Nunavut Research Institute

License Holder Reporting requirements For research undertaken in the 2025 calendar year (commencing January 01, 202**5** and ending December 31, 2025)

Prepared by M. Lafreniere
For multiyear Scientific Research Licence number: 02 022 25-RM

Project Title:

Long-Term Monitoring of Climate Change Impacts on Arctic Land and Water Ecosystems at Cape Bounty, Melville Island

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Project Leader(s) 2025: Full name, affiliation, and contact information (address, phone number, email) of each project leader (principle investigator and co-PIs)

1. Melissa Lafrenière (PI) : Queen’s University; melissa.lafreniere@queensu.ca; 613-533-6030
2. Neal Scott (Co-PI): Queen’s University; neal.scott@queensu.ca; 613-533-6000 ext. 75915
3. Zoe Panchen (Co-PI): Acadia University; zoe.panchen@acadiau.ca
4. Carl Mitchell, University of Toronto, carl.mitchell@utoronto.ca

Project Team 2025: Full name, affiliation, and address (name of city/community and province/territory/state) of each member of the project team

4. Cedelle Pereira: Queen’s University, Kingston, ON
5. David Atkinson, Toronto Metropolitan University, ON
7. Emma Vanderbelt, Queen's University, Kingston, ON
8. Natalie de Freitas, Queen's University, Kingston, ON
9. John Kinross , Queen's University, Kingston, ON
10. Tanya Koletic, Queen's University, Kingston, ON
11. Rory Wilkinson, Queen's University, Kingston, ON
12. Amelie Delasalle, Queen’s University, Kingston, On
13. Katerina McSween, University of Toronto, Toronto, ON
14. Teddi Pollak, Acadia University, Wolfville, NS

Project Leader(s) 2026: Full name, affiliation, and contact information (address, phone number, email) of each project leader (principle investigator and co-PIs)

1. Melissa Lafrenière (PI) : Queen's University; melissa.lafreniere@queensu.ca; 613-533-6030
2. Neal Scott (Co-PI): Queen's University; neal.scott@queensu.ca; 613-533-6000 ext. 75915
3. Zoe Panchen (Co-PI): Acadia University; zoe.panchen@acadiau.ca
4. Carl Mitchell, University of Toronto, carl.mitchell@utoronto.ca
5. David Atkinson, Toronto Metropolitan University, ON

Project Team 2026: Full name, affiliation, and address (name of city/community and province/territory/state) of each member of the project team

4. Cedelle Pereira: Queen's University, Kingston, ON
5. Sophie Pouillé, Queen's University, ON
7. Natalie de Freitas, Queen's University, Kingston, ON
8. Cooper Lazier, Queen's University, Kingston, ON
9. Jorja Garcelon , Queen's University, Kingston, ON
10. Sara Postuma, Acadia University, Wolfville, NS.
11. Laurel Berg-Khoo, Acadia University, Wolfville, NS
12. Alder O'Reilly, Acadia University, Wolfville, NS
13. Adelheid Willsie, University of Toronto, Toronto, ON
14. 2 TBD, Queen's University, Kingson ON

Abstract: A concise summary of what was done, found, and concluded to date, and how the results/information will be used. This summary must be translated into the appropriate dialect of Inuktut. Suggested length: 250-300 words. ***This section will be published in the NRI's annual compendium of licensed research**

Since 2003, we have been conducting research at the Cape Bounty Arctic Watershed Observatory (CBAWO) to understand the impacts of climate change on land and water systems. This long-term study represents the most extensive record of changes in rivers and lakes in Nunavut, providing valuable insights into how these systems, along with fish and vegetation, may respond to climate and permafrost changes.

We now have a 22-year record of summer air temperatures and rainfall, in addition to 10-19 year records of stream, lake, soil and terrestrial ecosystem responses to weather and permafrost changes. Our research has shown that thawed permafrost soils release nutrients, old organic carbon, and mercury to the atmosphere, streams and lakes. The combination of deeper thaw, increasing landslides and slumping, and shifting rainfall and snowfall patterns are changing stream flows, water quality and the health of lake ecosystems and fish populations. These landscape, water, and ecosystem changes are expected to continue with future climate warming. The research team at the CBAWO and our partners across Canada and internationally, continue to use our legacy of

observations, in concert with to build a more complete understanding of how the land and water processes and ecosystems respond to climate, with the aim of providing Inuit and northerners, with the best knowledge possible to inform wildlife, environment, and community management and adaptation plans.

Our team communicates our findings through both public and academic venues, including national and local news media as much as possible, meetings and events we host for the community in Resolute Bay, and through posts of our activities on Resolute social media pages. Additionally, we present results at national and international conferences (e.g. Arctic Change, and Permafrost Net, and Canadian Geophysical Union) and in open access academic journals.

