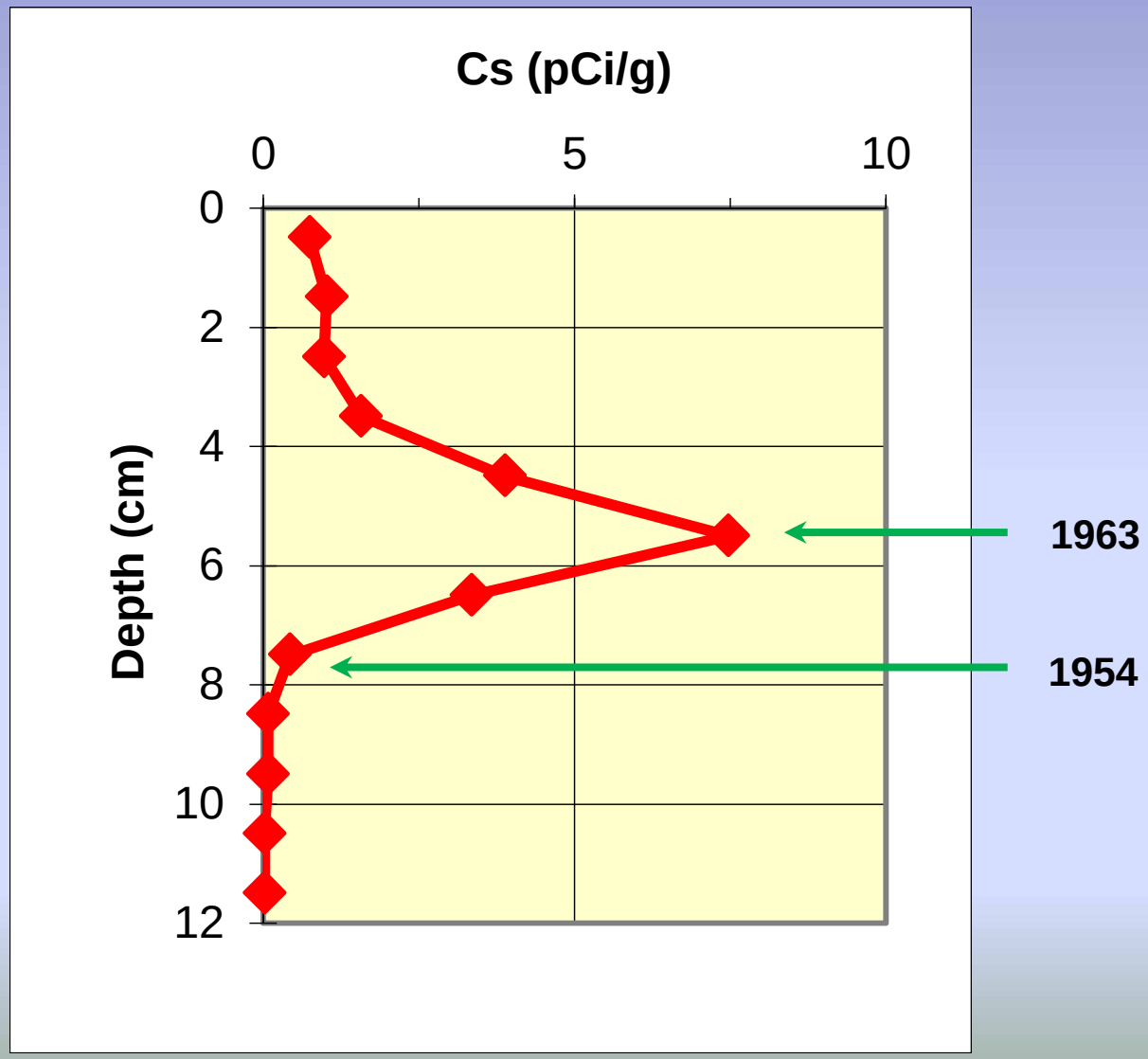
Lead-210 Dating



HALF LIVES

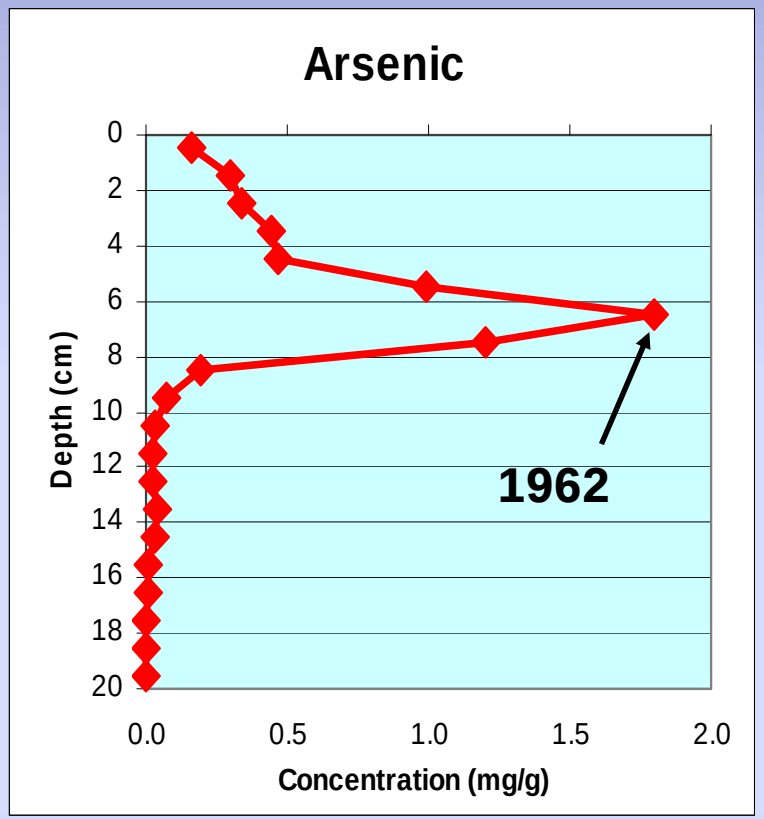
^{226}Radium	1024 yr
^{222}Radon	3.8 days
^{210}Lead	22.26 yr

