



# A PALEOLIMNOLOGICAL STUDY IN THE COMFORT LAKE – FOREST LAKE WATERSHED DISTRICT PHASE II



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# Comfort Lake – Forest Lake WD

- Aim - Use dated sediment cores to reconstruct the trophic (nutrient/algae) and sedimentation history of Bone and School lakes.
- Bone and School Lakes are in the NCHF Ecoregion and defined as “Deep”
  - ▣ MN State nutrient standard is 40 ppb TP
- Both lakes are currently impaired due to high nutrient levels.

# Sediment Coring

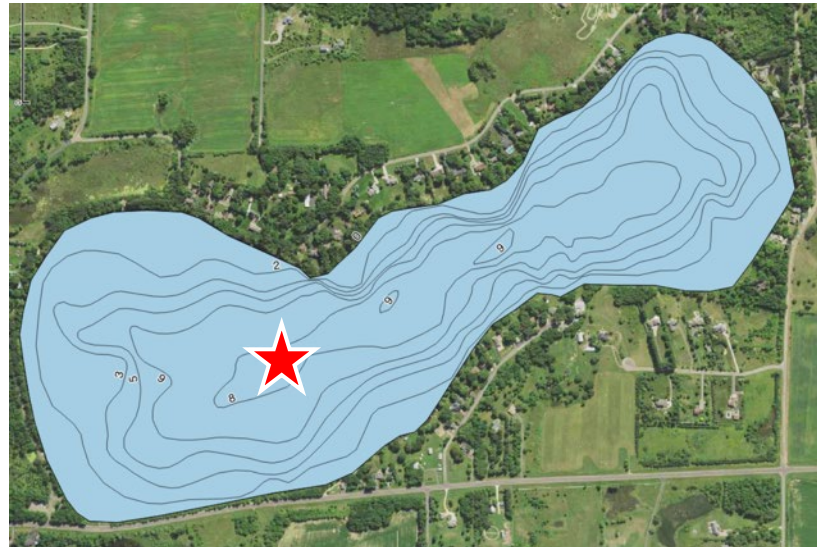


- Cores collected in Mar-Jun 2019
- Dated with lead-210
- Analyzed biological and geochemical markers in the sediments
- Interested in changes since European settlement
  - Bone 8 ft of mud
  - School 4.5 ft of mud



# What we found – Bone Lake

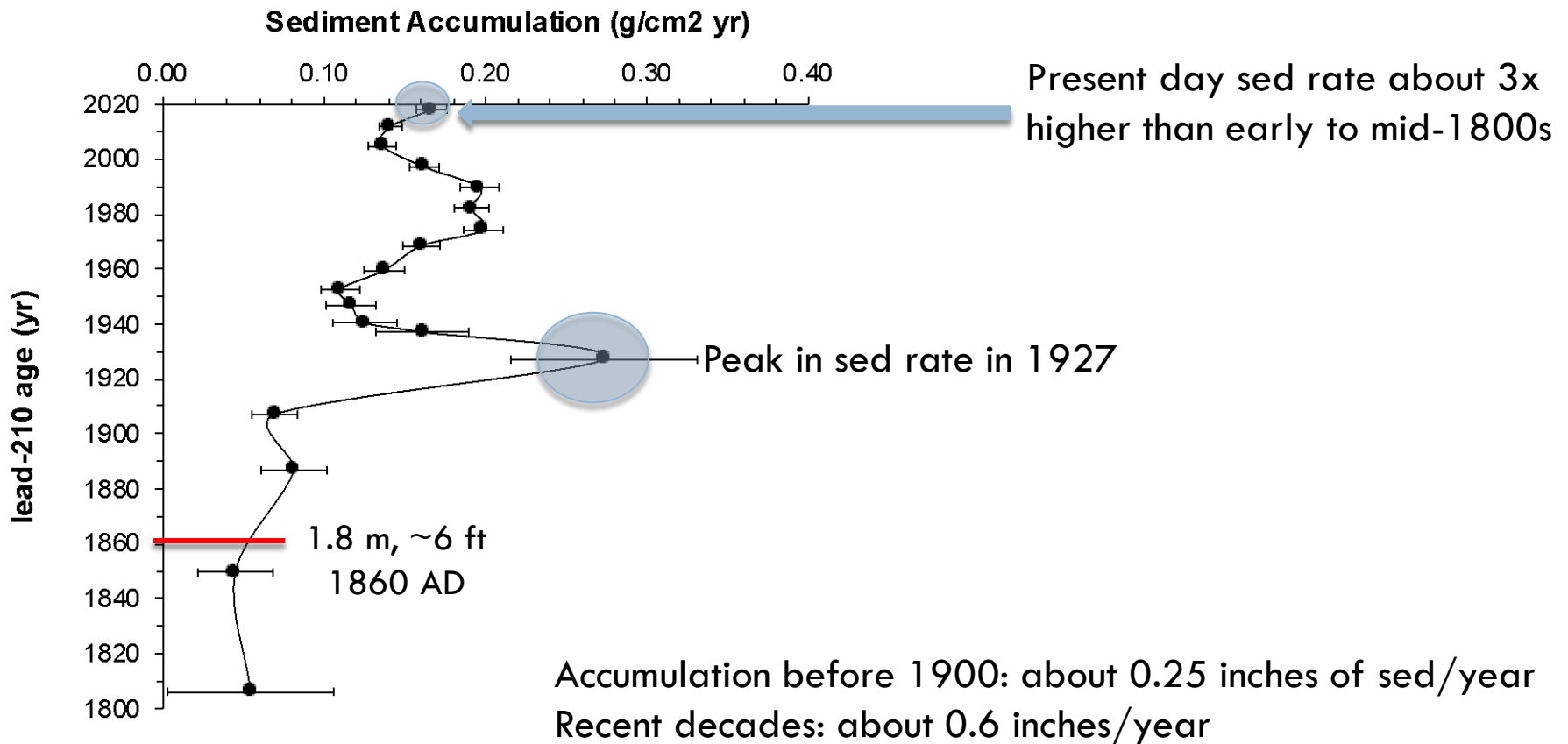
- Evidence suggests Bone Lake had poorer water quality in the 1940s-1990s.
- Trends in improvement since the 1990s.
- Recent Diatom-inferred TP values show Bone Lake poised near the 40 ppb TP standard.



