

Nunavut Research Institute 2025 Report

Project Title:

Responses of Permafrost Microbial Communities to Climate-Driven Thaw

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

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

Gwen Freeze, Field Researcher
Thompson Rivers University and Adventure Canada
Kamloops, BC, Canada

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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 Inuktitut. Suggested length: 250-300 words. *This section will be published in the NRI's annual compendium of licensed research and made available through the Isirvik research portal

The goal of this study was to assess the structure and function of soil and permafrost microbial communities across the Canadian Arctic and to better understand their responses to climate warming. This August, Gwen Freeze travelled with Adventure Canada aboard the *Ocean Endeavour* vessel on their ‘Baffin Island to Greenland’ and ‘Into the Northwest Passage’ trips, with the objective of collecting soil and permafrost samples across northern Nunavut. Soil samples were collected by digging small holes to a maximum depth of 2 feet 5 inches, with 2-3 soil samples taken from varying depths at each site. Soil sampling was successfully conducted at two locations within the Qikiqtani Region: Devon Island and Somerset Island. Permafrost could not be accessed at these two sites and was therefore not collected. Due to adverse weather conditions, no additional sampling sites could be accessed from the ship during the sampling window.

Analyses of the collected soils are ongoing and include microbial community composition profiling and soil physicochemical characterization. These samples are part of a larger

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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.

- Soil samples were collected from multiple depths at two sites in the Qikiqtani Region: Devon Island and Somerset Island.
- Analysis is ongoing and includes microbial community composition profiling and soil physicochemical characterization at each site.
- This work contributes to a broader effort to map microbial communities across the Canadian Arctic and predict how they may respond to permafrost thaw and climate warming.
- Adverse weather conditions prevented access to additional sampling sites, including permafrost collection, and sampling is therefore planned to be reattempted in 2026.

Objectives: Project objectives, preferably in bullet form.

- Characterize microbial community composition and function in soil and permafrost samples across northern Nunavut and assess how these communities are responding to climate change events.
- Develop models that explain relationships between environmental conditions and the structure of soil and permafrost microbial communities across diverse Arctic environments.
- Create models that predict how climate warming and permafrost thaw will change greenhouse gas flux and microbial community structure and function based on present day ecosystem characteristics.

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.

This August, Gwen Freeze travelled onboard Adventure Canada's *Ocean Endeavour* vessel during their 'Baffin Island to Greenland' and 'Into the Northwest Passage' trips to collect soil samples across northern Nunavut. Soil was collected on August 24th at Beechey Island (coordinates: N 74.72391°, W 91.84827°) and August 26th at Port Leopold (coordinates: N 73.85046°, W 90.24864°). Maps are attached in Appendix A.

In 1x1 meter sampling plots, a small quantity of overlying soil (~1 kg) was collected at various depths below the soil surface using a spade and shovel (e.g., top soil and at a depth of 20 cm). Sampling took no longer than 1 hour per site. All vegetation was avoided and there was careful restoration of each sampling site to its original state following soil collection. Equipment was cleaned between sampling sites with disinfectant wipes or using soap and water. Soil samples were stored in a cooler with ice while on land and transferred to a -20°C freezer upon return to the vessel. Samples were transported on ice to Thompson Rivers University in Kamloops, BC, where they remain stored at -20°C.

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).

The ability to successfully collect soil at two remote sites in the Canadian Arctic while travelling with Adventure Canada, as well as transport these samples back to TRU, is a significant achievement for this study. Despite challenging weather and field conditions, multiple soil depths could be accessed from each sampling site that represent distinct surface and subsurface horizons. Analyses are ongoing and will provide insight into microbial

community composition and soil chemistry at these sites, while also adding valuable geographic coverage.

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?

The primary challenge during this project year was the adverse weather encountered while travelling on the vessel. Several storms and unpredicted sea ice prevented many of the proposed landing sites, and alternate landing sites were accessed in many cases. As a result, only two of the seven proposed sampling sites were accessed and were able to be utilized for sample collection, reducing the number of samples obtained from the proposed plan. To mitigate this, more sampling sites could be proposed in the future to ensure that study objectives can still be met under variable field conditions, and with potential site inaccessibility and alternate site access.