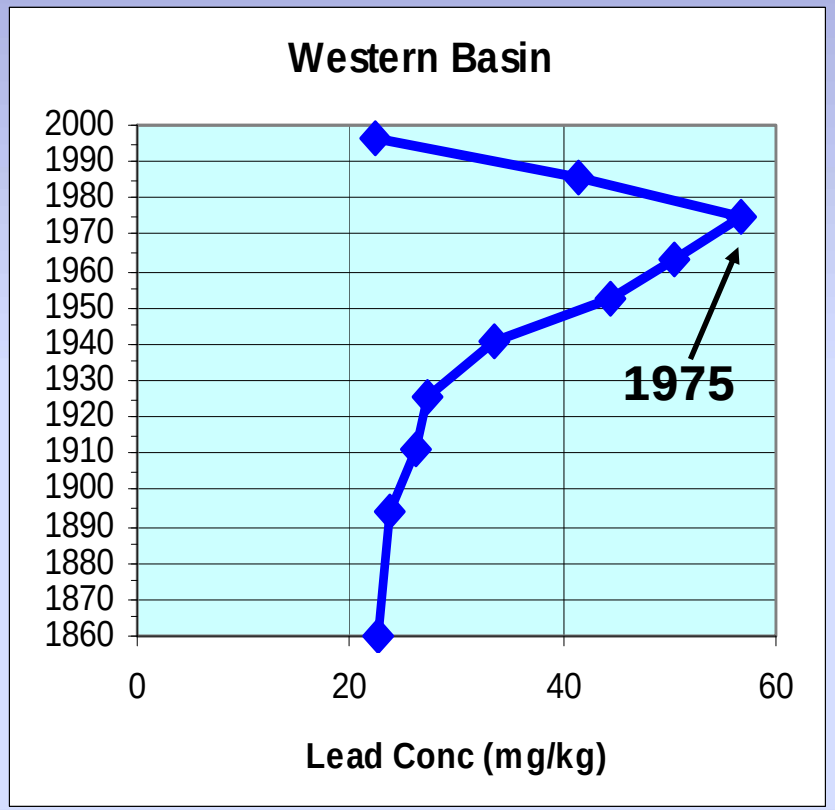
FALLOUT FROM ATMOSPHERIC BOMB TESTING



MACROPHYTE CONTROL

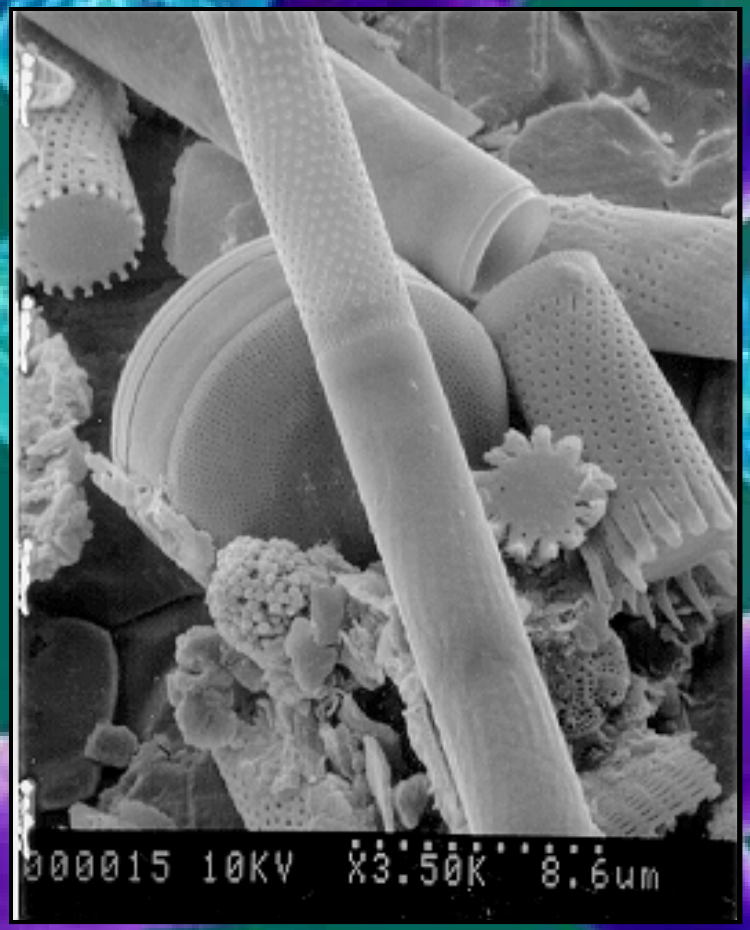
GASOLINE EMISSIONS



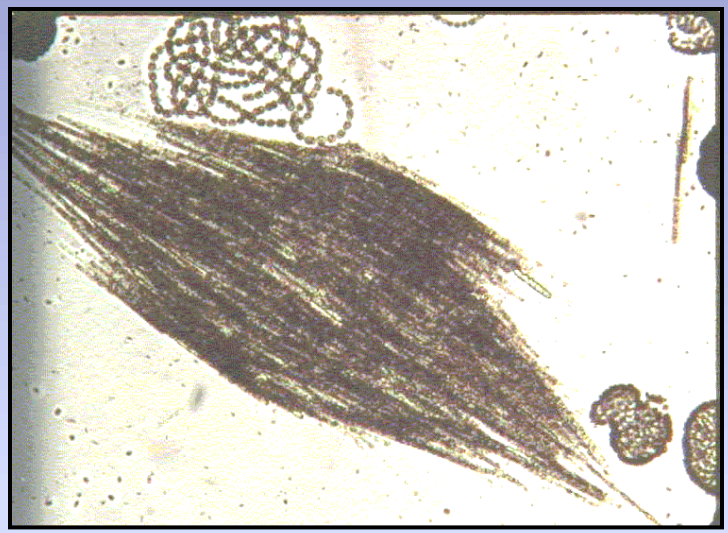


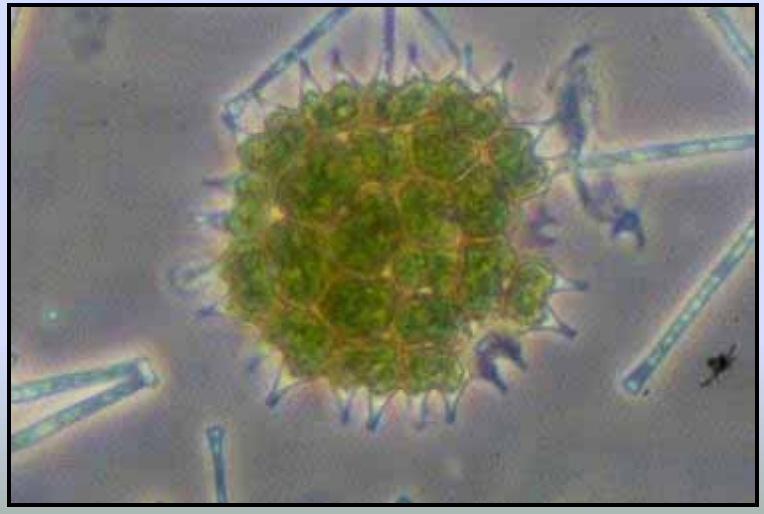
WHY DO WE CARE ABOUT PHOSPHORUS?

