

BEAUFORT SEA COASTAL RESTORATION PROJECT

2020
ANNUAL
RESEARCH
UPDATE

Project Summary

The Aurora Research Institute (ARI) received \$423,212 from the Coastal Restoration Fund (CRF; Fisheries and Oceans Canada) to support the Beaufort Sea Coastal Restoration Project. The Purpose of the Beaufort Sea Coastal Restoration Project is to examine the impacts of permafrost thaw slumping on Kugmallit Bay and to create a plan to mitigate these effects using local plant species.

Over the 5-year project (2018-2022), ARI will try to address the following key questions:

- How quickly are permafrost thaw slumps forming and expanding?
- How do permafrost thaw slumps impact the water quality of landscape runoff to Kugmallit Bay and How does this affect the aquatic health of the near shore environment?
- How can local plant species be used to restore coastline impacted by permafrost thaw slumping?

Project Team

Project Leader - Erika Hille (Erika.Hille@auroracollege.nt.ca)

Drone Pilots - Eric Cheyne (former), Celtie Ferguson

Botanical Technicians - Elizabeth Kolb (former), Kathryn Barr (former)

GIS Team - Garfield Giff, Celtie Ferguson

Research Technicians - Edwin Amos, Greg Elias and Ryan McLeod

Collaborators - Dustin Whalen (Natural Resources Canada),
Allison Cassidy (Parks Canada)

2018 & 2019 Project Activities: Recap

- ✓ Meeting with the Inuvialuit Land Administration and the Tuktoyaktuk Hunters and Trappers Committee to select 3 key study sites: Imnaqpaaluk/Peninsula Point, Tuktoyaktuk Island, Galiptat Area/North Pingo Point. (March 2018)
- ✓ Literature review on techniques for restoring Arctic coastlines, with an emphasis on revegetation. (Summer 2018)
- ✓ Obtained detailed imagery from the 3 primary study sites using an eBee SenseFly Drone. (Summer 2018 & 2019)
- ✓ Sampled and analyzed water runoff at each study site (off of thaw slump-impacted terrain and off of unimpacted terrain). (Summer 2018 & 2019)
- ✓ Used historical aerial photographs to map the progression of coastal erosion and thaw slumping at Kugmallit Bay between 1967 and 2004. This was combined with the eBee Sensfly Drone imagery to map the progression of thaw slumping at the 3 primary study sites between the years 1967, 2004, 2018, and 2019(Fall 2019).
- ✓ Experimental vegetation plots were established at each study site. (Summer 2019)
- ✓ Surface temperature and ground temperature sensors into the vegetation plots. (Summer 2019)

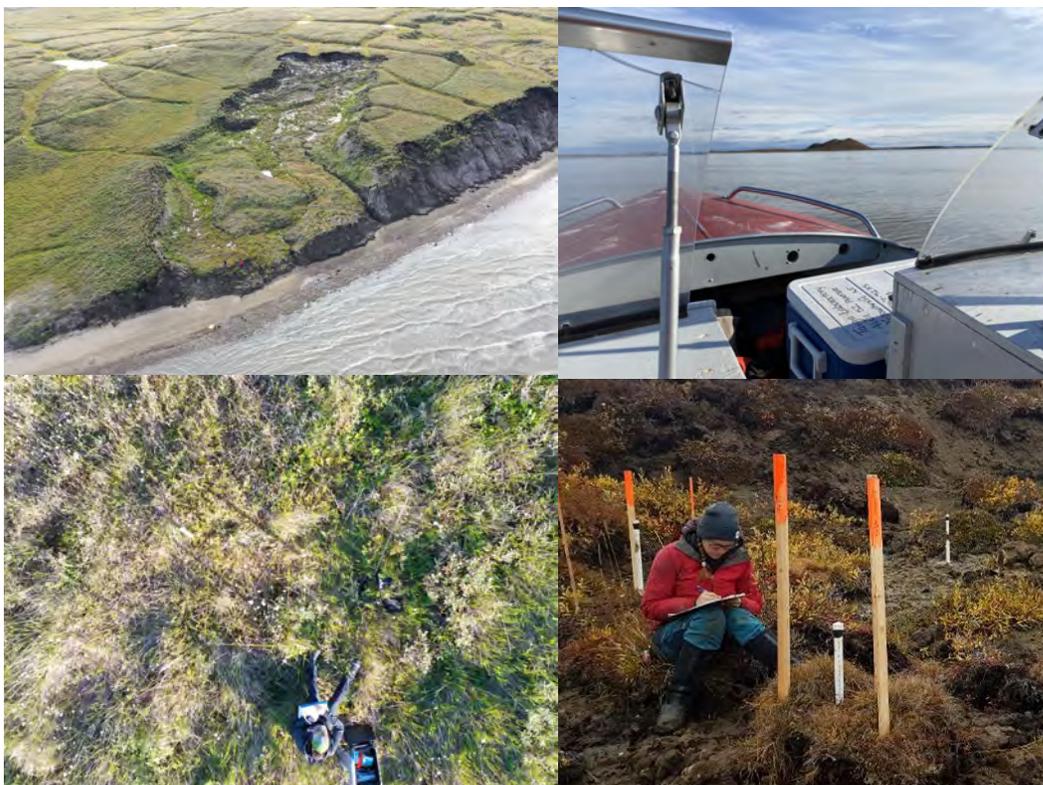
For more details, please see the 2018 Annual Report and the 2019 Annual Report at <https://nwtresearch.com/beaufort-sea-coastal-restoration-project>.