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ᑕᐃᒪᙱᓕᓂ 2003-ᒥ, ᖃᐅᔨᓴᖃᑦᑕᖅᓯᒪᔪᒍᑦ ᑭᙱᕐᓂ ᐅᑭᐅᖅᑕᖅᑐᒥ ᐃᒪᕐᓂᒃ ᖃᐅᔨᓴᕝᕕᖕᒥ (CBAWO) ᑐᑭᓯᓇᓱᒃᓲᑕ ᓯᑕᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓚᐊᓂᖕᒐᑕ ᐊᒃᑐᐃᓂᕆᔭᖕᒐᓂᒃ ᓄᓇᒧᑦ ᐃᒪᕐᒧᓪᓗ ᐋᖅᑭᒃᓯᒪᓂᖏᓐᓄᑦ. ᑖᓐᓇ ᐊᑯᓂᐳᓗᒃ ᖃᐅᔨᓴᕐᓂᖅ ᑭᒡᒐᖅᑐᐃᕙᖅ ᓯᕗᑐᓂᖅᐹᒥᒃ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᐊᓯᔾᔨᖅᐸᓪᓚᐊᓂᐅᔪᓂᒃ ᑰᖕᓂᒃ ᑕᓯᕐᓂᒡᓗ ᓄᓇᕗᒻᒥ, ᑐᓂᓯᓪᓗᓂ ᐋᑐᑎᖃᖅᑐᓂᒃ ᖃᐅᔨᒪᓂᐅᔪᓂᒃ ᖃᓄᖅ ᑕᒪᒃᑯᐊ ᐊᐅᓚᓂᐅᔪᑦ, ᐃᓚᒋᓪᓗᒋᑦ ᐃᖃᓗᐃᑦ ᐱᕈᖅᑐᐃᓪᓗ, ᑭᐅᔪᓐᓇᕐᒪᖖᑕ ᓯᑕᐅᑉ ᐊᓯᔾᔨᖅᐸᓪᓚᐊᓂᖓᓄᑦ ᐊᒻᒪᓗ ᖁᐊᖑᐃᓐᓇᖅᑐᒧᑦ ᐊᓯᔾᔨᖅᐸᓪᓚᐊᓂᖓᓄᑦ.

ᒫᓐᓇᐅᔪᖅ 22-ᓄᑦ ᐊᕐᕌᒍᓄᑦ ᑎᑎᕋᖅᓯᒪᔪᖃᓚᖅᑐᒍᑦ ᐊᐅᔾᔭᑯᑦ ᓯᑕᐅᑉ ᐆᓇᕐᓂᖓᓂᒃ ᐊᒻᒪᓗ ᓯᑯᖃᕐᓂᖓᓂᒃ, ᐃᓚᒋᓪᓗᓂᐅᒃ 10-19-ᓄᑦ ᐊᕐᕌᒍᓄᑦ ᑎᑎᕋᖅᓯᒪᔪᓂᒃ ᑰᑉ, ᑕᓯᐅᑉ, ᓄᓇᐅᑉ ᐊᒻᒪᓗ ᓄᓇᐅᑉ ᐊᕙᑎᖓᑕ ᑭᐅᔾᔪᑎᖏᓐᓂᒃ ᓯᑕᒧᑦ ᐊᒻᒪᓗ ᖁᐊᖑᐃᓐᓇᖅᑐᒧᑦ ᐊᓯᔾᔨᖅᐸᓪᓚᐊᓂᖏᓐᓄᑦ. ᖃᐅᔨᓴᕐᓂᕆᔭᕗᑦ ᑕᑯᔅᓴᐅᑎᑦᑎᓯᒪᕗᖅ ᐊᐅᒃᓯᒪᔪᑦ ᖁᐊᖑᐃᓐᓇᖅᑐᑦ ᓄᓇᐃᑦ ᓴᖅᑭᑦᑎᕙᓪᓕᑕ ᓂᕿᑦᑎᐊᕙᓂᒃ, ᐱᑐᖃᕐᓂᒃ ᐳᔪᕐᓗᖕᓂᒃ, ᐊᒻᒪᓗ ᓴᕝᕋᔾᔭᔅᓂᒃ ᓯᓚᒧᑦ, ᑰᖕᓄᑦ ᐊᒻᒪᓗ ᑕᓯᕐᓄᑦ. ᑲᑎᙱᓂᖅᒋᑦ ᐃᑎᓂᖅᓴᒥᒃ ᐊᐅᒃᐸᓪᓚᐊᓂᖅ, ᓄᓇᐅᑉ ᓯᒥᒃᓯᕙᓪᓚᐊᓂᖓ ᐊᒻᒪᓗ ᓯᒥᒃᓯᕙᓪᓚᐊᓂᖓ, ᐊᒻᒪᓗ ᓯᑯᖃᕐᓂᐅᔪᖅ ᐊᒻᒪᓗ ᐊᐳᑎᖃᕐᓂᐅᔪᖅ ᐊᓯᔾᔨᖅᐸᓪᓚᔪᑦ ᑰᑉ ᑰᓐᓂᖏᓐᓂᒃ, ᐃᒪᐅᑉ ᐱᐅᓂᖓᓂᒃ ᐊᒻᒪᓗ ᑕᓯᐅᑉ ᐆᒪᔪᖁᑎᖏᓐᓂᒃ ᐊᒻᒪᓗ ᐃᖃᓗᐃᑦ ᖃᖓᐅᓂᖏᓐᓂᒃ. ᑕᒪᒃᑯᐊ ᓄᓇᐅᑉ, ᐃᒪᐅᑉ, ᐊᒻᒪᓗ ᐆᒪᔪᐃᑦ ᐊᓯᔾᔨᖅᐸᓪᓚᐊᓂᖏᑦ ᓂᕆᐅᒋᔭᐅᔪᑦ ᑲᔪᓯᓂᐊᕐᓂᖏᓐᓂᒃ ᓯᕗᓂᒃᓴᒥ ᓯᑕᐅᑉ ᐅᖅᑰᓯᕙᓪᓚᐊᓂᖓᓄᑦ. ᖃᐅᔨᓴᖅᑎᐅᔪᑦ CBAWO-ᑯᓐᓂ ᐊᒻᒪᓗ ᐱᓇᓱᖃᑎᒋᔭᕗᑦ ᑲᓇᑕᓕᒦᒥ ᐊᒻᒪᓗ ᓯᓚᕐᔪᐊᒥ, ᑲᔪᓯᔪᑦ ᐊᑐᕐᓂᕐᒥᒃ ᑭᖑᕚᓇᔾᑎᓐᓂᒃ ᑕᑯᓯᒪᔾᑎᓐᓂᒃ, ᑲᑐᔾᔨᓪᓗᑎᒃ ᓴᓇᓂᕐᒥᒃ ᐃᓗᐃᒃᑲᐅᓂᖅᓴᒥᒃ ᑐᑭᓯᐅᒪᓂᕐᒥᒃ ᖃᓄᖅ ᓄᓇᒥ ᐊᒻᒪᓗ ᐃᒪᕐᒥ ᐃᓕᖅᑯᓯᐅᔪᑦ ᐊᒻᒪᓗ ᐊᕙᑎᐅᔪᑦ ᑭᐅᖃᑦᑕᕐᒪᖖᑕ ᓯᓚᒧᑦ, ᑐᕌᒐᖃᖅᖢᑎᒃ ᐱᑕᖃᖅᑎᑦᑎᓂᕐᒥᒃ ᐃᓄᓐᓂᒃ ᐊᒻᒪᓗ ᐅᑭᐅᖅᑕᖅᑐᒥᐅᓂᒃ, ᐱᐅᓂᖅᐹᓂᒃ ᖃᐅᔨᒪᓂᐅᔪᓂᒃ ᐊᕙᑎᓕᕆᓂᕐᒧᑦ, ᐊᐅᓚᑦᑎᓂᕐᒧᑦ ᐊᒻᒪᓗ ᐆᒪᔪᓕᕆᓂᕐᒧᑦ ᑐᓴᐅᒪᑎᑦᑎᓂᕐᒧᑦ.

