Evaluating thaw resilience and ecosystem change of peatland permafrost environments in coastal Labrador using repeat uncrewed aerial vehicle surveys

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Introduction

Across the circumpolar North, regional warming has caused permafrost thaw and degradation of periglacial landforms. Peatland Permafrost landforms (palsas & peat plateaus) found in the discontinuous, sporadic and isolated patches permafrost zones are amongst the most vulnerable to climate change. Recent studies have identified widespread permafrost thaw in subarctic peatlands, with implications for cultural keystone species and infrastructure.

Peatland permafrost ecosystems in Labrador are particularly important for hunting, berry picking, and plant harvesting. Further, these culturally keystone places are foraging habitats for; **caribou** (*Tuttuk* in Inuttitut; *atik^{u}* in Innu-aimun), **geese** (*Nillik* in Inuttitut; *nishk* in Innu-aimun), **bears** (*Adlak* in Inuttitut; *mashk^{u}* in Innu-aimun), and **foxes** (*kajuk* in Inuttitut; *matsheshu* in Innu-aimun).

Figure 1: Photograph of monitoring site in e Labrador acquired with an uncrewed aerial vehicle.

Key findings of past research

Prior work by Way et al. (2018) and Anderson et al. (2018) identified a need for re-evaluation of peatland permafrost in coastal Labrador due to a previously **unrecognized abundance** of peatland permafrost ecosystems in the area. Wang et al. (2023; 2024) would later **characterize the distribution** of these environments and historic (50+ year) change at a subset of peatlands.

Further work by Beer et al. (2024) and Wang and Way (2025) describes the use of **geomorphology and ground temperatures** for a first regional assessment of future peatland permafrost vulnerability to change.

Ongoing peatland permafrost thaw is impacted by both regional and local factors. Yet, there has been **no assessment of local drivers** of thaw vulnerability. This proposed research will use a combination of field and remote sensing techniques to assess drivers of short-term thaw rates across a north-south transect along the Labrador Sea Coastline.

Vulnerability index factors

Prior research by Beer et al. (2024) hypothesized that the following three factors were important for local vulnerability:

Total **area** of palsa or peat plateau

Fragmentation of palsa or peat plateau

Total estimated **volume** of ice present within palsa or peat plateau

Objectives

1. **Quantify permafrost thaw** at 22 study sites across coastal Labrador over a ~5 year period (2021/2022 to 2026/2027).
2. Disentangle **short term regional controls** of peatland **permafrost vulnerability** or resilience to thaw; and
3. **Characterize** ongoing changes to **Cultural Keystone Species** and **Places** due to peatland permafrost thaw.

Study area & site selection

Twenty-two sites with existing maps of permafrost distribution and characteristics from 2018 - 2022 will be revisited in the summers of 2026 and 2027 to evaluate change over a 4-7 year time period.

