

Current state of salinity and salinization in Manitoban surface waters



by

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Introduction

- ▶ The salinity (dissolved salt content) of inland surface waters is driven by several natural processes
 - ▶ Weathering of rocks
 - ▶ Rainfall
 - ▶ Aerosol deposition
 - ▶ Seawater intrusion
- ▶ Anthropogenic stressors may be responsible for accelerating the rate of freshwater salinization
 - ▶ Agriculture
 - ▶ Resource extraction
 - ▶ Construction activities
 - ▶ Wastewater
 - ▶ Road de-icing

Introduction

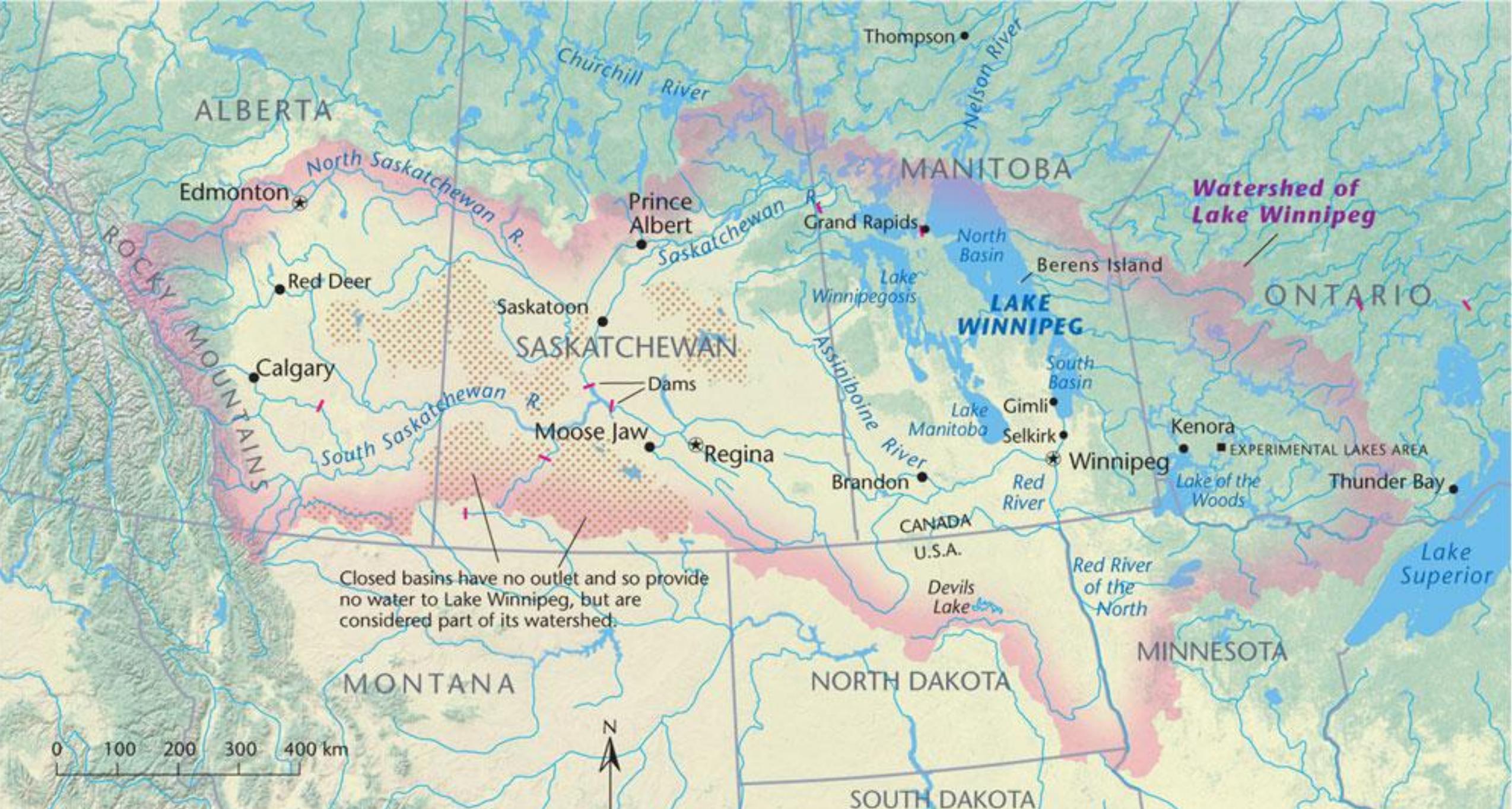
- ▶ Any changes in land cover may expose bedrock materials at the surface to chemical weathering, which can result in the increased transportation of ions to surface waters
- ▶ Land clearing may also cause naturally saline groundwaters to enter surrounding surface waters
- ▶ Agricultural practices can produce highly saline irrigation return flows that enter freshwater ecosystems
- ▶ In addition, wastewater treatment facilities contribute saline waters to freshwater ecosystems