ᐃᖅᑲᓇᐃᔭᖅᑎᒋᑦ ᑐᓴᐅᒪᑎᑦᑎᖃᑦᑕᖅᑐᑦ ᖃᐅᔨᔭᑦᑎᓐᓂᒃ ᑕᒪᒃᑮᑎᒍᑦ ᑭᒃᑯᑐᐃᓐᓇᕐᓄᑦ ᐊᒻᒪᓗ ᐃᓕᓐᓂᐊᕝᕕᓐᓄᑦ, ᐱᖃᓯᐅᑎᓪᓗᒋᑦ ᑲᓇᑕᒥ ᐊᒻᒪᓗ ᓄᓇᓕᓐᓂ ᐱᕙᓪᓕᐊᔪᓕᕆᔾᔪᑦ ᐊᔪᕐᓇᖏᑦᓯᐊᒻᒪᑦ, ᑲᑎᒪᓂᐅᔪᑦ ᐊᒻᒪᓗ ᖃᓄᐃᓕᐅᕐᓂᐅᔪᑦ ᑐᙱᓱᒃᑎᑦᑎᕙᑦᑐᑦ ᓄᓇᓕᓐᓄᑦ ᖃᐅᓯᐃᑦᑐᒥ, ᐊᒻᒪᓗ ᓴᖅᑮᔭᖅᑎᑦᑎᓂᒃᑯᑦ ᐱᓕᕆᐊᕆᕙᑦᑕᑎᓐᓂᒃ ᖃᐅᓯᐃᑦᑐᒥ ᖃᕋᓴᐅᔭᒃᑯᑦ ᑐᓴᐅᒪᖃᑦᑕᐅᑎᔾᔪᑎᒃᑯᑦ ᒪᑉᐱᖅᑐᒐᖏᓐᓂ. ᐊᒻᒪᓗᑦᑕᐅᖅ, ᓴᖅᑭᑦᑎᖃᑦᑕᕐᒥᔪᒍᑦ ᖃᐅᔨᔭᐅᔪᓂᒃ ᑲᓇᑕᒥᒦᒥ ᓄᓇᕐᔪᐊᕐᒥᓗ ᑲᑎᒪᓂᐅᔪᓂ (ᓱᕐᓗ ᐅᑭᐅᖅᑕᖅᑐᒥ ᐊᓯᔾᔨᕐᓂᐅᔪᖅ, ᐊᒻᒪᓗ ᖁᐊᖑᐃᓐᓇᖅᑐᖅ ᑲᑐᔾᔨᖃᑎᒌᑦ, ᐊᒻᒪᓗ ᑲᓇᑕᒥ ᓄᓇᐅᑉ ᖃᓄᐃᑦᑐᙱᓂᖓᓄᑦ ᑲᑐᔾᔨᖃᑎᒌᑦ) ᐊᒻᒪᓗ ᒪᑐᐃᖓᔪᓂ ᐃᑦᓐᓂᐊᕈᑎᒃᓴᐅᔪᓂ.

Key messages: Concise, plain language summary of key take-away messages of work to date, findings and conclusions. Preferably 3-5 points, in bullet form.

- permafrost thaw is increasing the flow of water, nutrients, old carbon, sulfate, and mercury from previously frozen soils
- organic carbon from old permafrost soils are likely broken down and converted to atmospheric CO_2 more rapidly than organic matter in active layer soils

- summer rainfall events, that are increasing in frequency and intensity, are more efficient at moving materials (sediment, nutrients, sulphate, and carbon) from the land to waterways, than is snowmelt
- vegetation and soils are likely to take up and store more atmospheric CO2 under if the regional climate is warmer and wetter, but a warmer dryer Arctic will likely lead to vegetation becoming a source of CO2 to the atmosphere
- deep thaw and increased inputs of sediment to lakes, lead to increases in sulphate ion concentrations, and fish contaminant concentrations
- Warmer summer air temperatures can trigger the resumption of streamflow, with the water supplied by meltwater originating from ground ice in shallow permafrost.

Objectives: Project objectives, preferably in bullet form.

