

Water Quality in Saskatchewan Lakes: Current Status and Future Challenges

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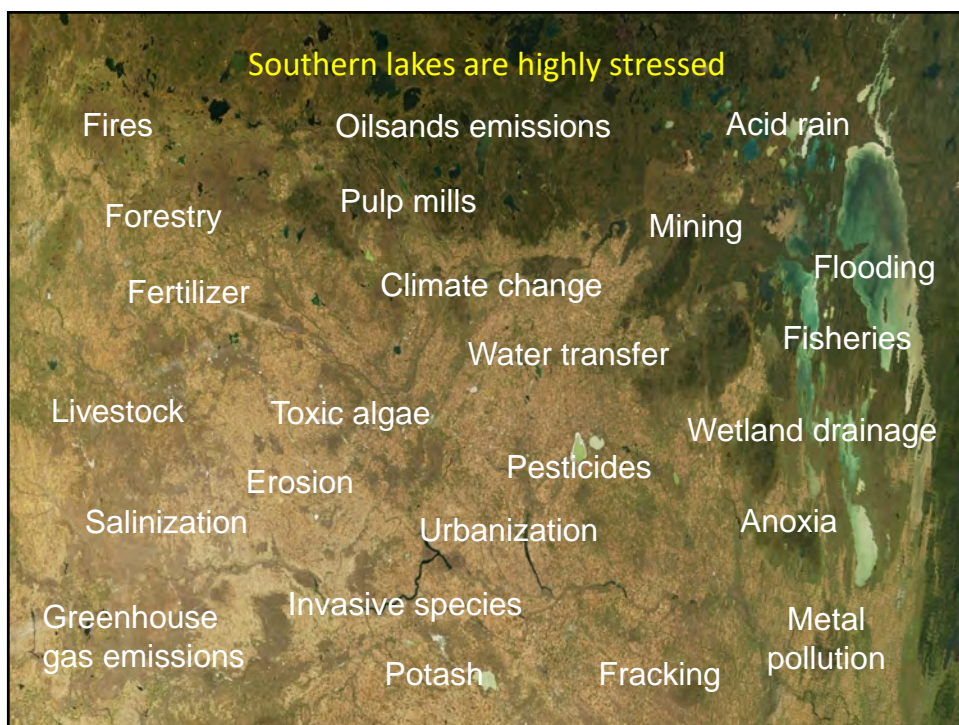
These are the ancestral lands of the Cree, Saulteaux, Dakota, Lakota, and Nakota peoples and are the homeland of the Metis.

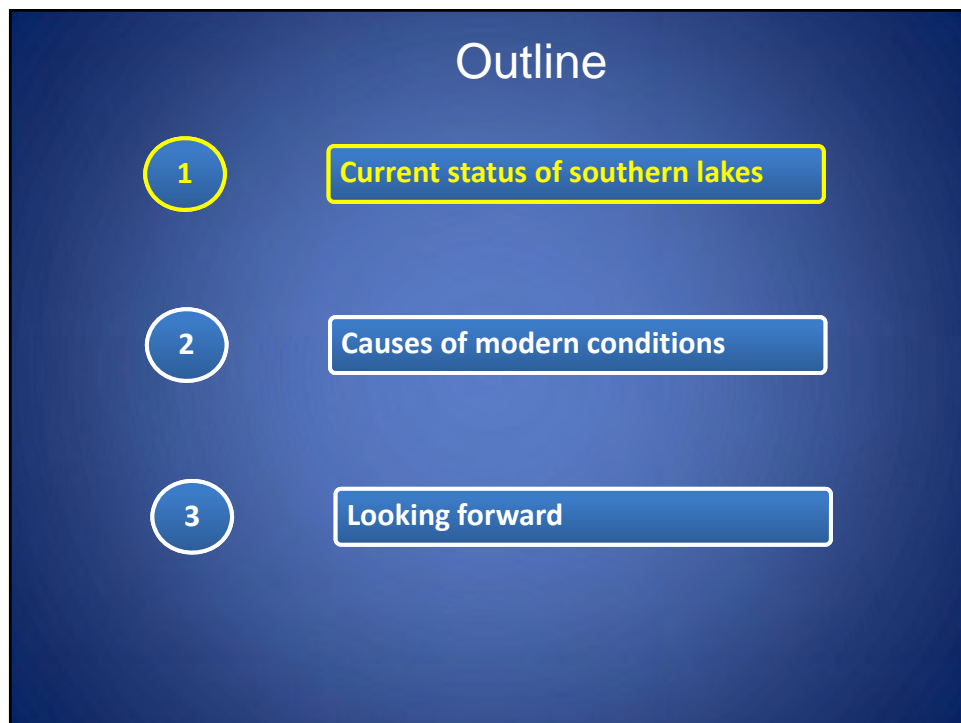
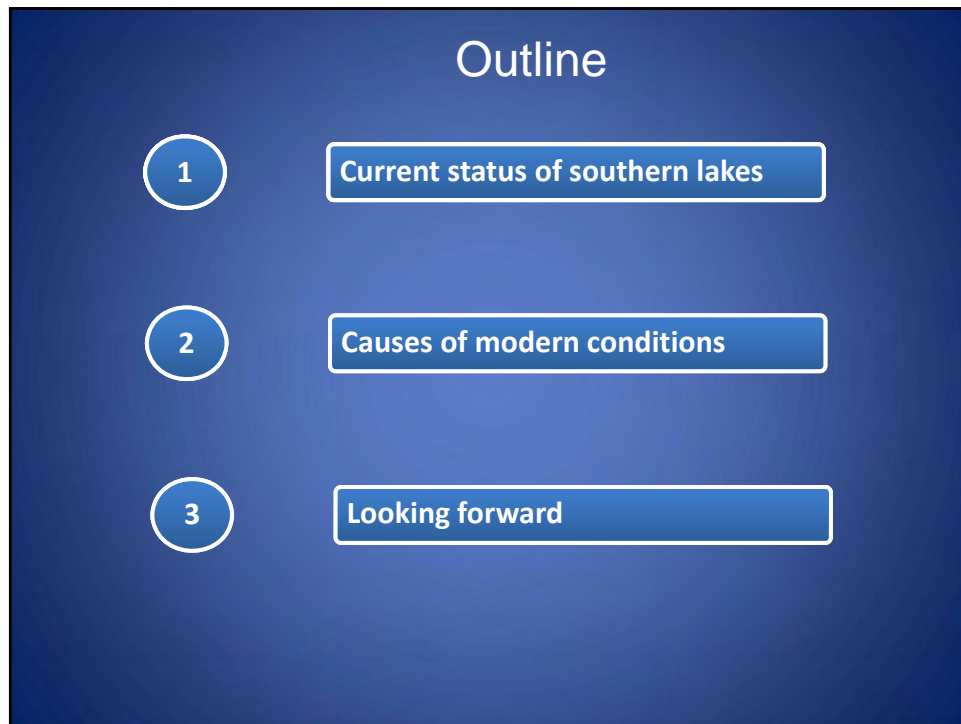
We respect and honour the Treaties that were made on all territories.
We acknowledge the harms and mistakes of the past, and we are committed to move forward in partnership with Indigenous Nations in the spirit of Truth, reconciliation and collaboration.

We sincerely thank all treaty people for sharing the land.



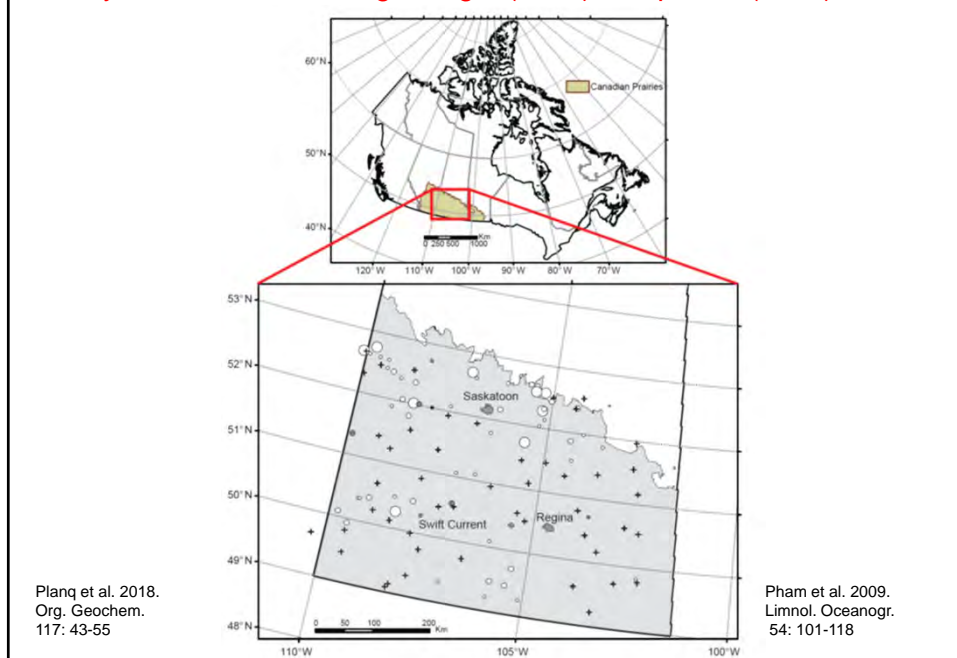
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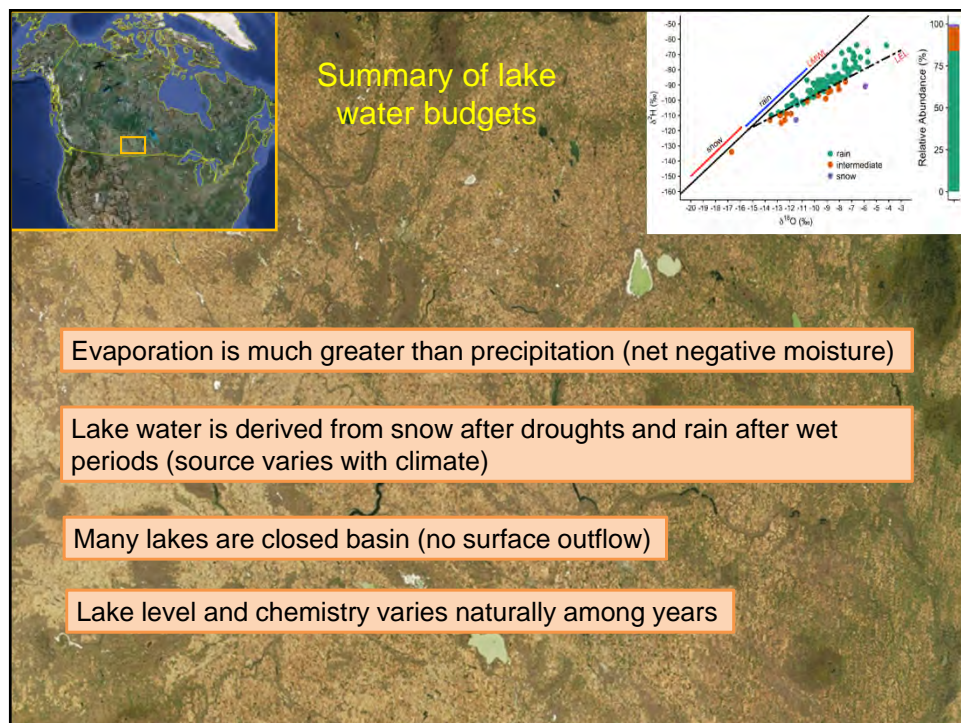


