

Kugmallit Bay: A Landscape in Flux

Presented by Erika Hille and Celtie Ferguson

Aurora Research Institute
Virtual Speaker Series
February 1, 2021

Erika Hille

Principal Investigator

Special Projects Coordinator,
Aurora Research Institute
(2011 - Present)

PhD Candidate,
Queens University
(2020 – Present)

Research Interests:

- Water Quality
- Hydrology
- Run-off Processes
- Climate Change
- Permafrost
- Northern Infrastructure



Celtie Ferguson

Technician

GIS Technician,
Aurora Research Institute
(2018 - Present)

RPAS Pilot, Advanced Operations
(2019 Basic – 2021 Advanced)

Research Interests:

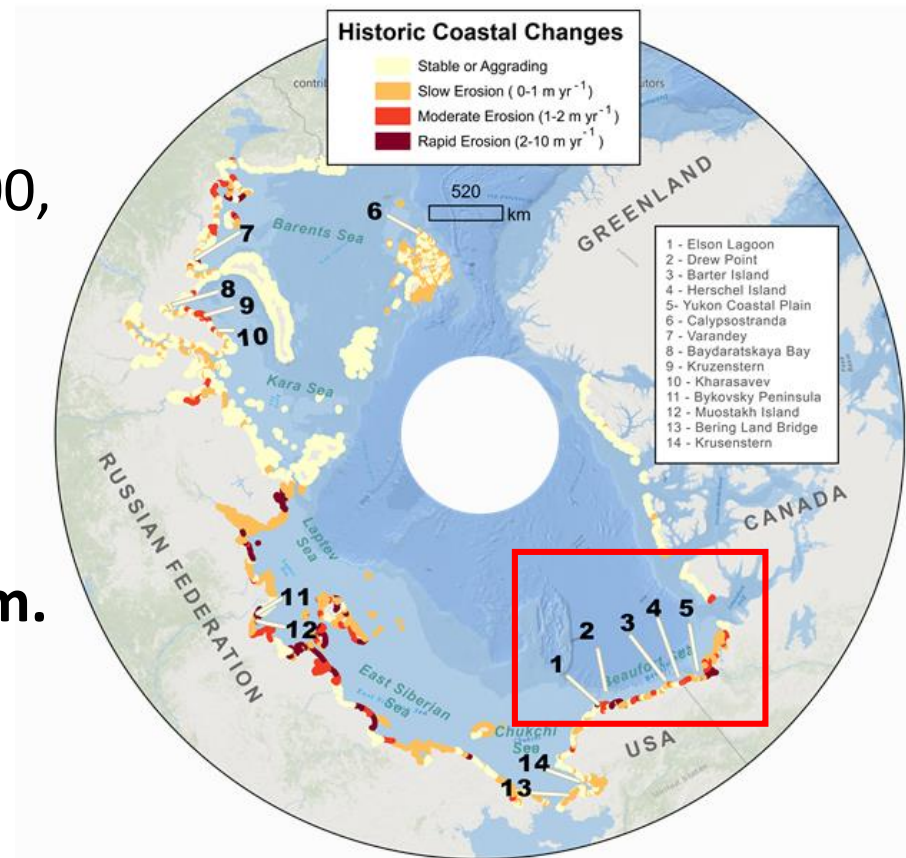
- Geography
- GIS and Cartography
- Remote Sensing
- Climate Change
- Permafrost
- Education and Outreach

