Monitoring seasonal and spatial variability of water quality properties across riverine and coastal ecosystems of southern Hudson Bay and James Bay

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Introduction

Spanning an area of 474,000 km^2 , the Hudson and James Bay Lowlands (HJBL) region is the second largest peatland in the world (1, 2). These peatlands are known to be a rich carbon sink, where much of this carbon is locked within the permafrost (3), however climate change (4) and development initiatives such as the "Ring of Fire" in northern Ontario are threatening ecosystem changes that could alter carbon storage and how it's transported. The watersheds that drain the HJBL, extend inland (Fig. 1) where mining claims have drastically increased. Activity in this region may alter the downstream environments, but these implications are not well understood.

An additional stressor on the HJBL coastline is the changing Hudson Bay marine system. This system has been experiencing rapid sea ice loss, increased warming and occurrences of marine heat waves (5), among other changes. The coastline is a crucial habitat for thousands of birds, fish and mammals, including caribou and polar bears, which are critically important for sustenance, and local economic development for the communities in the region such as Peawanuck (Weenusk First Nation) and Moose Factory (Moose Cree First Nation). This poster is a presentation of preliminary results from two community-led and –based monitoring programs in Omushkego Territory, both with their own local objectives, but ultimately, the work within each program leads us to a greater understanding of the riverine and coastal ecosystems of southern James Bay and southern Hudson Bay. Weaving different forms of knowledge is crucial to improving the overall understanding of these coastal ecosystems to inform decision making for conservation initiatives at the community, regional and national levels.

Objectives

- To assess the HJBL carbon and nutrient conditions in different permafrost conditions and across the aquatic continuum, from the land, to the rivers, to the sea, so we may better understand the impacts of climate change and human development on these important ecosystems.
- Create a baseline database of water quality properties around the Winisk River as there is a scarcity of data, and build up the Moose Cree First Nation database.
- Identify whether there are spatial or seasonal patterns of water properties (carbon and nutrients).
- Co-develop standardized methods for riverine and coastal data collection across the region.

Methods

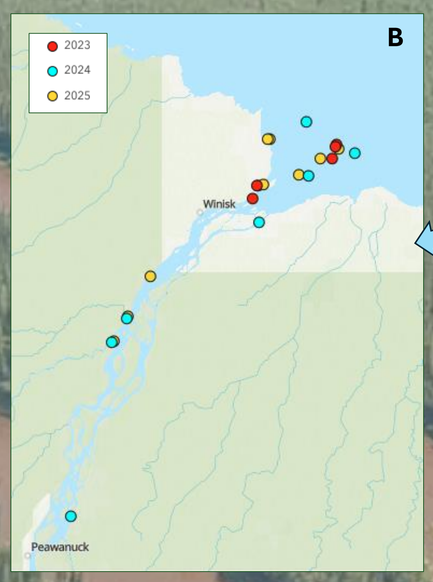
Water samples were collected at various sites and analyzed for:

- Inorganic carbon (pH, dissolved inorganic carbon (DIC), methane, total alkalinity)
- Dissolved organic carbon (DOC)
- Coloured Dissolved Organic Matter (CDOM)
- Nutrients (nitrate, phosphate, silicate)
- Conductivity / salinity
- Oxygen and carbon stable isotopes
- Suspended Particulate Matter (SPM)

Study Areas

Weenusk First Nation Partnership

- Summer water sampling of the Winisk River and estuary took place in 2023, 2024 and 2025.
- In addition to water sampling there were:
  - Short-term mooring deployments with sensors measuring temperature, salinity, pressure, and recording sounds of belugas.
  - Sediment sampling, via sediment cores, conducted in summer 2023 to assess the carbon content of the mudflats at low tide near the Winisk River.