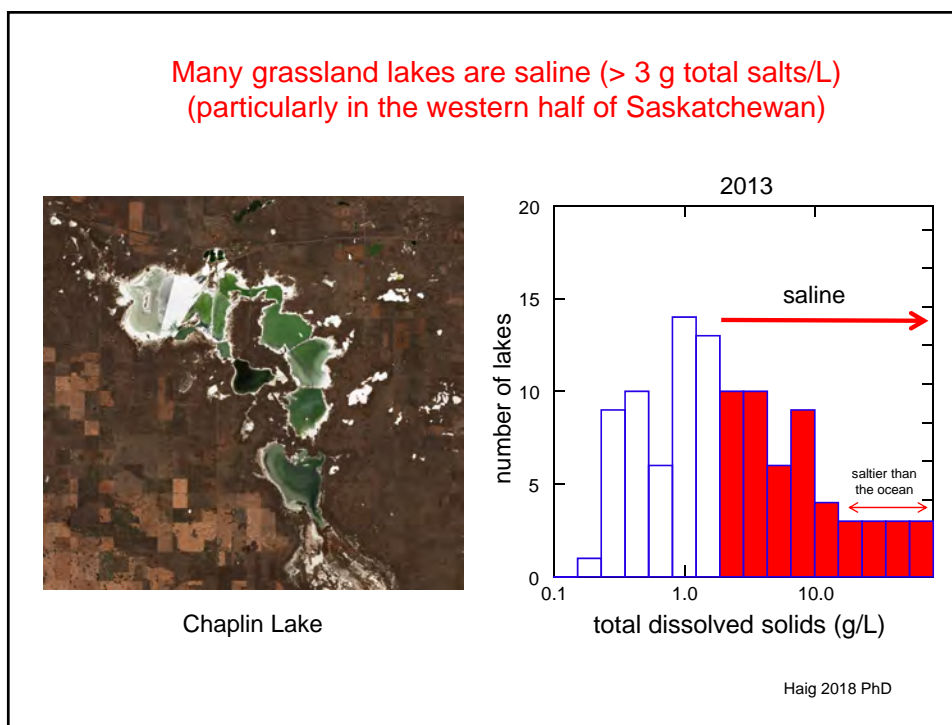
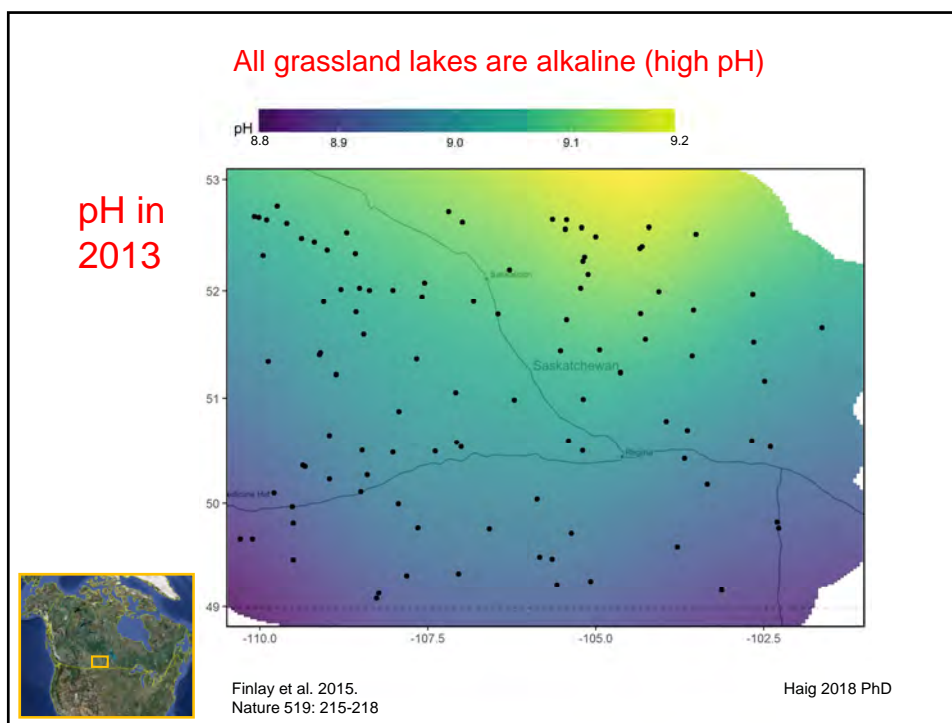




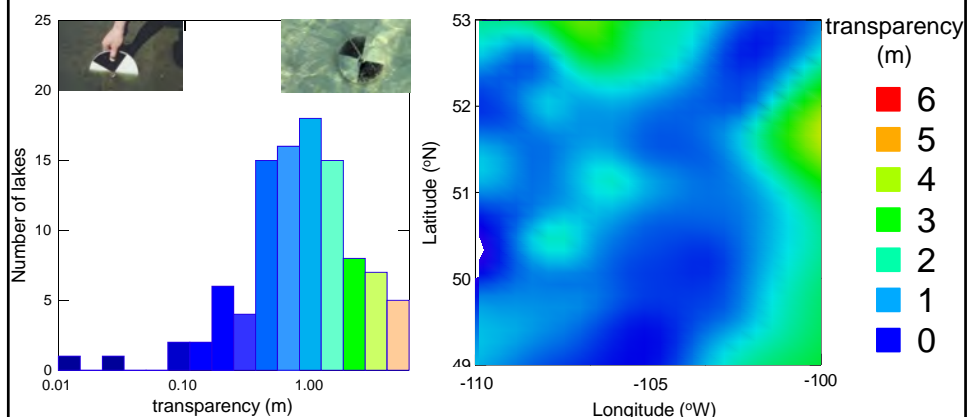
Survey ~100 lakes following drought (2003) and pluvial (2013) intervals



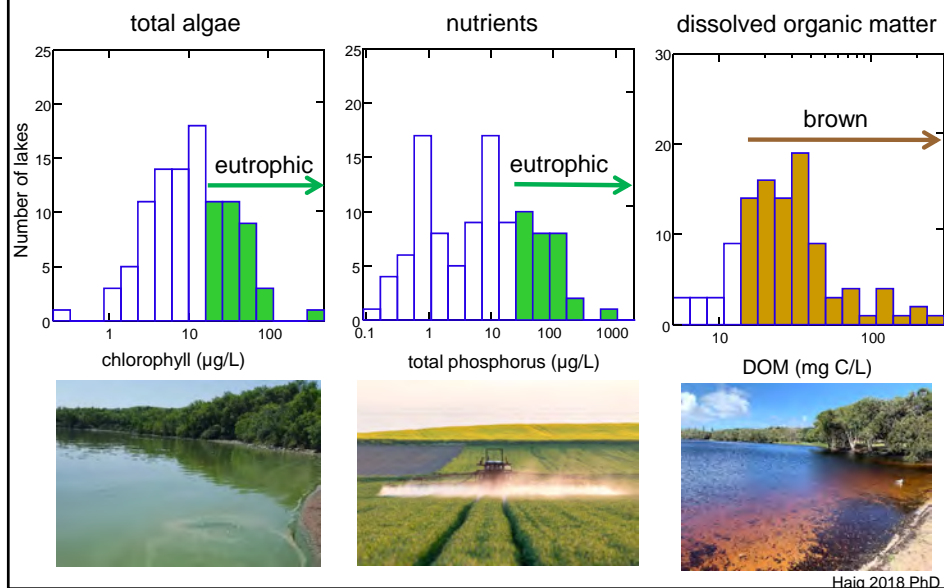




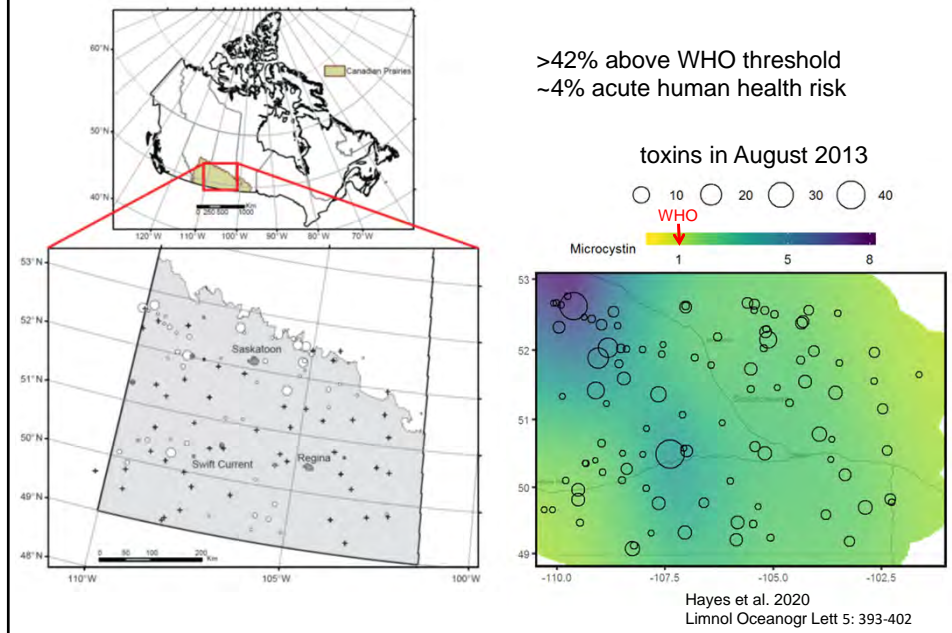
Grassland lakes have low transparency
relative to northern or eastern lakes



Low transparency is due to abundant algae, nutrients, suspended
sediments, and (possibly) dissolved organic matter



Toxic algae are present in most grasslands lakes



Outline

1

Current status of southern lakes

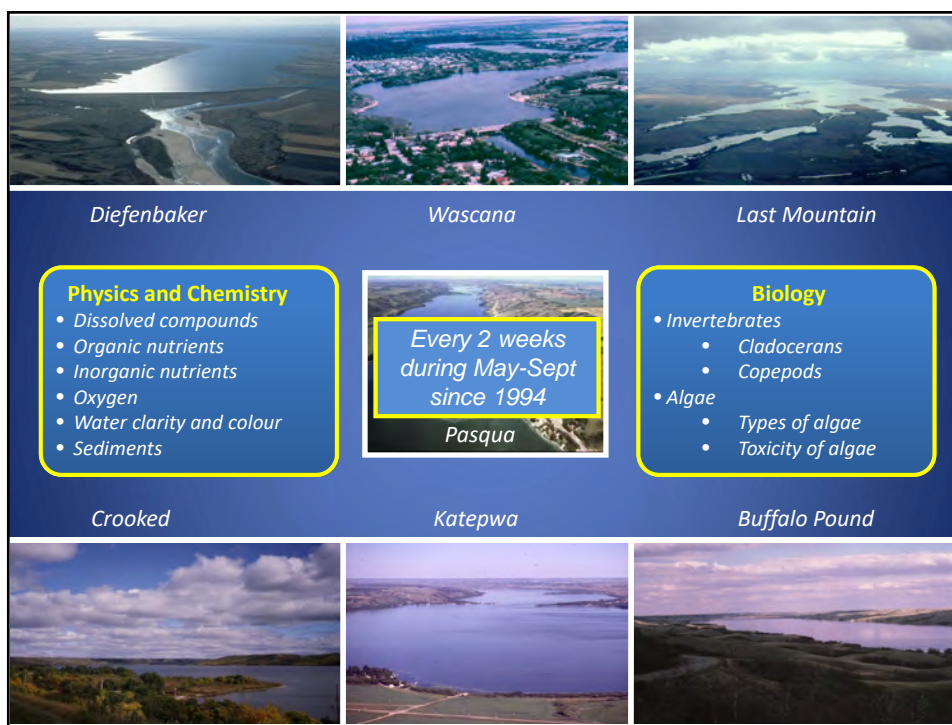
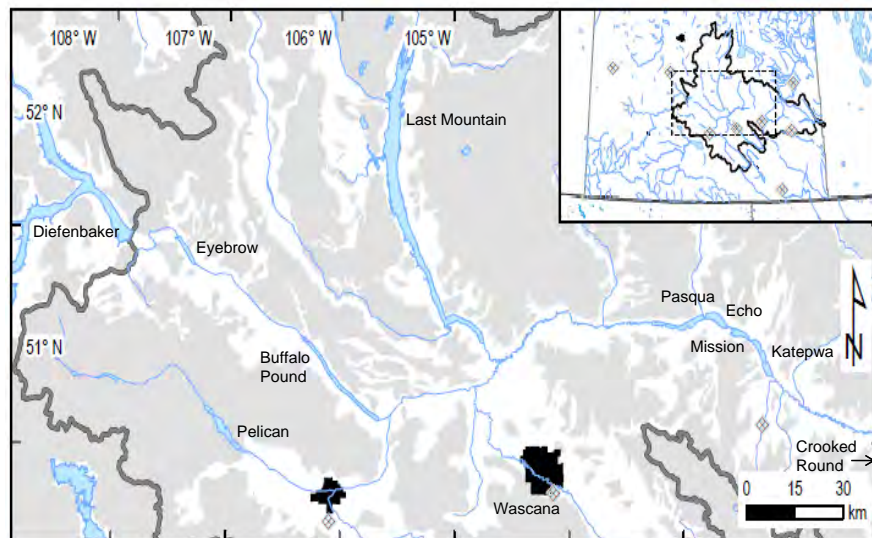
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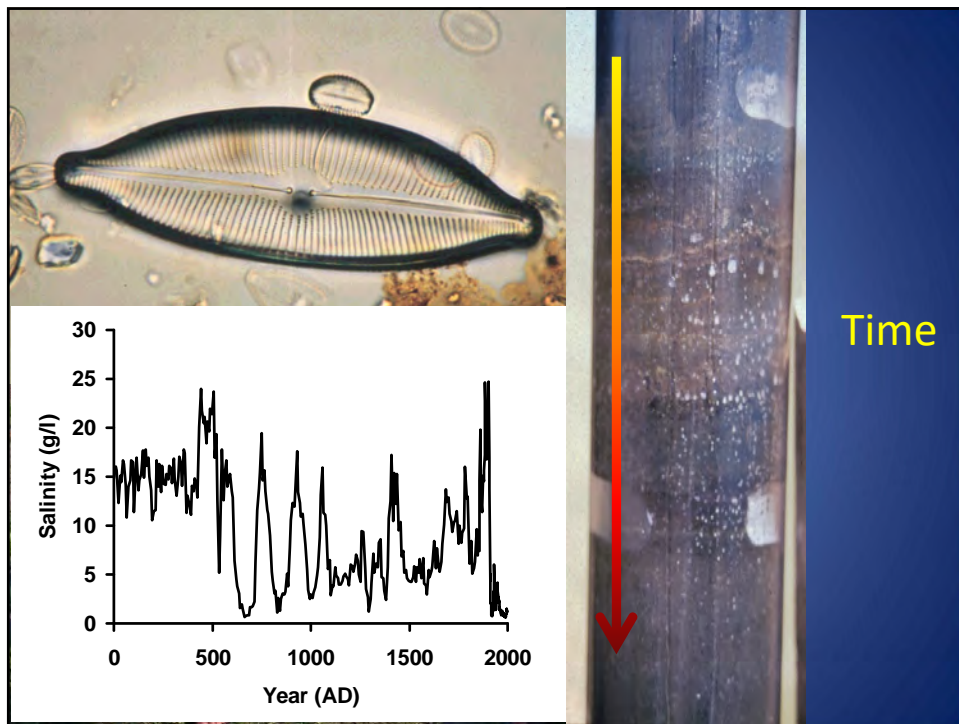
Causes of modern conditions

