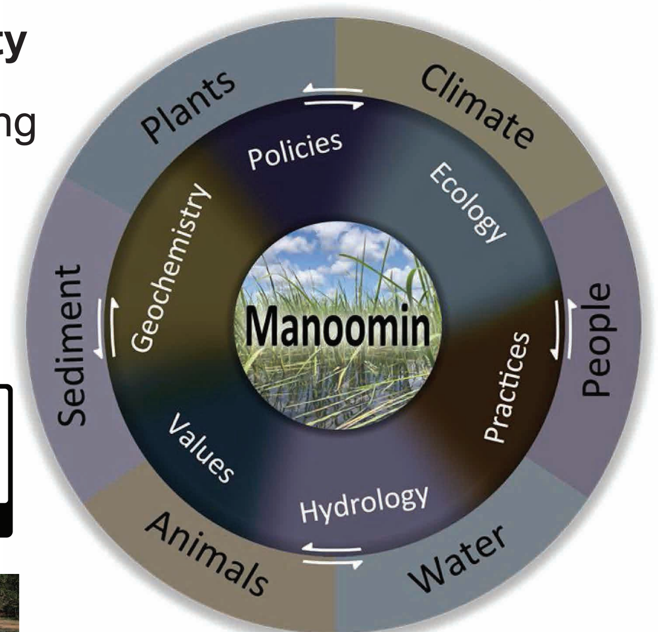
Environmental and anthropogenic impacts on lacustrine sedimentation and Manoomin/Psiŋ (wild rice) ecosystems

Introduction: Sediment and its relationship with Manoomin/Psiŋ

Respecting Tribal Sovereignty is our foundation.
Memorandums of Understanding regarding research practices were signed between Tribal Governments and University researchers.

See Matson et al. 2021 for details, including our research protocol in the supplementary material.
https://manoominpsin.umn.edu

SCAN ME



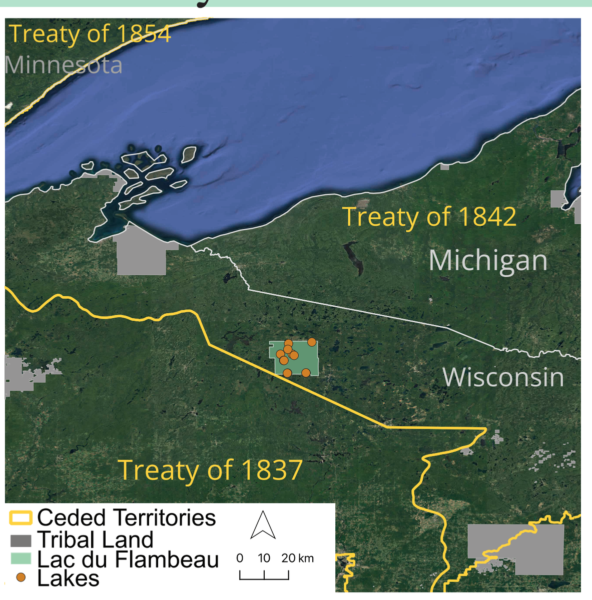
Matson et al. 2021

Manoomin in Ojibwe and Psin in Dakota, known as wild rice, is a sacred and dietary plant to Indigenous people in the Upper Great Lake region. It is an annual grass with seasonal germination, submerged, floating, and aerial stages (Figure from: David et al. 2019)

- Manoomin grows in organic-rich muck (e.g. David et al., 2019).
- When sediment becomes too flocculant or sediment accumulates more than 8 cm/yr, Manoomin decreases (Meeker et al., 1999).
- Disturbance of the lake bottom (i.e. from muscrats or moose)