DIATOMS



BLUE-GREEN and GREEN ALGAE





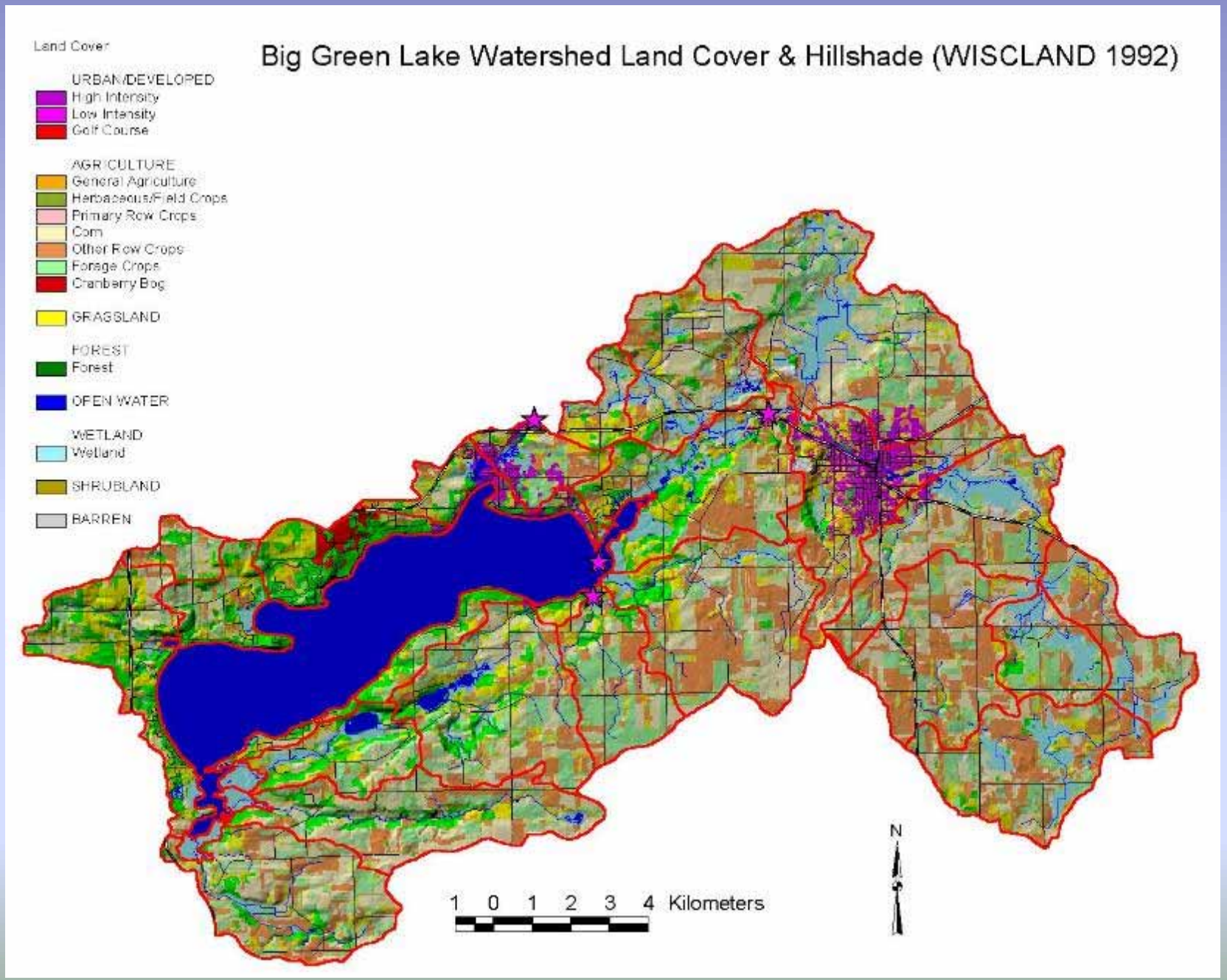
CASE STUDIES

AGRICULTURE

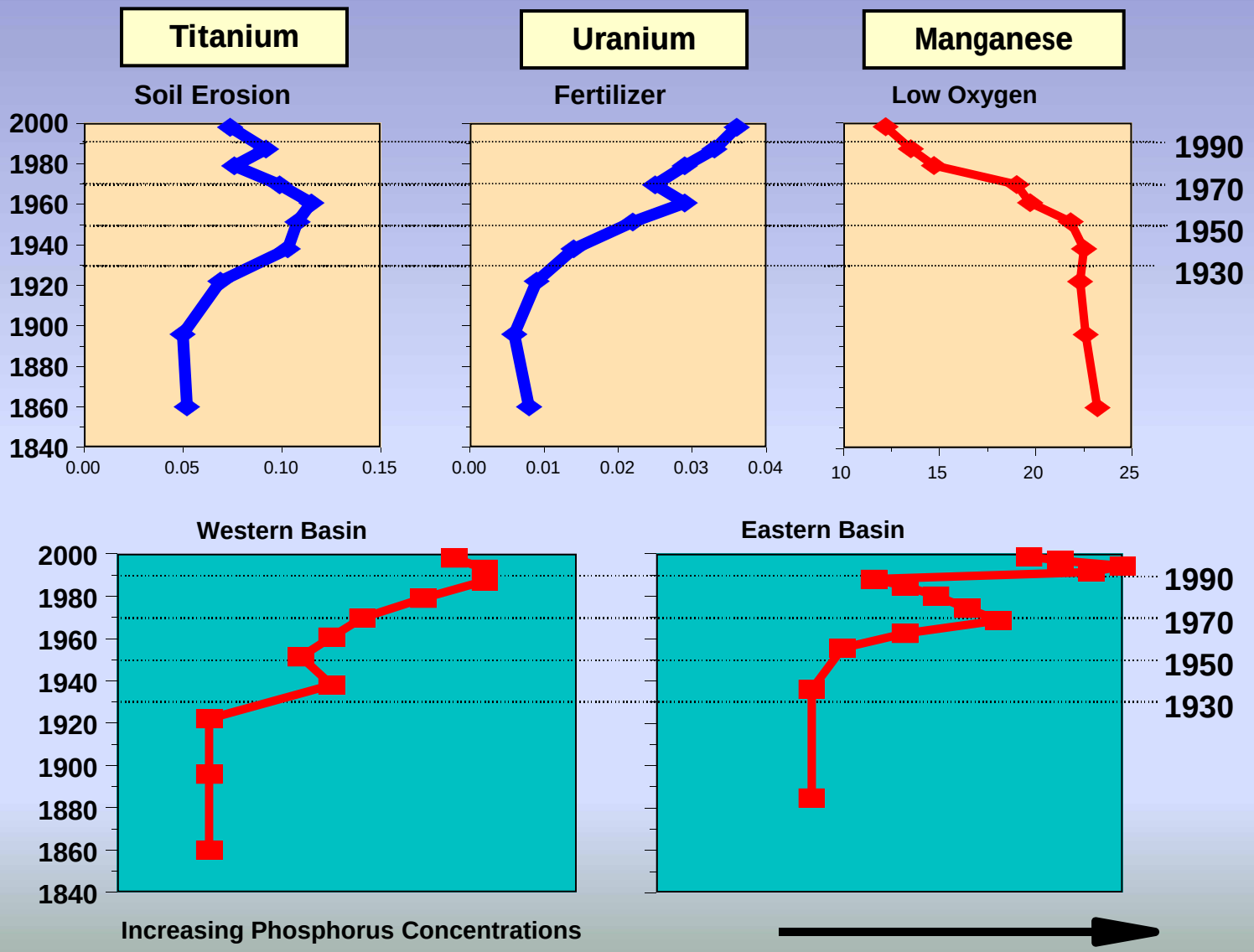
Circa 1880

Circa 1910


Green
Lake


Big Green Lake Watershed Land Cover & Hillshade (WISCLAND 1992)
Land Cover
URBAN/DEVELOPED
High Intensity
Low Intensity
Golf Course
AGRICULTURE
General Agriculture
Herbaceous/Field Crops
Primary Row Crops
Corn
Other Row Crops
Forage Crops
Cranberry Bog
GRAGSLAND
FOREST
Forest
OPEN WATER
WETLAND
Wetland
SHRUBLAND
BARREN
1 0 1 2 3 4 Kilometers
N

Green Lake


Titanium
Uranium
Manganese
Soil Erosion
Fertilizer
Low Oxygen
2000
1980
1960
1940
1920
1900
1880
1860
1840
0.00
0.05
0.10
0.15
0.00
0.01
0.02
0.03
0.04
10
15
20
25
1990
1970
1950
1930
Western Basin
Eastern Basin
2000
1980
1960
1940
1920
1900
1880
1860
1840
1990
1970
1950
1930
Increasing Phosphorus Concentrations

