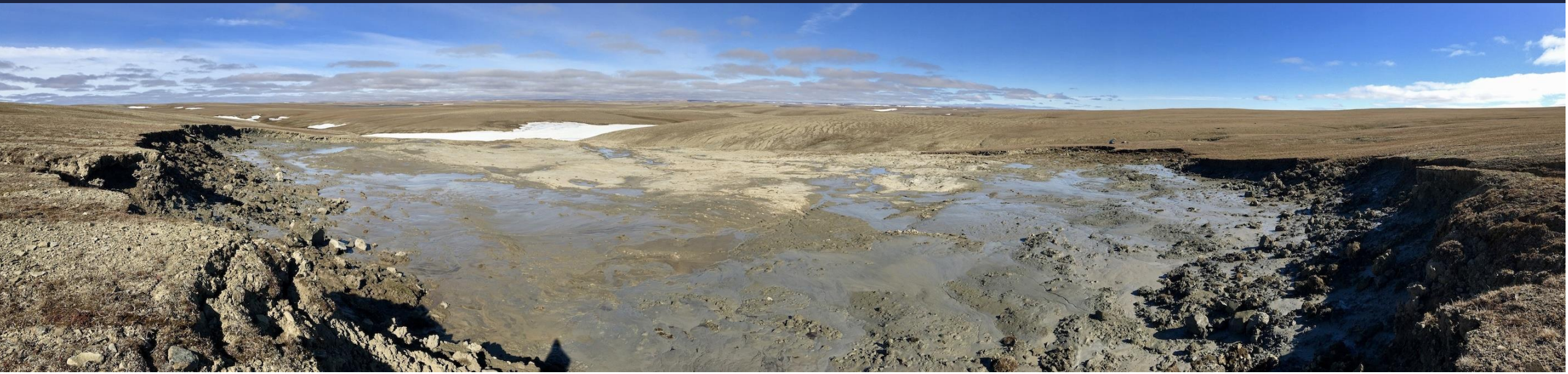
Integrating Knowledge:

Water and hydrological monitoring for detecting permafrost change and safeguarding water security



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Water level and chemistry diagnostic of permafrost change

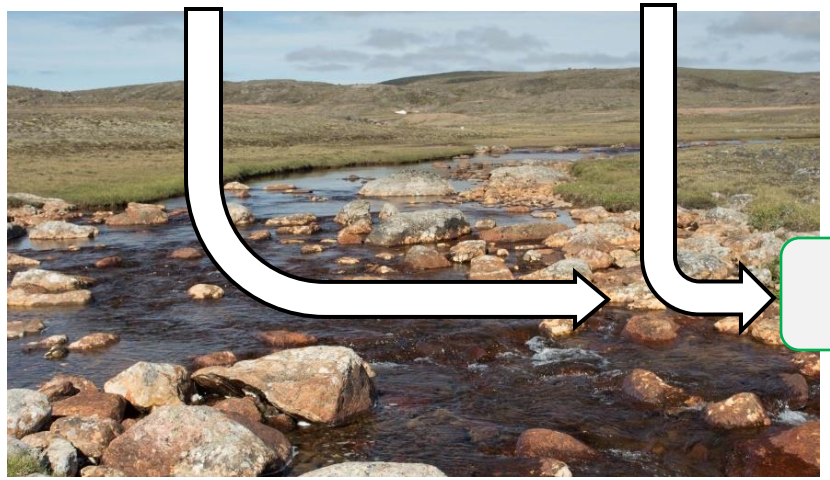
Permafrost Conditions
- Nature of Thermokarst
- Magnitude of Thermokarst

Terrain Conditions
- Surficial Geology
- Soil Organic Content
- Relief
- Hydrologic Connectivity