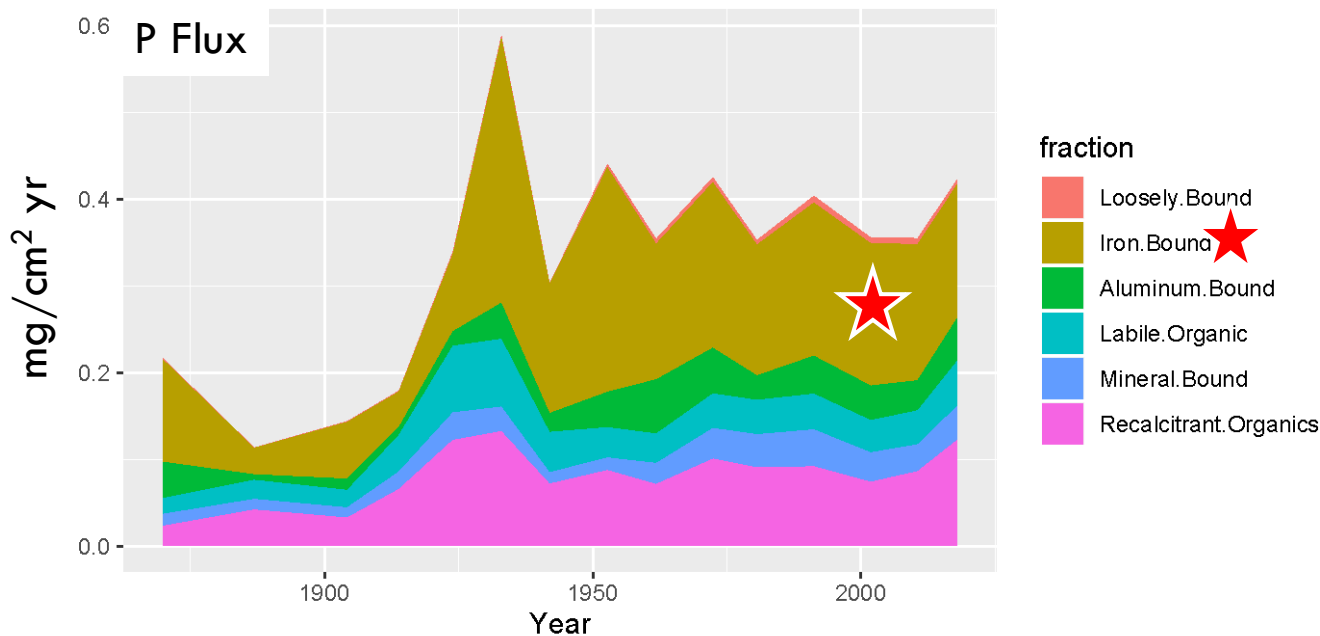
# Management Recommendations – Bone Lake