SHORELAND DEVELOPMENT

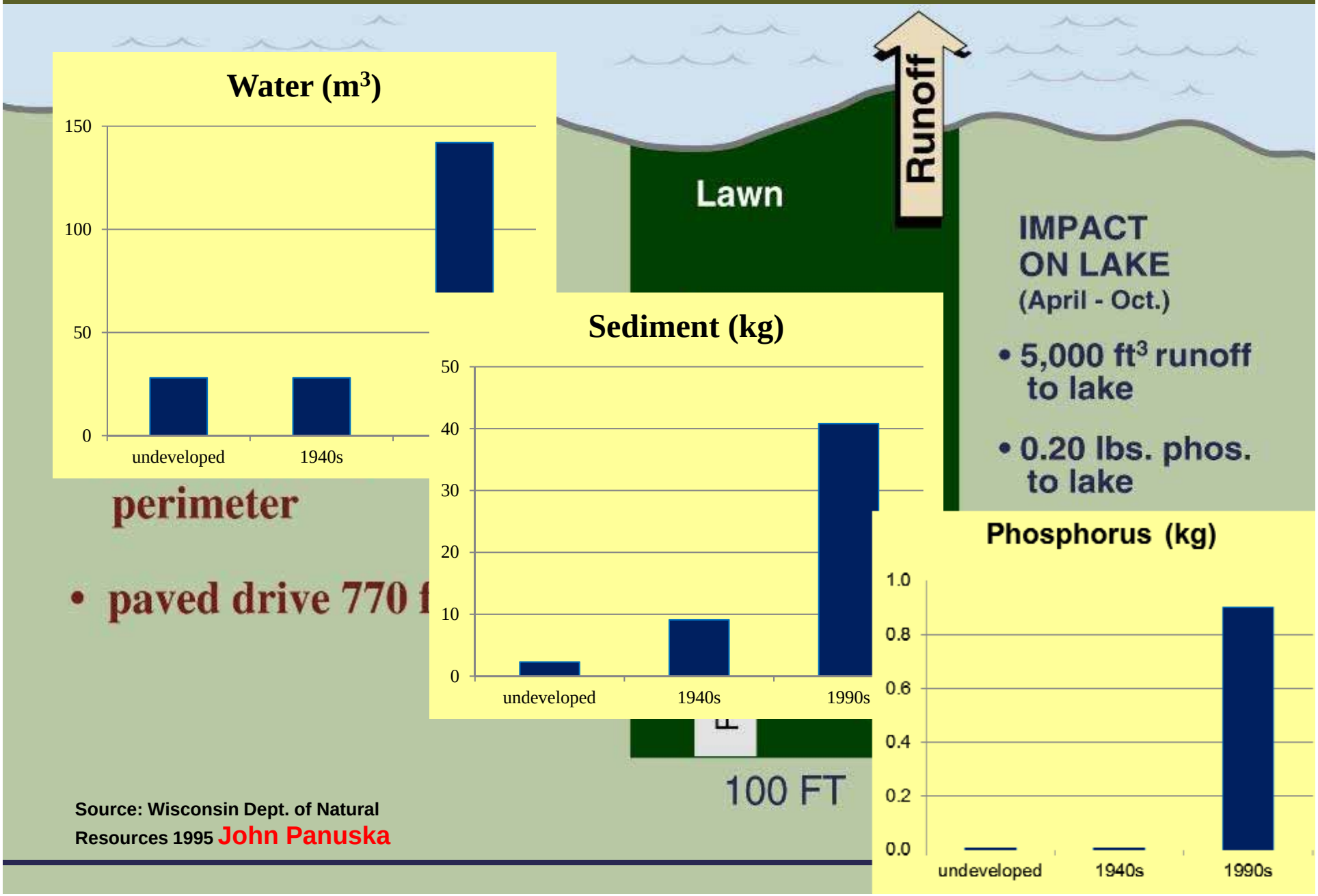
1940s

Today

circa 1940

2009

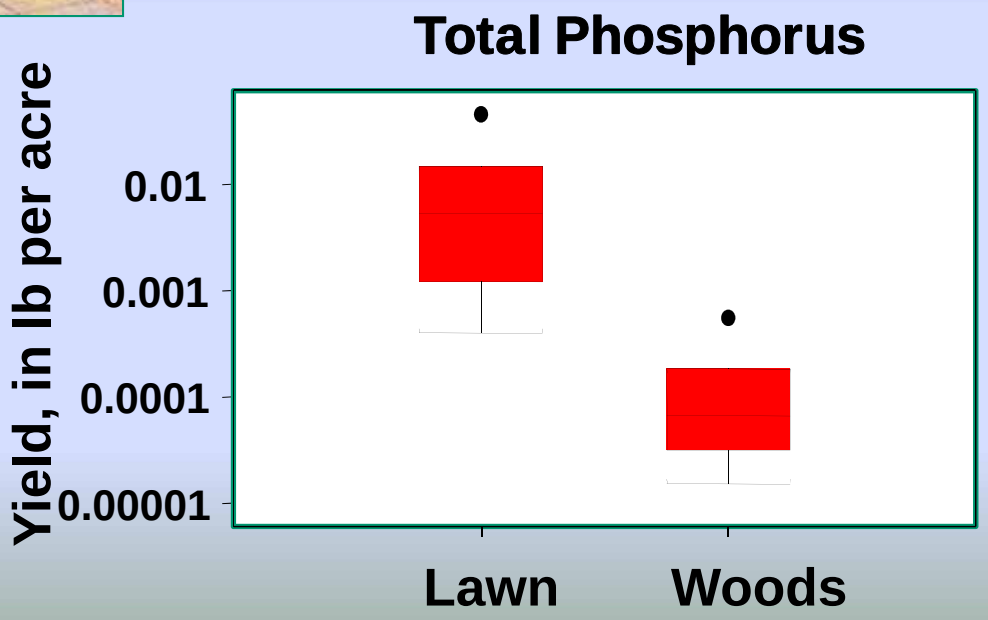
1990s development – Apr.-Oct. phosphorus/sediment runoff model



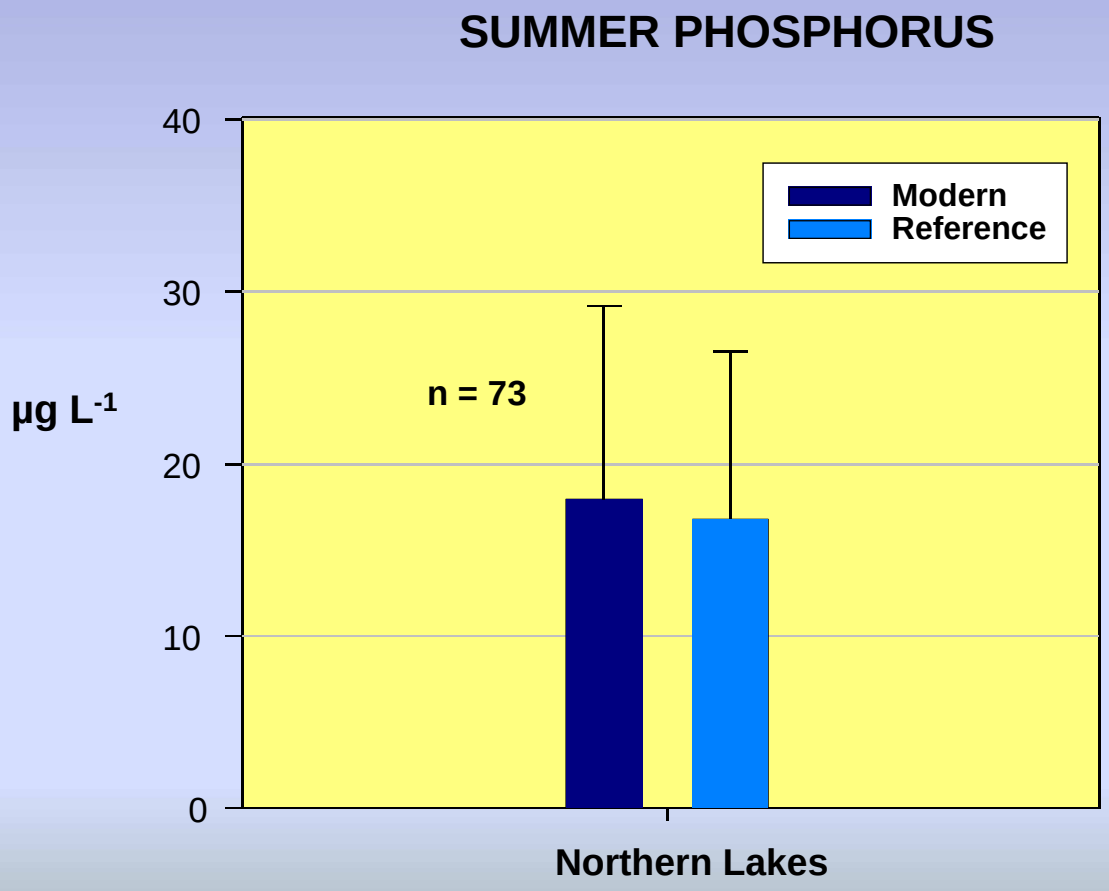
Source: Wisconsin Dept. of Natural Resources 1995 John Panuska

Lower Ninemile Lake

Greb et al.