Climate
- Magnitude & Intensity of Spring snowmelt
- Extreme Rainfall

Precipitation

In-Stream Biochemical Processes



Landscape Runoff
- Surface Water
- Infiltration
- Ground Water

In-Stream Biological Processes

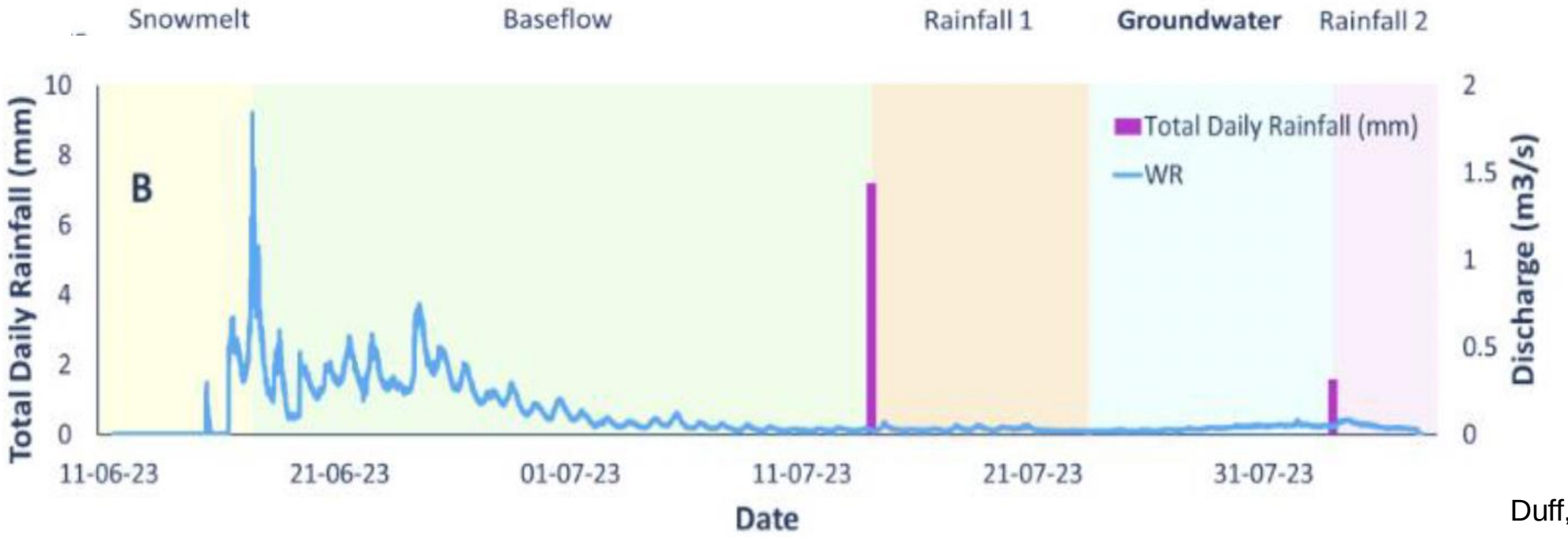
Tributary Streams

Precipitation

Fluvial Chemistry

(Tank et al., 2020; Chiasson-Poirier et al., 2020; Quinton & Pomeroy, 2006; Beel et al., 2021)