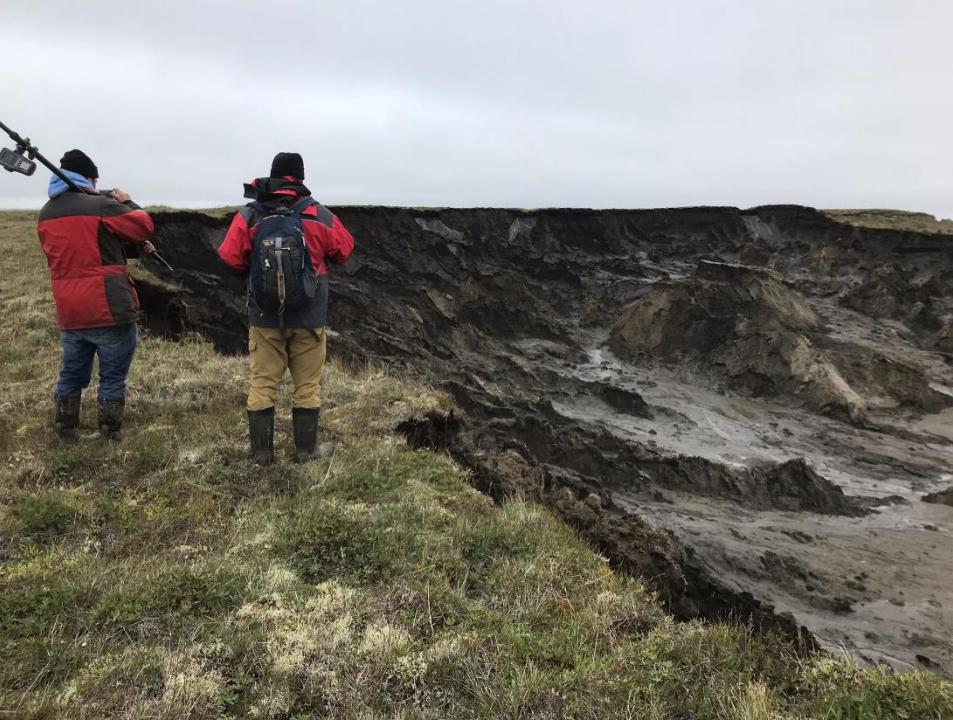


Photo: Kellen Martel / Parks Canada

Arctic Coastal Erosion

- Coastal Erosion varies with *Space* and *Time*
- Over the period of ≈ 1980 to ≈ 2000 , the Beaufort Sea experienced an average erosion rate of **1.1 m.yr^{-1}**
- Some areas experienced an average erosion rate of up to **10 m.yr^{-1}**
- The rate of erosion is increasing