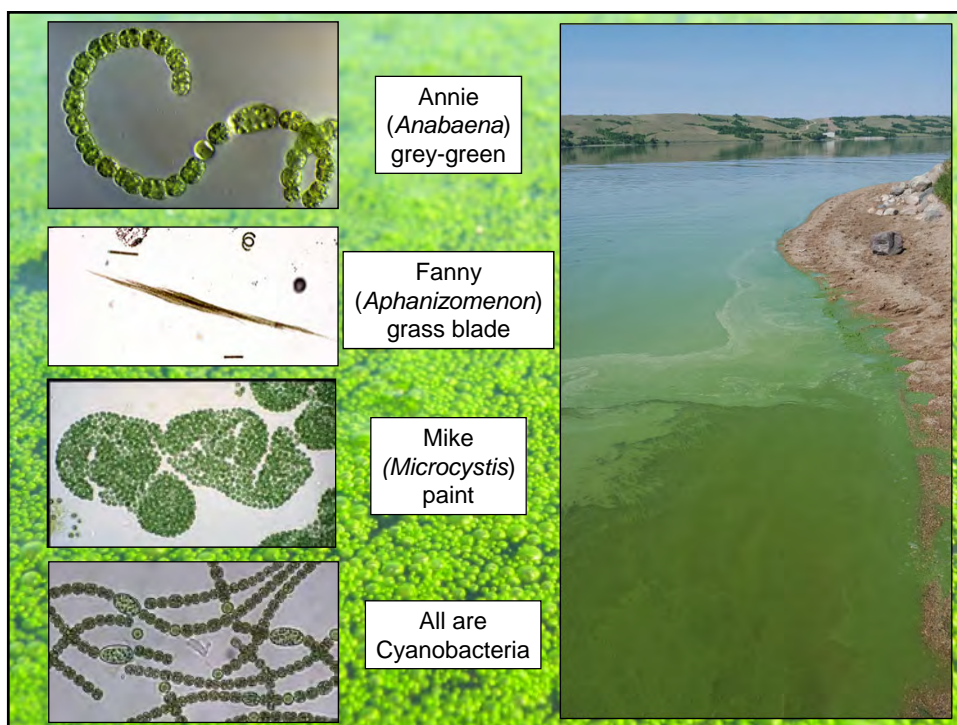
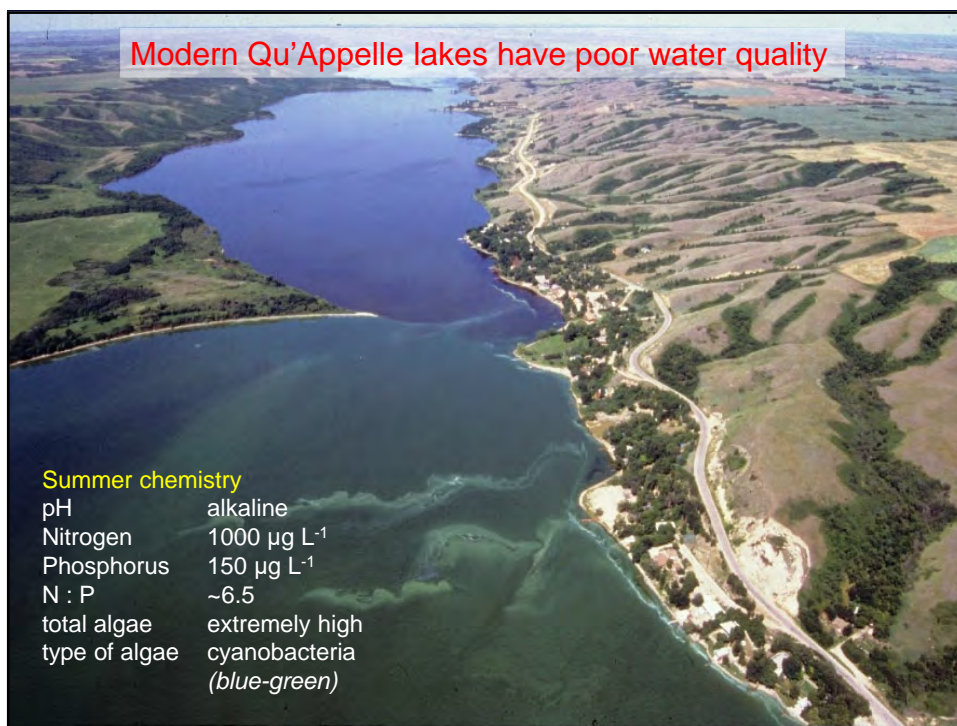
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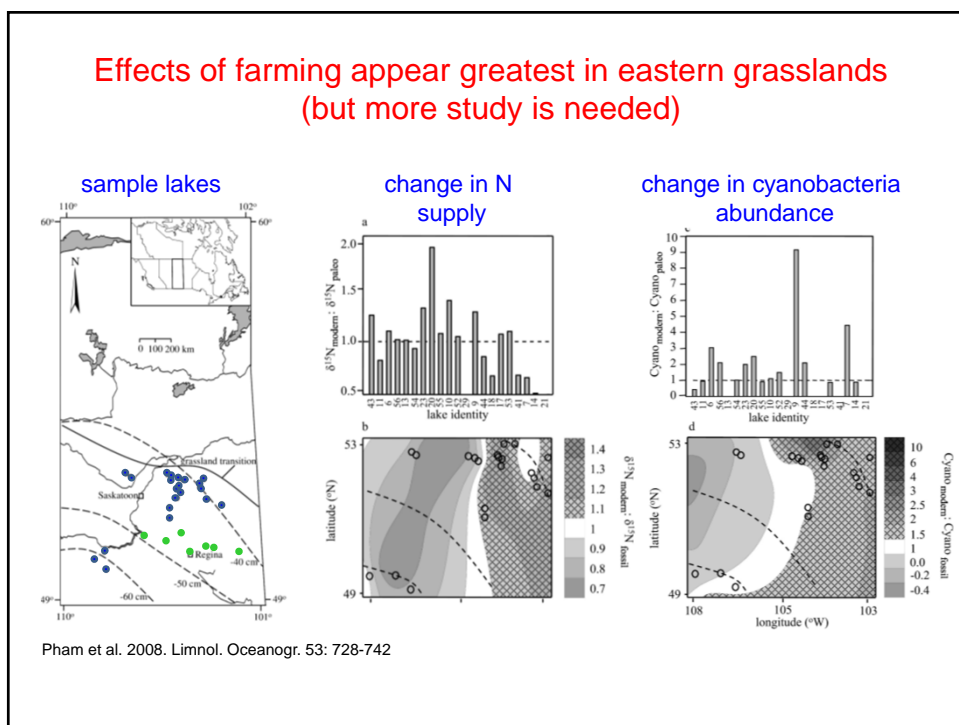
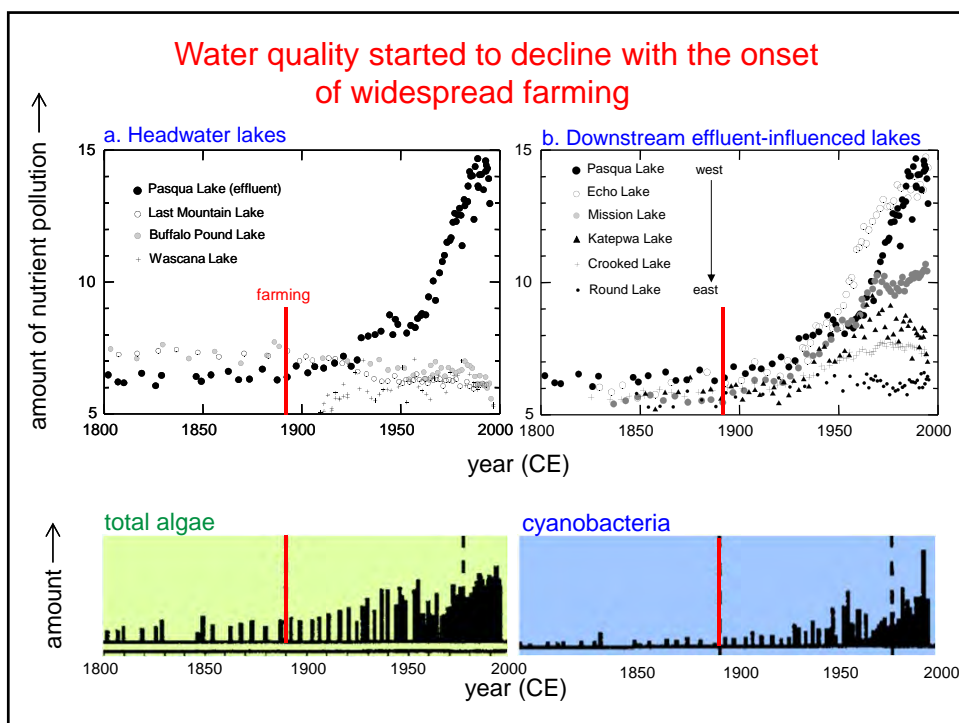
Looking forward

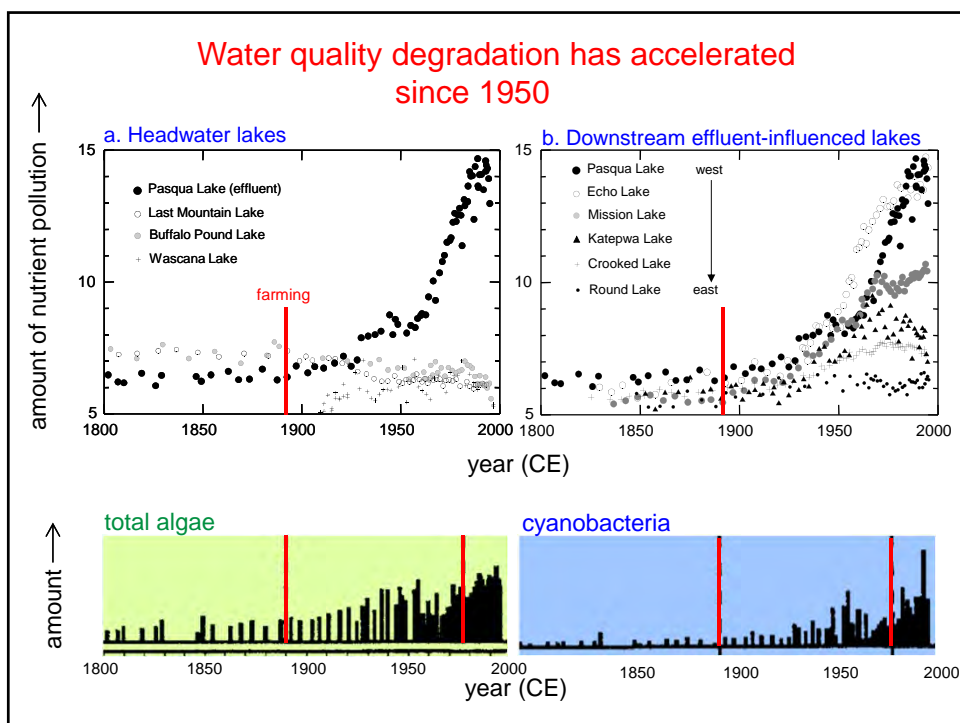
Long term research on the Qu'Appelle River system (1994-present)