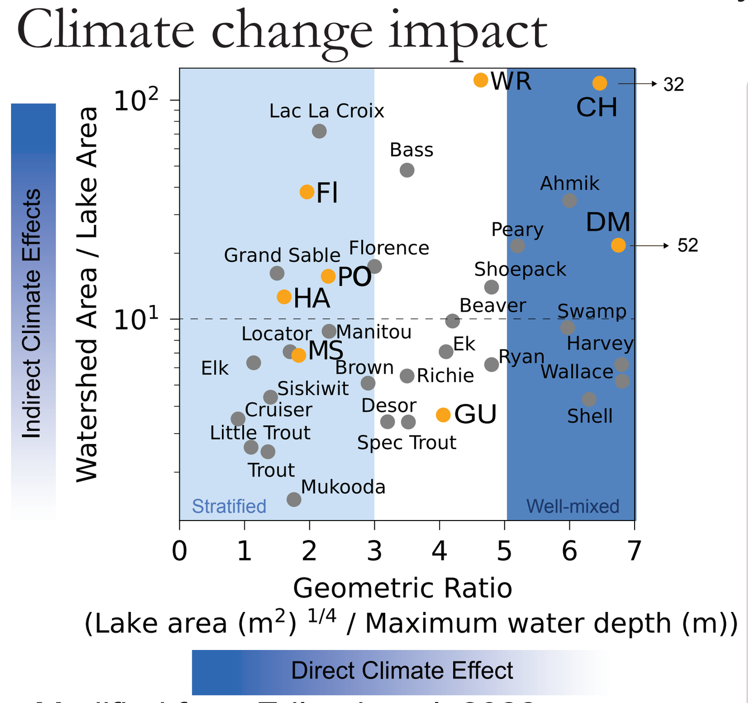
Can sediment cores record changes affecting Manoomin?

Study Site and Context



- 8 lakes were cored in 2013 on Lac du Flambeau territory (see map)
- Cores were collected as part of a previous project funded by the Great Lakes Restortation Iniative to assess Manoomin abundance.
- Most cores were taken along shores Locations were chosen based on a 1911 map with Manoomin.
- Lake locations and names are anonymized.

Climate change impact



Modified from Edlund et al. 2022

Anthropogenic impact

1860-1887	Logging confined to river since used to transoprt logs
1887	Dawes Act: settlers can acquire land within reservation, resulting in more logging and shoreline development
1887	Dams downstream of FL, PO, WR installed and railroad built
1887-1914	Clear cutting is at its height due to railroad
1980s 2000s	Droughts based on instrumental record

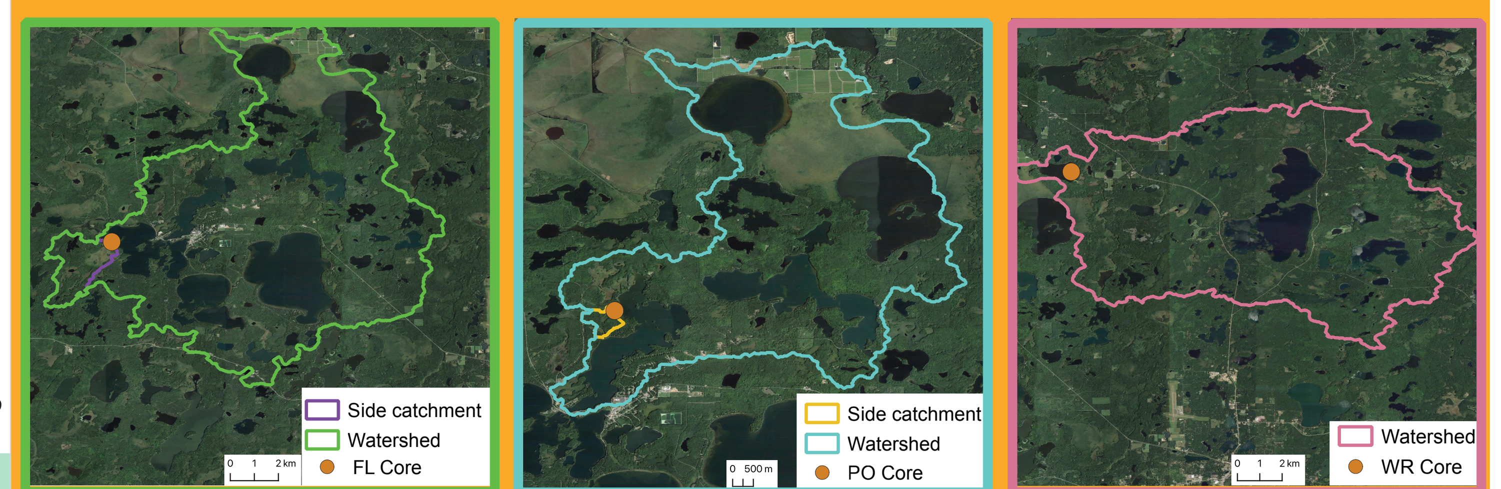
Acknowledgment:
We thank TNR partners Dee Allen, Kristen Hanson, Celest Hockings, Virden Andre, and Jason De Vries for their feedback and contribution to the study. All data originates from a 2013 study comissioned by LDF with funds from Great Lakes Restoration Iniative and completed by the CSD Facility at UMN. We thank everyone who contributed to the coring and an analysis.