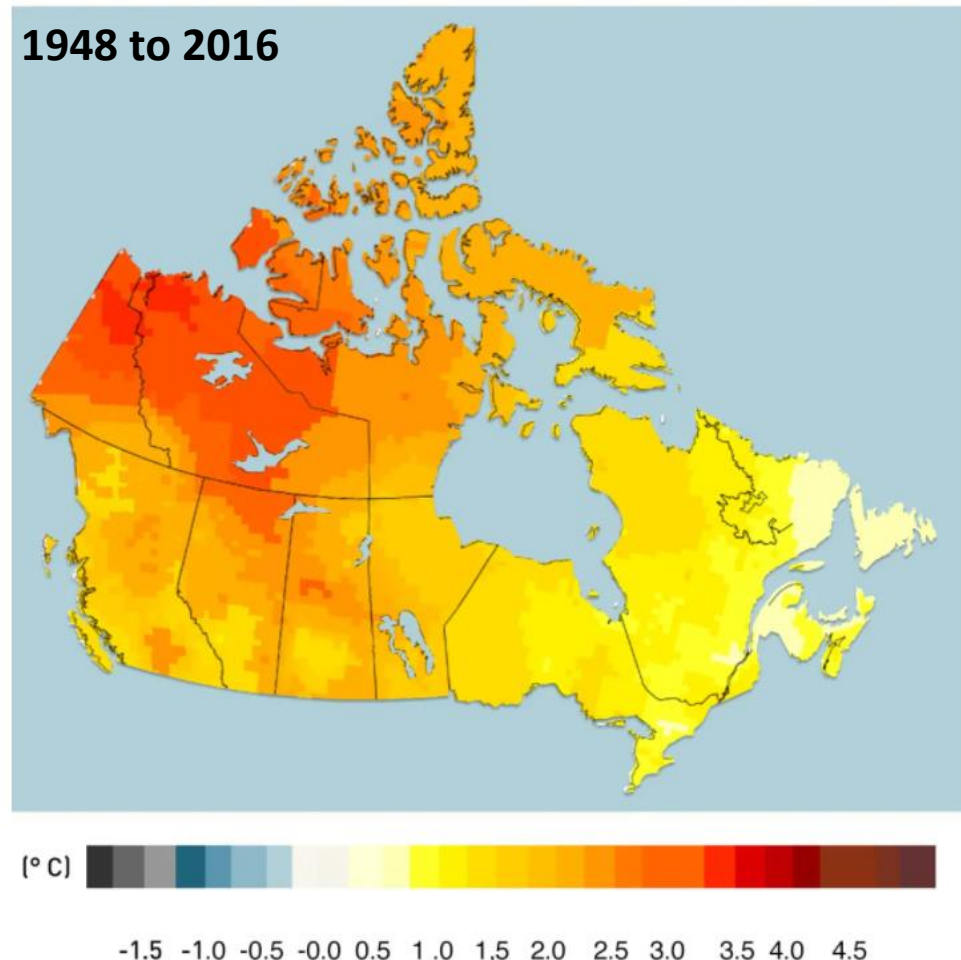




Climate Change

“a change in the state of the *climate* that can be identified by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer.” (IPCC, 2018)

- Climate generally refers to Temperature, Precipitation, and Wind
- Changes in climate are influencing key environmental factors and accelerating the erosion of permafrost coastlines



(Environment and Climate Change Canada, 2019)