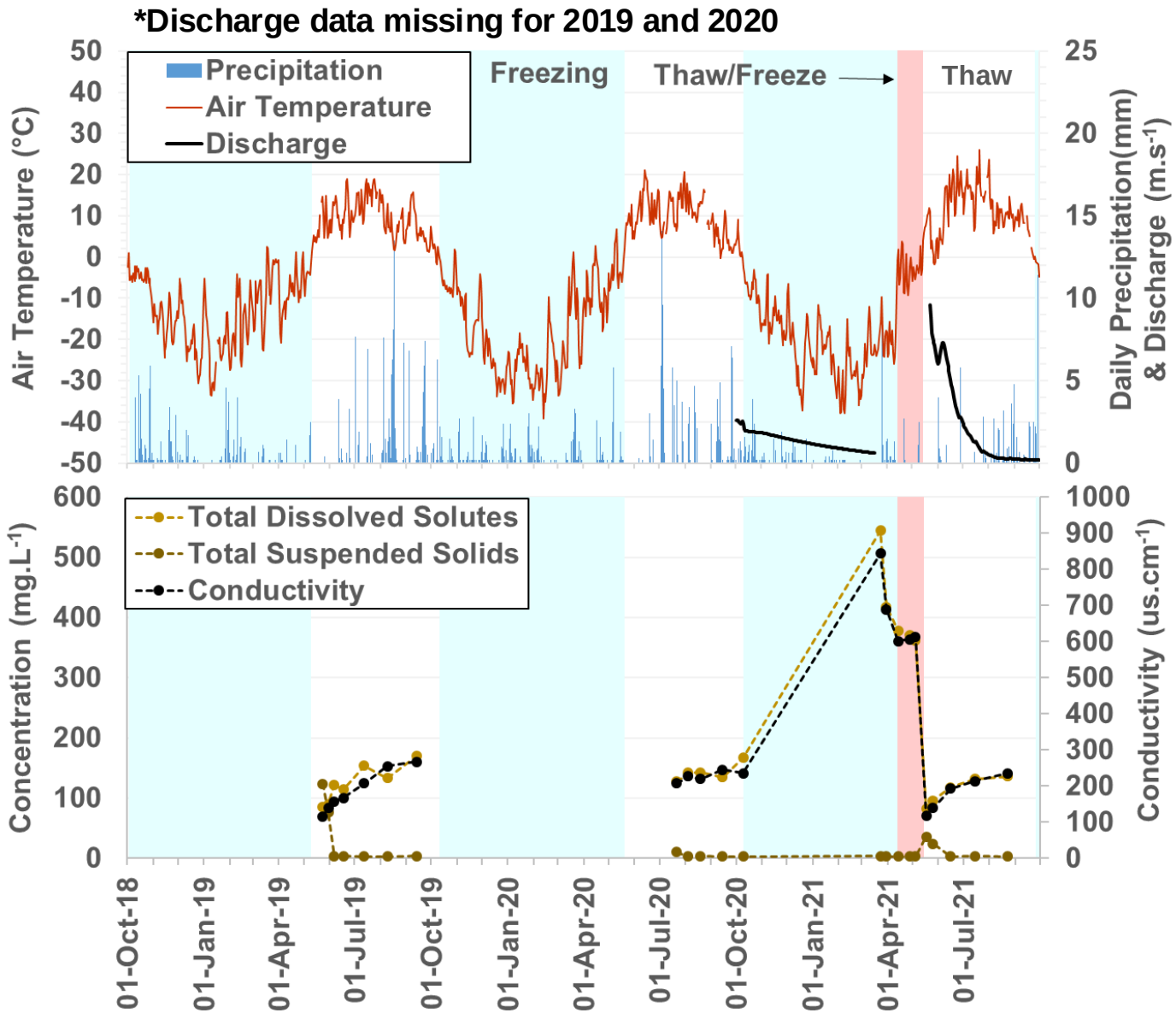
- Deepening active layers and thawing permafrost
  - Water from ground ice → Increase summer water levels (baseflow)
  - Alter/subsurface flow pathways → failure of containment (e.g. sumps)



Duff, G.

*Figure 2. Hydrograph of each sampling site, collected between June 11th and August 6th, 2023, using ONSET HOBO U20 water level loggers, including **A)** the PT, GS, and FX headwater catchment sites, and **B)** the WR site, along with total daily rainfall throughout the 2023 hydrological season, collected from the West Meteorological Station at*

Rengleng River: flow in winter



WINTER:

- Steep *increase* in conductivity and TDS concentration

→ Lateral flow through Talik

SPRING MELT:

- Conductivity and TDS concentration *decreases*
- TSS concentration *increases*

→ Dilution of TDS and mobilization of surficial material via surface runoff

SUMMER THAW:

- Conductivity and TDS concentration *increases*

→ Active layer thickening leading to an increase in the importance of subsurface flow.

E. Hille

- Thermokarst and slope movements
  - Change surface flow paths and volumes → Weathering, erosion, dissolution
  - Mobilizes sediment, nutrients, salts, metals, contaminants from previously frozen material