1. Measure winter snow accumulation using both remotely piloted aircraft systems and ground measurements to validate results.
2. Collect water samples from streams and take water quality measurements to investigate how permafrost disturbances affect dissolved organic matter (DOM) composition and phosphorus loads in High Arctic streams, ponds and lakes.
3. Investigate sources of metals and sulfate in late summer flow derived from groundwater.
4. Collect active layer and permafrost samples to quantify carbon, nitrogen, and metals that can be derived from thawing permafrost across different soil types.
5. Quantify terrestrial methane (CH4) fluxes across gradients of temperature and moisture in our ITEX site.
6. Set up new experimental plots near the ITEX site in order to evaluate the impact of climate extremes on local vegetation.

Annual activities: A description of activities and methods carried out during the current reporting period. This section should answer the questions: What? Where? When? Who? How? Include dates team members conducted research at remote field sites or collected data (including interviews) in communities; append a map with locations and/or coordinates of remote field sites, if applicable.

In 2025, we had a camp of 4 - 8 people from May to early August.

The first team in May (Lafreniere, Kinross , Atkinson, and Vanderbelt) were unable to make it to camp due to weather delays and were unable to conduct the UAV survey of snow, or obtain the snow and lake water samples we had intended. We are therefore attempting to conduct this work in 2026 (see challenges below)

Due to these weather delays, combined with the absence of a PI due to personal circumstances, we were unable to open camp until the snow had largely thawed and airstrip was dry enough to allow for aircraft to land. Camp finally opened in early July, our the second team (Panchen, Pollak, Desrocher, and Wilkinson) arrived to begin taking measurements of the plants to determine growth rates,

patterns and the carbon gas exchanges between soils, plants and the atmosphere.

In mid July new members (Mitchell, Kolectic, McSweeny; deFreitas, Vandebelt) arrived to continue the vegetation and carbon flux research, and initiated the stream water quality and discharge measurements and collected samples one or two times a day to determine patterns in sediment and nutrients in waters over the season and across the landscape.

Later in July some of our crew returned to Resolute where they joined members of the Environment and Climate Change Canada team to participate in leading outreach activities in the community, demonstrating some of the ways that we collect water and organisms that we study in the lakes. The new crew arriving at Cape Bounty (Lafreniere, arrived with two Queen's students O'Meara and Lingertat), joined the remaining team members to complete some groundwater measurements, and sampling. This team also installed new multiparameter sondes to collect high frequency measurements of turbidity, nitrate, dissolved organic matter and electrical conductivity. .

Results and Achievements: Findings and results to date of the above activities, highlighting any key research achievements (see guide below for formatting tips regarding tables and figures).

Much of the samples and data collected in 2025 are still being analyses by most of the students involved. However, results from studies delivered from previous years were completed, and some preliminary results from 2025 were presented at the *Arctic Change conference in Calgary* in December. The recent key findings are summarized below.

MSc student Clara Schryer, investigated full watershed scale C budgets, by integrating both terrestrial atmosphere CO_2 and methane (CH_4) exchanges (vertical C fluxes) with the stream carbon or lateral C fluxes (dissolved organic carbon, dissolved CO_2, particulate organic carbon and dissolved inorganic carbon). They collected terrestrial ecosystem C fluxes across the different vegetation classes, and used remote-sensing data to upscale these point CO_2 measurements to the respective watershed areas and calculate a net CO_2 budget, and used daily stream samples and stream discharge records ot calculate the mass of C exports from streams. Their study illustrates that The watersheds were net sources of carbon to the atmosphere during the growing season, with terrestrial CO_2 emissions accounting for 97.6%-99.6% of total C losses, and C lost/exported by streams represented less than 2% of total C lost. Variations between 2023 (a near record warm summer) and 2024 (a relatively cool summer) showed a nearly 50% reduction in terrestrial CO2 emissions during the warmer summer, owing both to increased uptake in highly vegetated areas, and smaller emissions in partially vegetated areas. Stream carbon export on the other hand was nearly double in 2023 relative to 2024 due to both increased discharge and increased dissolved carbon concentrations. Even with these differences, stream carbon export still only accounted for 1.6% of total carbon losses, confirming that terrestrial CO2 emissions dominate in these watersheds. As climate warming continues, the CO_2 sink in this environment is expected to increase due to enhanced CO_2 uptake with warming.

Lafrenière presented results of a study from data that were derived from field research conducted in 2023 by undergraduate student Gillian Duff. work presents the hydrological and geochemical responses of hillslope watersheds at the Cape Bounty Arctic Watershed Observatory (CBAWO) on Melville Island, Nunavut, during the unusually warm and dry summer of 2023. Higher than normal July temperatures, and limited rainfall resulted in significant active layer development. During the

late-season flow period, and in the absence of rainfall, runoff resumed in two of the streams that had ceased flowing in early July, indicating runoff was sourced from groundwater flow derived from thawing soils. The runoff sampled in a catchment where 11% of the area was affected by active layer detachment slides in 2007, exhibited tenfold higher dissolved organic carbon (DOC) concentrations, and 100 fold higher sulphate ion concentrations relative to mean concentrations observed in this stream before flow ceased. The dissolved ion and DOC concentrations in three other catchments (undisturbed) that resumed flowing, or that continuing flowing at this time, were also higher, however these increases were muted (no more than a doubling in concentrations) relative to those observed in the previously disturbed watershed. The geochemistry in the late season runoff from the disturbed catchment serves as a chemical fingerprint of water emanating from deep permafrost in this area, and indicates that elevated DOC, and sulfate to chloride ratios in runoff may be key tracers for permafrost thaw. The next steps for this research involve investigating the source of the elevated sulfate in deep permafrost. It may be that this is marine sulphate that is concentrated in the deep buried Quaternary marine clays, or it may be derived from the oxidation of sulfide metals (such as pyrite, iron sulfide), which is a source of acidity and high metal concentrations that can have adverse effects on aquatic ecosystems; a process that has been observed across the Yukon and Alaskan Arctic in recent years.