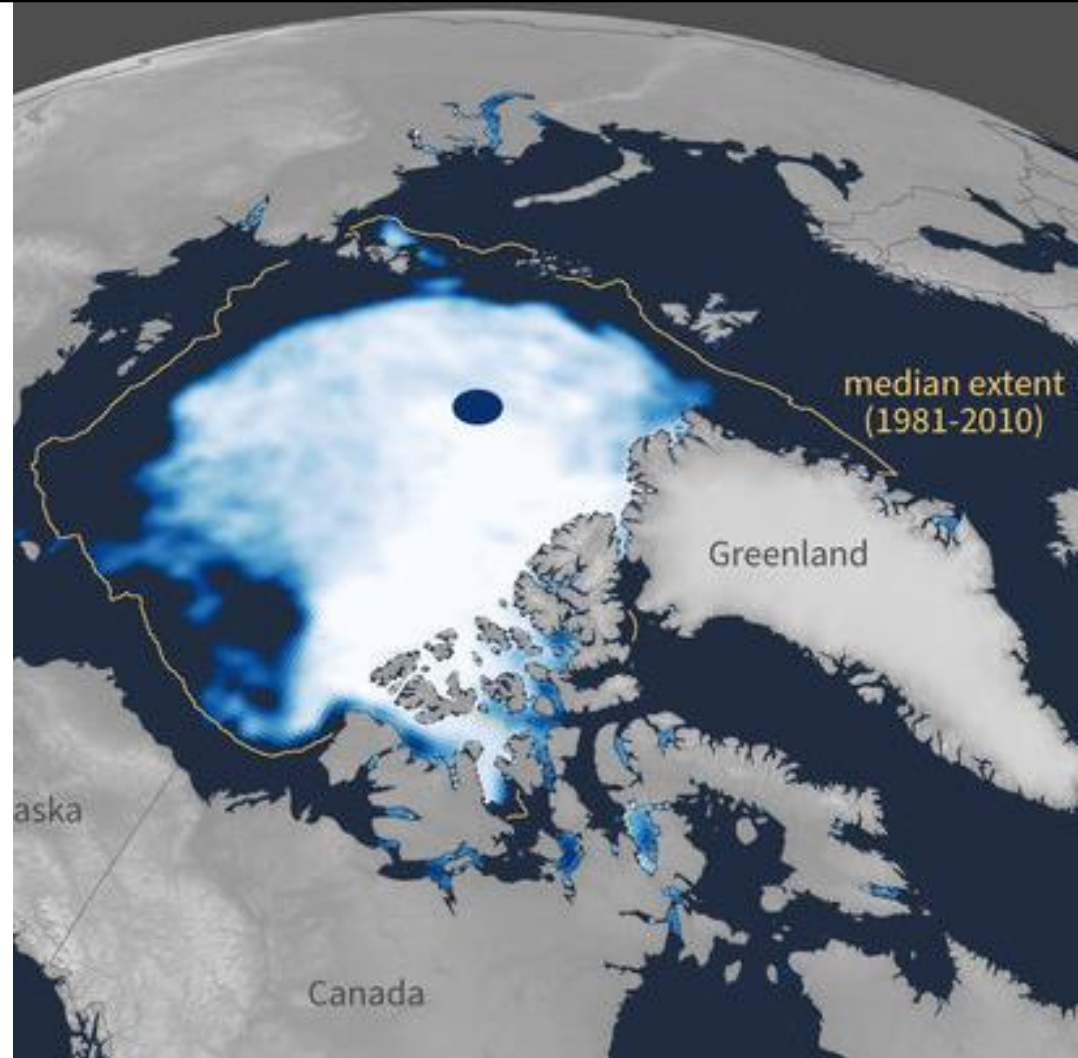
Permafrost & Ground Ice

- Arctic coasts contain Permafrost and Ground Ice.
- Permafrost is “Ground (organic material, soil, rock, ground ice) that remains at or below 0°C for at least two consecutive years.” (IPCC, 2018)
- Coastal permafrost is protected by vegetation, organic and mineral soil, and sea ice



Permafrost & Ground Ice

- Stability of Arctic coasts depends on the Permafrost staying frozen.
- This is threatened by the effects of climate change:
 - ↑ air, ground, and sea surface temperatures
 - ↑ sea levels
 - ↑ storm surge events
 - ↓ sea ice extent and duration



Comparing the median late-summer sea ice extent for the years **1981-2010 (yellow)** to **2021 (white)**

Beaufort Sea

- The Beaufort Sea coast is eroding at a faster rate than other regions
- The coastline of the Beaufort Sea is characterized by:
 - Ice-rich Permafrost
 - Unconsolidated and easily eroded material (sedimentary rock vs. shield rock)



Lake Drainage



Galiptut Area



Galiptut Area



Impacts

- Landscape Change
- Communities
- Infrastructure
- Ancestral Sites
- Aquatic Health

Tuktoyaktuk working with feds to address climate change and eroding shoreline



Funds available for clean energy projects and response to community's coastal erosion problem

CBC News · Posted: Jul 10, 2020 9:49 AM CT | Last Updated: July 10, 2020



Aurora Research Institute
Virtual Speaker Series

GISday
Nov 17, 2021

Archaeology and Climate Change: Mapping threats to Inuvialuit Ancestral Sites

Presented by Dr. Mike O'Rourke,
Climate Change Archaeologist, GNWT Cultural Places Program



Beaufort Sea Coastal Restoration Project

Funding: \$423K

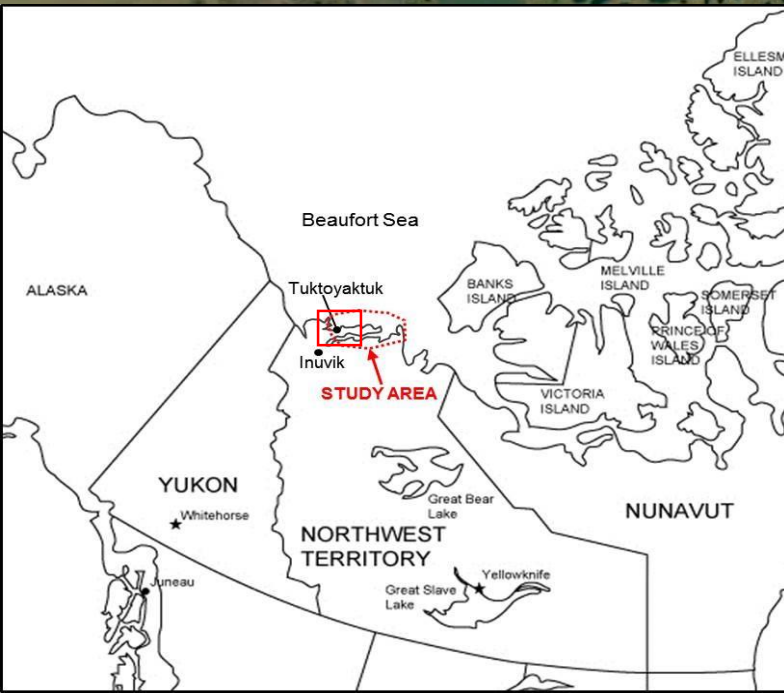
Source: Coastal Restoration Fund (Fisheries and Oceans Canada)

Duration: 2018 to 2022

Goals and Objectives:

1. To examine the effects of coastal erosion and permafrost thaw on Kugmallit Bay
 - Mapping (RPAS Surveys, Historical Aerial Photographs, Satellite Imagery)
 - Water Quality Studies
2. Assess the feasibility of using vegetation to mitigate the effects of permafrost thaw on the coastline of Kugmallit Bay
 - Vegetation Plots

Study Site Locations





Tuktoyaktuk Island



Imnaqpaaluk Peninsula



Galiptut Area



Reindeer Island

Examining the effects of coastal erosion and permafrost thaw on Kugmallit Bay...