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Introduction

- Road salts are used as de-icing chemicals in winter months to provide safer conditions for drivers
- Large quantities (~4.9 million tonnes) of road salts are released onto Canadian roadways annually
- Snowmelt and rainfall events allow for salts to enter the surrounding aquatic ecosystems
- The primary drivers of freshwater salinization at large spatial scales are, however, not fully understood



Closed basins have no outlet and so provide no water to Lake Winnipeg, but are considered part of its watershed.

The Lake Winnipeg Watershed. (Map: Steven Fick/Canadian Geographic)

Introduction

- ▶ Increasing ion concentrations from salts could pose a risk to freshwater organisms, as they often rely on osmotic pressure to maintain cellular stability
- ▶ Freshwater salinization may adversely affect the fitness and survival of aquatic organisms
 - ▶ Increased uptake of ions
 - ▶ Loss of pH regulation
 - ▶ Increased energy demand
 - ▶ Reduced growth rates
 - ▶ Developmental delays
- ▶ Impacts in organisms with high sensitivity to osmotic stress, may indirectly affect the structure and function of the ecosystem by altering trophic interactions

Introduction

- Salinity is a conservative tracer, as it correlates with runoff, and it may help us to understand where the hotspots are and where there are vulnerabilities of the landscape
- Elevated concentrations of Cl can reduce water quality
- Inputs of Cl and other ions can alter nutrient cycling in soils and stream sediments, resulting in the increased release of nutrients
- Inflows of saline waters may reduce the seasonal mixing of lakes and ponds, which can alter biogeochemical cycles

LWF

LAKE WINNIPEG FOUNDATION

- ▶ LWF is an ENGO advocating for change and coordinating action to improve the health of Lake Winnipeg
- ▶ LWF works collaboratively with non-profit, academic, industry, and government sectors, along with the public to restore and protect our great lake
- ▶ The Lake Winnipeg Community-Based Monitoring Network mobilizes citizens to collect water samples across Manitoba



Purpose

- ▶ We are interested in looking at the current state of salinity in the surface waters of Manitoba, as evaluated through the lens of a community-based monitoring program
- ▶ This project shall hopefully benefit local communities by providing data that is useful for ecological risk assessment

Hypotheses

- ▶ We have a number of preliminary hypotheses at this time:
 1. Waterways close to roads with significant road salt use will be associated with greater salinity than those that are not
 2. Spring run-off events will see the greatest concentrations of salt inputs to surface water systems