2020 Project Activities: An Overview

- ✓ eBee SenseFly Drone imagery could only be collected from the study site near Galiptat Area/North Pingo Point. New Canadian Aviation Regulations restricted us from flying the other sites. (August 2020)
- ✓ Imagery was also collected from one additional site off of Reindeer Island (Crumbling Point). (August 2020)
- ✓ Water runoff was sampled at each study site (off of thaw slump-impacted terrain and unimpacted terrain). (August 2020)
- ✓ Nearshore and offshore water was also sampled at each study site (offshore of thaw slump-impacted terrain and offshore of unimpacted terrain) (August 2020)
- ✓ Water samples were analyzed for carbon, major ions, and trace metals. (August 2020)
- ✓ Allison Cassidy (Parks Canada) monitored the species composition and plant height within each vegetation plot. (August 2020)
- ✓ Ground temperature data was downloaded. (August 2020)
- ✓ Historical aerial photographs and eBee Sensefly imagery was used to map the progression of thaw slumping at Galiptat Area between 1967, 2004, 2018, 2019, and 2020. (Fall & Winter 2020)

For more details, please refer to pages 4-11 of this Report.



Study Site Locations

Below, is a map of Kugmallit Bay. The colours represent the rate of coastal erosion (or aggradation) in metres. This was created using historical aerial photographs of Kugmallit Bay, which were obtained in 1967 and 2004. The letters indicate the location of the three main study sites. They are as follows:

- A** Galiptat Area (North Pingo Point)
- B** Tuktoyaktuk Island
- C** Imnaqpaaluk (Peninsula Point)