- **Mapping (RPAS Surveys, Historical Aerial Photographs, Satellite Imagery)**

Water Quality Impacts

Removal of vegetation and organic soil



Exposure of ice-rich permafrost to atmosphere



Thawing



Shoreline Instability & Collapse



Water Quality Impacts

- Vary with *Space* and *Time*
- ↑ Fine Material (organic material and mineral sediment)
- ↑ Major Ions
- ↑ Trace Metals
- ↑ Contaminants (i.e., Mercury)

Landscape Runoff

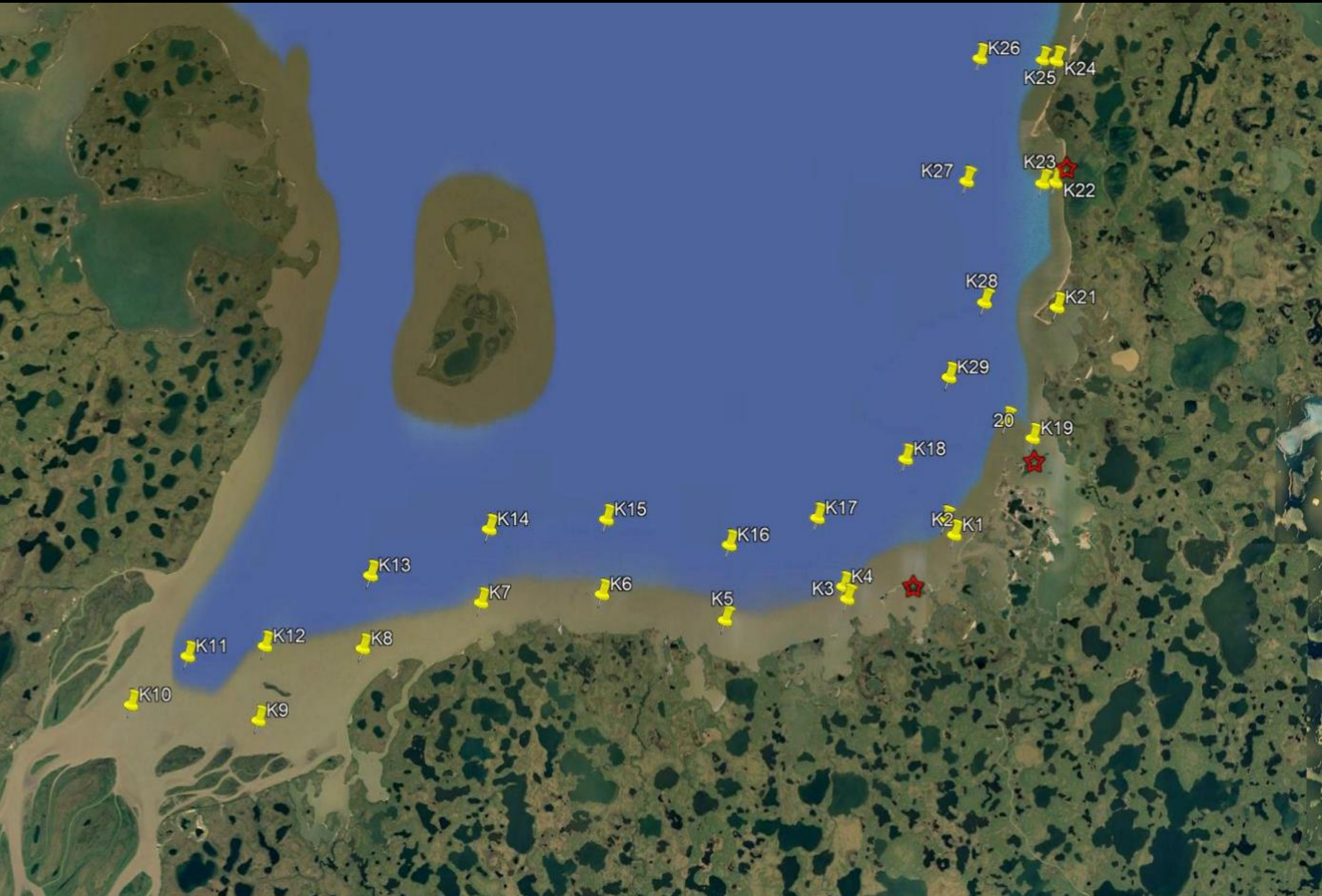
- Water samples were collected from landscape run-off **ON** and **OFF** of each thaw slump
- Landscape run-off from ON the thaw slumps was notably higher in:
 - Fine Material (organic material and mineral ions)
 - Major Ions
 - Trace Metals
 - Aluminum*
 - Barium
 - Iron
 - Maganese