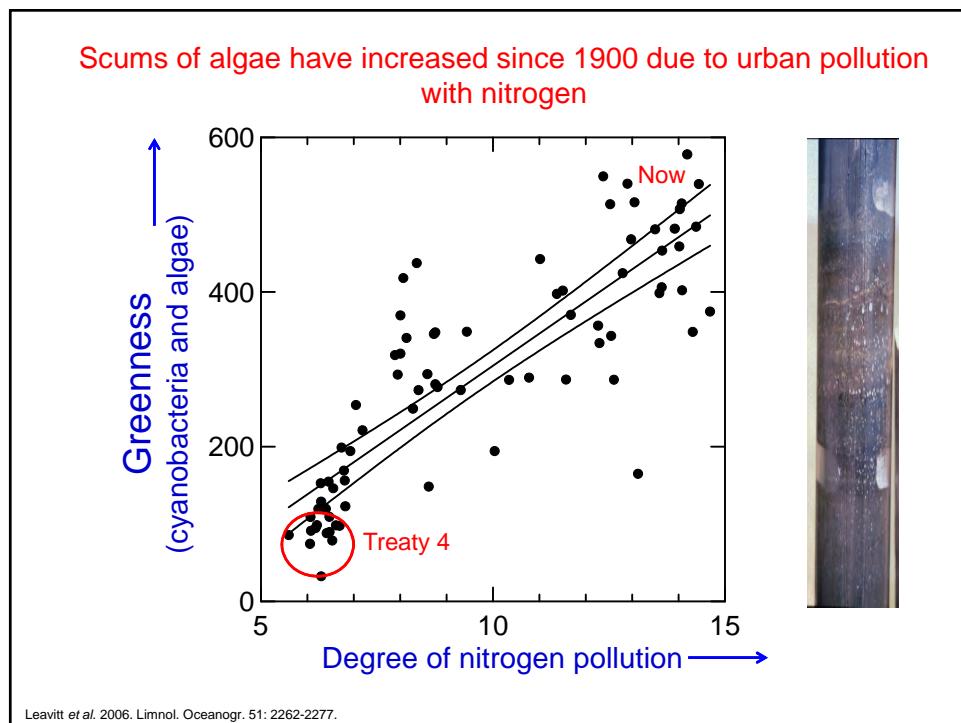
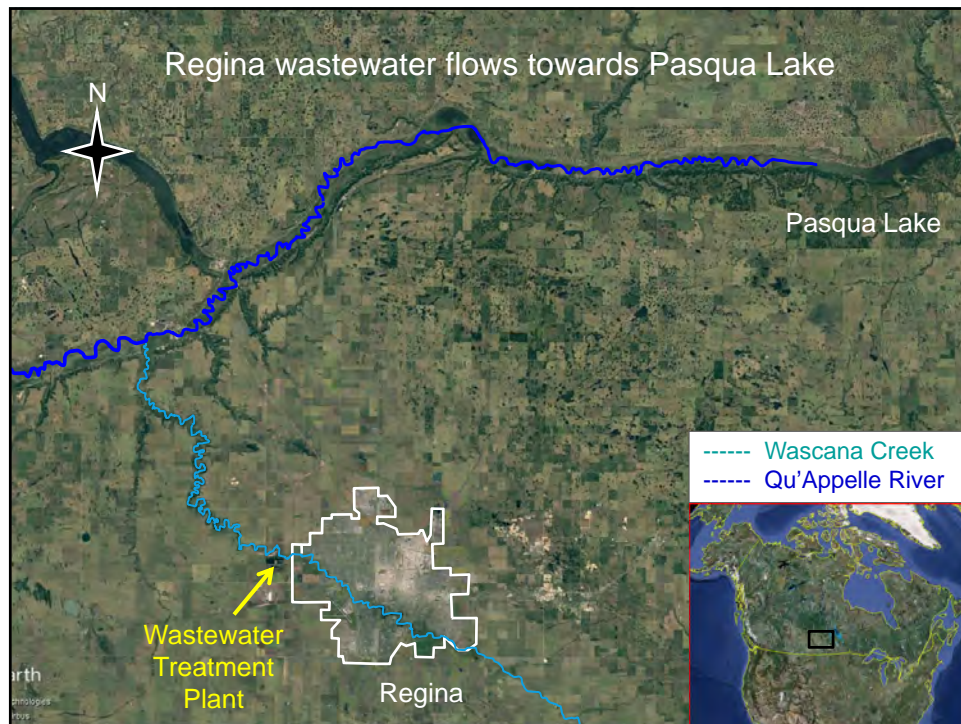




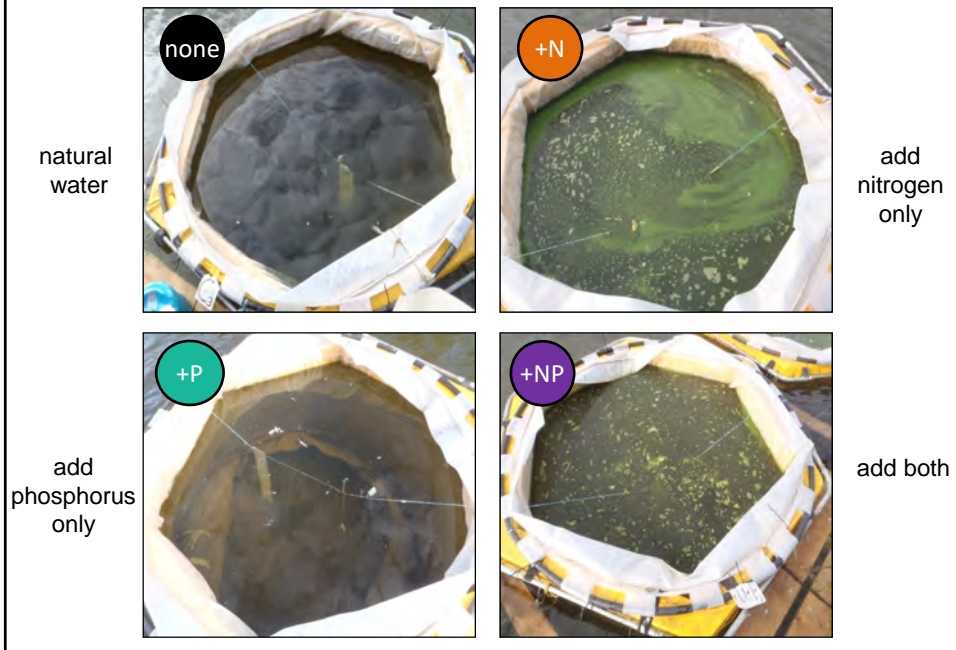








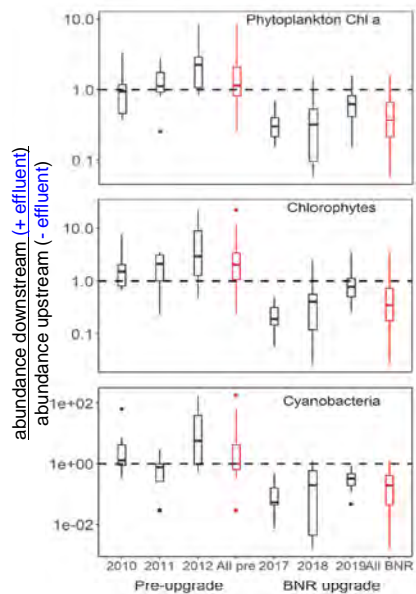
Experiments show that urban pollution degrades Qu'Appelle water



Regina's wastewater upgrade showed that removing N has improved water quality in regional streams

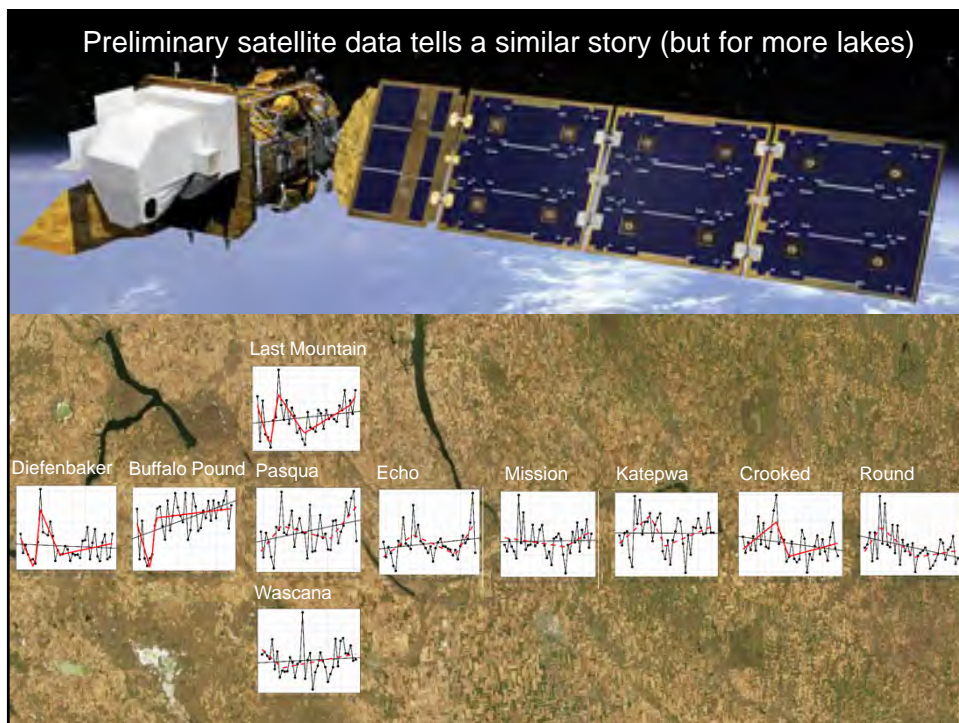
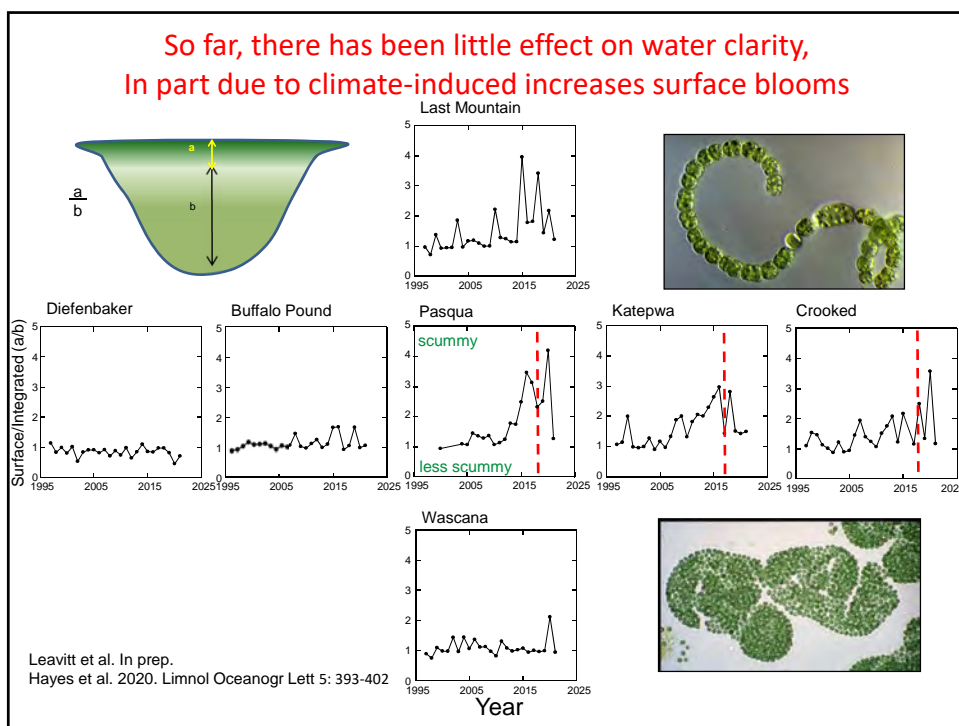