Objectives

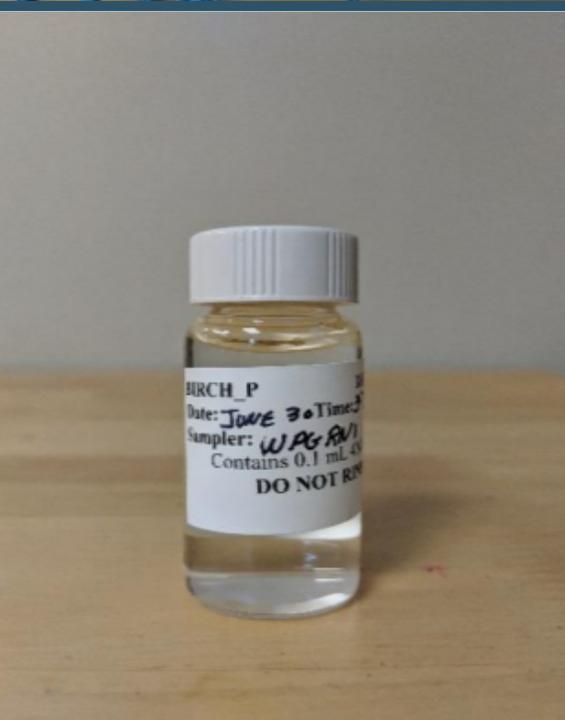
- ▶ **General Objective:** Determine the current state of salinity and salinization of Manitoban surface waters
 - ▶ **Specific Objectives:**
 1. Determine the possible sources and drivers of salinity in the Lake Winnipeg watershed, along with any temporal patterns that might be observed
 2. Perform a strength of methods assessment for freshwater salinity toxicity data
 3. Create a species sensitivity distribution for an ecological risk assessment of the data gathered