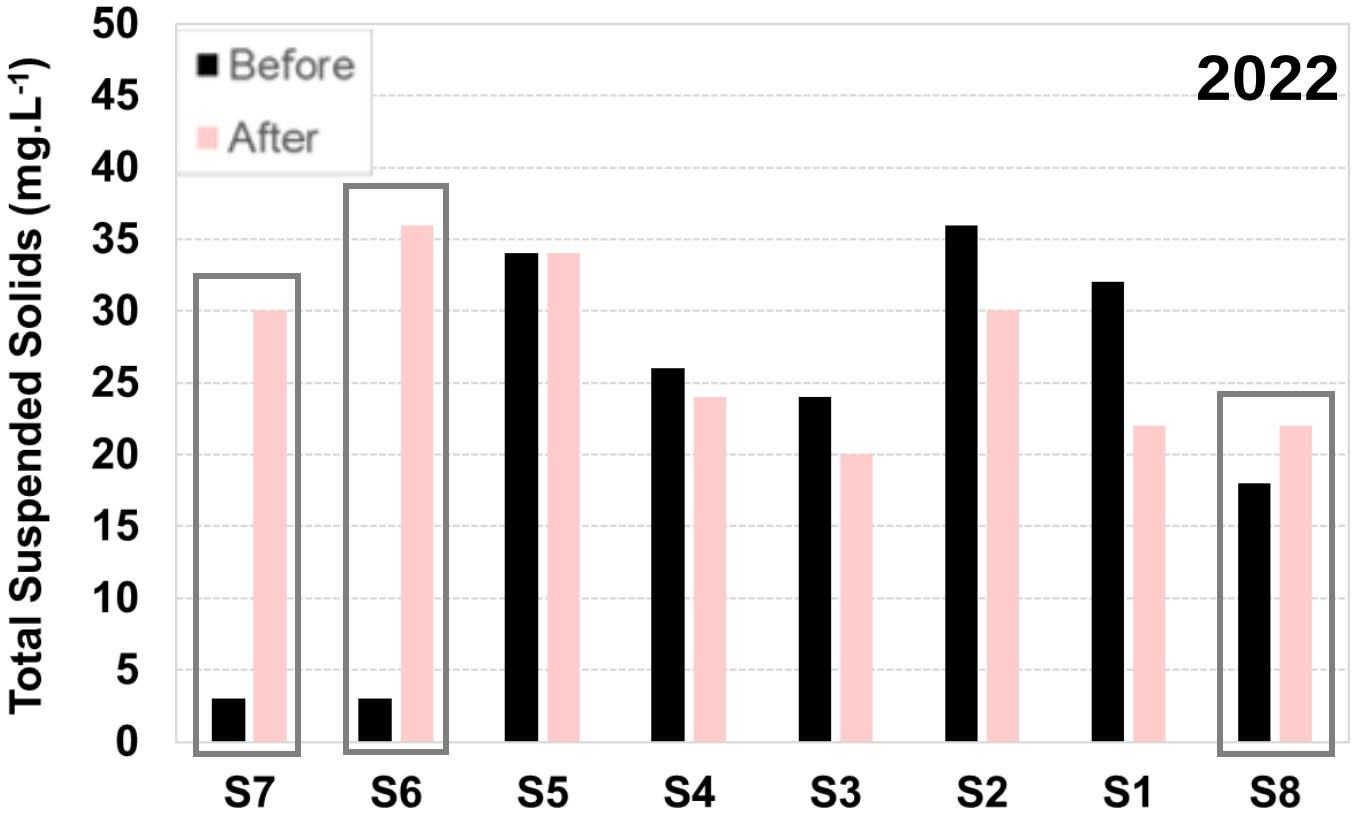


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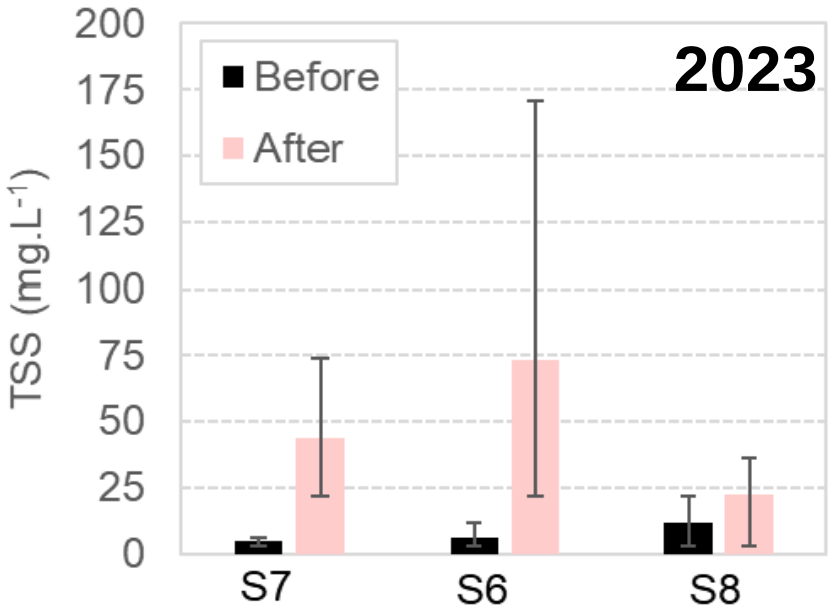
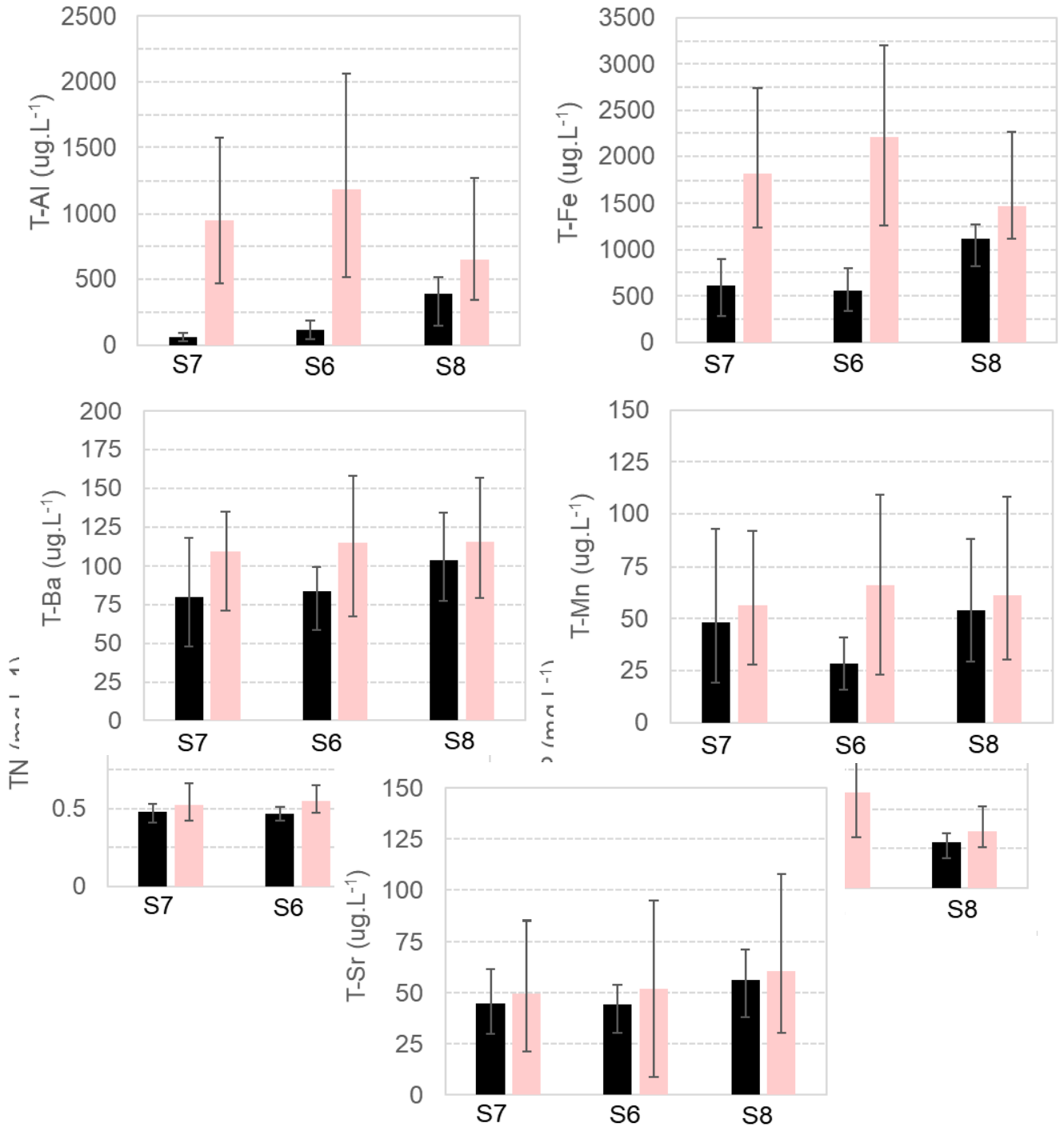
Photo Credit: Alice Wilson

Miner River, NWT, E. Hille

Water Chemistry

- Sediment is a source of Total Nitrogen, Total Phosphorus (TP), and Trace Metals.