Key Question:

What implications does this have for Kugmallit Bay?

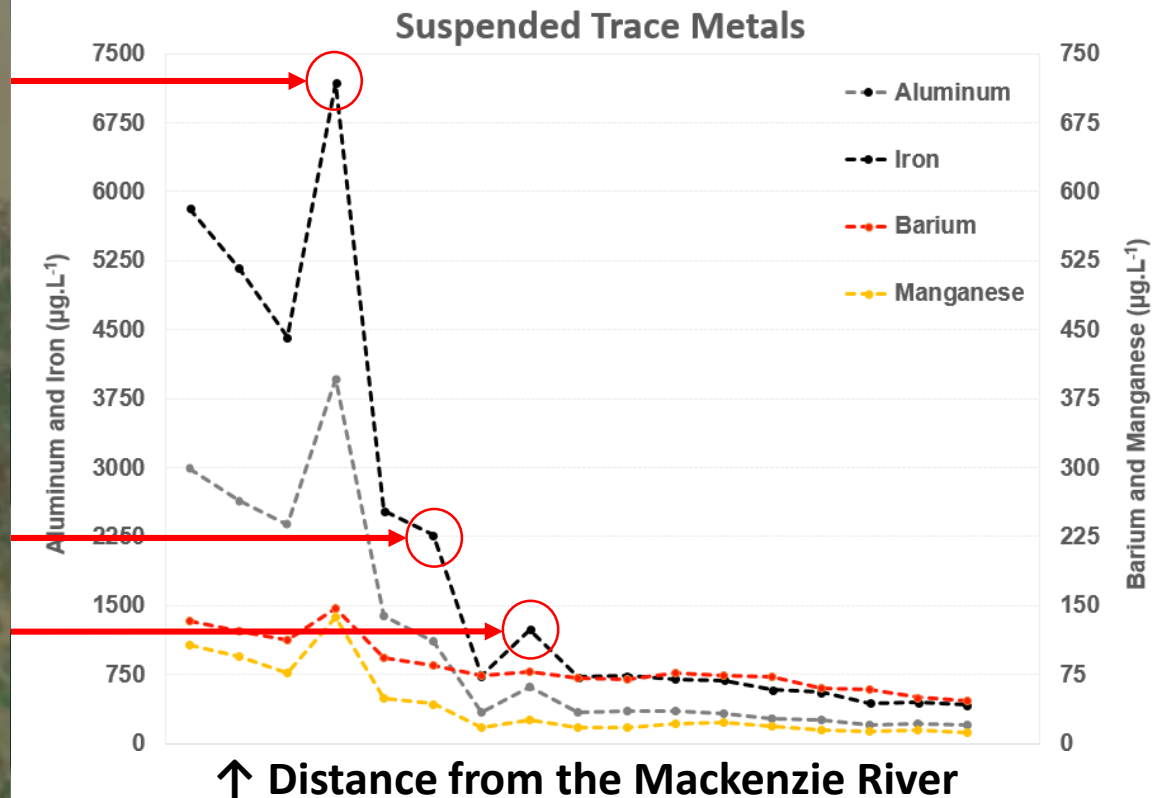


Mackenzie River



Mackenzie River

- The concentration of Sediment, Organic Carbon, Major Ions, & Trace Metals decreased with distance from the Mackenzie River
- No noticeable impact of thaw slumping on near shore water quality
- Lake drainage has a marked impact on water quality



Why Vegetation?