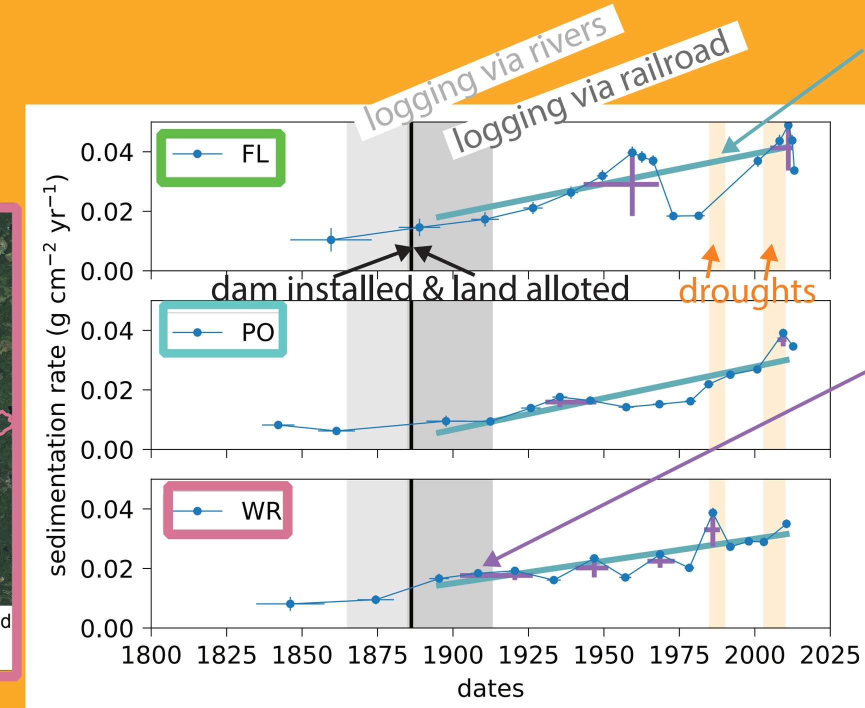
Preliminary Takeaways

Lakes with Manoomin/Psiŋ (wild rice) have that are increasing in sedimentation rate, likely due to increases in primary productivity.

In the late 1800s – early 1900s, increases in sedimentation rates correlated with clearcut logging, dam installations, and lakeshore development.

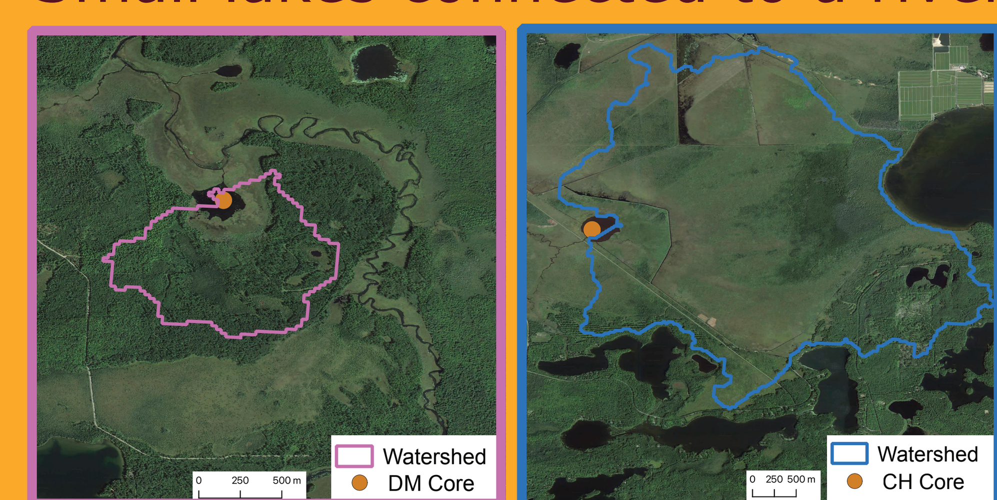
Lakes with large upstream watershed and a downstream dam that raised water level