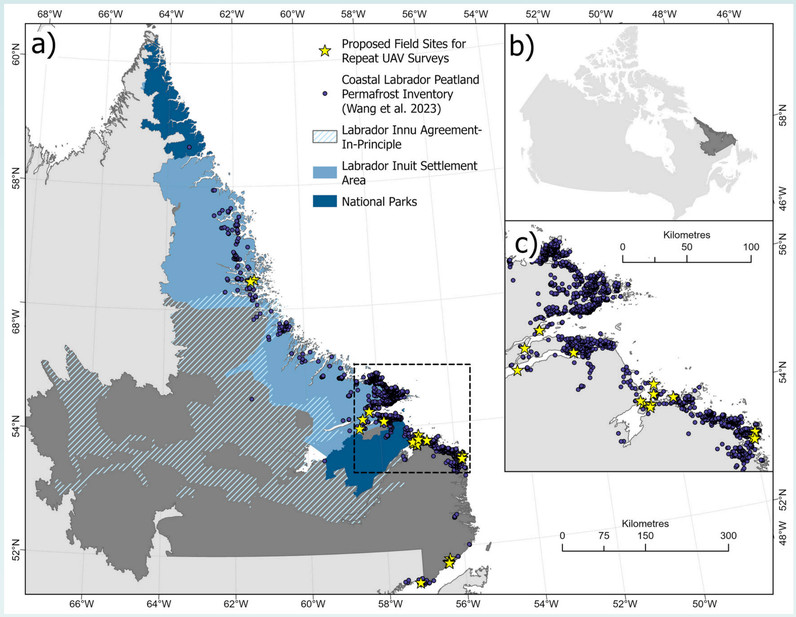
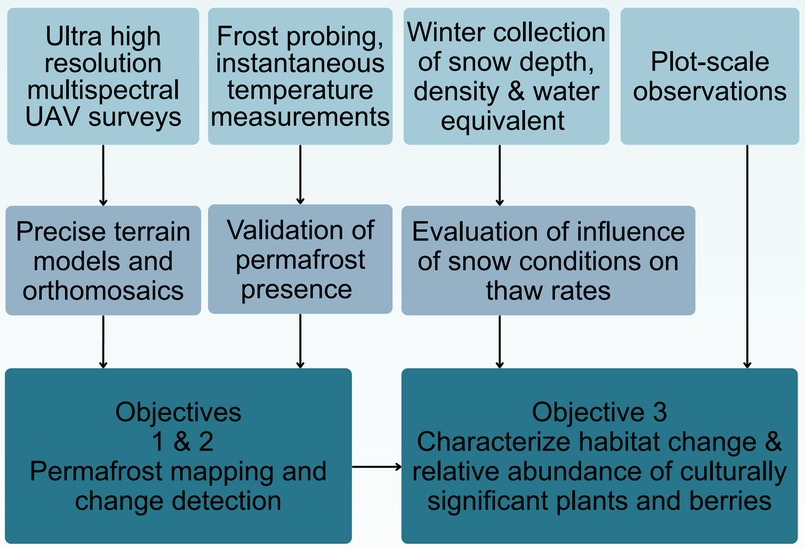
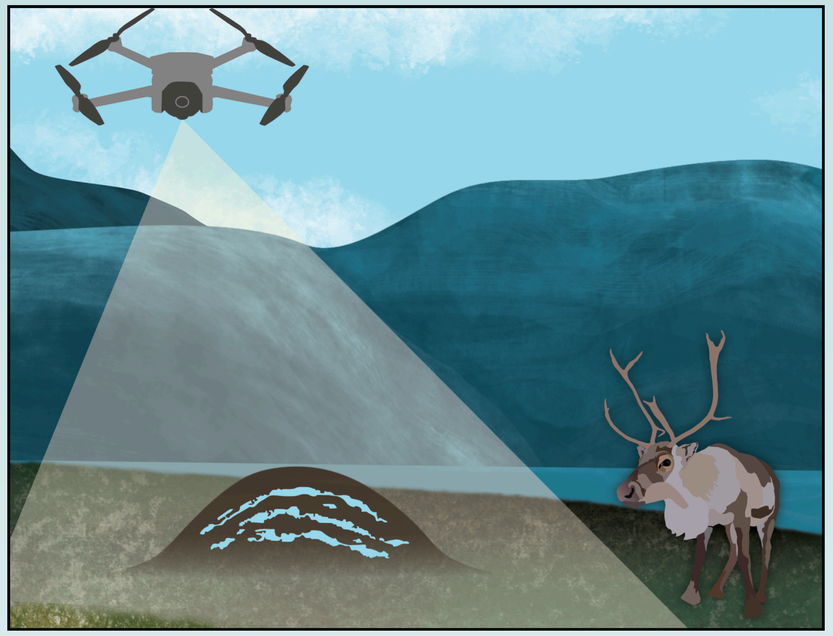


Figure 2: (a) Spatial distribution of inventoried peatland complexes (n=1822) and proposed field site in coastal Labrador. (b) Labrador's position in Canada. (c) Inset of southern Labrador.

Methodology

At each field site, uncrewed aerial vehicle (UAV) surveys will be completed in tandem with standard permafrost detection approaches, vegetation plots and winter measurements of snow conditions to measure short-term thaw rates over a period of (warm) climate extremes.





Research significance

As a contribution to the **scientific community**, this research will help disentangle the factors influencing the persistence and/or disappearance of permafrost in warming Subarctic peatlands. **Globally,** this work will contribute to improved permafrost mapping initiatives and will support improved representation of thermokarst environments and carbon stores modeling.

Regionally, these findings will provide important information to governments and organizations in Labrador about ongoing and future ecosystem change in the region. An improved understanding of landscape vulnerability will allow for more informed decisions and evaluation of potential protection and/or adaptation approaches in northern coastal and at-risk ecological areas.

This project will also help **local communities** anticipate and plan for changes to ecological integrity for Cultural Keystone. This will support better planning and resource allocation for all rightsholders and stakeholders.

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References

Beer et al. (2024). *Permafrost and Periglacial Processes* 35 (4): 461–77. https://doi.org/10.1002/ppp.2242.
Wang et al. (2023). The Cryosphere 17 (1): 63–78. https://doi.org/10.5194/tc-17-63-2023.
Wang and Way (2025). Journal of Geophysical Research: Earth Surface 130 (2): e2024JF007930. https://doi.org/10.1029/2024JF007930

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