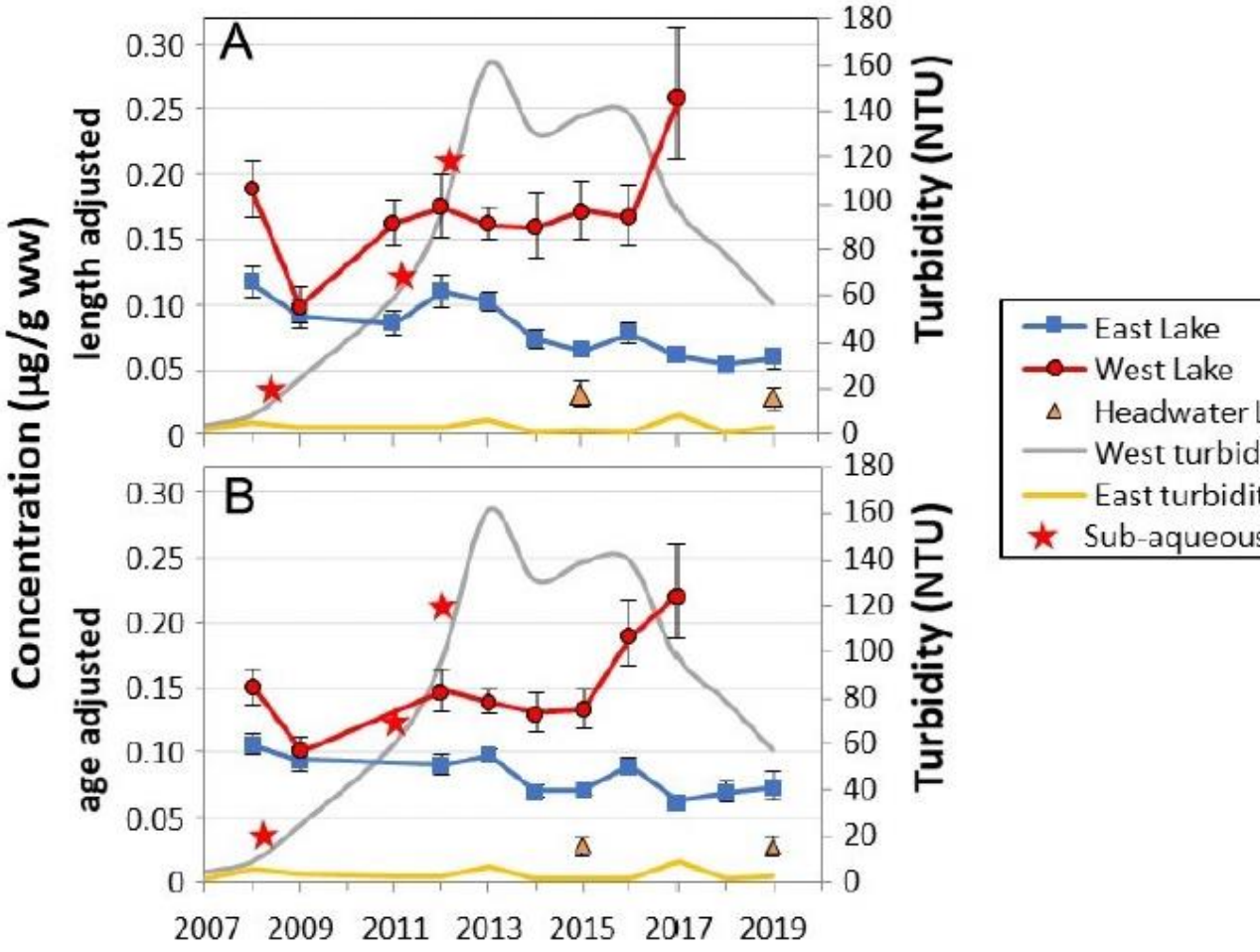




Miner River, NWT, E. Hille

Thaw, Disturbance → Water quality and ecosystem changes

- Mercury, metals, contaminants



Burke et al (2023)

Output:

A resource/guide for communities and decision makers, on monitoring approaches for early detection of permafrost changes and potential hazards

Is this what is needed?

What permafrost changes are most critical?

Where and what are the concerns for fresh water, water infrastructure?

What indicators might best serve as tools for communities to detect permafrost change and to mitigate impacts on communities and infrastructure?