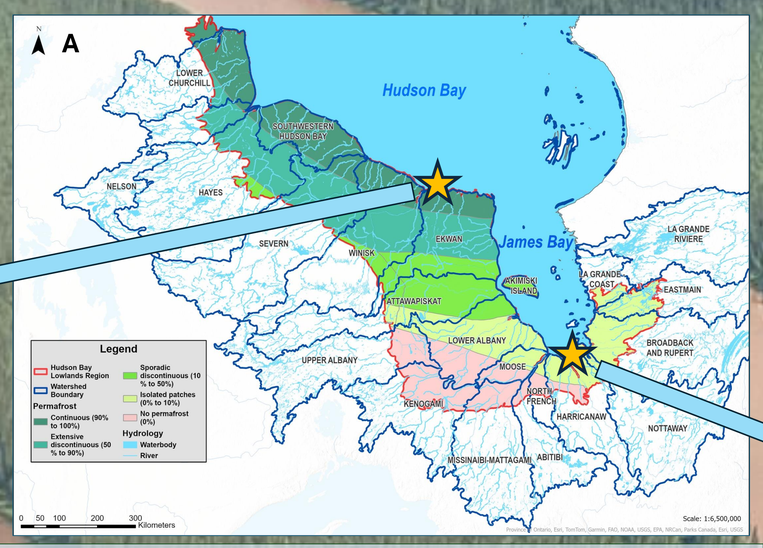
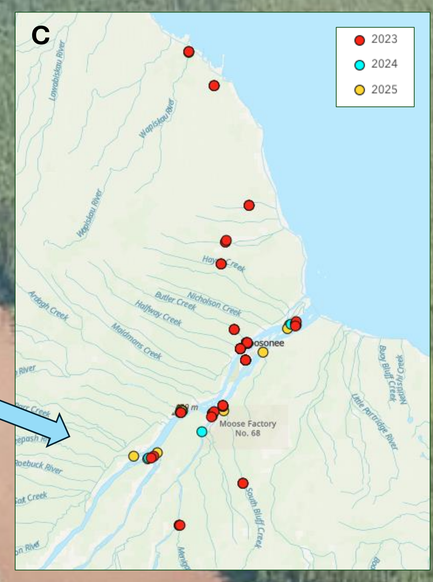


Figure 1. (A)Map of study area with watersheds relevant to study area (dark blue outline). Permafrost categories mapped across the Hudson Bay Lowlands area (red outline). Proposed National Marine Conservation Area led by Mushkegowuk Council shaded in blue within the Bays. Stars indicate locations of monitoring programs. See corresponding star colours in Figure 2. Figure adapted from A. Regehr. (B&C) Sampling locations from 2023-2025

Moose Cree First Nation Partnership



- Moose Cree First Nation has, for many years, conducted water sampling to assess general water quality, of the Moose River, its tributaries and other streams located where the winter road crosses.
- In 2023, additional sampling for carbon and nutrients (listed above) were added with this partnership.
- Seasonal water sampling was conducted in conjunction with their environmental monitoring program, in 2023, 2024, and 2025.
  - 2023: winter, spring, summer, fall
  - 2024: spring
  - 2025: winter, spring and summer

  Figure 1C shows the sampling locations each year, note that some locations overlap and were sampled in multiple years. For example, the red dots to the north were also sampled in 2023.

Winisk River and Estuary Preliminary Results – Annual Comparison

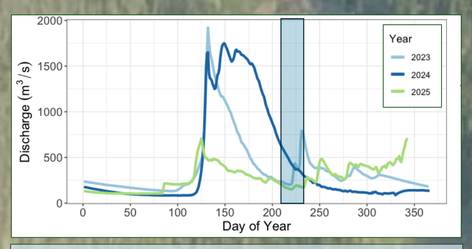


Figure 2. Winisk River daily mean discharge. Data from Environment Canada, Hydrometric Data from station 04DC001. Box represents time of the year when sampling has been conducted.

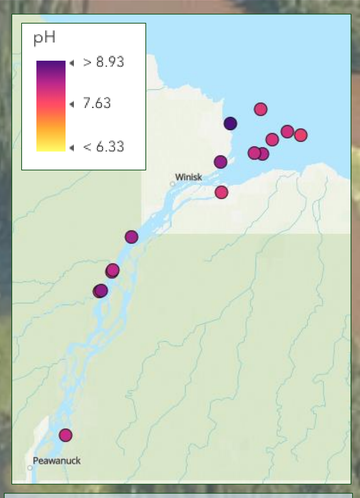


Figure 3. pH values plotted from combined 2023-2025 data from summer at stations in the Winisk River study area