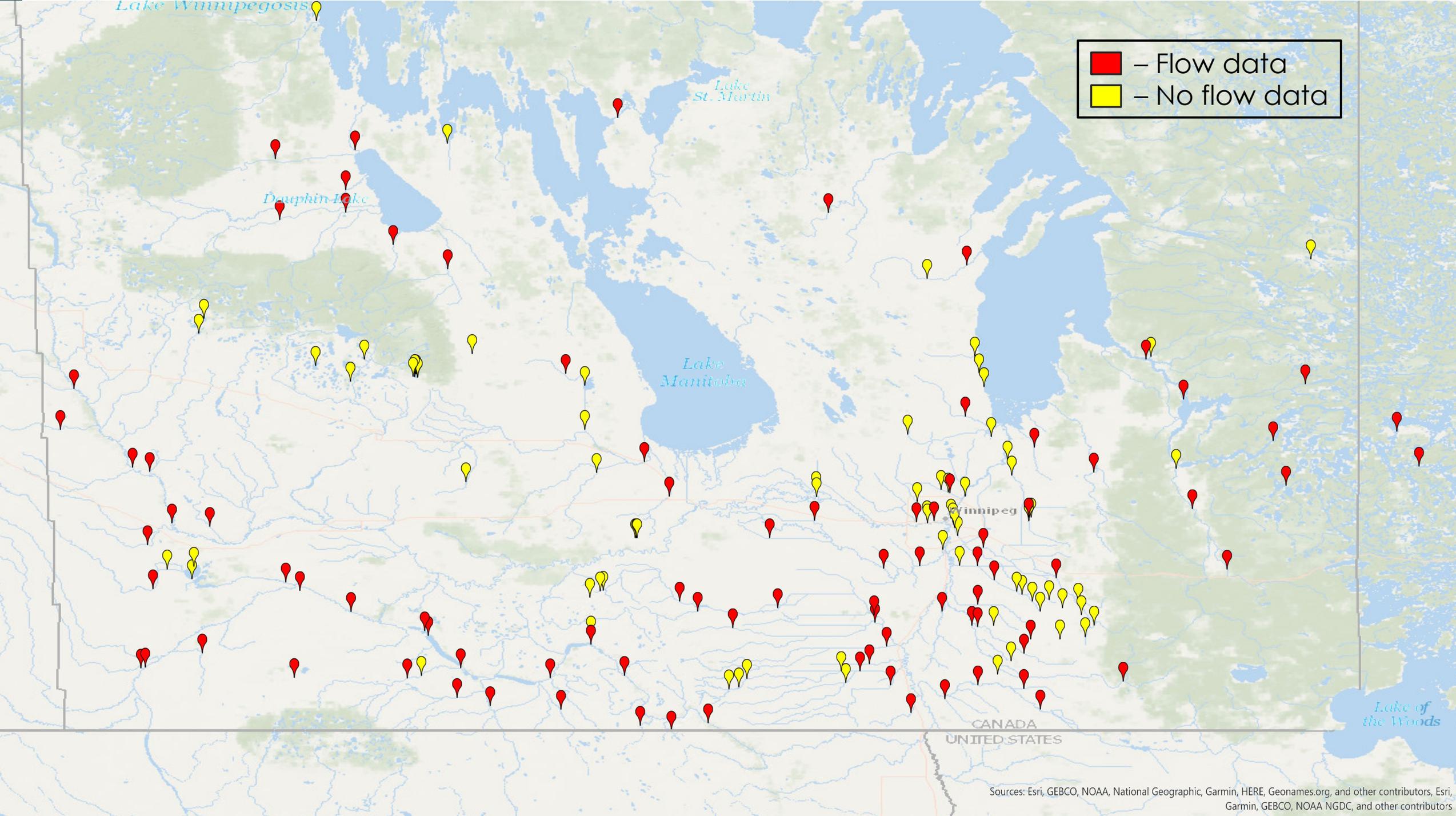
Methods

- ▶ We will be collaborating with the Lake Winnipeg Foundation's nutrient program to engage their network of volunteers in collecting water samples over the course of two field seasons (2020 and 2021)
- ▶ Samples will be analyzed in our lab for salinity, and with collaborators for major ions (e.g., Na, Cl, K, Ca)

Methods

- ▶ Volunteers will collect integrated water samples by using a weighted sampler with a 500 mL collection bottle
- ▶ 20 mL glass sample vial will be collected and used for analysis
- ▶ Field blanks
- ▶ Benchtop meter will measure salinity (0.01 PSU), specific conductivity (0.001 $\mu\text{S}/\text{cm}$), TDS (0.001 ppm), temperature (0.1°C), and pH (0.001)
- ▶ Ion chromatography will be used to measure major ion concentrations