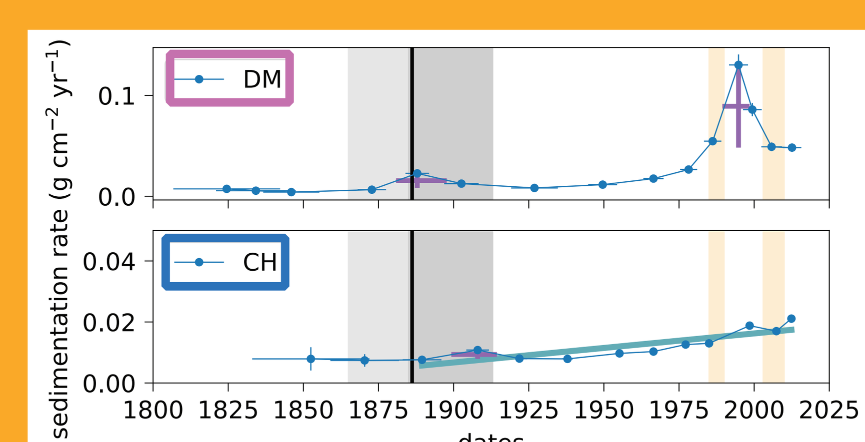




Lake	Sedimentation rate increase since 1887 (g cm⁻² yr⁻¹)	Sedimentation rate increase 1880s-1910s (g cm⁻² yr⁻¹)
FL	0.025	no peak
PO	0.024	no peak*
WR	0.017	0.003