MSc student Noa Caspi's research examines the impacts of warming, precipitation and snow depth on net methane (CH_4) exchange using the International Tundra Experiment site at the CBAWO and laboratory incubations. The first study examines the effects of experimental winter snow enhancement and summer warming treatments on summer CH4 fluxes. Contrary to expectations, plots that received more snow accumulation exhibited stronger net CH4 uptake, with a significant relationship between snow depth and cumulative seasonal flux ($R2=0.30$, $p<0.001$). Findings suggest that increased snow accumulation during the winter may increase the CH4 sink capacity of upland soils. The second study focused on laboratory incubations examining CH4 dynamics with soil depth and assessing the effects of a long-term field experiment on soil characteristics. Results showed CH4 oxidation potential was highest between 0-15cm. There was no observed effect of long-term enhanced snow or warming on soil characteristics or CH4 incubations. Warming treatments at the site had no effect on soil temperatures, which likely explains the lack of observed effects on CH4, in addition the small sample size and high variability in results was an additional source of uncertainty.

The results of all these research projects reinforce the need for systematic multi-year measurements of the responses of terrestrial, fluvial and permafrost processes, as they vary in both time (seasonally, and interannually) and according to spatial differences in landcover characteristics that control snow accumulation, moisture, vegetation, and permafrost conditions to fully understand how landscape stability, water flows, water quality, plants, and fish populations are likely to be impacted by warming and changing precipitation patters in the High Arctic.

Challenges/Obstacles: In this section, please comment on any challenges/obstacles (if any) that you experienced during this project year. If there were any actions to mitigate or resolve these challenges, please list them here. Were any concerns raised regarding the conduct of research team members or the impacts of the project?

In 2025, a number of circumstances beyond our team's control resulted in a shorter field season,

and the dropping of many planed science activities. First, our snow sampling and snow survey team that left Ottawa May 20st, were delayed by weather and mechanical issues, and only arrived in Resolute Bay the day of our planed field deployment (May 24th). Upon arrival the weather at Cape bounty and/or Resolute prevented access to the field site for several weeks. By which time, we had to extend our trip in hopes of getting out to camp. At the same time, other circumstances meant that one of our PIs and the planned camp supervisor for June was unable to travel, and having no alternate available to supervise camp for June, the camp was inaccessible until Dr. Panchen and her student arrived in Resolute early July. This meant that our early season team (Lafrenière, Kinross, Vandebelt, and Atkinson) returned home without having been able to conduct any of the planned research; and the snowmelt/vegetation team (A. Delasalle, and R. Wilkinson), were without a supervisor and could not be deployed. These events undeermined the snow pack accumulation research, as well as the early spring terrestrial and soil ecosystem research.

The team finally was able to establish camp ~ July 8th, 2025. From that point onward the vegetation and terrestrial ecosystem research, as well as the work planned by Dr. Mitchell's team was largely successful. Finally the end of July and early August proved to be very cold, with snow falling and freezing temperatures setting in by August 3rd or 4th. This limited the late season biogeochemical and hydrological research efforts, as most of the hillslope streams that dried up earlier in July, never resumed flowing, given that winter was upon us early, we decided to close camp August 8th, as there was little left for the team to do.

Expected Project Completion Date: Provide month and year of expected completion date of the project.

Our current land use permit extends until February 2029. Thus our plan for now is to maintain our integrated research program until at least 2029. Ideally, we would like to keep the project going until the next International Polar Year in 2032-33 which would mark the 30th year of the Cape Bounty Arctic Watershed Observatory.

Project website (if applicable): If your project has a presence on the internet, including a website and/or social media page, please provide the link and/or account handle.

http://www.queensu.ca/geographyandplanning/fabrecc-lafreniere/home
https://capebountyresearch.com/
https://www.facebook.com/CBAWO/

Citations: Please append a complete reference list if citations are used anywhere in the document.

POLICY RELEVANCE

Does this research support policy development or decision-making in Nunavut? If yes, please describe.

The CBAWO is the only long-term research site in the Canadian High Arctic, where scientists have

come together to coordinate studies of the earth systems process and ecosystems responses to climate and environmental, and thereby examining these problems from different perspectives (vegetation communities, aquatic ecosystems, water quality and quantity) and spatial and temporal scales. The research at this site has been ongoing for 23 years.

Key research themes over this time have included quantifying changing surface water flow volumes, and stream and lake water quality (nutrient and contaminant concentrations) responses to permafrost change and climate. Additionally, our team has been using both ground based measurements and remote sensing data to measure changing terrestrial ecosystem productivity and carbon exchange rates. Our study years span a time prior to and following significant permafrost disturbances that occurred in parts of the watershed in 2007, and important inter-annual variations in summer air temperatures and rainfall. Hence, we have a data set that quantifies the magnitude and duration of changing permafrost and weather on terrestrial, and freshwater processes and ecosystem function.

The research at CBAWO therefore represents a unique source of knowledge to support decision making and developing policies related to: water security, terrestrial vegetation changes, landscape stability, fisheries, and climate change adaptation strategies.

RESEARCH OUTCOMES: BENEFITS

Community engagement: Briefly list and describe any community consultation, engagement, collaboration and outreach activities that you have undertaken for the project; describe the role(s) that community members and/or specific organizations have played in research co-design and activities.

We have approached local engagement in our research in three ways.