- Evidence suggests Bone Lake had poorer water quality in the 1940s-1990s.
- Trends in improvement since the 1990s.
- Recent Diatom-inferred TP values show Bone Lake poised near the 40 ppb TP standard.
- **Continue efforts to curb nutrient loading to the lake.**
- **Goal is to maintain recent trend of improving water quality.**
- **Keep lake below state standard (40 ppb TP) and potentially reach district goal (30 ppb TP).**

# Sedimentation in Bone Lake

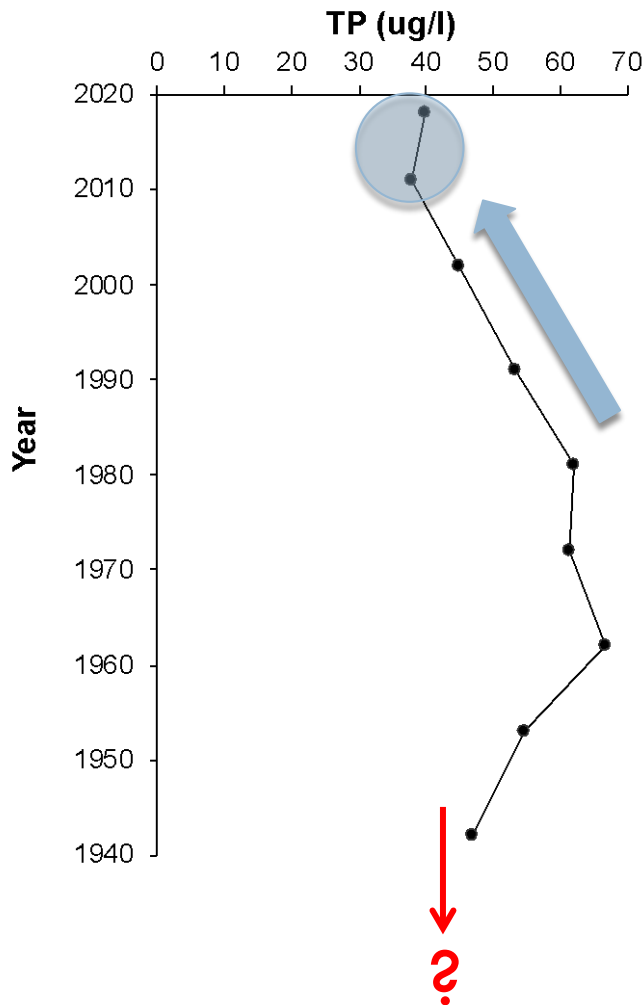


# Bone Lake – Sediment Phosphorus



- Spike in Sediment P flux in the 1930s.
- From the 1930s to core top, Fe-bound P is the largest fraction.
- Internal loading of P may be an issue in Bone Lake.

# Bone Lake – Diatom-Inferred TP



- In the Eutrophic category since the 1940s
- poorer WQ 1950s-1990s
- Prior to 1940, diatom preservation was poor

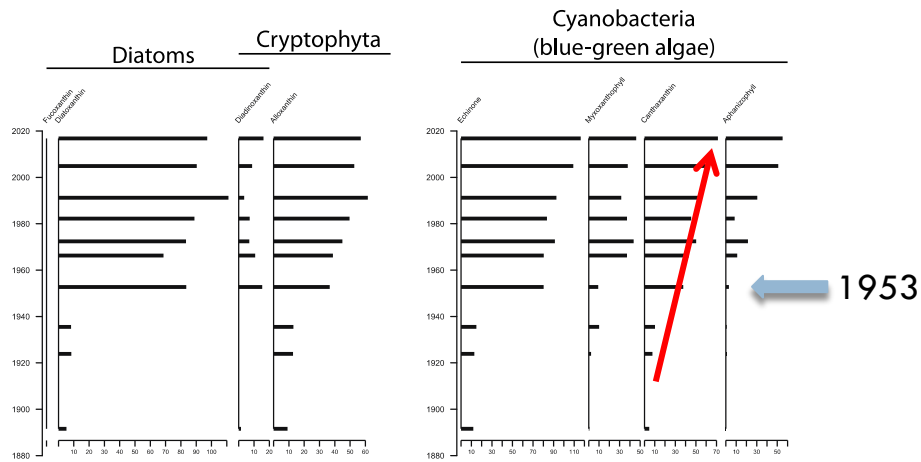
Downward trajectory since the 1980s matches WQ improvements.