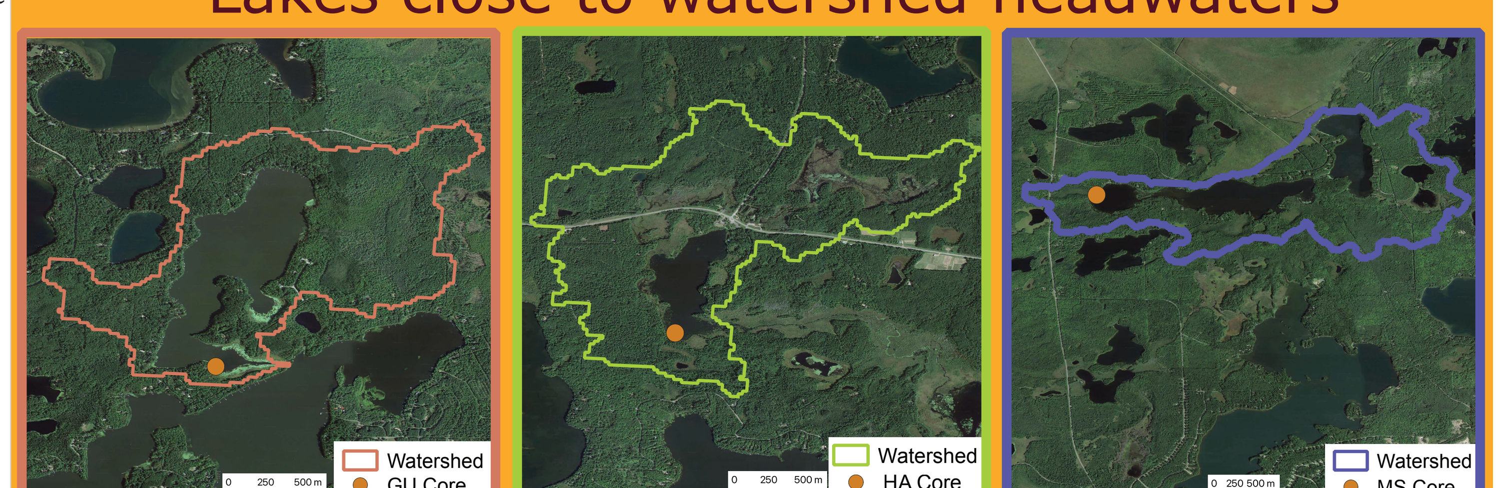
Small lakes connected to a river

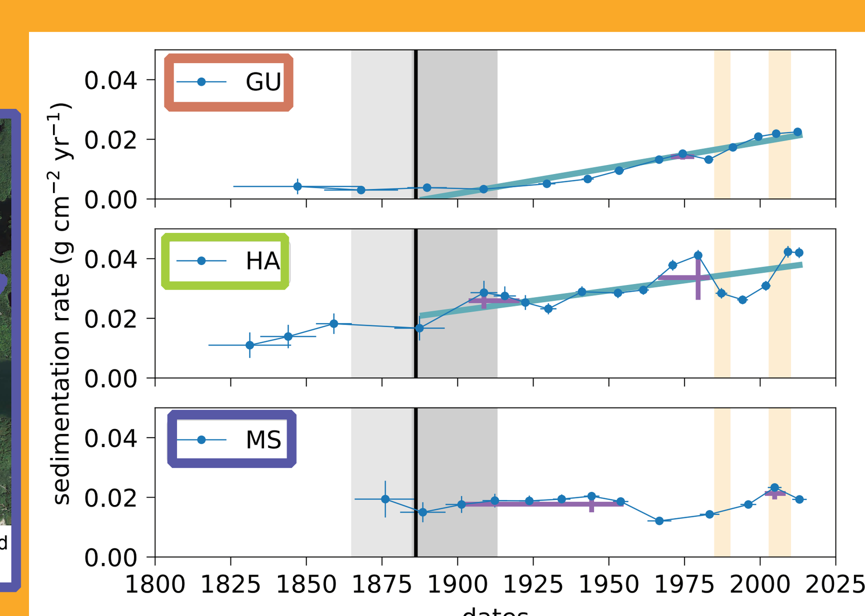




Lake	Sedimentation rate increase since 1887	Sedimentation rate increase 1880s-1910s
DM	not significant	0.015**
CH	0.012	0.003

Lakes close to watershed headwaters





210 Pb based ages and sedimentation rates prepared by Dan Engstrom St. Croix Watershed Reserach Station

Lake	Sedimentation rate increase since 1887	Sedimentation rate increase 1880s-1910s
GU	0.021	no peak
HA	0.017	0.005
MS	not significant	0.005

* increase starts right after logging
** largest sedimentation rate of all lakes peaks in 2005 with 0.82 (g cm-2 yr--1)