- Vegetation and organic material insulates the permafrost
- Thaw Slumping removes vegetation and organic material
- The ground in terrain affected by Thaw Slumping is warmer
- Thaw slumps continue to expand or stabilize and reinitiate

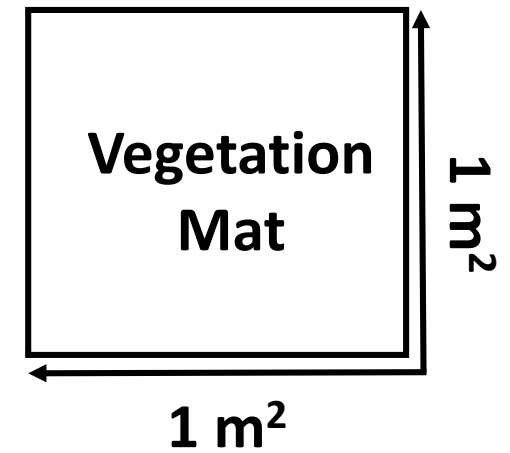
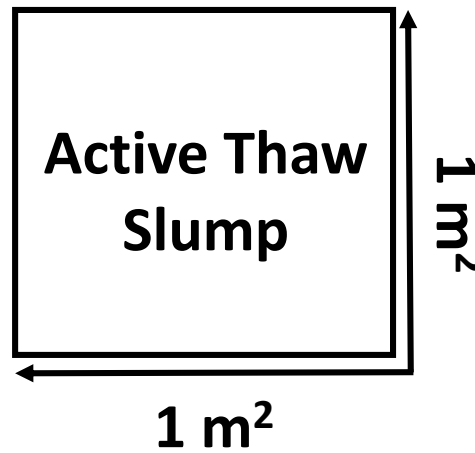
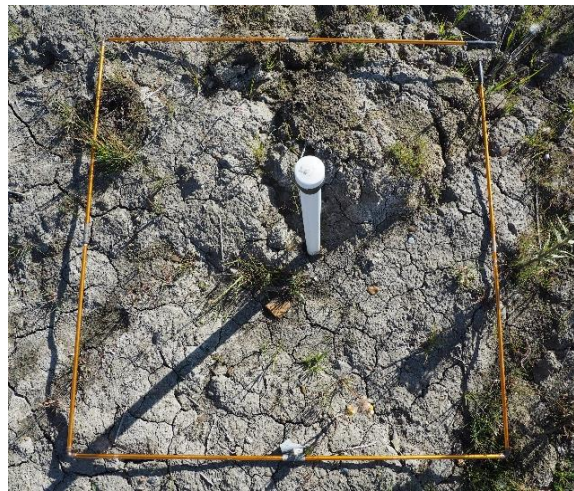
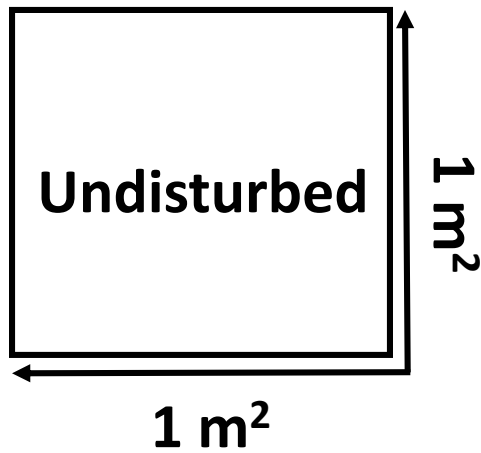
Key Question:

Can vegetation be used to restore the permafrost within permafrost thaw slumps?