Values in recent decades similar to the 1940s.

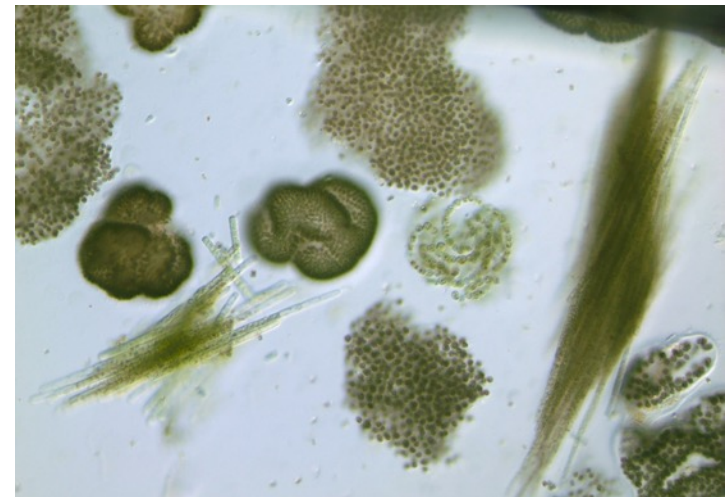
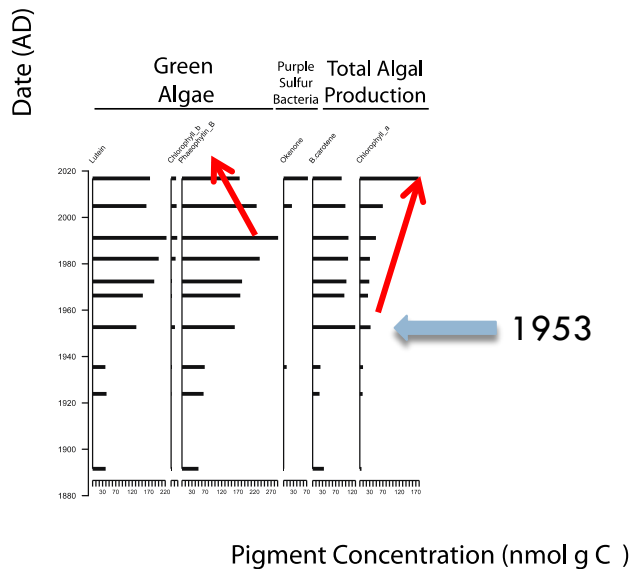




# Bone Lake – Algal Pigments

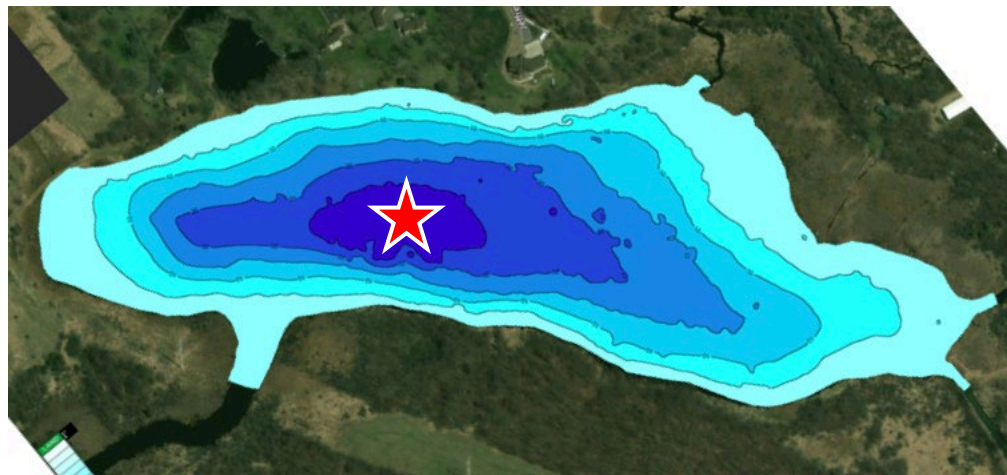


- Large increase in algal productivity after 1930s. This increase was seen in multiple algal groups.
- Some groups showing recent declines