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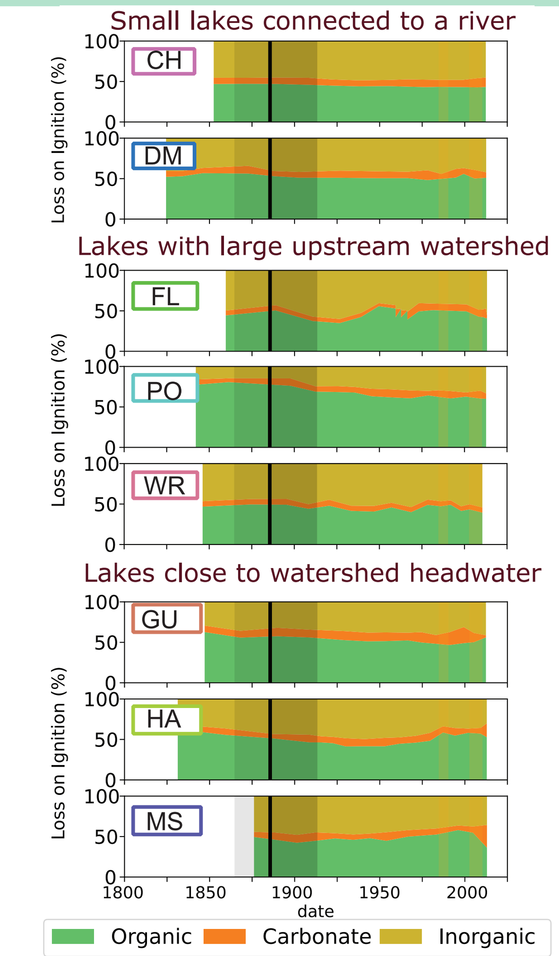
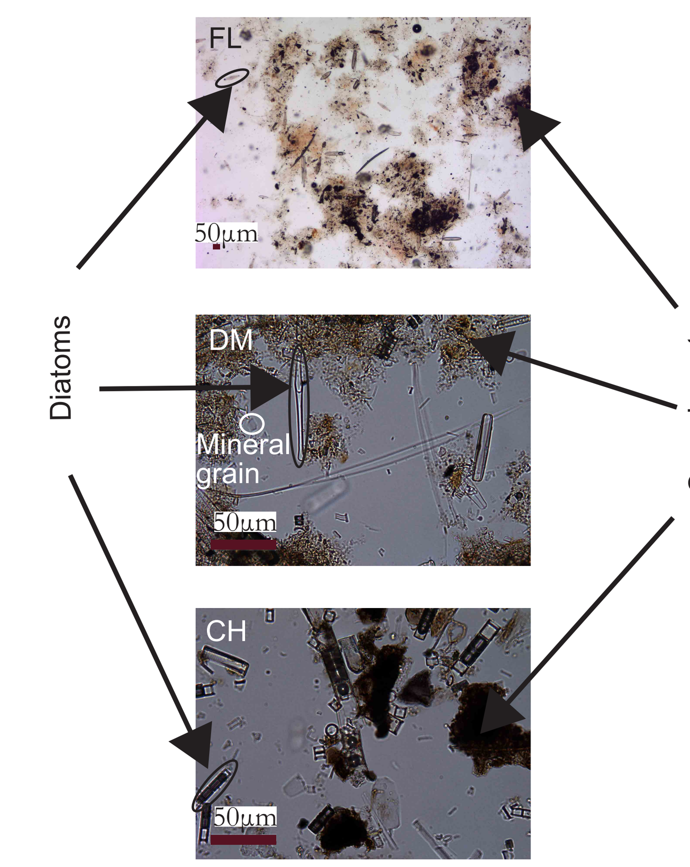
References:
David, P. et al. 2019. Manoomin, Version 1.0. Great Lakes Indian Fish and Wildlife Commission. 158 pgs.
Edlund, M.B., Ramstack Hobbs, J.M., Heathcote, A.J., Engstrom, D.R., Saros, J.E., Strock, K.E., Hobbs, W.O., Andresen, N.A. and VanderMeulen, D.D., 2022. Physical characteristics of northern forested lakes predict sensitivity to climate change. Hydrobiologia, pp.1-25.
Matson, L., Ng, G.H.C., Dockry, M., Nyblade, M., King, H.J., Bellcourt, M., Bloomquist, J., Bunting, P., Chapman, E., Dalbotten, D. and Davenport, M.A., 2021. Transforming research and relationships through collaborative tribal-university partnerships on Manoomin (wild rice). Environmental Science & Policy, 115, pp.108-115.
Meeker, James E., 1999. The Ecology of "wild" wild-rice (Zizania palustris var. palustris) in the Kakagon Sloughs, a riverine wetland on Lake Superior, Pages 68-83 /n Proceedings of the Wild Rice Research and Management Conference, Edited by Williamson, Dlutkowski and McCammon-Soltis, Great Lakes Indian Fish and Wildlife Commission, July 7-8, 1999.

NO RECORDING

Where is the sediment coming from?
Lessons learned from sediment composition



Loss on Ignition results.
Little variation exists.

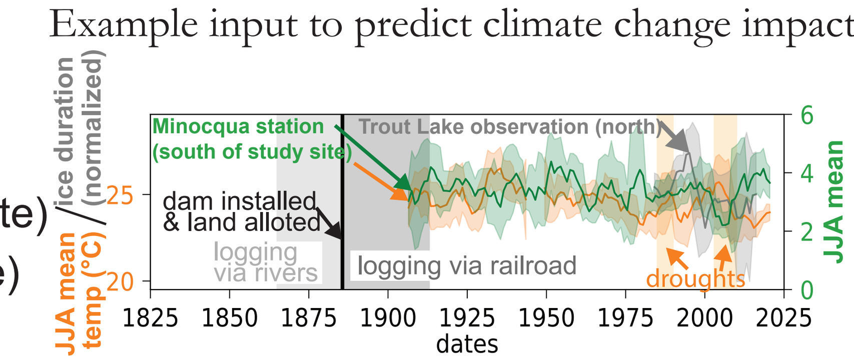


Preliminary smear slides results: lake-derived organic matter and biogenic silica with few mineral grains.