There were no concerns raised regarding the conduct of research team members (solely Gwen Freeze) or the impacts of the project. Field work was carried out as proposed, ensuring minimal harm on the local environment, with only small holes dug and carefully restored, as well as ensuring minimal impact in the travels to and from sampling.

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

Extension will be submitted for 2026 with a new end date of approximately October 1st, 2026.

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.

n/a

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.

Yes, this research does support policy development in Nunavut. By providing data on soil and permafrost microbial community compositions across Nunavut, it provides a baseline to monitor environmental changes, including in relation to greenhouse gas emissions, in the future.

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.

Community consultation and engagement for this project was focused to the Hamlet of Panniqtuuq, which was our sole proposed community sampling site within the project's

scope. Initial outreach to community members was in April 2025 and directed to Anita Evic, as facilitated through Adventure Canada. In our communication we shared our research aims and plans, as well as wanted to assess interest in community employment during sampling. We had not heard back and later contacted Jack Hicks, the Senior Administrative Officer, in June 2025, who had advised us to reach out once our research license had been obtained from the NRI. However, closer to the planned field work dates, we were notified by the Nunavut Impact Review Board that it was unlikely the first half of our proposed sampling sites, including Panniqtuuq, would be approved in time. As such, we did not continue outreach with Panniqtuuq as sampling in the community was no longer feasible. Should there be the opportunity for community collaboration and engagement in future sampling efforts, we remain committed to working with local community members, with hopes to hire and compensate community members to help with research efforts.

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.

No youth outreach was undertaken in this project. In the future, collaboration and outreach with schools or youth programs is of interest for this project.

Training and Employment:

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

No Nunavummiut received training for this project, as all proposed sampling locations were remote. In future sampling efforts, we would be excited to provide training and compensation for individuals when sampling in communities.

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

Gwen Freeze, the sole team member, did not receive training from Nunavummiut, as all sampling occurred in remote locations.

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

No Nunavummiut received employment. We had intended to employ 2-3 Nunavummiut to carry out the research activities when in the community of Panniqtuuq; however, sampling did not occur in this community.

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

There were no Nunavummiut research participants in this project.

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

Unfortunately, we were unable to employ or contract any services while working in Nunavut due to the remote operation of the Adventure Canada trips and the sampling efforts. However, at the end of the voyages we travelled through Kugluktuk and donated field equipment (i.e., the shovel) to a local community member.

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)**

Research - YES

Post-Doctoral Research

PhD Thesis

Masters (Major Research Paper)

Masters (Thesis)

Graduate Course Project

Staff/Administration Research - YES

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	0	0
Equipment, Materials and Supplies	5000	5000
Salaries/Wages for Nunavut residents	2000	0
Salaries/Wages for non- Nunavut resident researchers	0	0
Professional Fees and services in Nunavut	0	0
Professional Fees and Services outside of Nunavut	0	0
TOTAL EXPENDITURES	7000	5000

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

\$250,000 – NSERC Discovery Grant awarded to Eric Bottos, 2022-2027.

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.

No formal datasets or publications have been produced to date; however, these can be made available to the NRI research licensing database once generated. Soil samples have been collected and analyses are ongoing, as described above. Upon completion, the data will be used to generate peer-reviewed publications and staff research outputs at Thompson Rivers University.

Have peer-reviewed manuscripts been published as a result of your project? If Yes, complete the following table:

No

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

Yes, we do attend to do so once all data has been generated.

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:

Title	Description of Materials	Link (if available)	DOI (if available)
Permafrost, Microbial Life, and Climate Change in the Canadian Arctic	A presentation outlining the study objectives and sampling methods was presented to approximately 200 passengers travelling onboard the Adventure Canada vessel. The presentation aimed to educate passengers about the goals of the research and to highlight the importance of studying Arctic soil and permafrost microbial communities in the context of climate change in Nunavut.	n/a	n/a

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.