# What we found – School Lake

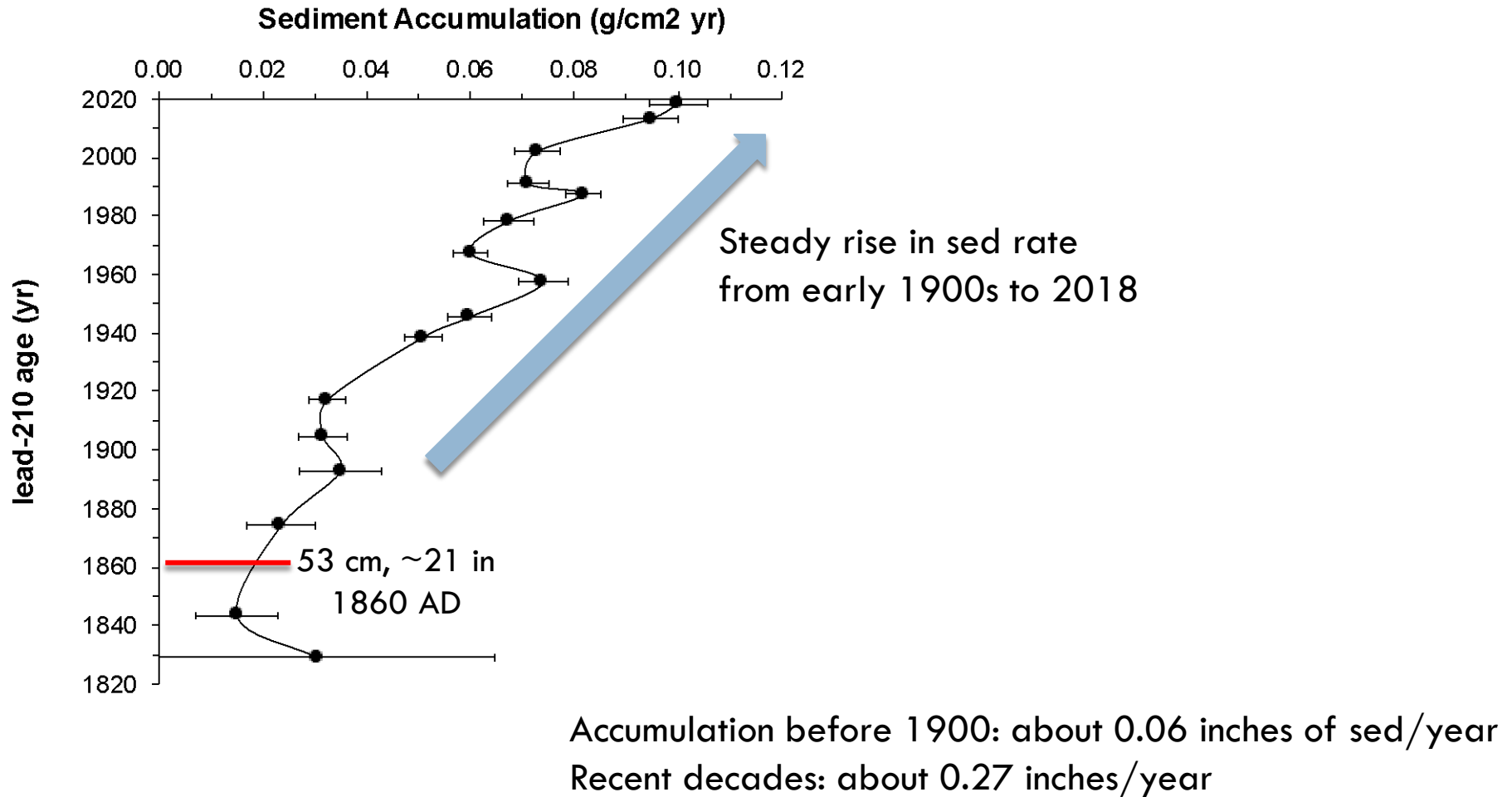
- Multiple lines of evidence suggest that School Lake has long been eutrophic and productive.
- The lake was even more nutrient-rich in the 1940s and 50s – with a recovery trend since the 1960s.
- Current nutrient levels similar to 1920s and earlier.