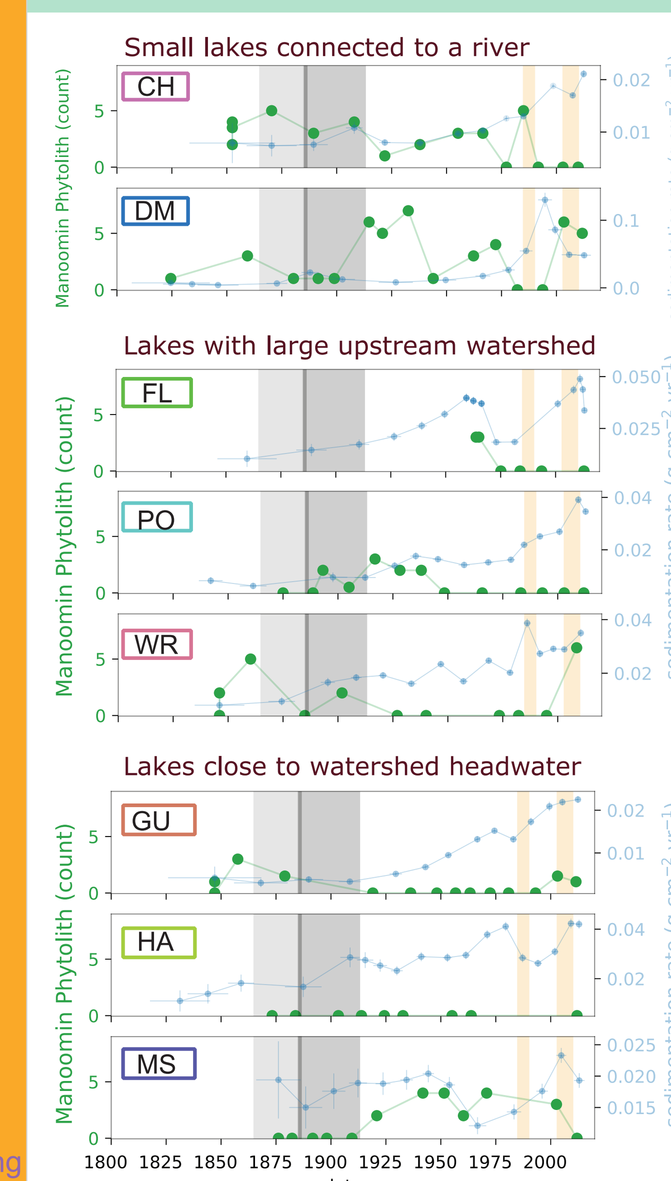
Why is primary productivity changing?
Future work direction to predict impacts

- Nutrient loading (anthropogenic)
- Water depth change (anthropogenic & climate)
- Ice on duration (climate)
- Temperature (climate)

Example input to predict climate change impacts



What about Manoomin/Psiŋ?



Phytolith record prepared by Mikhail Blinnikov and Brook Hoffman at St. Could State University

- Manoomin phytoliths are silicious plant material.
- Oral history: more abundant Manoomin than phytoliths.
- Each lakes has Manoomin history. Coring location chosen for their known Manoomin in 1911. Manoomin phytoliths present for 3 lakes around 1911.

Preliminary Takeaways

- Given this incomplete record, cannot establish correlation between phytoliths and sedimentation.
- However, if sedimentation rates continues to increase, there is a point where sedimentation rates will impact Manoomin growth (e.g., Meeker et al. 1999).
- More broadly, these cores can reveal past changes in lake (e.g., primary productivity, temperature, ice duration) and watershed (e.g., logging, land use) conditions, which is known to affect Manoomin.

Next steps

- Continue collecting oral histories for each lake
- Smear slide analysis of sediment composition during clear cutting.
- Determine watershed versus lake inputs and their impact on nutrient loading via total Nitrogen, total Carbon and their isotopic composition.
- Model primary productivity changes with historical data.
- Model landscape sedimentation rates using USDA's RUSLE (Revised Universal Soil Loss Equation).