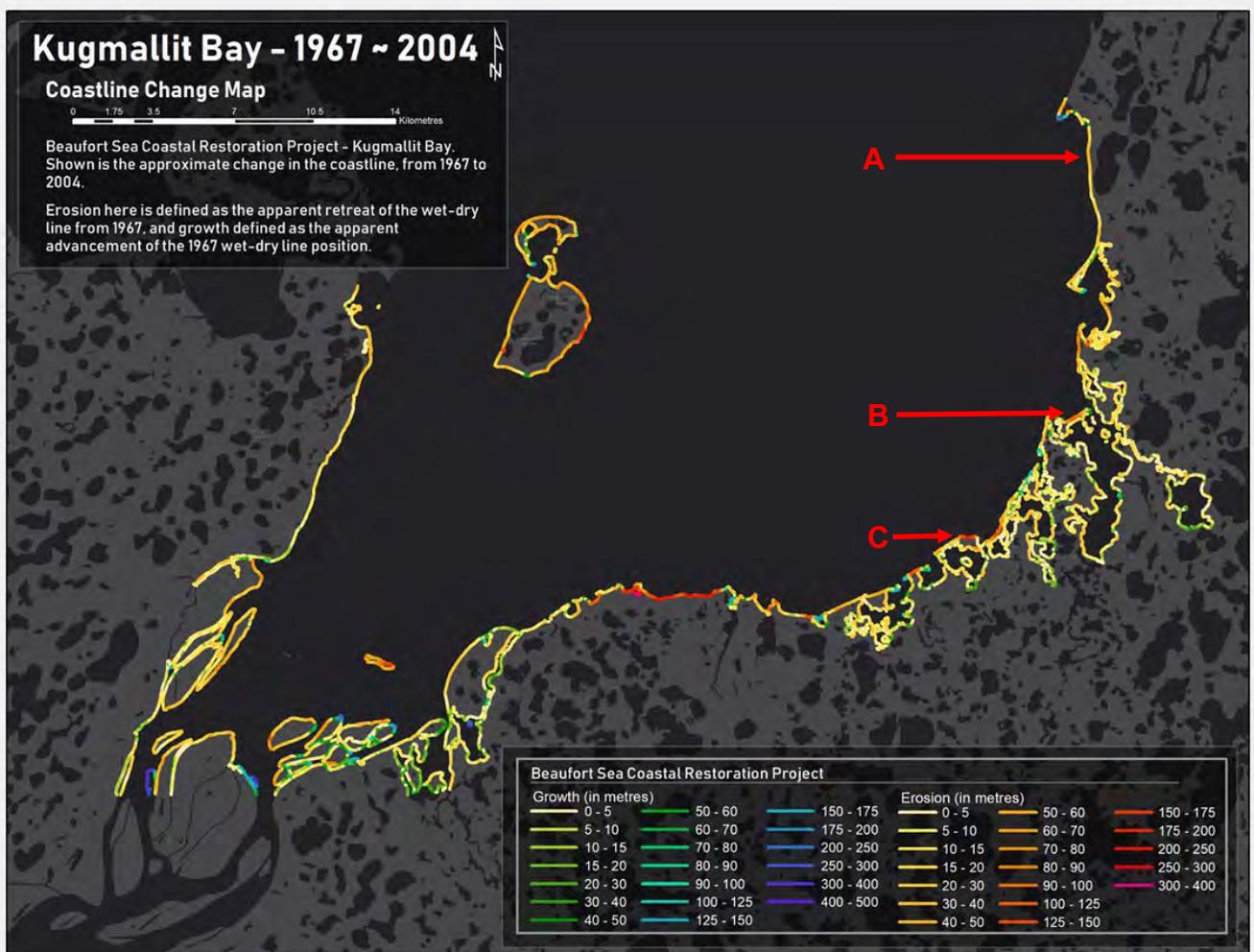


Figure 1: A map illustrating how much (in metres) the coastline retreated between 1967 and 2004.

The progression of thaw slumping in the Galiptat Area between the years 1967, 2004, 2018, 2019, and 2020...

Historical aerial photographs, in combination with UAV imagery, was used to map the progression of thaw slumping in the Galiptat Area between 1967, 2004, 2018, 2019, and 2020. Additional drone surveys are planned for 2021.