# Management Recommendations – School Lake

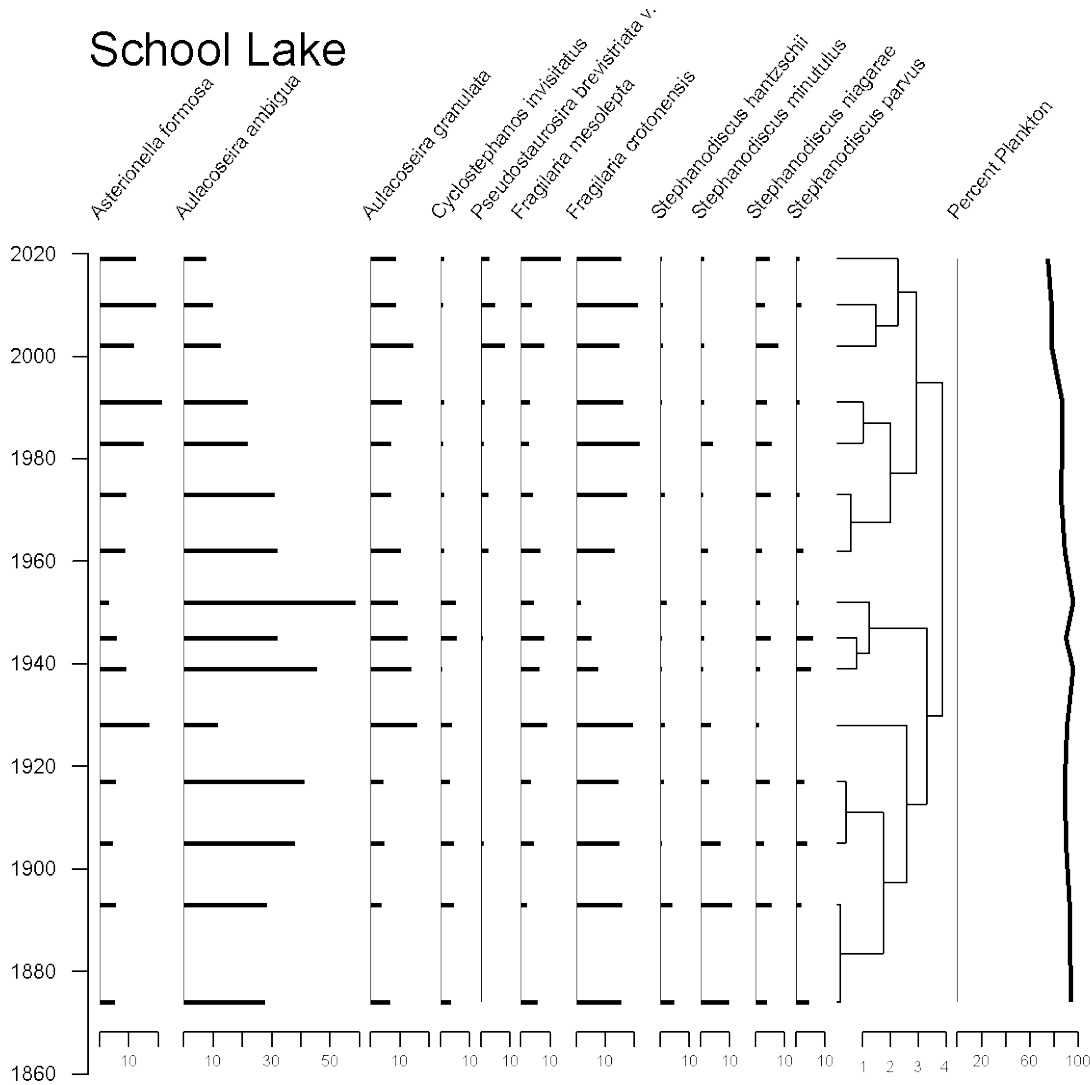
- Multiple lines of evidence suggest that School Lake has long been eutrophic and productive.
- The lake was even more nutrient-rich in the 1940s and 50s – with a recovery trend since the 1960s.
- Current nutrient levels similar to 1920s and earlier.
- **Continue all nutrient control measures to prevent return to 1940s/50s conditions.**
- **School Lake may have difficulty reaching nutrient levels consistently below state standards.**
- **Consider work with MPCA for site-specific standard.**