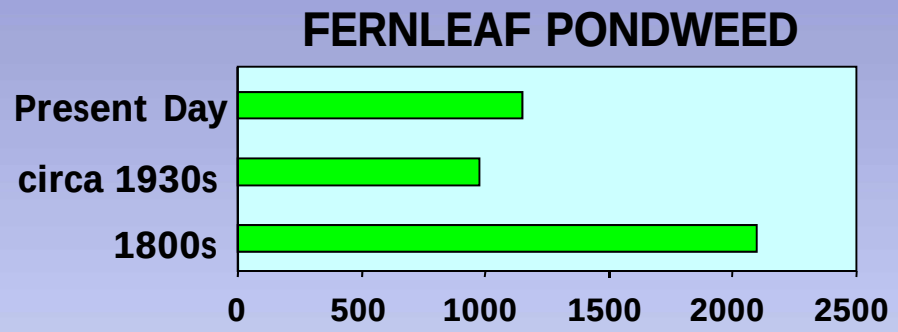


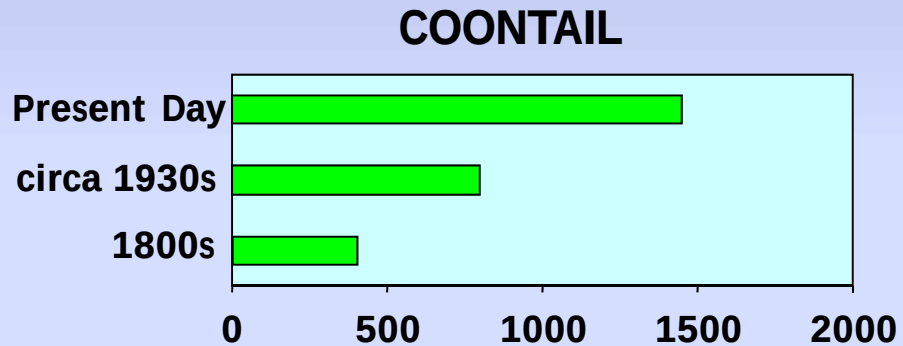
CHANGE IN PHOSPHORUS

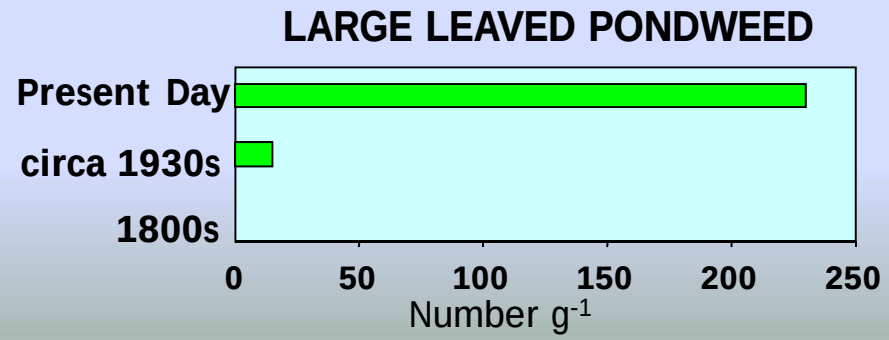



Little
Bearskin
Lake

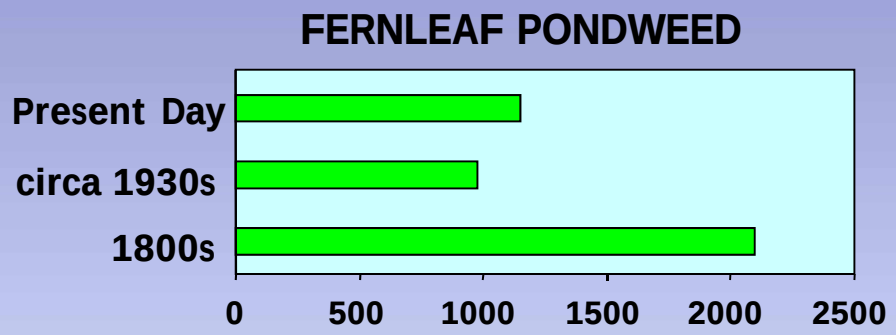
Little Bearskin Lake

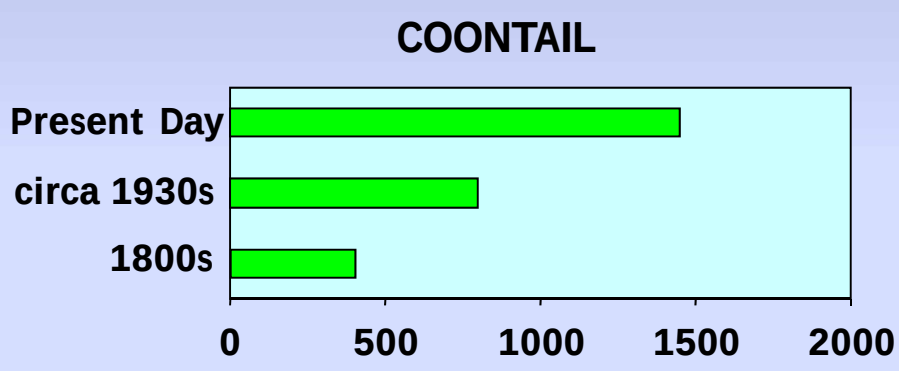


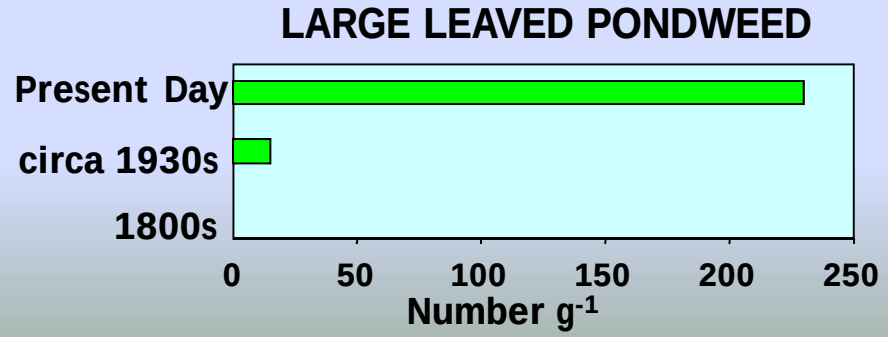