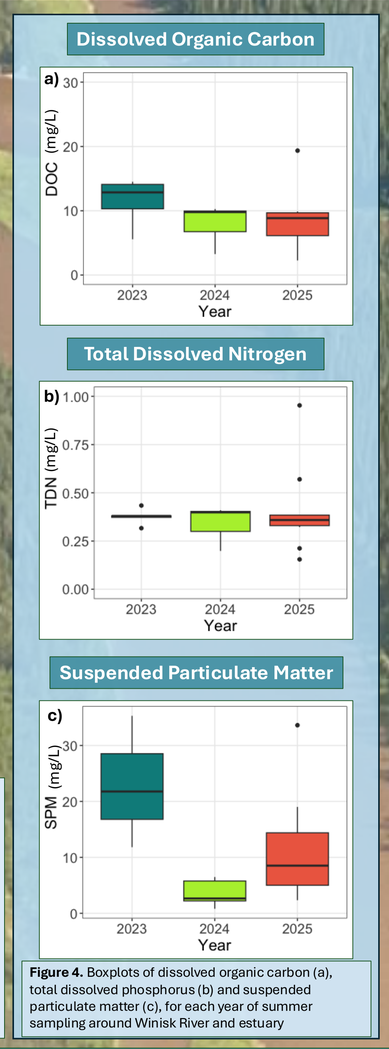


Figure 4. Boxplots of dissolved organic carbon (a), total dissolved phosphorus (b) and suspended particulate matter (c), for each year of summer sampling around Winisk River and estuary

- Winisk River hydrographs varied year to year, with an extremely low freshet in 2025 and very low water condition in summer (Fig. 2)
- pH varied slightly spatially and was overall more basic than stations around Moose River (Fig. 3).
- DOC concentrations show that 2025 is overall lowest while 2023 has the highest concentrations (Fig. 4a).
- TDN stays relatively the same between summers but the range varies (Fig. 4b).
- SPM concentrations varied but may be due to sampling locations and weather. More regular sampling is needed to understand the sediment story (Fig 4c).

Moose River Preliminary Results – Seasonal Comparison

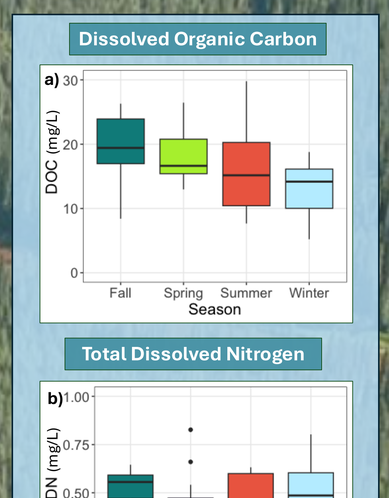
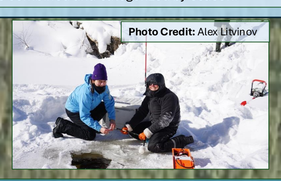


Figure 5. Boxplots of dissolved organic carbon (a) and total dissolved phosphorus (b). Data from 2023-2025 was combined and categorized by season.



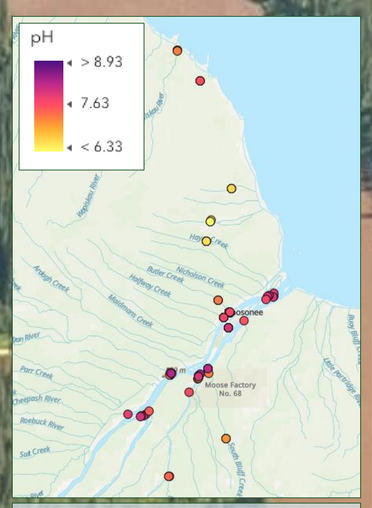


Figure 6. pH values plotted from combined 2023-2025 data from all seasons at stations in the Moose River study area.

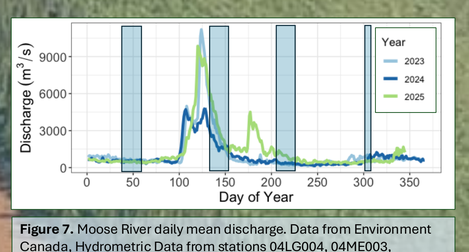


Figure 7. Moose River daily mean discharge. Data from Environment Canada, Hydrometric Data from stations 04LG004, 04ME003, 04MF001, and 04KA001. Boxes represent time of the year when sampling has been conducted.

- The Moose River is partially impacted by hydroelectric development and sees those effects on the hydrograph. 2024 was an overall lower flow year for the Moose mainstem (Fig. 7).
- DOC concentrations are overall higher in Moose River area than the Winisk River/estuary, and vary seasonally when 2023-2025 data is combined (Fig. 4a and 5a).
- The range of TDN concentrations differ between seasons (Fig. 5b).
- pH varies spatially across the entire region depending on the watershed composition of each river/stream (Fig 6). It also varies seasonally.
- We are working towards capturing properties of the true spring freshet.

Steps Forward

- Work is ongoing to create a full carbon and nutrient story for this region by looking at both inorganic and organic pieces.
- We are working towards incorporating seasonal sampling in the Peawanuck region
- Supporting community-led priorities and initiatives associated with the establishment of a National Marine Conservation Area in southern Hudson Bay and western James Bay.

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