# Sedimentation in School Lake

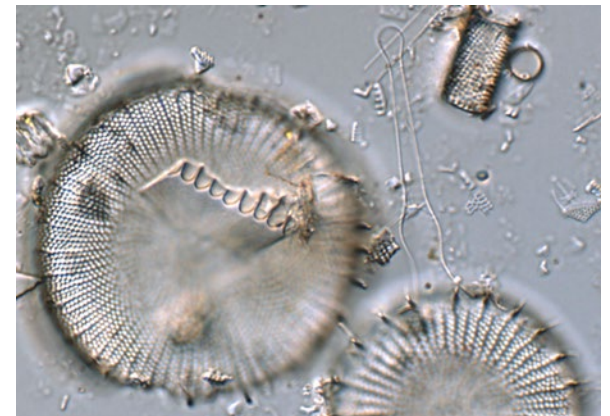


# School Lake - Diatoms

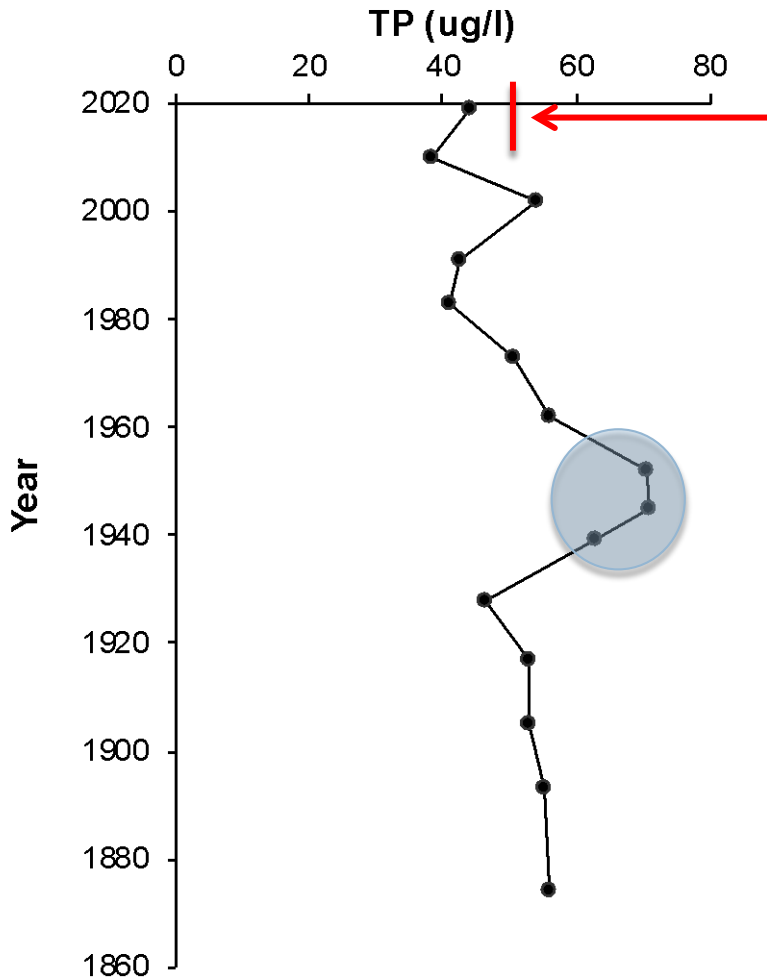
## School Lake



- No significant changes in diatom community from 1870s through 2018
- Dominated by species indicative of eutrophic conditions