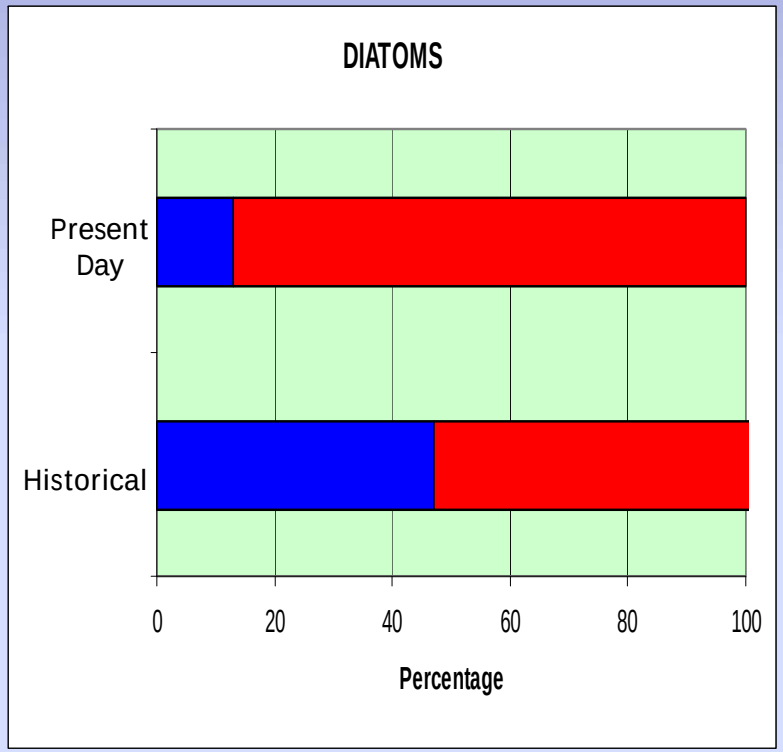


Little Bearskin Lake









Open-water Macrophyte

Shift in the ratio of isoetids to elodeids

1930s: 50/50

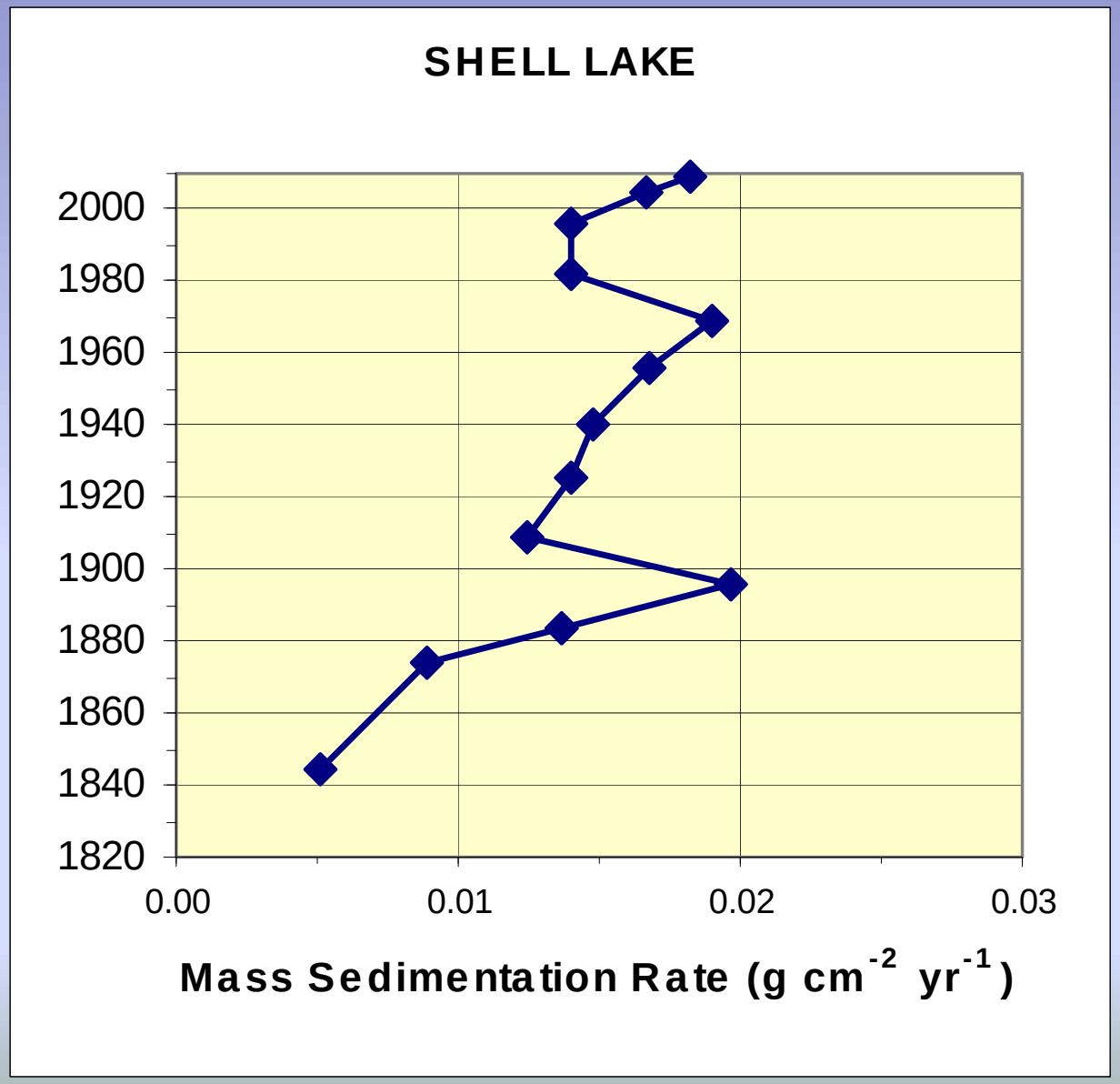
2000s: 30/70

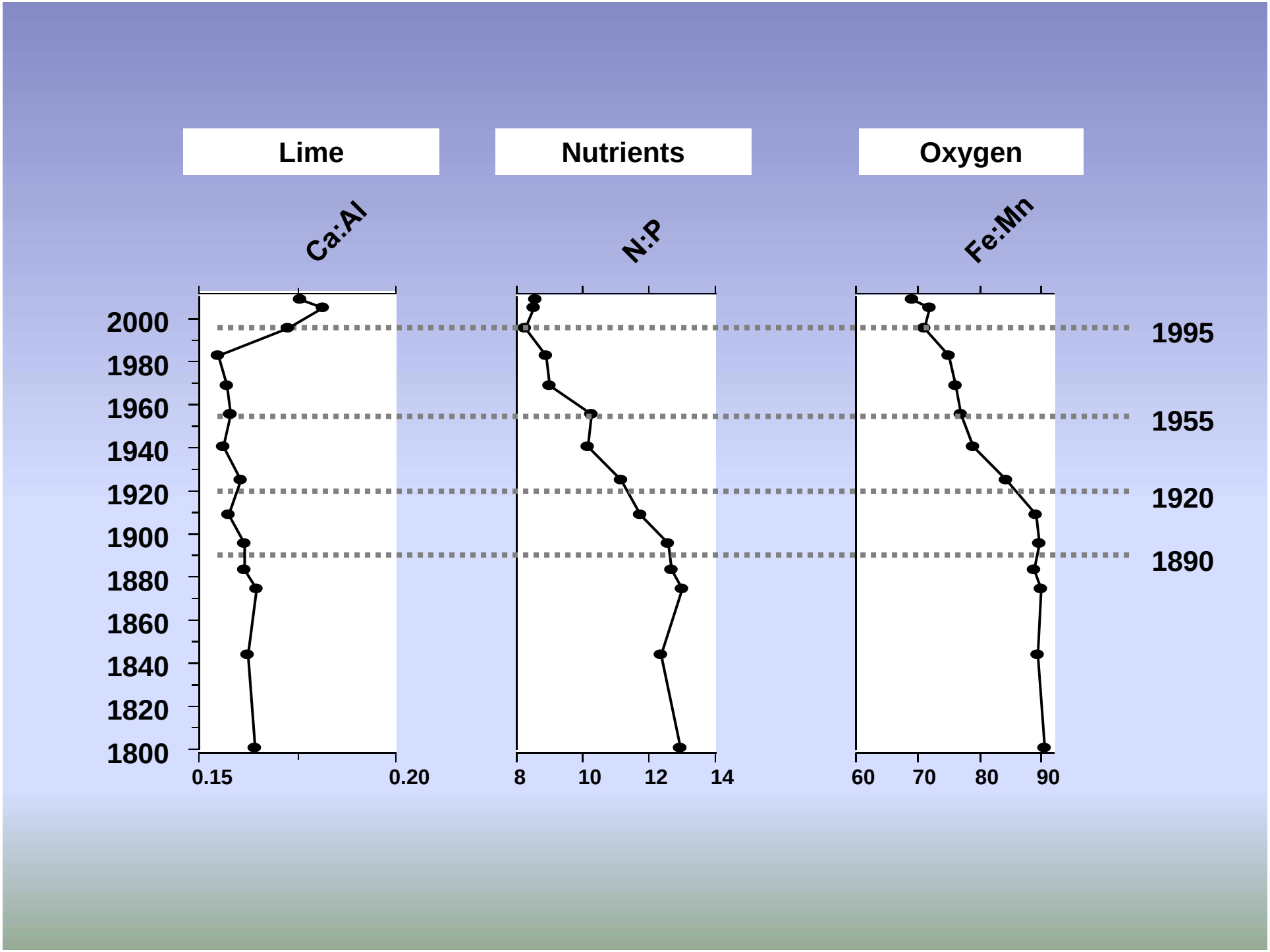
Susan Borman and Ray Newman-U. of Minnesota