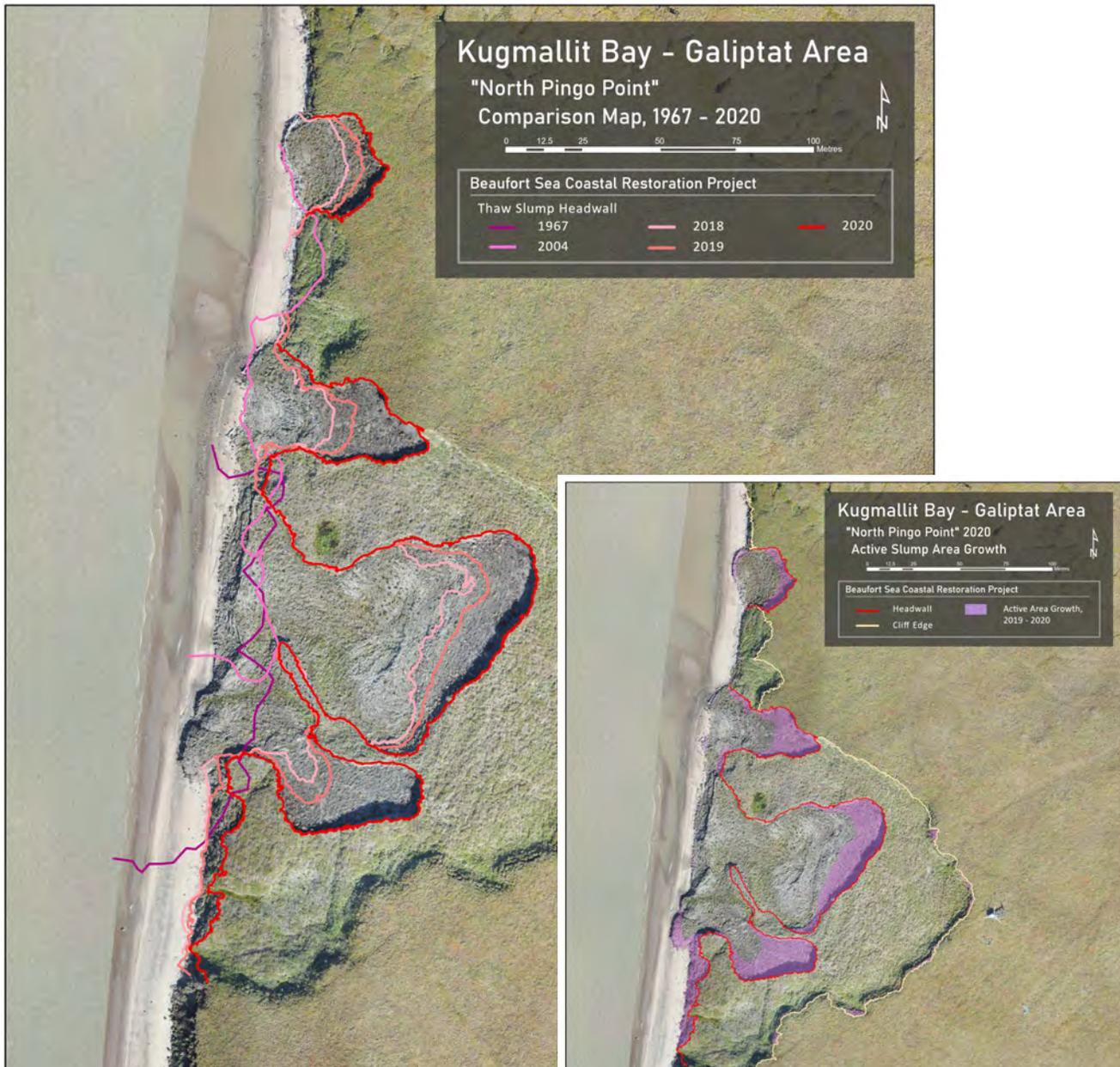


Figure 2: An overhead view of a large thaw slump in the Galiptat Area. The lines show the location of the headwall in 1967, 2004, 2018, 2019, and 2020. The shaded portion represents the amount the headwall retreated between 2019 and 2020.

The progression of thaw slumping on Tuktoyaktuk Island between the years 1967, 2004, 2018, and 2019...

Historical aerial photographs, in combination with UAV imagery, were used to map the progression of thaw slumping on Tuktoyaktuk Island between 1967, 2004, 2018, and 2019. New Canadian Aviation Regulations restricted the Aurora Research Institute from flying this site in 2020. Since the technicians at ARI now have their Advanced RPAS Licenses, an additional drone survey is planned for 2021.