First, we normally have community members from Resolute, or Inuit researchers from elsewhere participate in fieldwork. In July 2024, Dorianna Malliki, ETP graduate from Naujaat, participating in ECCC's Inuit Field Research Assistant program (IFRA) conduct field work with us at CBAWO. In 2025 we were unable to recruit an IFRA participant. We hope to continue to be able to recruit a community members from Resolute or IFRA participants to participate in the research each year if possible. Often our limited logistics support requires our team members to stay in camp for 3 or more weeks, which makes recruitment of participants challenging as many IFRA participants and community members are not in a position to be able to leave home for extended periods of time.

We also promote local input, and engagement through events and meetings hosted in Resolute Bay. Most years members of our team have met with Mayor and Hamlet SAOs to discuss our work and the impacts of changing climate on water in the region. Members of our team also visit the Qarmartalik School when the opportunity arises. These visits have ranged from short presentations to judging school Science Fairs. These opportunities are positive ways to share knowledge and to encourage student interest in research. Each year members of our team host an open house meeting or other outreach event to share our research activities, findings and plans with the community, and seek their

input on our research. In July 2025, in collaboration with ECCC our team members took part in an outreach event demonstrating how we sample waters for aquatic ecosystem studies, measurements of water quality parameters, and how arctic char are measured.

Additionally, we communicate with community by providing research updates to the Resolute Bay and Cape Bounty Facebook pages throughout the year to explain our findings and activities in plain language.

In 2026, Neal Scott and Zoe Panchen will be working to establish ITEX (International Tundra Experiment) long-term monitoring plots near Resolute Bay. The goal is to use these plots to engage with residents of Resolute Bay on issues such as climate change impacts on Arctic vegetation. Once the plots are established this year, we will engage with the Qarmartalik school and the Hunters and Trappers Association in Resolute Bay to ascertain the information they would like to see obtained from these experimental plots. This work was planned for 2025, but was delayed due to circumstances that prevented Neal Scott from travelling to Resolute Bay. Ideally, our goal would be to have ongoing monitoring of these plots conducted by local students.

Youth engagement: Briefly list and describe any outreach, school or classroom activities that you have undertaken for the project; describe the role(s) that youth have played in your research activities.

See above section

Training and Employment:

How many Nunavummiut received training from team members? Please describe training and/or compensation provided.

As previously mentioned, we aim to hire at least one Nunavummiut to come to Cape Bounty to participate in field research activities. Normally this is a community member from Resolute Bay who is hired to assist with the lake water sampling and fishing with the Environment Canada team. It is not always possible to recruit a member from Resolute, as many Resolute residents have full time employment in the community, and most of those who do not, are not able to leave the community for extended periods of time. In 2024 we were fortunate to recruit the participation of Dorianna Malliki (and ETP graduate from Nunavut Arctic College) for three weeks at the CBAWO. Dorianna was compensated via the Environment and Climate Change Canada's (ECCC)Inuit Field Research Assistant (IFRA) fund. They were trained to take measurements supporting the plant phenological research, as well as the soil and plant carbon exchange research. In 2025, we were not able to train any Nunavummiut directly as part of our research, however our outreach event was a great success, with > 30+ youth participants, who learn about the way our team members study the aquatic ecosystems. In 2026, we hope to recruit some local youth to train them in how we use the open top chambers to study how warming changes vegetation growth and community structure. This will involve training them on how we measure plant abundance and seasonal growth patterns.

How many team members received training from Nunavummiut? Please describe training received and/or what knowledge sharing and/or skills exchange took place.

In 2024 there were 5 other team members in camp during Dorianna's stay, who all benefited from daily knowledge sharing on the land. Some of the knowledge exchanges concerned plant identification (especially edibles and others that are used for traditional activities), animal behavior, and weather.

In 2025, due to a combination of bad weather and unexpected circumstances for one of our camp leads, two of our students (Amelie Delasalle, Rory Wilkonson) were required to stay at PCSP in Resolute for nearly a month. During this time these students participated in several outreach activities in the community with PCSP staff. Additionally the students had the opportunity to go out to the flow edge by dog sled with local guide Devon Manik. Through this experience they learned about the importance of this means of travel for hunting, survival, and culture in the community.

How many Nunavummiut received employment? Please describe employment type and length, role(s) and responsibilities, and compensation provided.

In 2024 Dorianna was employed for three weeks. I am not aware of the compensation that she received as an IFRA with ECCC. In 2025, upon the return to Resolute, our team members with Environment and Climate Change Canada employed Debbie Iqaluk to assist with dissecting the fish caught at Cape Bounty, and sampling the tissues for contaminants. I am not aware of the salary or contract arrangements between the parties.

How many Nunavummiut received honoraria as research participants? Please describe method of participation (interview, observation, sample, survey, etc.), including compensation provided.

None

Please explain how the project directly benefited Nunavut organizations and/or businesses (e.g., through contract services, local purchases, equipment donations, etc.)

Our team purchased a large amount of fresh food and canned goods from the Co-Op in Resolute Bay. To support our camp. For our outreach activity, we rented space at the Hamlet, and purchased door prizes, food and refreshments from the Co-Op and also at South Camp.

OPTIONAL: Nunavut Team Members, hires, and/or trainees (excluding research participants e.g., interviewees)

The NRI is creating an inventory of Nunavummiut who are skilled and/or interested in research. The information provided below will not be shared publicly but will support long-term capacity sharing by connecting local and visiting researchers with research talent in each community.

Name	Expertise/skills	Training/interest areas	Contact Info	Community

Academic Mobility

If you are affiliated with an academic institution, please answer the following question: For which Level of Project(s) will the data be used? (Check all that may apply)

- [x] Research
- [x] Post-Doctoral Research
- [x] PhD Thesis
- [ ] Masters (Major Research Paper)
- [x] Masters (Thesis)
- [ ] Graduate Course Project
- [ ] Staff/Administration Research
- [x] Undergraduate Honours Thesis

BUDGET

Please complete the table below to detail your projected and actual research expenditures during the reporting period.