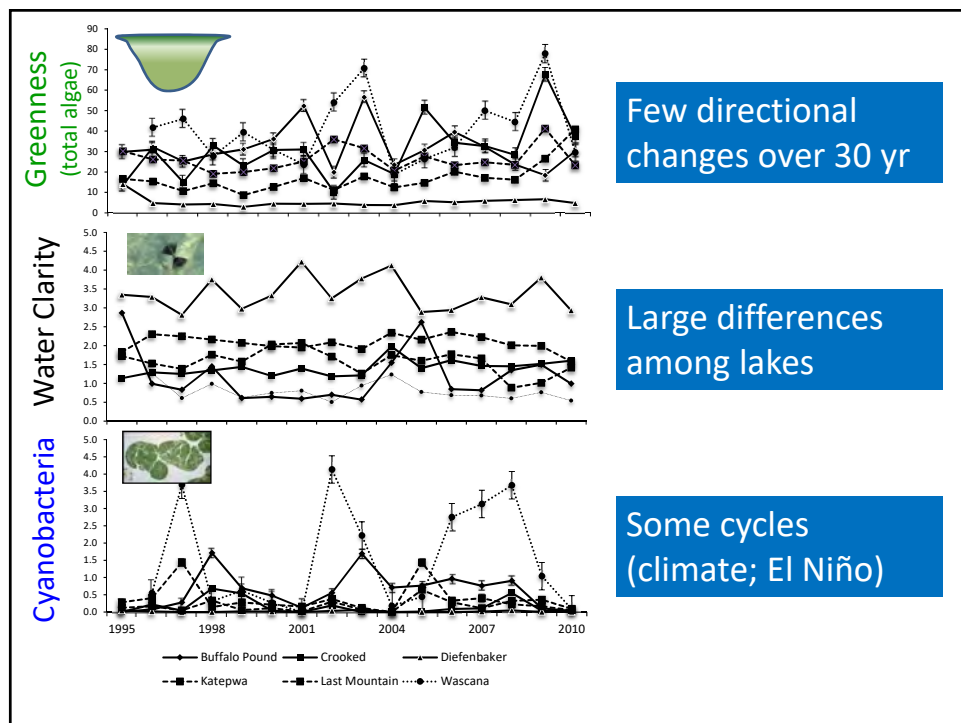
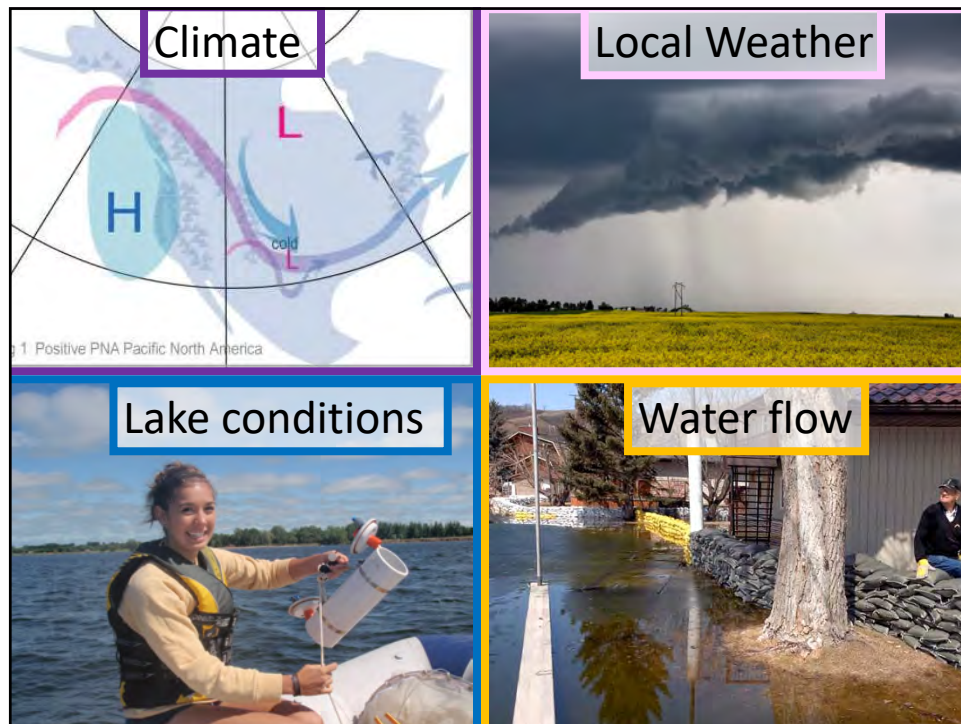
New wastewater treatment to remove N
decreased suspended algae and toxic cyanobacteria.

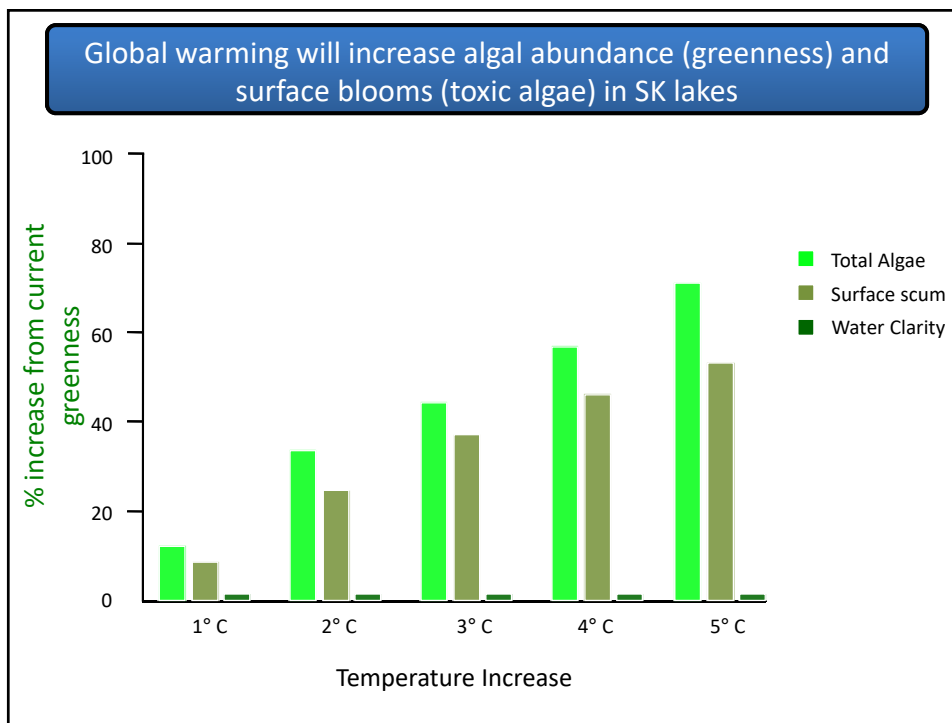
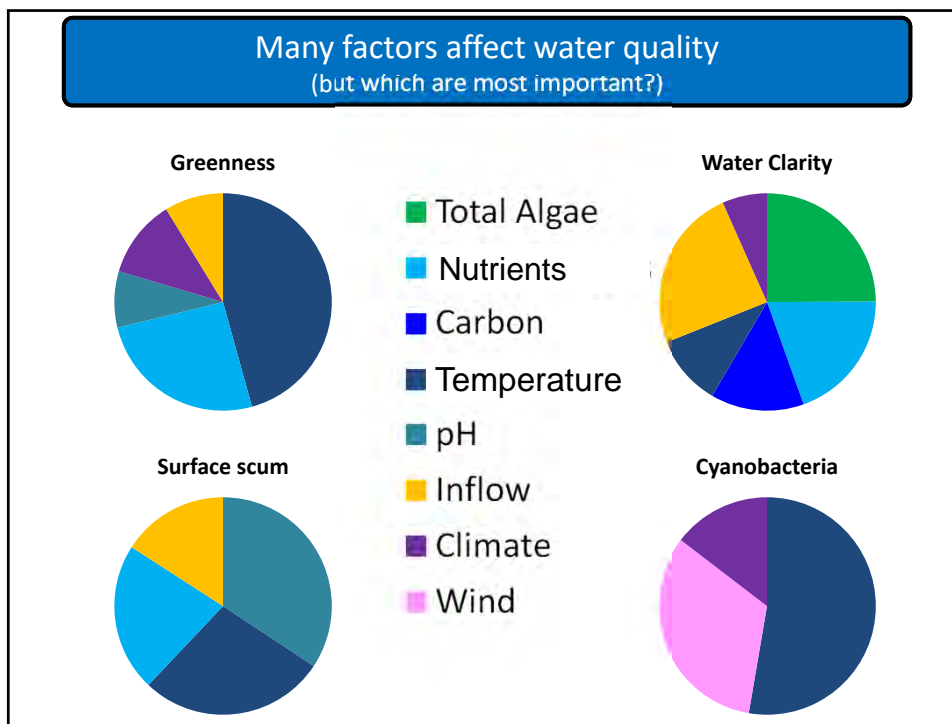


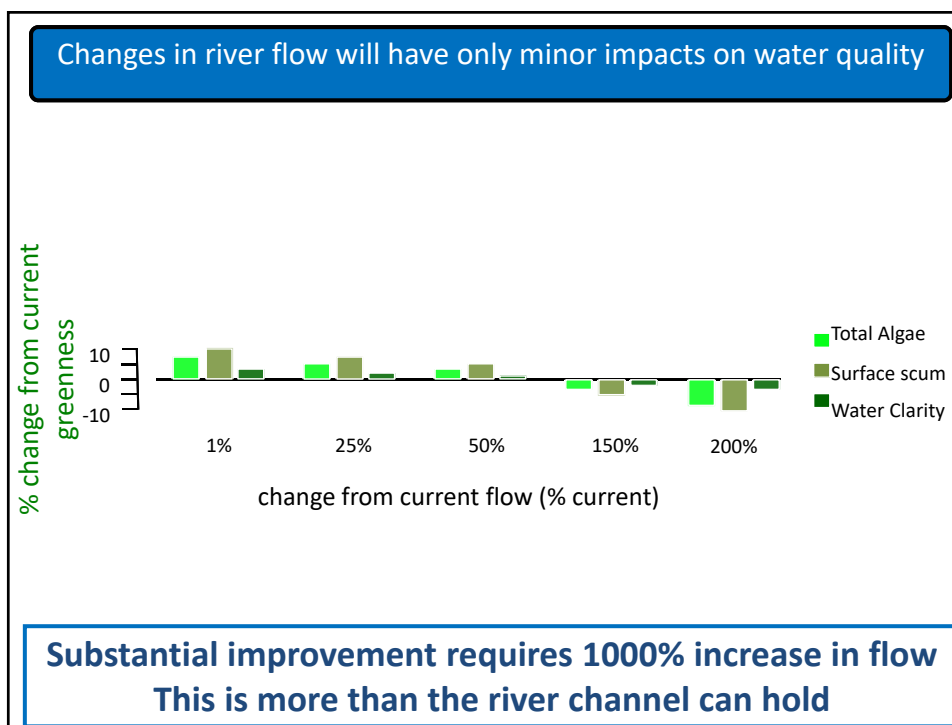
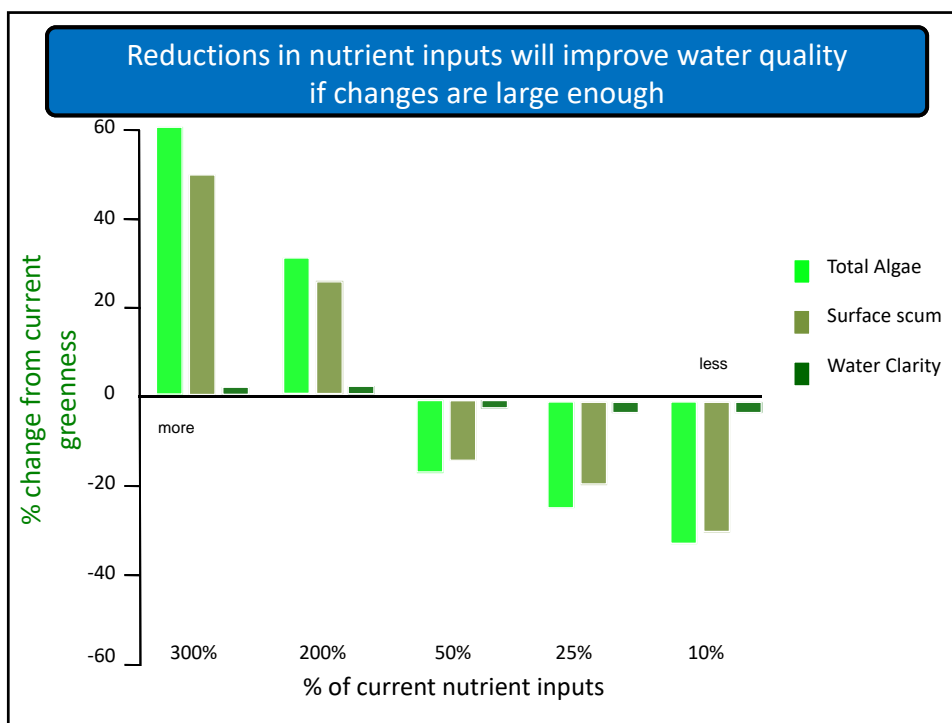
How have the lakes responded?