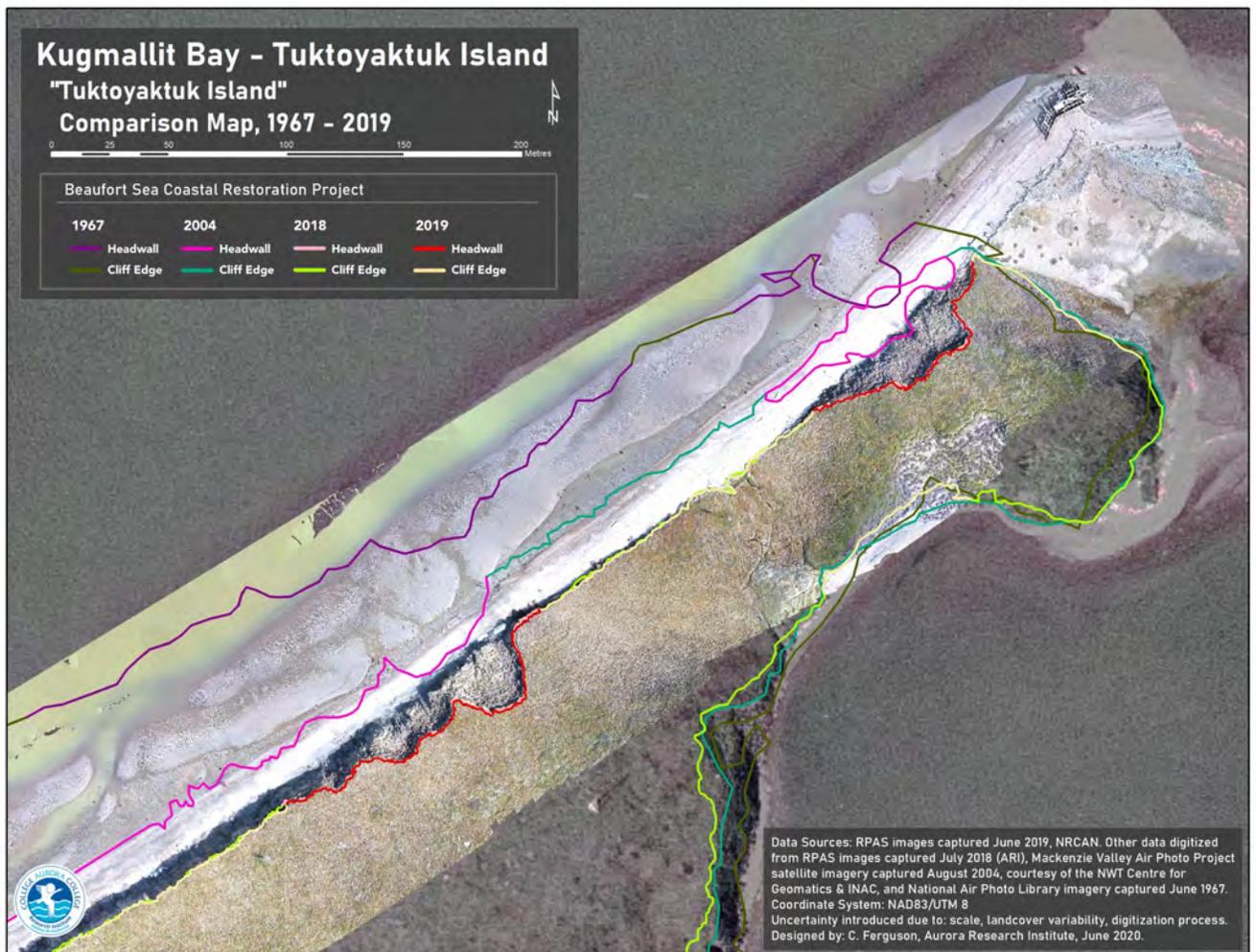


Figure 3: An overhead view of a large thaw slump on Tuktoyaktuk Island. The lines show the location of the headwall in 1967, 2004, 2018, and 2019.

The progression of thaw slumping at Imnaqpaaluk between the years 1967, 2004, 2018, and 2019...

Historical aerial photographs, in combination with UAV imagery, was used to map the progression of thaw slumping at Imnaqpaaluk (Peninsula Point) between 1967, 2004, 2018, and 2019. New Canadian Aviation Regulations restricted the Aurora Research Institute from flying this site in 2020. Since the technicians at ARI now have their Advanced RPAS Licenses, an additional drone survey is planned for 2021.