Category	Planned/Approved Expenditure	Actual Expenditure
Travel and Accommodation	171670	171670
Equipment, Materials and Supplies	26550	28550
Salaries/Wages for Nunavut residents	2400	2400
Salaries/Wages for non-Nunavut resident	72,000	72,000

researchers		
Professional Fees and services in Nunavut	63,050	69,950
Professional Fees and Services outside of Nunavut	11,000	11,000
TOTAL EXPENDITURES	346,670	356,570

Since our budget for research at the site involves expenses incurred by 4 or more research groups, I have estimated the actual spending, as I do not have access to a fulsome accounting of actual expenditures.

The budgets presented here represent best estimates based on the number and types of personnel in camp, and duration of stays for 2025. The planned budgets presented here represent best estimates of actual expenditure based on the number and types of personnel in camp, and duration of stays for 2025. These are likely on the conservative side of our expenditures, as I suspect that food, materials, supplies and shipping costs are underestimated here. The higher "actual" costs reported here reflect the costs associated with accommodation and travel costs associated weather delays.

List the total $ amount of funding from each funding source for your full research program, including in- kind support

Funding Sources	**Amount**
Polar Continental Shelf in Kind logistics	171,600
Northern Scientific Training Program	26,250
NSERC Discovery Grants to PIs (Lafrenière, Mitchell, Devoie)	70,140
Queen's Summer Work Experience Program (salary contributions)	60,500
Environment and Climate Change Canada	2,400

RESEARCH OUTPUTS / REPORTING TOOLS

What research outputs were generated? Please list below and append copies of each. Specify which outputs (if any) may be made public on the NRI research licensing database.

Have peer-reviewed manuscripts been published as a result of your project? If Yes,

complete the following table:

*publications from since 2025

Full citation	Publicly accessible/ free to access (Y/N)	Link (if available) and DOI (if available)

*Adediji JO, *Momejian N, Lafrenière MJ, Guan E, Duchesne PN, Scott N. (submitted) Spatial Variability in SOC decomposability linked to Vegetation Type Influences Carbon Release Rates in High Arctic. Environments, ID#3776843; (revisions)	Revised and resubmitted	
Thomas, M., Fouché, J., Titeux, H., Morelle, C., Bemelmans, N., Lafrenière, M. J., *Heslop, J. K., and Opfergelt, S. (2025). Mineral-bound organic carbon exposed by hillslope thermokarst terrain: case study in Cape Bounty, Canadian High Arctic, EGUsphere [preprint],	Revised and resubmitted	DOI:10.5194/egusphere-2025-3428.
Rodenhizer H. et al (69 authors, Lafrenière MJ listed 30th) (submitted) Disturbances Increase Net Carbon Emissions in the Arctic-Boreal Zone - An Expert Assessment, submitted to Nature Communications,	Submitted, in review	
Culha C., Godsey S., Chartrand S., Lafrenière MJ, McNamara J., Kirchner J. (submitted) Characterizing runoff response to rainfall in permafrost catchments and its implications for hydrological and biogeochemical fluxes in a warming climate *Hydrology and Earth Systems Sciences*	Submitted, in review	

If No, do you intend to submit a manuscript (or manuscripts) for peer reviewed public

- All graduate student and PDF research projects will eventually result in published manuscripts in open access peer reviewed journals. Many of the projects from 2023 to 2025 are in submission or revision, there were no new peer-reviewed publications from the project in 2025

Were non-peer reviewed materials produced to either communicate or synthesize results to the public? Examples of these materials include (but are not limited to): websites, reports, brochures, podcasts, webinars, presentations, non-peer reviewed publications, etc.

If Yes, complete the following table:

Graduate Student Theses and Conference Presentations	Description of Materials	Link
Caspi, N (2025) Impact of Enhanced Temperature and Snowfall on Soil Methane Dynamics in High Arctic Tundra, MSc Thesis, Queen's University,	MSc Thesis	https://queensu.scholaris.ca/items/8dca01d8-7268-47fa-b172-4f75379f4454
Schryer, C. (2025) Integrated Terrestrial and Hydrological Carbon Budgets in High Arctic Watersheds, MSc Thesis, Queen's University,	MSc Thesis	https://queensu.scholaris.ca/items/14376c5d-f86b-4900-b5d0-b813f8972d44
Sapin Q. (2025) How to Assess Unfrozen Water Content Using Capacitance Sensors in Frozen Soils: A New Physics Based Conversion Curve, MASc, Queen's University.	MSc Thesis	https://queensu.scholaris.ca/items/580dbb80-d6ae-4f60-b4a1-02922dc7c346