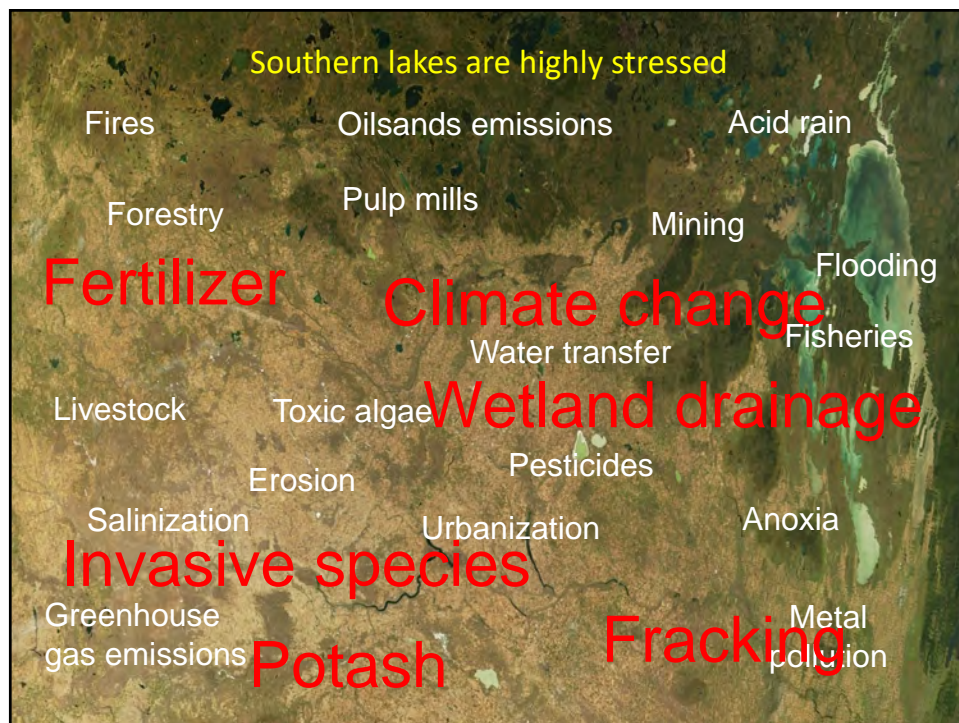
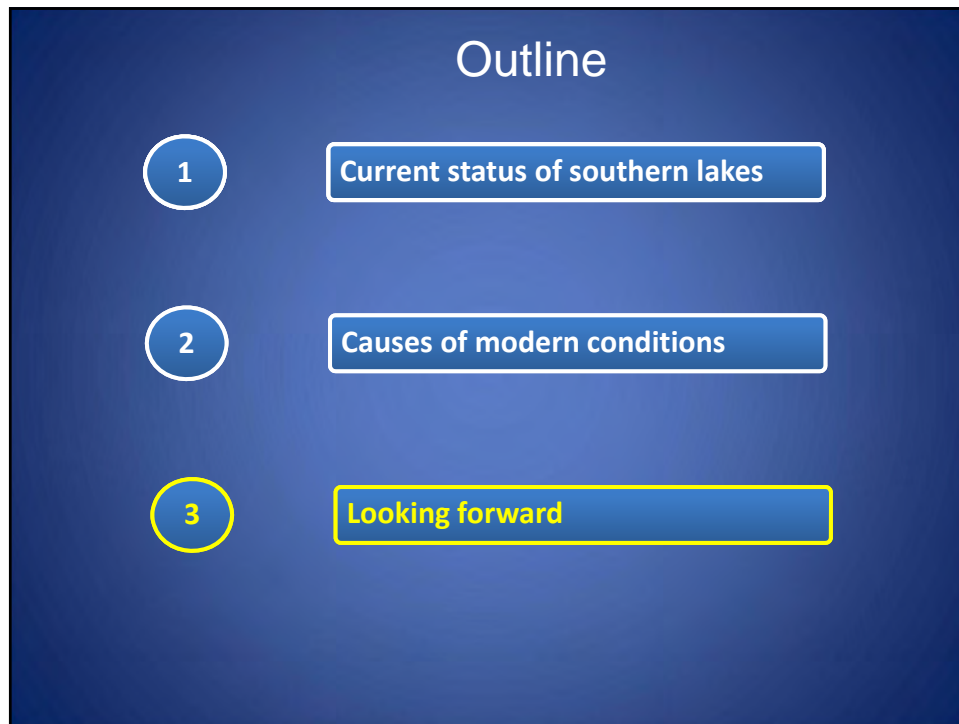












Moderate climate models predict 3-5°C increases

2021-2050 Projected Average Annual Mean Temperature

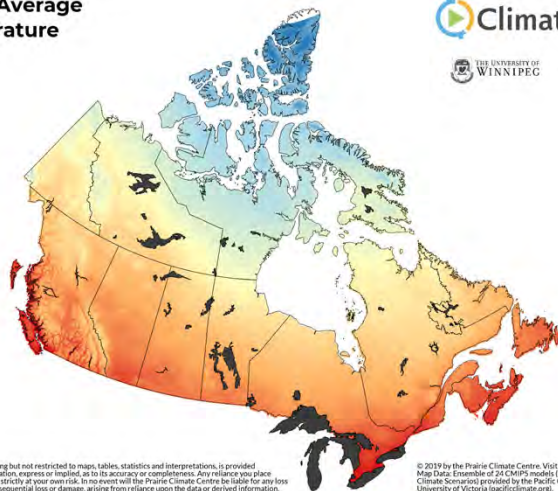
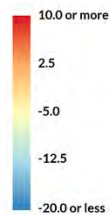
Under the RCP4.5 scenario

ClimateAtlas.ca

UNIVERSITY OF WINNIPEG

Prairie Climate Centre
Institute for the Future

Temperature (°C)



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Map Data: Ensemble of 24 CMIP5 models (BCCADv2-Statistics) downloaded Climate Scenario(s) provided by the Pacific Climate Impacts Consortium, University of Victoria (pacificclimate.org).

Canadian wheat production has doubled since 1960 but is still below potential yield

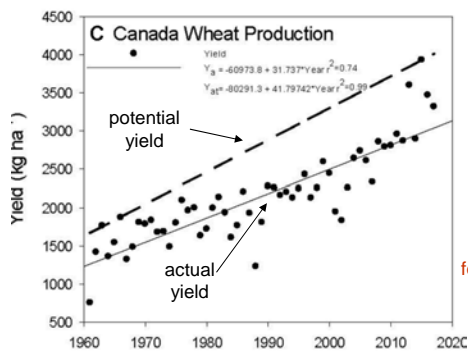
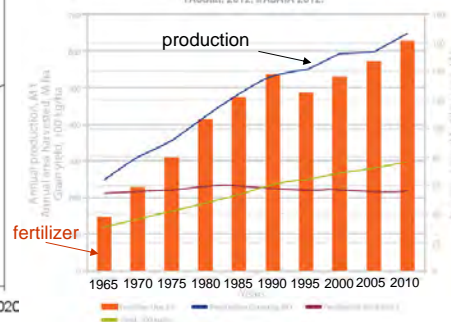
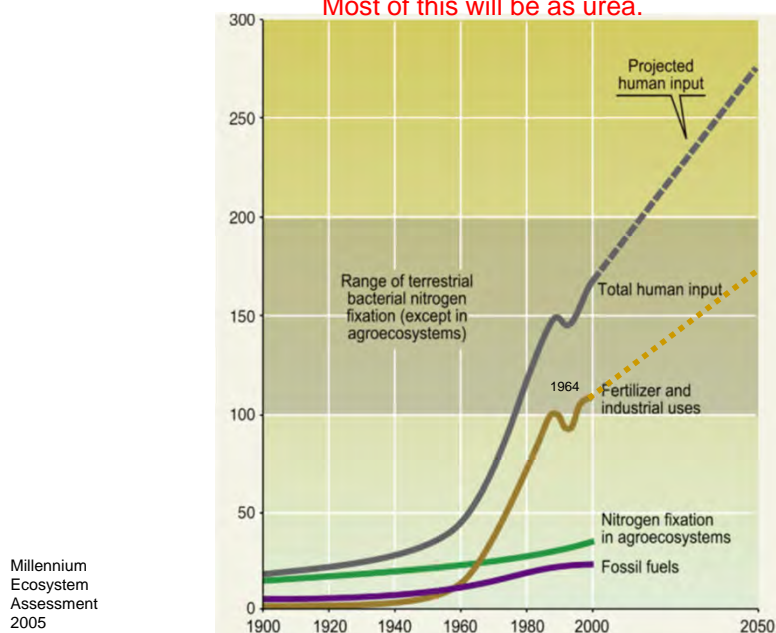


Figure 1. Global wheat production, area, yield and total fertilizer use (1961 to 2010)
FADStat, 2012, IFADATA 2012.

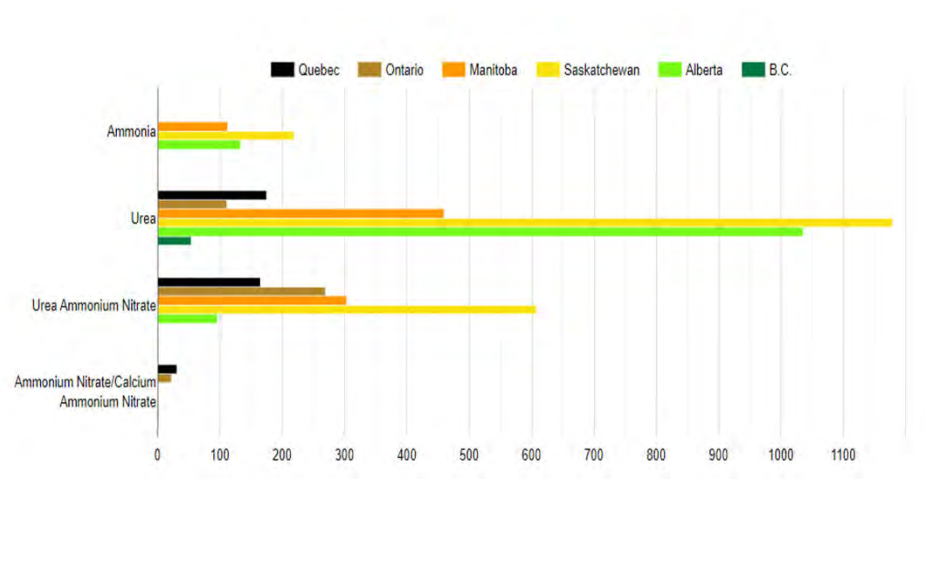


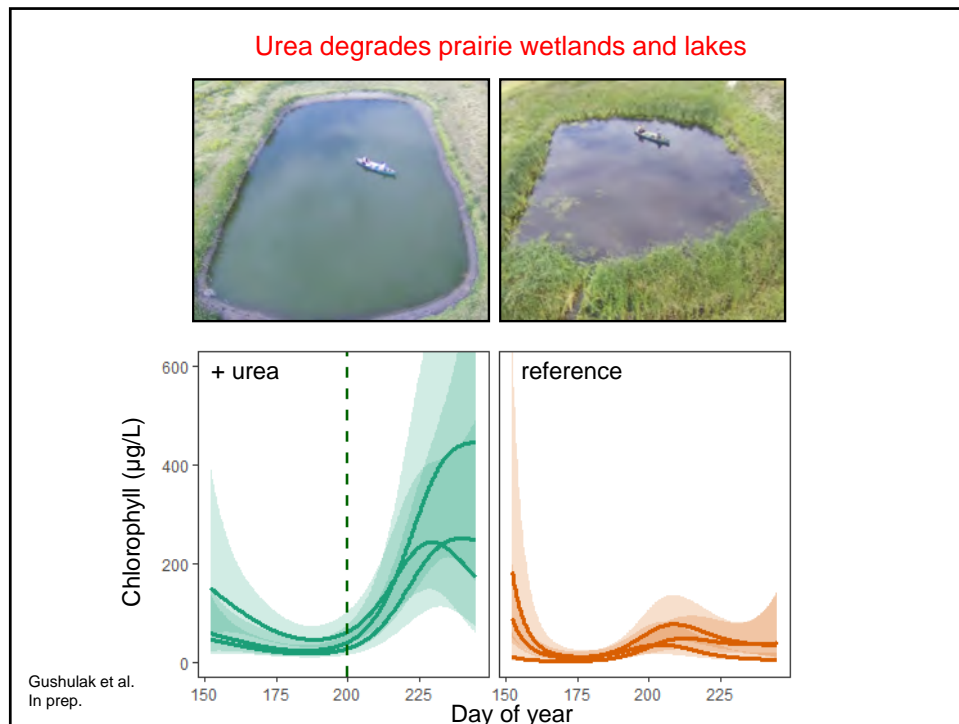
Wheat production has increased as a function of fertilizer application

Crop fertilizer application will nearly double by 2050.
Most of this will be as urea.