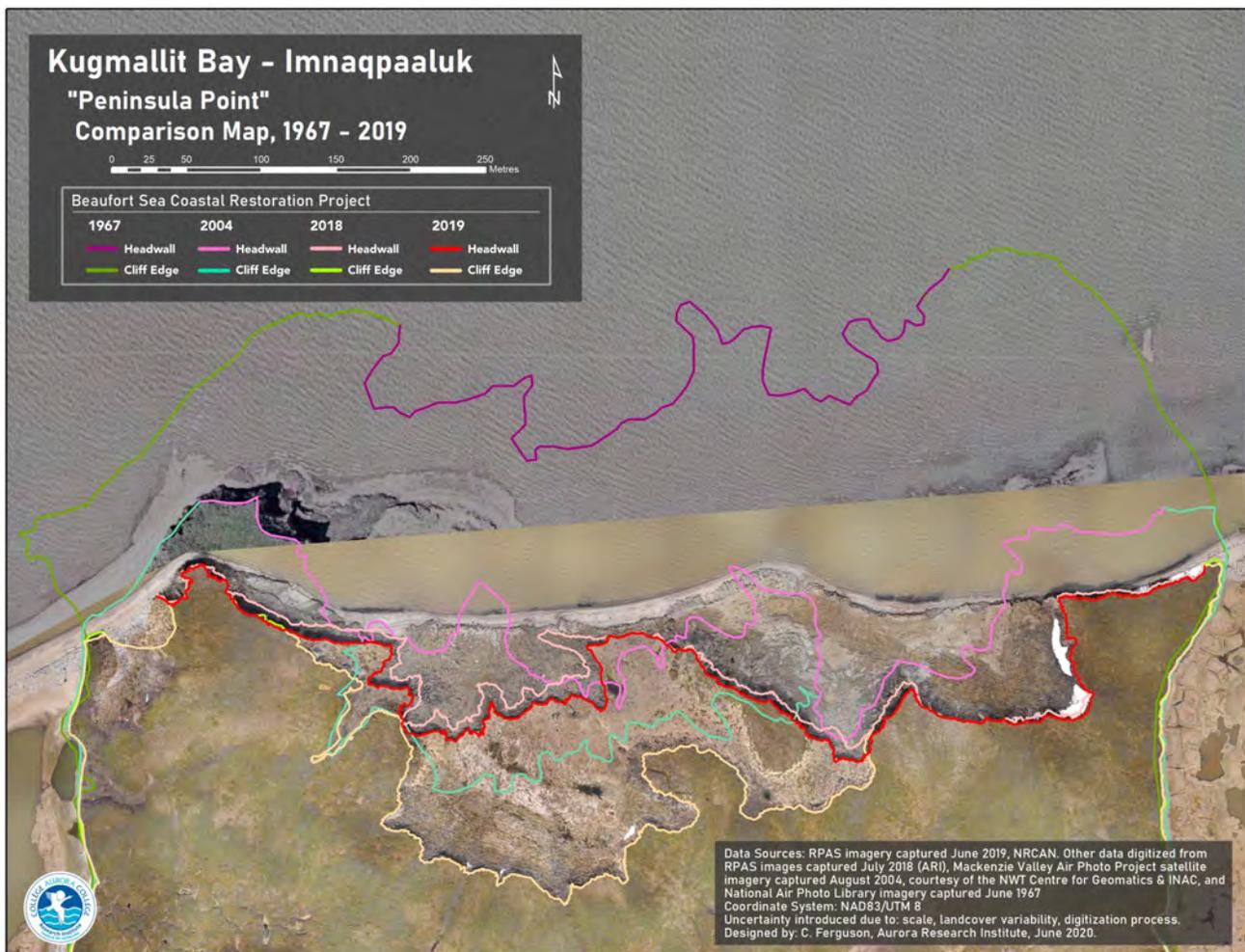


Figure 4: An overhead view of the large thaw slump at Imnaqpaaluk (Peninsula Point). The lines show the location of the headwall in 1967, 2004, 2018, and 2019.

How is coastal erosion and thaw slumping affecting Kugmallit Bay...

In August 2020, the research team sampled landscape water at each of the three study sites (Galiptat Area, Tuktoyaktuk Island, Imnaqpaaluk). The team sampled ponded water and runoff water from each thaw slump and when possible, from the adjacent unaffected terrain. In addition to landscape water, the research team also collected water samples from Kugmallit Bay. This was to assess the impacts of landscape runoff on nearshore water quality. Water samples were collected from 100m and 2Km offshore of each thaw slump and from 100m and 2Km offshore of the unaffected terrain 5Km west of each thaw slump. All of the water samples were sent to Taiga Environmental Laboratories in Yellowknife, NT where they were analyzed for nutrients, carbon, physical parameters, anions/cations, carbon, and trace metals. A complete list of the parameters that were tested can be found in Table 1 (below).

The presence or absence of thaw slumping does not appear to influence the water quality of Kugmallit Bay. This can likely be explained by a few factors. First, the sediment plume from the Mackenzie River is masking the influence of thaw slumping, as it appears to be the main factor driving the water quality of the nearshore zone of Kugmallit Bay. Second, the study sites weren't actively slumping when we were sampling. We would likely see a larger impact during or after a major slumping event. Extreme rainfall events could also influence the relationship between thaw slumping and nearshore water quality. Third, the sediment mobilized from thaw slumps is likely transported quickly by lateral currents. With this in mind, nearshore water quality may not be a good indicator of how coastal erosion and thaw slumping is impacting Kugmallit Bay.