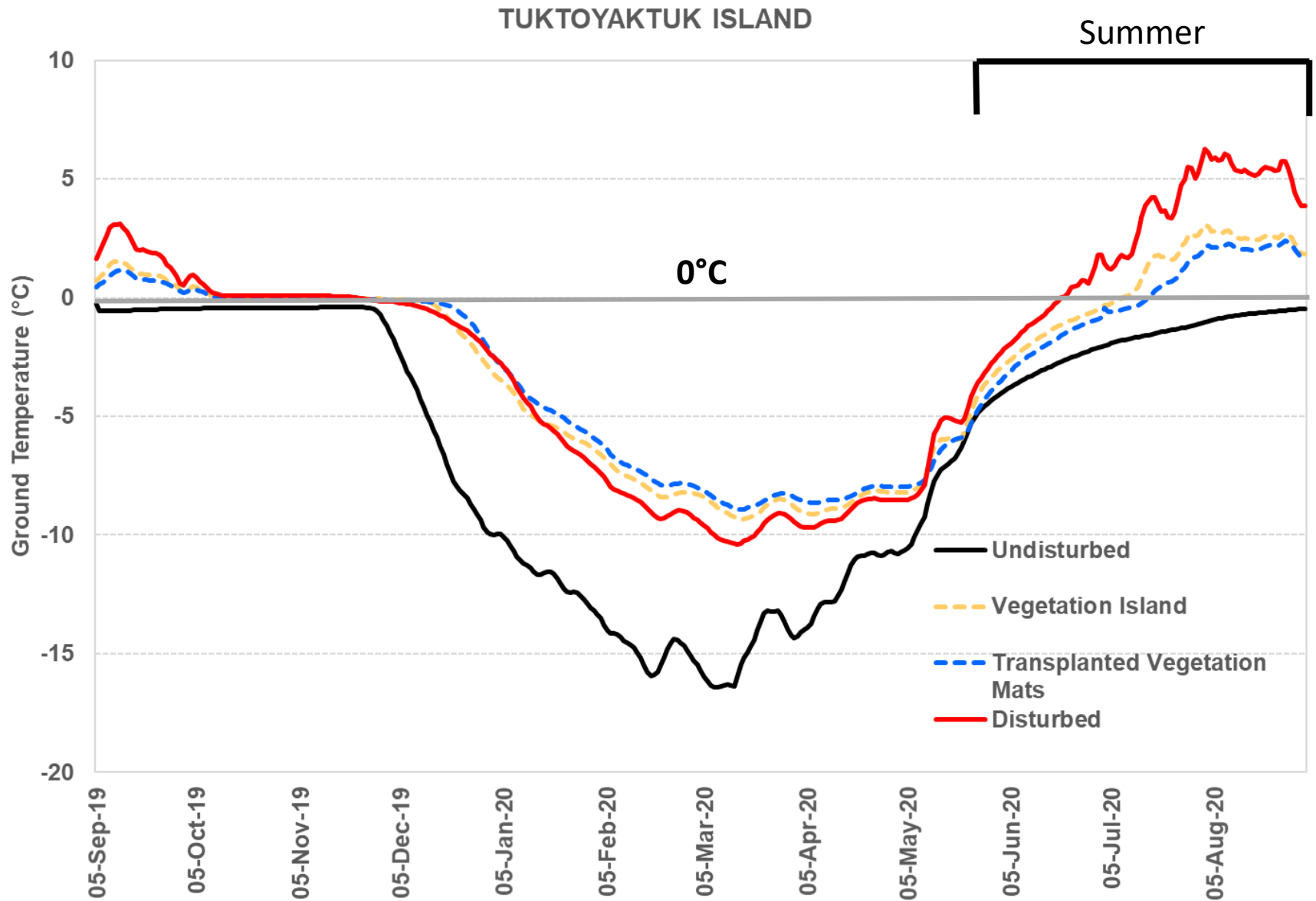


Manipulations

- 3 of each plot type were established at each study site
- Ground temperature loggers were installed at 1m in each plot



Ground Temperature at 1m



Observations

- The ground temperature (GT) at 1m below undisturbed terrain remained below 0°C year round
- Disturbed terrain (bare soil) was *warmer* than undisturbed terrain
- Vegetation mats can be used to *cool* disturbed terrain
- The same observations were made at the other two study sites



Considerations

- Vegetation Mats can be used to ↓ permafrost ground temperatures
 - Local plant species
 - Locally sourced organic material and mineral soil
 - Harvesting mats is labour intensive. Consider producing them.
- Vegetation mats do not protect the coastline from wave action
 - Consider supplementing with other protective measures (i.e., wave breaks)
- Man-made materials should be used cautiously
- This approach would be most effective in sheltered harbours (not open ocean)

Thank you!

Wayne Thrasher (Inuvialuit Land Administration)
Abraham Klengenberg (Inuvialuit Land Administration)
Noel Raymond (Elias Services)
Dustin Whalen (Natural Resources Canada)
Allison Cassidy (Parks Canada)
Lance Gray (Aurora Research Institute)
Greg Elias (Aurora Research Institute)
Coastal Restoration Fund (Fisheries and Oceans Canada)
Polar Continental Shelf Program