Urea is the main global nitrogen fertilizer,
Saskatchewan leads Canada in urea use





Proposed water management policy will likely reduce water quality

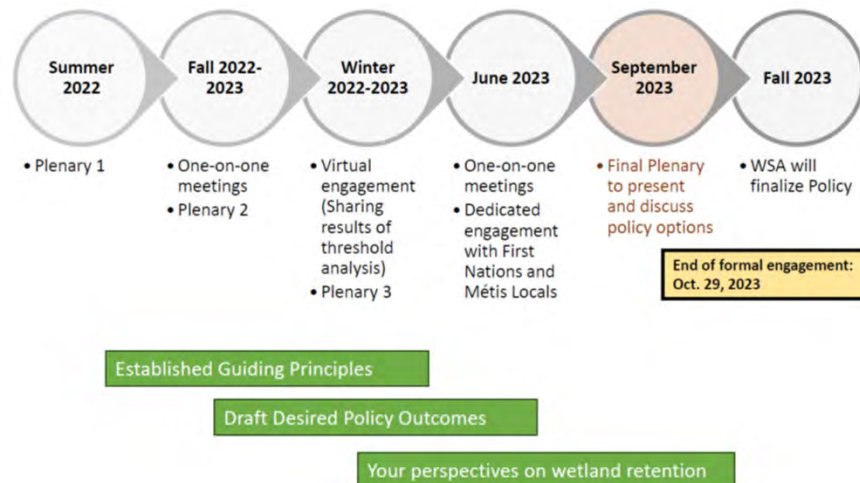
Water Security Agency

September 2023

Agricultural Water Stewardship Policy

Final Plenary

For over a year, the Water Security Agency and SK Agriculture have been developing a policy to increase wetland drainage in farmed land of Saskatchewan



3

Wetland Definition is reasonable as written but is misapplied



Adopted from the Canadian Wetland Classification System, 1997:

“Wetlands are lands that are saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation (plants that grow partly or completely in water), and various kinds of biological activity which are adapted to a wet environment.”

This includes river, lake, pothole and peatlands, as well as wetlands that typically dry up during the growing season.

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Estimates of wetlands area do not include past losses

A vast majority of wetlands in Saskatchewan's agricultural zone are undrained.

	Cumulative wetland retention by area in pothole wetlands
Counting farmed wetlands	86%
Not counting farmed wetlands	72%

Similar results are found when all wetland types are included. Partially drained wetlands are considered as drained and not counted.

Small ephemeral/temporary wetlands that are farmed through as undrained:

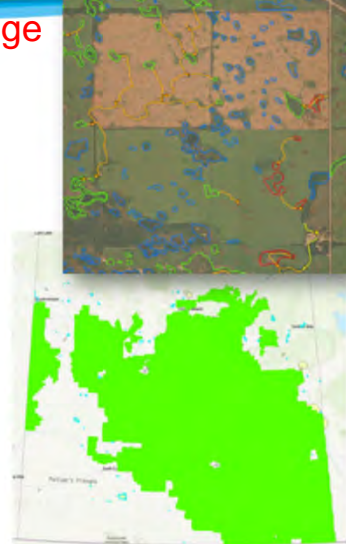
- Provide temporary water storage during spring, thereby addressing downstream flooding.
- By not draining, water quality impacts are mostly managed. Water quality impact is mainly driven by volume (nutrient exported downstream from drainage are mostly in dissolved form).

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Estimates of wetlands area do not include effects of climate change

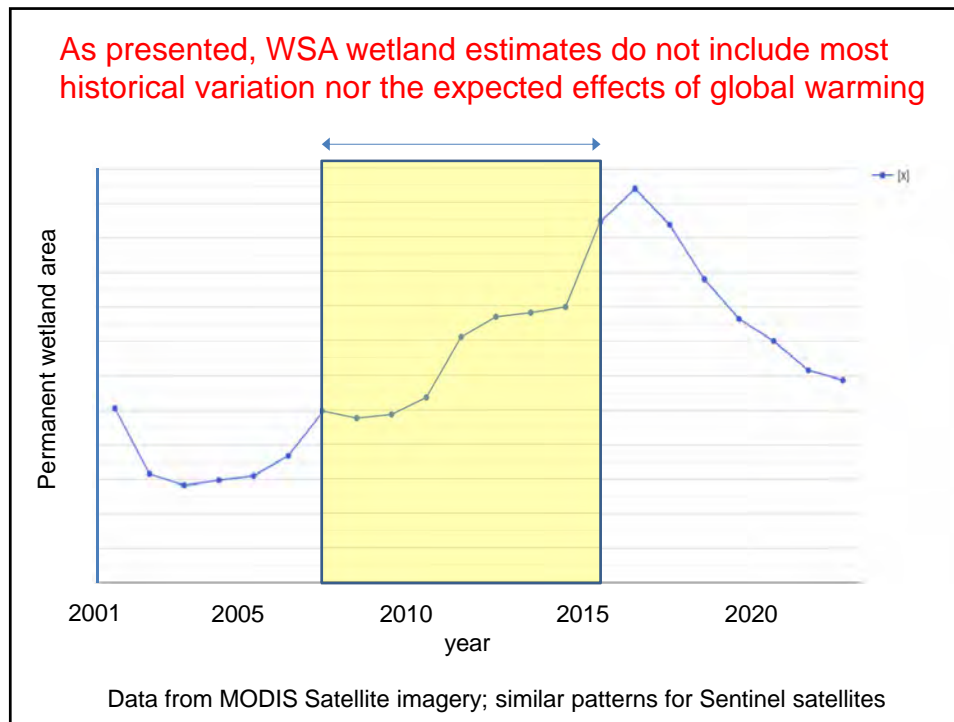
WSA's wetland inventory

- WSA and partners have mapped all wetlands on **47 M acres of agricultural land** in Saskatchewan's agricultural zone.
 - **4.6 M acres of wetlands** (~10% of total land base inventoried)
- The wetland inventory delineates drainage works, as well as intact and lost wetlands. Imagery is from 2007-2015 but allowed WSA to quantify historical wetland loss.
- Emerging new technology (e.g., Artificial Intelligence) will result in more robust data.



Wetland inventory coverage

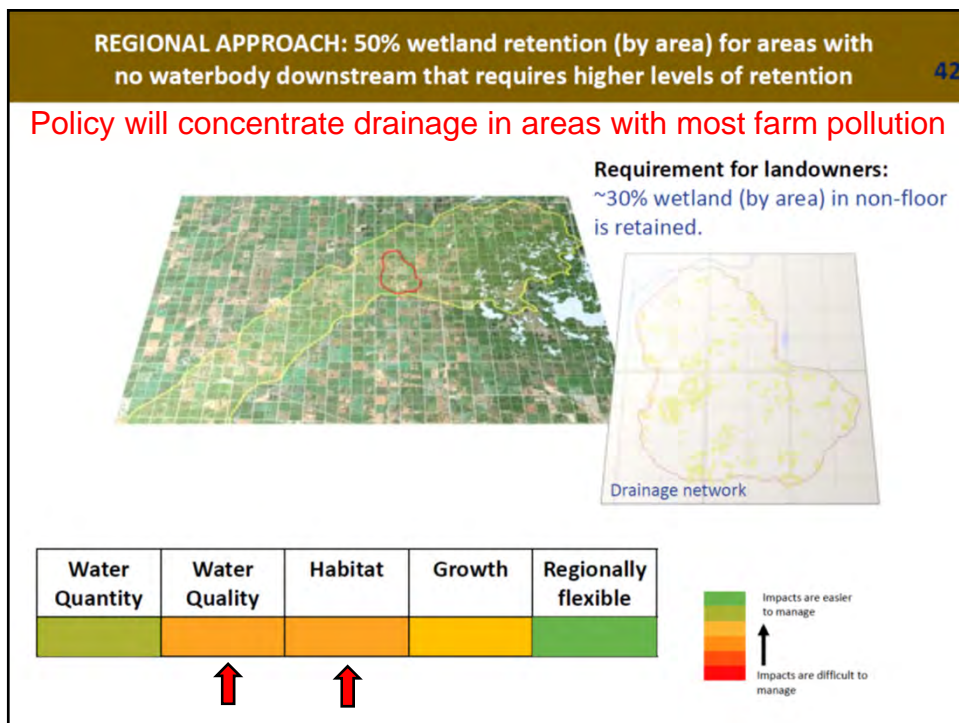
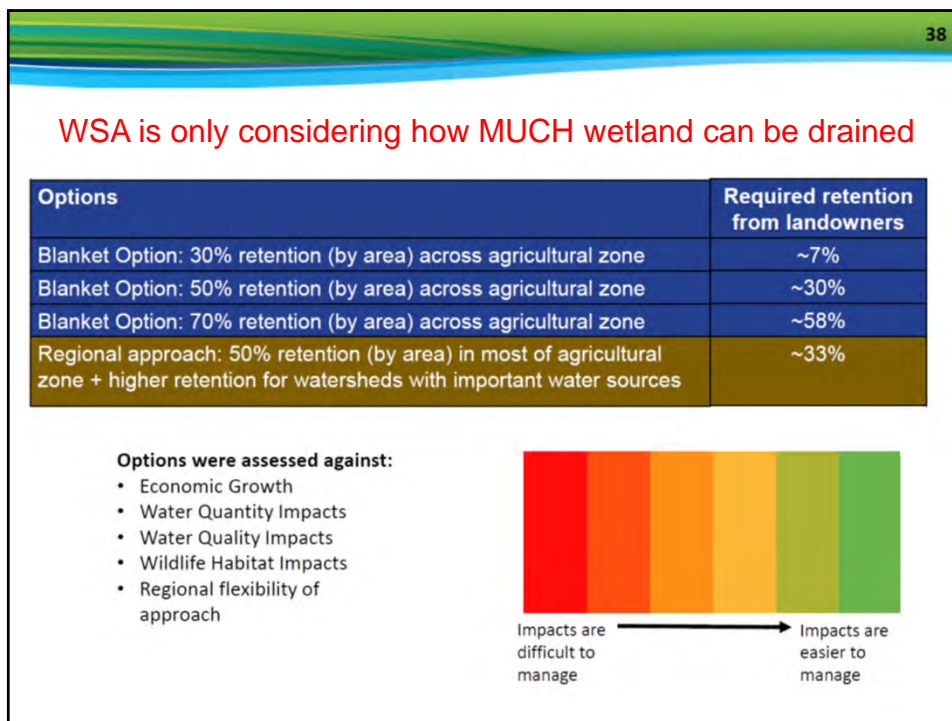
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WSA eliminated “no net loss” option with no discussion and using misleading pretenses

Policy option	Economic Growth from additional drainage	Protects infrastructure, water quality and habitat	Reflects regional variation
No net loss (no further drainage)	✗	✓	✗
Blanket retention of a certain percentage of wetlands	✓	✓	✗
A regional approach: Retention of certain percentage of wetlands that varies what is needed by region	✓	✓	✓



The only “protected” areas will be those unusable for farming

Wetlands that are unlikely to be drained: “The Floor”



- Protected areas within the inventoried area (for example, Provincial Parks, Recreation sites, Crown conservation easements, WHPA lands)
- Ag Capability Class 6, 7 Land (e.g., unfarmable sides of valleys)
- Organic Soils (peatlands)
- Community pastures
- Slope classes 5, 6, 7 (very steep e.g., Allan Hills)

In previous presentations, the floor was estimated at 19% (wetlands by area).