By examining the water quality of landscape runoff, relative to Kugmallit Bay, we get a much clearer picture of how thaw slumping could be influencing aquatic health. Landscape runoff has notably higher concentrations of Total Suspended Solids, Total and Dissolved Organic Carbon, and Nitrate. Landscape runoff also has higher concentrations of some trace metals. In particular, the landscape appears to be a source of Aluminum, Barium, Iron, and Manganese. This suggests that the concentration of trace metals in Kugmallit Bay could increase in the future, as coastal erosion and thaw slumping progresses. In the absence of long term water quality data, however, the actual impact on Kugmallit Bay is difficult to ascertain.



Can vegetation be used to restore permafrost?

Technicians from ARI harvested vegetation mats from the coastline of Kugmallit Bay. These vegetation mats had already been displaced via coastal erosion or thaw slumping. Each mat consisted of a vegetation layer, an organic soil layer, and some mineral soil.

The field team established 3 experimental manipulations within each thaw slump (see Figure 5). Each manipulation consisted of three 1m² plots.

The first test plot was left

bare (control). The second plot was seeded using a mixture of seeds collected in the previous year (see Figure 6 on Page 10 for a list of the species that were used and a map of the seed collection sites). By comparing this quadrat to the bare (or control) quadrat, we should be able to test whether manual seeding is more effective than wind dispersal, which occurs naturally.

The third plot was covered using a vegetation mat. The vegetation on each mat was characterized by

%Herbaceous, % Grassy, % Shrub species.

Ground Temperature sensors were installed at 0.5m, 1m, and 1.5m beneath each plot. This will allow us to examine how seeding and vegetation mats influence near-surface ground temperature.

Key questions are:

- Can vegetation be used to restore disturbed permafrost?
- What method of revegetation has the largest influence on ground temperature?

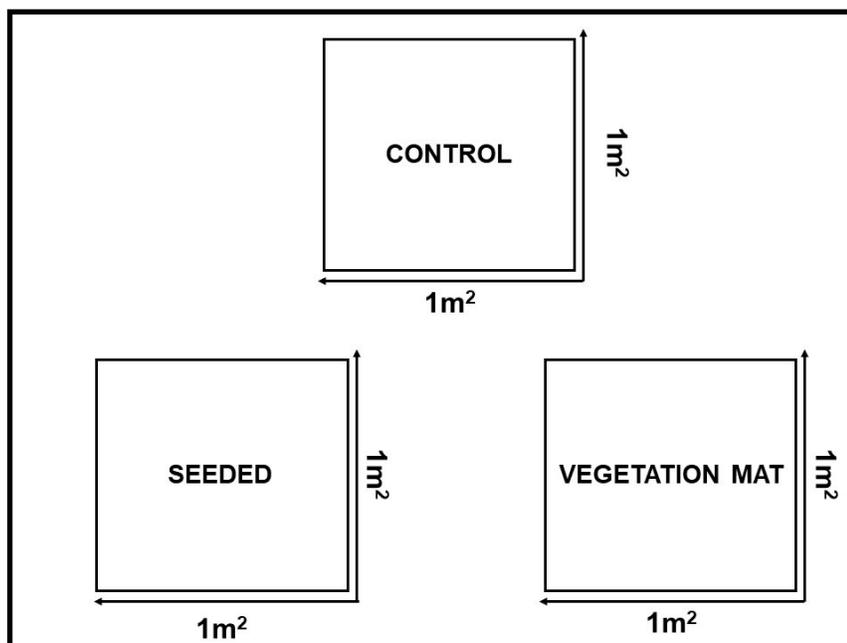


Figure 5: Diagram of one experimental manipulation. Each manipulation has 3 quadrats (one control, one seeded, and one with a vegetation mat). Three Test Plots were established at each study site (Imnaqpaaluk or Peninsula Point, Galiptat Area or North Pingo Point, and Tuktoyaktuk Island).