HABITAT CHANGE

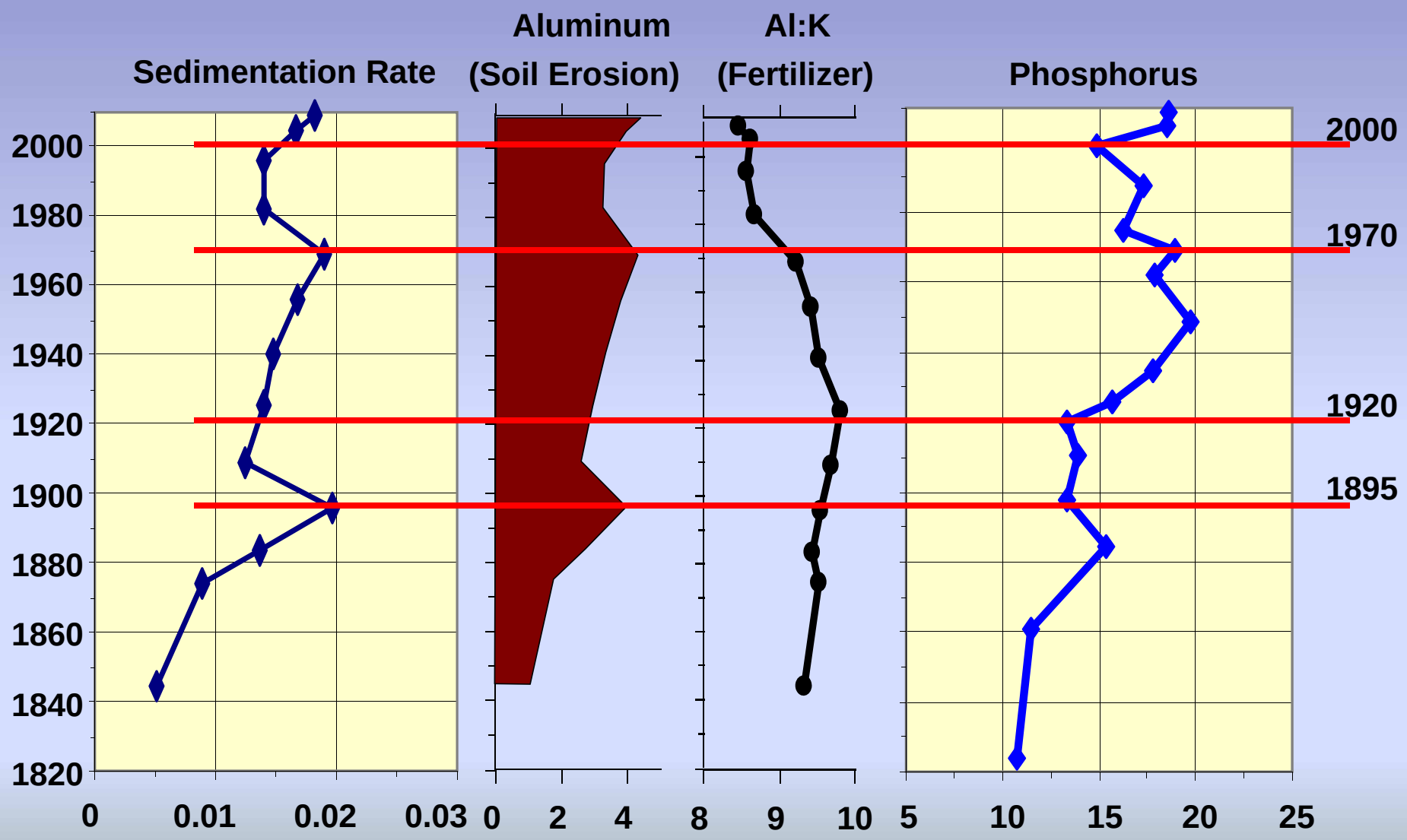
circa 1910


Shell Lake
63
Shell Lake Muni
Shell Lake Muni
Shell Lake Muni
Shell Lake Muni
Shell Lake Muni
Shell Lake
Scout Island
1250


SHELL LAKE
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
0.00
0.01
0.02
0.03
Mass Sedimentation Rate (g cm-2 yr-1)

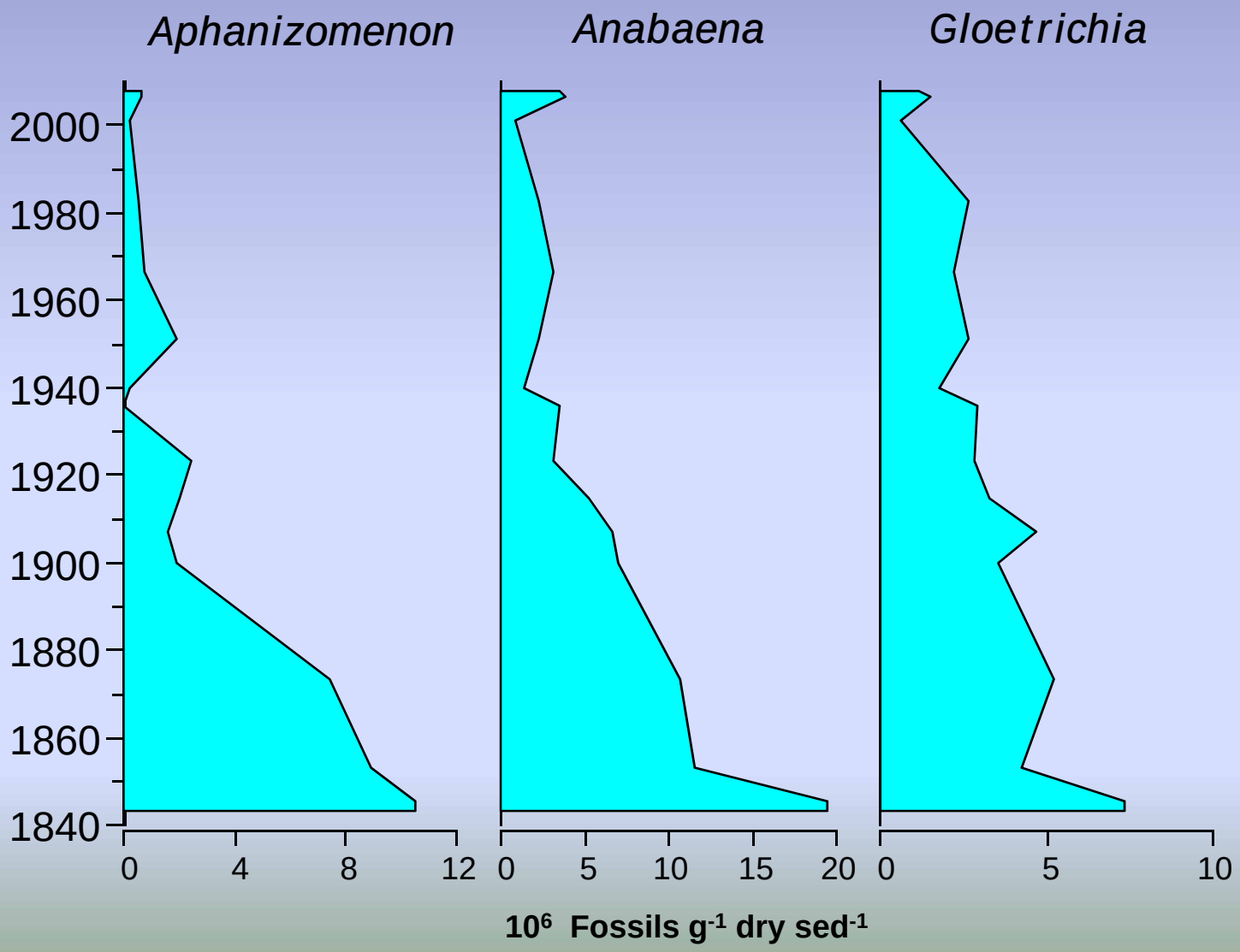

Lime
Nutrients
Oxygen
Ca:Al
N:P
Fe:Mn
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
1800
1995
1955
1920
1890
0.15
0.20
8
10
12
14
60
70
80
90

SUMMARY

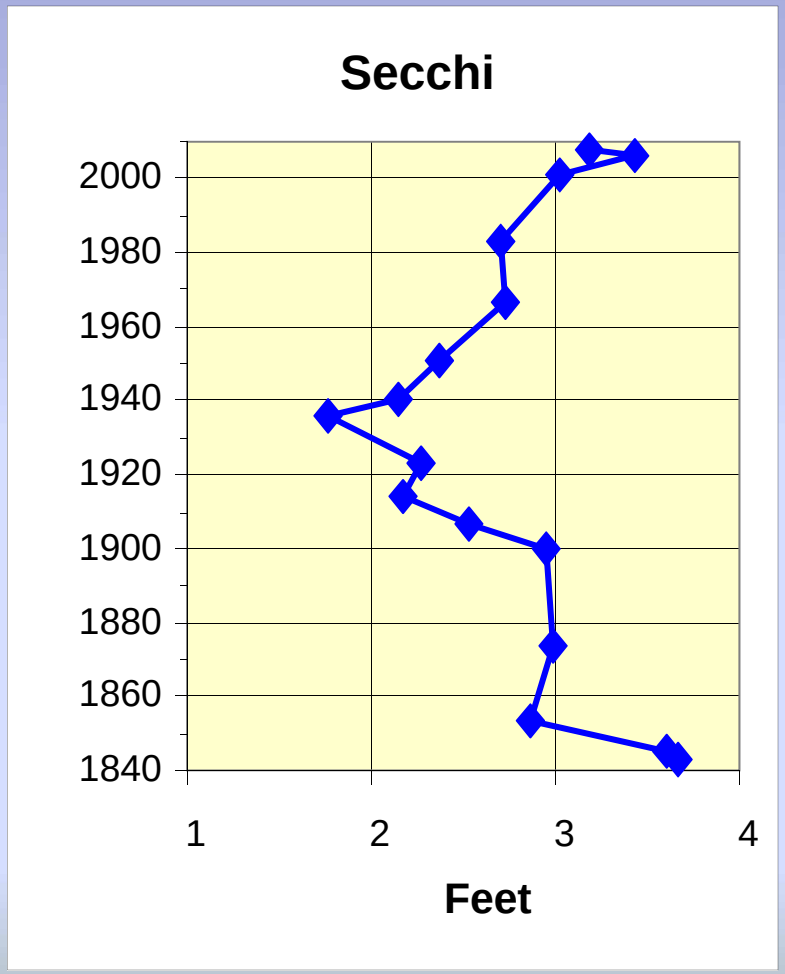

Sedimentation Rate
Aluminum
(Soil Erosion)
Al:K
(Fertilizer)
Phosphorus
2000
1980
1960
1940
1920
1900
1880
1860
1840
1820
0
0.01
0.02
0.03
0
2
4
8
9
10
5
10
15
20
25
2000
1970
1920
1895