Including community pastures and very steep areas increased the floor to 29% (wetlands by area).

Water runs downhill – drainage will carry nutrients and pollutants to rivers and lakes



Conclusions

1. Saskatchewan prairie lakes exhibit high levels of water stress, pH, salinity, nutrient content, algae, and toxic cyanobacteria.
2. Cultivation increased lake production and cyanobacterial abundance. Urban and agricultural pollution with nitrogen accelerated water quality loss, especially since ~1950.
3. Climate warming degrades water quality by favouring cyanobacterial blooms. Future warming alone may double cyanobacterial abundance.
4. Climate warming and agricultural fertilization will combine to degrade water quality (400% more cyanobacteria)
5. Proposed Saskatchewan drainage policy will likely damage most permanent water bodies in the grasslands

Acknowledgements

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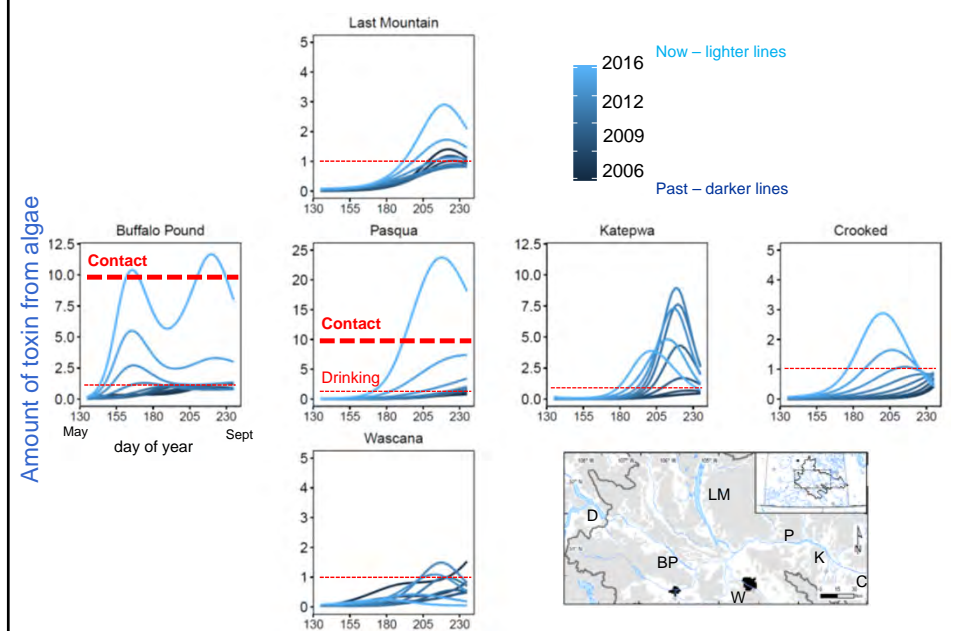
Personnel: Zoraida Quiñones-Rivera, Vincent Ignatiuk, Martin Callahan, Samantha Pham, Nicole Knezacek, Mark Graham, Curtis Brock, Jeff Hovdebo, Chris Teichreb, Tyler Cobb, Laura Ambrose, Daren Sherbot, Kim Cuddington, Deirdre Bateson, all our students, post-docs and collaborators.

Data: Environment Canada, Saskatchewan Watershed Authority, Saskatchewan Environment, SaskWater Corporation, City of Regina, Wascana Centre Authority, Saskatchewan Water Security Agency.

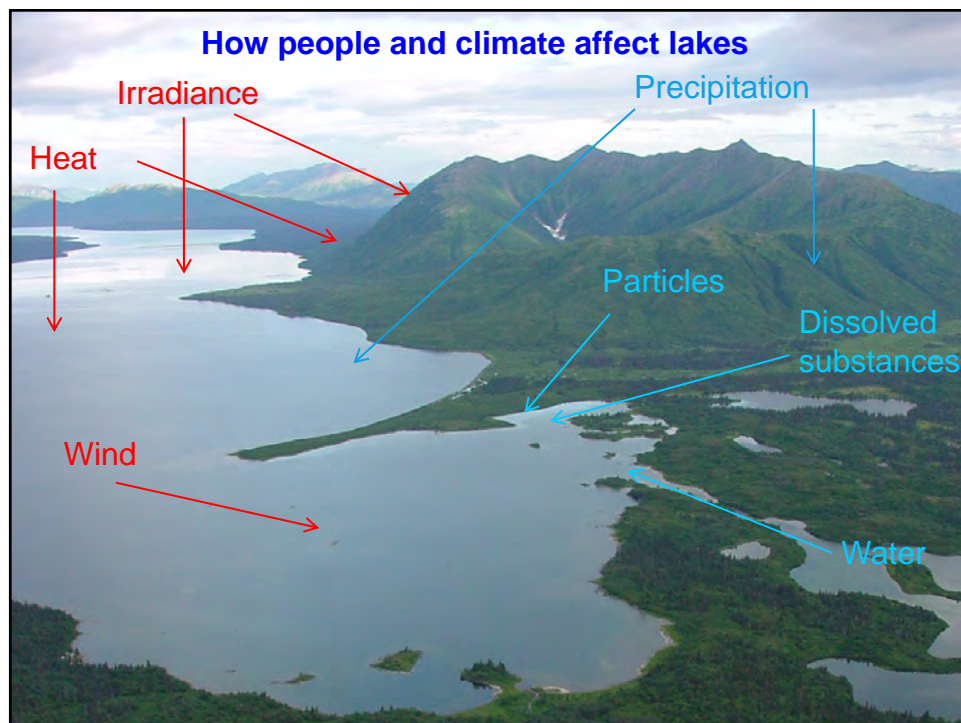
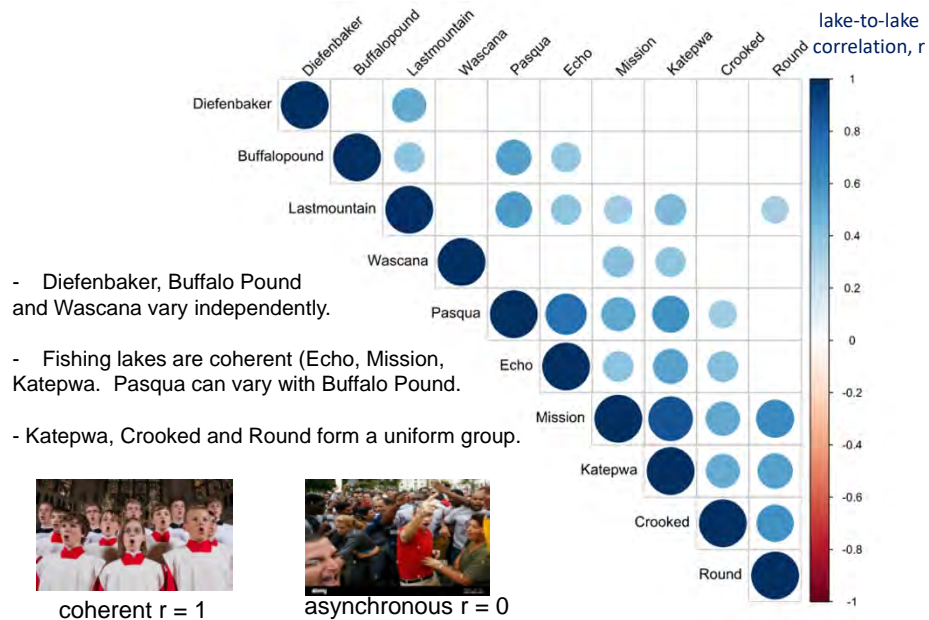
Photo: G. McCullough



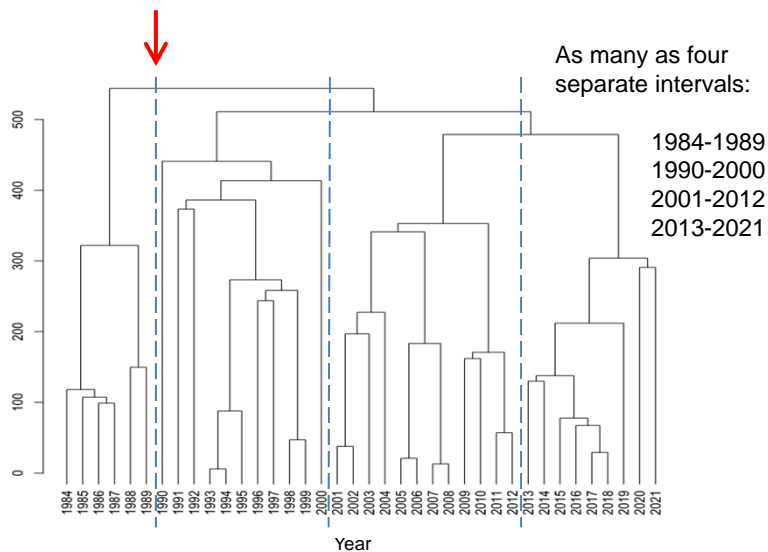
Toxic cyanobacteria blooms have been getting worse in past 30 years



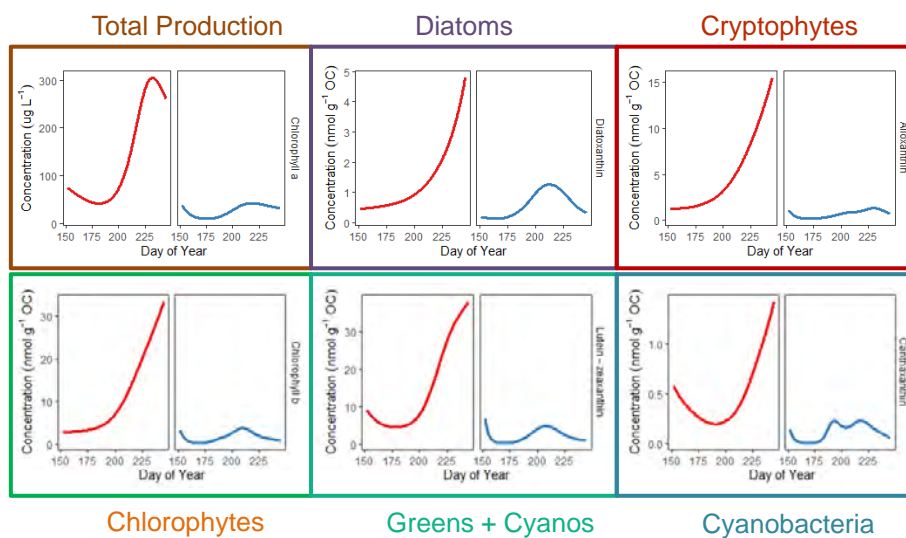
Synchrony among lakes varies with geographic position



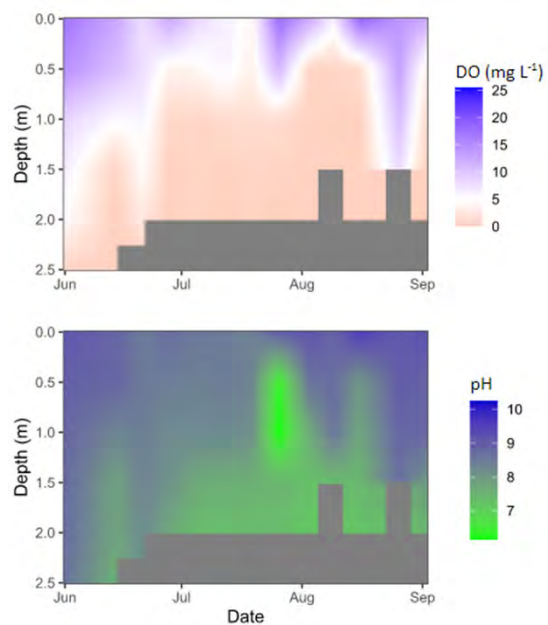
Preliminary satellite image analysis suggests that there was sudden change in the Qu'Appelle River system ca. 1990



Urea promotes growth of all algae and cyanobacteria



Excess production reduces deepwater oxygen



Gushulak et al.
In prep.