As data analysis is still ongoing, a formal communications plan has not yet been developed. However, there are several expected communications/reporting tools to be output:

Scientific publications and conference presentations – Manuscripts and related conference presentations are planned once analyses are complete. The target audience is the scientific community, especially in the field of microbial ecology/permafrost studies.

Research activity report – Within one year of sample collection, results are to be shared with communities near to sampling sites and territorial organizations both as plain-language summaries and a technical report, if desired. The target audience is community members and Nunavut residents.

Data sharing – All DNA and RNA sequencing data generated as part of this project will be made publicly available in nucleotide sequence databases (see below). The target audience is the scientific community.

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

No work has been output from this project to date. Although no Nunavummiut directly participated in the fieldwork or data collection, all future publications and work will acknowledge the people and land for granting and enabling this research to be carried out in Nunavut.

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

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

No, intellectual properties do not apply to this research.

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?

Dr. Eric Bottos is the owner of this data. The raw data, which has not yet been generated, will be shared with the appropriate communities should there be interest. Results were proposed to be shared with participating communities, but given sampling did not occur within any community boundaries, results will instead be shared with the nearest communities if there is interest (i.e., Resolute), such as through the Hunters and Trappers Association. Regarding data security and storage by community-based co-owners, this is to be established in future communications with the community to ensure secure access and storage.

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

All data generated will be securely stored and managed on institutional servers at Thompson Rivers University. This data will not be destroyed within a set timeframe.

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.

Once data is generated it will be submitted to public data repositories. All DNA and/or RNA sequencing data generated as part of this project will be made publicly available in nucleotide sequence databases (e.g., National Center for Biotechnology Information's Genbank and European Molecular Biology Lab's Nucleotide Sequence Database). Links will be provided upon request, as well as shared with the results of this study to interested groups.

Please append a copy of your data management plan.

Attached.

CLIMATE CHANGE

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

Yes, this research is related to climate change and better understanding its impacts and future mitigation strategies. Climate change is increasing the rate and extent of permafrost thaw, thereby increasing the bioavailability of permafrost carbon and rates of microbial processes in these soils. These processes transform soil carbon to carbon dioxide (CO₂) and methane (CH₄), increasing positive feedbacks on climate warming.

This work aims to characterize the structure and function of microbial communities in soil and permafrost across the Canadian Arctic and to understand how they respond to thaw events and climate warming. By analyzing diverse samples collected across Nunavut, we aim

to develop models that explain how environmental conditions are related to microbial community composition and activity. Ultimately, this research will support predictive models that assess how climate warming and permafrost thaw will alter greenhouse gas emissions and microbial community structure and function based on present day ecosystem characteristics.

Data Management Plan

Project: Responses of Permafrost Microbial Communities to Climate-Driven Thaw

Principal Investigator: Eric Bottos

Field Researcher: Gwen Freeze

Data Collection and Generation:

Field data includes the collection of soil from various sites in the Canadian Arctic.

Laboratory-generated data will include the extraction of DNA and/or RNA from soil samples and metagenomic sequencing outputs to understand microbial community composition and function. Soil physicochemical data will also be generated. Data will be further processed using bioinformatic analyses, statistical analyses, and modelling to address the study objectives.

Data Storage and Security: All data generated will be securely stored and managed on institutional servers at Thompson Rivers University. Only authorized laboratory members will have access to the data.

Data Access: All sequencing datasets generated as part of this project will be made publicly available in nucleotide sequence databases. Additional data will be provided upon request, with both plain-language summaries and a technical report of data results being shared with communities and territorial organizations within one year of sampling, should there be interest. Research findings are to be published in open-access journals and presented at scientific conferences and meetings, once generated.

Appendix A: Maps of Field Sites

Site 1: Beechey Island (N 74.72391°, W 91.84827°) – accessed August 24, 2025



Site 2: Port Leopold (N 73.85046°, W 90.24864°) – accessed August 26, 2025