# School Lake – Diatom-Inferred TP

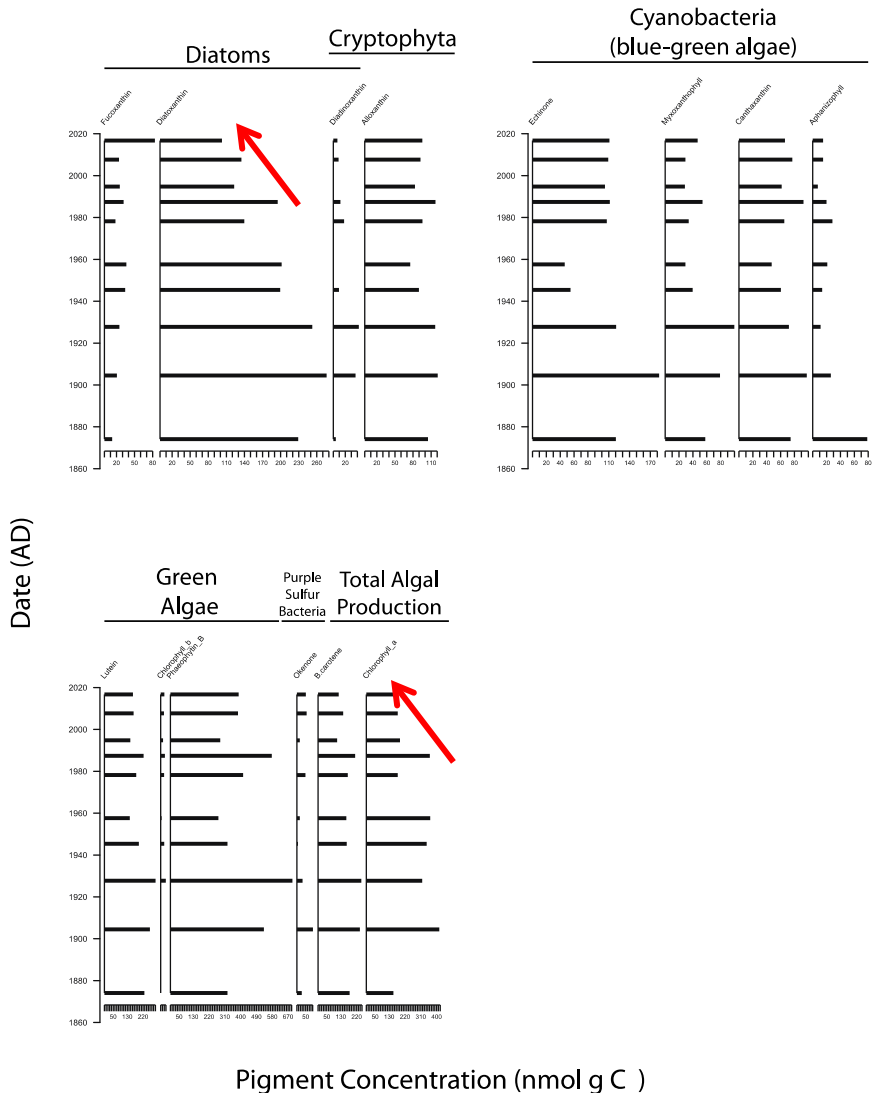


2018, mean monitored TP 51 ppb

- In the Eutrophic category since the 1870s
- Diatom-inferred TP highest from the 1930s – 1950s



# School Lake – Algal Pigments



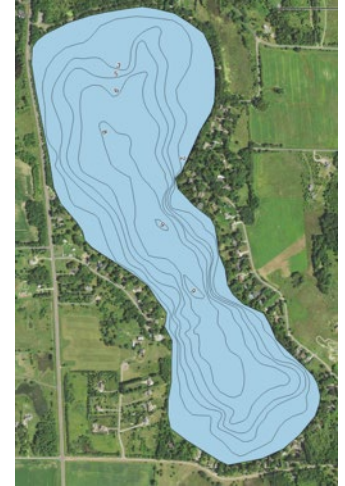
- Overall, algal production has not changed drastically since the late 1800s
- Total algal abundance has declined slightly from the mid-1990s to 2017



# Recommendations

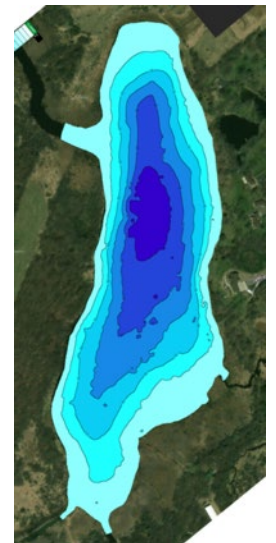
## Bone Lake

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- Continue efforts to curb nutrient loading to the lake.
- Keep lake below state standard (40 ppb TP) and potentially reach district goal (30 ppb TP).



## School Lake

- Continue all nutrient control measures to prevent return to 1940s/50s conditions.
- School Lake may have difficulty reaching nutrient levels consistently below state standards.
- Consider work with MPCA for site-specific standard.





# Questions?

- Thanks, esp. School Lake access
- CLFLWD team
- SCWRS lab: Dan Engstrom, Shawn Schottler, Adam Heathcote, Michelle Natarajan, Erin Mortenson, Alaina Fedie
- Univ of St Thomas - Earth, Environment & Society



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