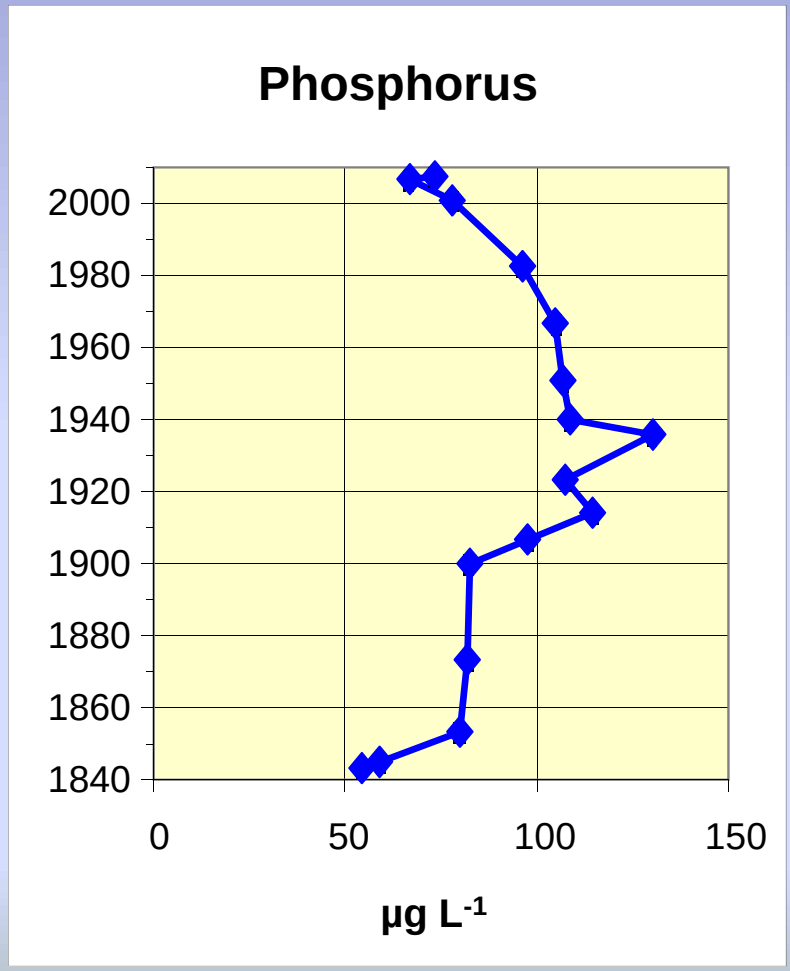

Lake
Chetac

BLUE-GREEN ALGAE

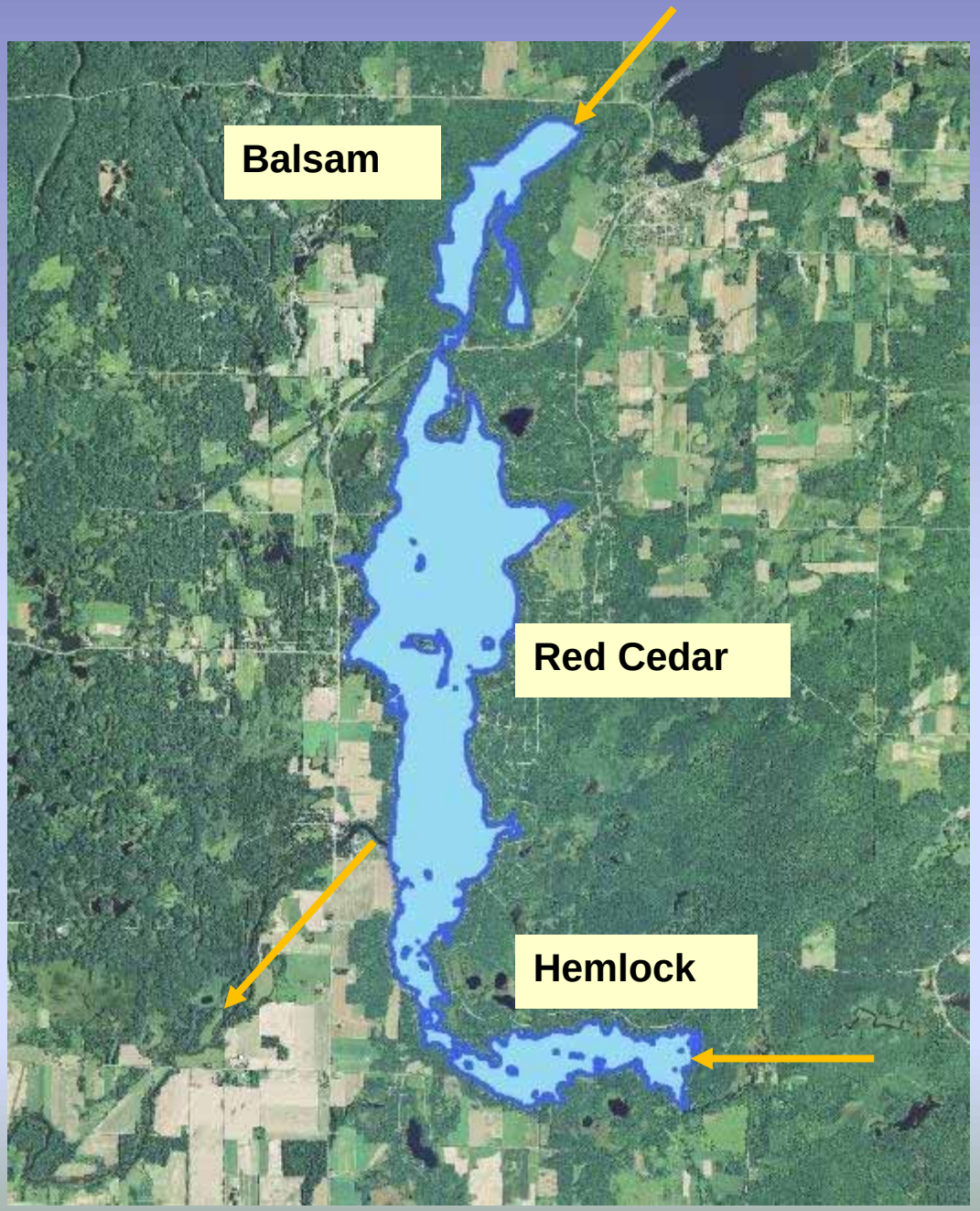


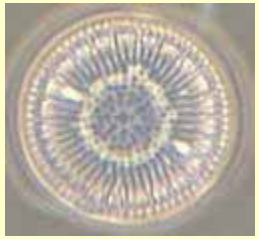
LAKE CHETAC


Secchi
2000
1980
1960
1940
1920
1900
1880
1860
1840
1
2
3
4
Feet


Phosphorus
2000
1980
1960
1940
1920
1900
1880
1860
1840
0
50
100
150
µg L-1


Red
Cedar
Lakes


Balsam
Red Cedar
Hemlock



CONCLUSIONS

- **The lakes are naturally eutrophic 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 in which agricultural practices intensified. To

QUESTIONS?