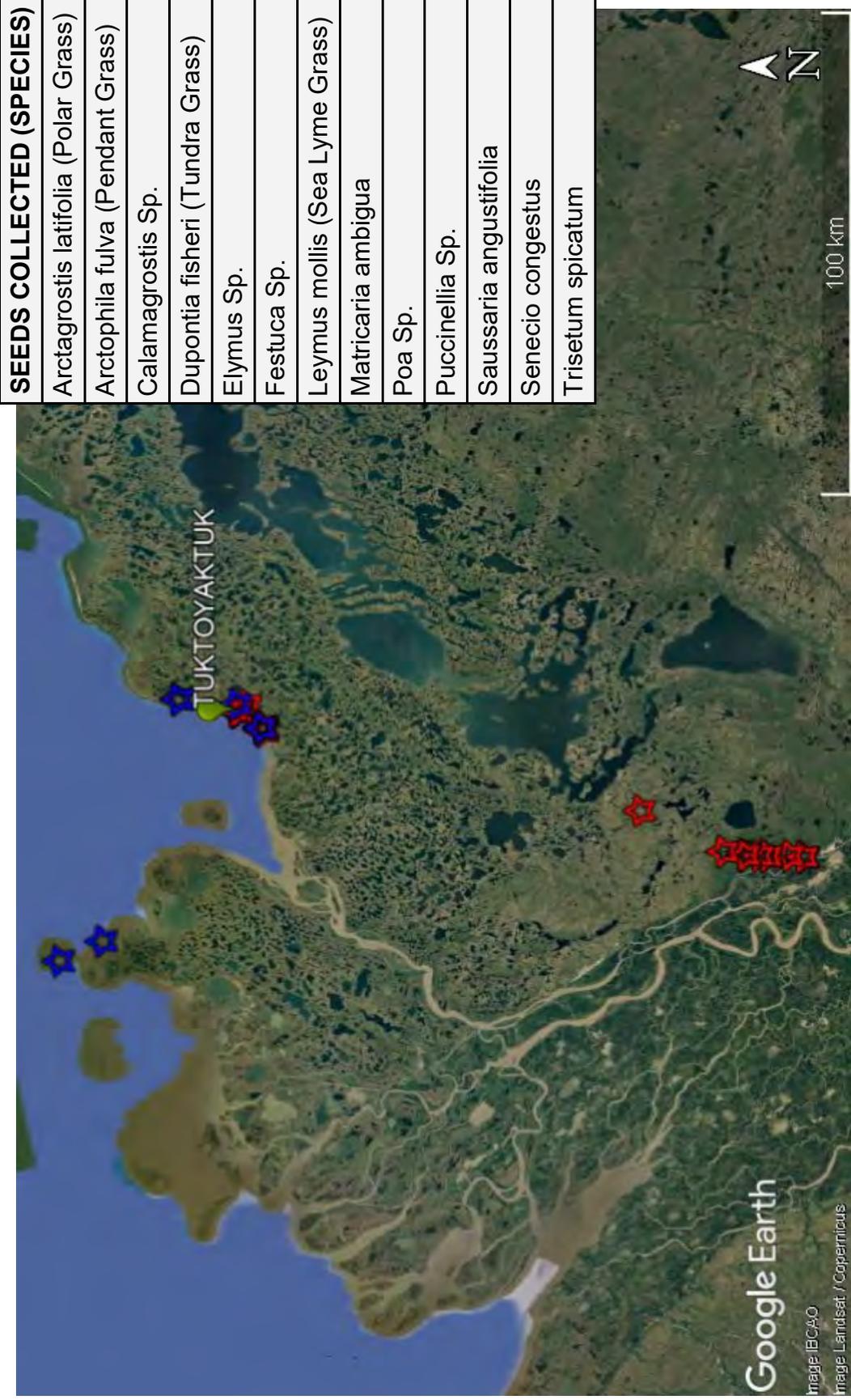


Figure 6: Seed collection sites are indicated in red. The seeds collected are listed in the table on the top right corner. Water sampling sites are indicated in blue.

Plans for 2021...

- Hold in-person meetings with the Tuktoyaktuk Hunters and Trappers Committee, the Inuvialuit Land Administration, and the Tuktoyaktuk Community Corporation to discuss the project progression and present preliminary results (Fall/Winter 2021).
- Obtain current, detailed imagery from each study site using an eBee SenseFly Drone (Summer 2021).
- Conduct a detailed water sampling campaign to track the sediment flux from the Mackenzie River out to the Beaufort Sea (Summer 2021)
- Examine ground temperature data collected from below the vegetation plots established at each study site (Summer/ Fall 2021).
- Monitor the quadrats within each vegetation plot for (plant height, % cover, species composition).

Acknowledgements

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Elias Services Ltd.

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Check out the project website at:

<http://nwtresearch.com/projects/environment/>

[beaufort-sea-coastal-restoration](http://nwtresearch.com/projects/environment/beaufort-sea-coastal-restoration)