Schryer C., Lafrenière M., Scott N. (2025) Integrated terrestrial and hydrological carbon budgets for two small High Arctic watersheds on Melville Island, Nunavut, #12478, CGU-CMOS Joint Congress, Saskatoon, May 25-29.	Poster	https://cmosarchives.ca/Congress_P_A/program_abstracts2025.pdf
Caspi N., Scott N. 2025 High Arctic Tundra as a Methane Sink: Effects of Snow and Warming on Soil Methane at an International Tundra Experiment (ITEX) Site on Melville Island, NU, ID#12458, CGU-CMOS Joint Congress, Saskatoon, May 25-29.	Poster	https://cmosarchives.ca/Congress_P_A/program_abstracts2025.pdf
Poirier S., Lafrenière M. (2025) Understanding the Longevity of Impacts on Nitrogen Cycling Caused by Active Layer Detachments in the Canadian High Arctic, #12366, CGU-CMOS Joint Congress, Saskatoon, May 25-29.		https://cmosarchives.ca/Congress_P_A/program_abstracts2025.pdf
Pereira P, Lafrenière MJ (2025) Geo-Manitoba and Canadian Permafrost Association, Winnipeg, September 22-26. (*award for best poster)	Poster	
Kirk, J. Barst B., Tetreault G., Burke S., Iqaluk D., Wang X., Gleason A., Sett A., Lamoureux S., Lafrenière M. (2025) Temporal Trends of Mercury and Condition Factors in Arctic Char from Paired Lakes Influenced by Increased Turbidity and other Climate-related Drivers, #298 ArcticNet ASM, Calgary, Dec 14-18	Poster	
Lafrenière, M; Poirier, S., Duff, G. (2025) Geochemical Signature of Deep Permafrost Revealed in Runoff from Watershed Affected by Active Layer Detachments, #347 ArcticNet ASM, Calgary, Dec 14-18 (oral)	Oral	
Barst B. Leggatt M., Hawkins K., Tetreault G., Kirk J., Muir D., Mitchell C., Lafrenière M. (2025) #523, Tracking the flow of mercury through the food webs of paired high Arctic lakes impacted by climate change ArcticNet ASM, Calgary, Dec 14-18	Poster	
Macsween K., Mitchell C., Panchen Z., Pollack T., Bullen E., Scott N., Lafrenière M. (2025) Mercury concentrations in arctic vegetation and lichen in relation to enhanced warming and altered snow deposition, #193, ArcticNet ASM, Calgary, Dec 14-18 (oral)	Oral	

Did your project develop a communications plan? Please describe communications/reporting tools used, and list the target audience for each and/or who requested which.

Our project does not have a formal communications plan.

How were Nunavummiut credited and/or acknowledged in all project outputs, such as co-authorship, participant biographies, article acknowledgements, etc.

Nunavummiut who assisted with the data or sample collection are acknowledged on research outputs as co-authors.

DATA AND INTELLECTUAL PROPERTY

Did you enter into a research agreement, data-sharing agreement and/or intellectual property rights agreement with a community and/or designated Inuit organization (DIO)? If yes, please explain.

No we did not enter into a research or data-sharing agreement with a community of Inuit Organization

Do intellectual property rights apply to your research? If yes, please explain.

Who owns the data? Has the raw data been shared with the appropriate community and/or DIO? If yes, how? How is data security and storage handled by community-based co-owners?

The data is currently owned by the researchers involved including N. Scott, M. Lafrenière at Queen's University, C. Mitchell at University of Toronto, and also Z. Panchen at Acadia University.

Raw data has not been shared with the community of Resolute Bay most is still preliminary and not yet quality controlled sharing. Much of our data generated from previous years is posted on the Polar Data Catalogue, where they are available to the community.

Where is the data stored and will the data be destroyed within a set timeframe?

The data is stored on computers in the analytical facilities at Queen's and also with each PI. Additionally, PIs store their data on cloud servers (e.g. Dropbox, OneDrive) as an offsite storage.

Additionally, many data sets from previous years is posted on the Polar Data Catalogue, where they are available to the community.

Is the data trackable and/or available in a public data repository? If yes, please provide the appropriate information and/or link to ensure the findability and accessibility of the data.

The data from 2025 are not currently available in a public data repository, however once the data are complete, they will be available on a public data repository. Likely Polar Data Catalogue, as this is the public repository that we have used so far for submitting our metadata and data records.

PI Lafreniere is in the process of developing a Research Data Management plan with the team at Queen's Library to create a searchable, accessible archive of all the legacy data from the Cape Bounty

Arctic Watershed Observatory under one secure collection. Given that this will require collating data from many PIs (some now retired), it is anticipated this research data management plan take several year to develop and launch.

Data that appear in published manuscripts are available through the journal supplementary information and/or have been made available on Polar Data Catalogue, or other data repositories.

Please append a copy of your data management plan.

CLIMATE CHANGE

Is your research about climate change (causes, impacts, mitigation, adaptation, etc.)? If yes, explain.

The research conducted by our team at Cape Bounty is intimately related to climate change. The rapidly warming High-Arctic represents the world's "canary in the coal mine" for climate driven ecological and surface process changes. Warming here has already resulted in significant changes in rainfall, air temperature, and permafrost conditions. These changes in turn have important effects on terrestrial and aquatic ecosystems, water quality, landscape changes, and greenhouse gas (GHG) production and uptake.

The exchange of carbon between terrestrial and aquatic environments and the atmosphere are important control on atmospheric GHG concentrations and thus are important in regulating the magnitude of climate change. High Arctic regions are particularly vulnerable to the effects of climate change, with recent changes including altered precipitation regimes, warming soils, thawing permafrost, contaminant mobility, and changing vegetation cover.

These changes all have the potential to alter the exchange GHG between the land, water and the atmosphere. These changes can augment the rates that watershed soils and vegetation remove from the atmosphere (via photosynthesis and microbiological processes in soils), and some of these changes can have the opposite effect and increase the output of GHG some land and waters to the atmosphere. A comprehensive understanding the how the changes in Arctic watersheds with influence atmospheric GHG concentrations is critically important to create realistic climate models and improve the accuracy of predictions of future change, both in the Arctic and globally.

PHOTOGRAPHS

If possible, please provide high-resolution photos of licensed research activities that NRI may use in communication materials, organizational reporting, and other promotional purposes. The photographer and all recognizable people in each photo must sign the attached Photo and Video Release form. Please also complete the table below for each photo provided and submit to NRI along with all required NRI photo release forms. The photographer/owner will be credited in all uses of the photograph(s).

File Name	Location	Description	Subjects	Photographer/Owner	Date

Would you like your project to be considered for a research profile and promotion by the NRI? Yes