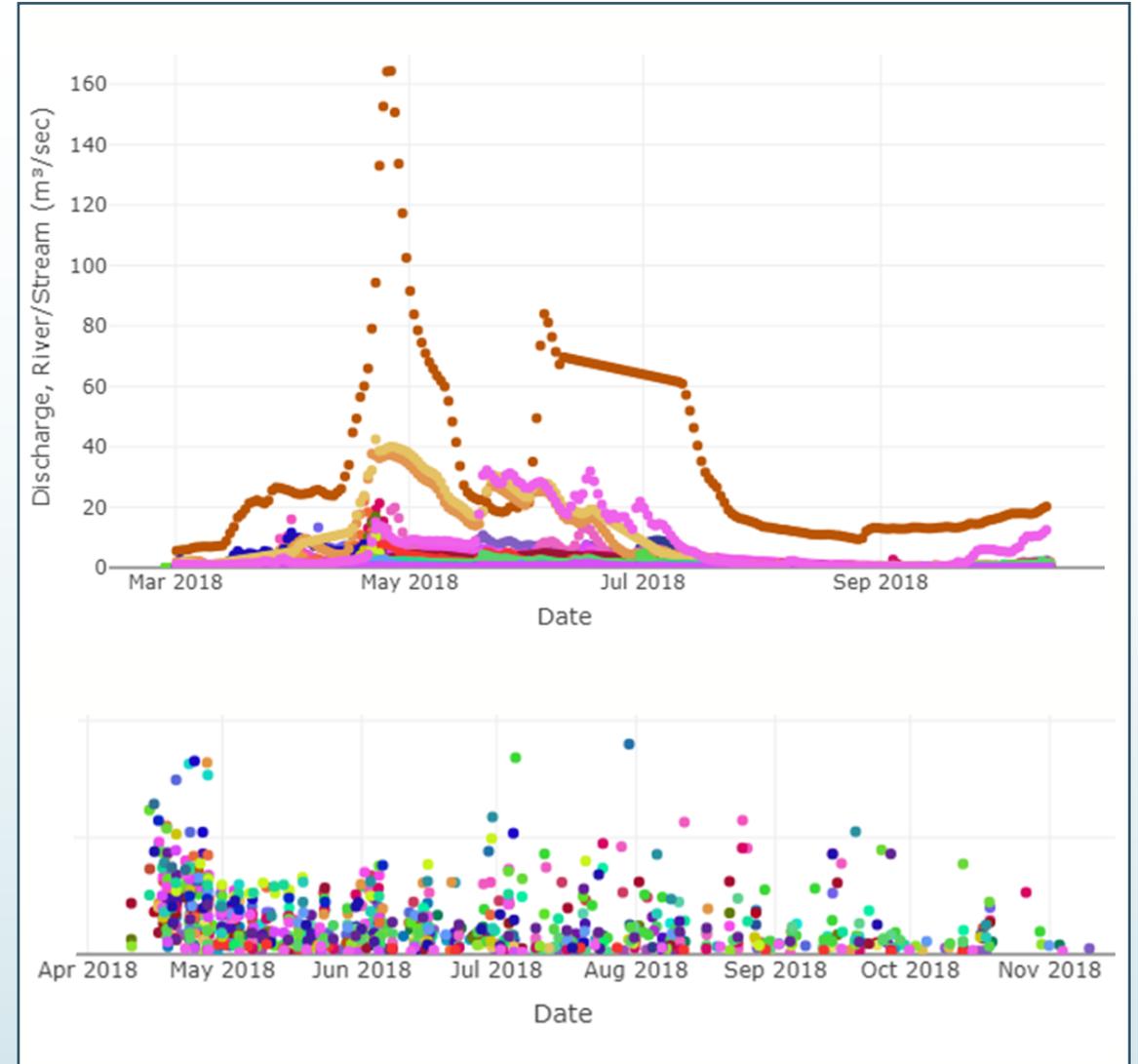


Flow data
No flow data

Methods

	Number of Sites	Sampling Times	Total Samples
Flow data	90	20	1800
No Flow data	75	20	1500
Approximate number per year	3300		

- ▶ Water Survey of Canada log water levels every 5 minutes
- ▶ Lake Winnipeg Community Based Monitoring Network dataset retrieved from LakeWinnipegDataStream.ca



Methods

- ▶ A strength of methods assessment for freshwater salinity toxicity literature will also be performed to identify the data of the greatest quality
- ▶ This will be done by developing and applying a transparent scoring system for assessing the quality of peer-reviewed studies
- ▶ From these, a species sensitivity distribution will be created for an ecological risk assessment of these data in the form of exposure distributions

Implications of the Research

- ▶ This work will help identify a possible driver of ecological change in the Lake Winnipeg watershed
- ▶ Changes to food web structure and function could result in cascading socioeconomic effects, as Lake Winnipeg generates millions of dollars in commercial fishing revenue annually
- ▶ Numerous stakeholders may be impacted, as several million people populate Lake Winnipeg's watershed

Closing Remarks

- ▶ This is a two-year study, as data from the first year will be examined for trends and hotspots, allowing for us to test other hypotheses in the second year about landscape drivers, activities on the landscape, and other factors that may contribute to salinity
- ▶ We encourage any feedback, ideas, or suggestions for this proposed research project
- ▶ Access to datasets, hydrological models, and other valuable information would be greatly appreciated
- ▶ Data from this research will be made publicly available

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Questions?



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