

Northwest Territories

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Project Progress Report

Project Title

Accelerating recovery of boreal caribou habitat via lichen seeding for oil and gas related remediation.

Contact Person

Dr. Jennifer Baltzer (co-lead)
Email: jbaltzer@wlu.ca; Phone: 519-504-5025

Project team:
Catherine Dieleman, University of Guelph
Elise Brown-Dussault, MSc Candidate, Wilfrid Laurier University

Project Objectives and Rationale

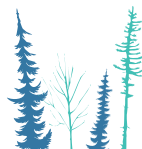
Boreal caribou represent a culturally imperative food source for Indigenous populations throughout much of the Northwest Territories (NWT); however, habitat degradation, predation, and cascading impacts from climate change have reduced boreal caribou populations across Canada by over 30% in the past 20 years – resulting in their current designation as a Schedule 1 “threatened” species under the Canadian Federal Species At Risk Act. In the NWT there is concern over the cumulative effects of climate warming-related acceleration of disturbances (wildfire and permafrost thaw) coupled with development activities on boreal caribou populations. Successful remediation of sites that have been naturally disturbed by wildfire or associated permafrost decay could, in part, mitigate modern habitat loss, reducing stress on targeted boreal caribou populations. Lichen seeding techniques represent a novel remediation strategy, however, we have limited knowledge of the environmental conditions (i.e., permafrost presence, fire severity, stand age, etc.) that best promote seeded lichen establishment, particularly in discontinuous permafrost systems common to the Northwest Territories.

Objective: We will address this knowledge gap by determining under what landscape conditions caribou habitat recovery can be accelerated by lichen seeding.

Project Progress

(1) Synthesis of literature, data and imagery on wildfire and permafrost disturbance interactions in NWT and forage taxa recovery trends

Permafrost and Fire Disturbance Interactions – Permafrost and fire literature and in-hand data were surveyed to identify core knowledge gaps for the southern NWT region and quantify on-going permafrost decay rates at fire impacted sites. This effort resulted in a novel manuscript detailing on-going permafrost thaw rates across southern NWT with relationship to fire history and the implications for organic soils. This synthesis has also been incorporated into an international effort characterizing the relationship between local environmental conditions and ongoing permafrost decay and is expected to significantly contribute to a high impact manuscript detailing the mechanisms advancing boreal region permafrost loss in relation to fire history at the global scale.



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Outputs to date:

Dieleman, CM, Day, NJ, Holloway, JE, Baltzer, JL, Douglas, TA, Turetsky, MR. 2022. Carbon and nitrogen cycling dynamics following permafrost thaw in the Northwest Territories, Canada. *Science of the Total Environment*, accepted with minor revisions.

Dieleman, CM, Day, N, Baltzer, JL, Turetsky, MR. 2020. Carbon and nitrogen co-cycling dynamics following discontinuous permafrost thaw in the Northwest Territories, Canada. AGU Fall Meeting, Virtual.

Forage taxa recovery trends post-disturbance - Using in-hand data we have been developing models of wildlife forage recovery following fire and across a range of environmental and permafrost conditions. This includes two main efforts. The first is the characterization of lichen biomass recovery following fire. This work brought together data from NWT and a related project in Saskatchewan, thereby traversing a broad latitudinal gradient from northern SK to the Sahtú region and a range of permafrost conditions. This study provides a critical baseline for the current work as it established the lichen biomass recovery curves that have informed study site selection and expected recovery rates. The second effort involves modelling the post-fire recovery of forage taxa in the NWT. This focuses on a range of wildlife taxa with a goal of understanding periods of time during which caribou may face biotic pressures due to shared use of an area by other wildlife. This effort formed part of a MSc project that was completed in Sept 2021 and included both a full review of the literature on wildlife forage preferences in boreal Canada and a new manuscript presenting the models described above. This work has been presented at an International conference and forms two manuscripts at different stages of preparation.

Outputs to date:

Gruel, R, Degré-Timmons, G, Baltzer, JL, Johnstone, JF, McIntire, E, Day, NJ, Hart, S, McLoughlin, P, Schmiegelow, F, Turetsky, MR, Truchon-Savard, A, van Telgen, M, Cumming, SG. 2021. Predicting patterns of terrestrial lichen biomass recovery following boreal wildfires. *Ecosphere*, 12(4): e03481.

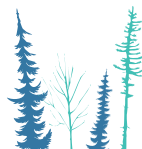
Jorgensen, A, Hodson, J, Armstrong, T, Schmiegelow, F, Gonet, J, Johnstone, J, Baltzer, J. 2022. Forage and dietary overlap among large ungulates, snowshoe hare, and bears in boreal North America. Submitted to *Journal of Wildlife Management* on January 25, 2022.

Jorgenson, A, Alfaro-Sanchez, R, Cumming, S, White, A, Degre-Timmons, GW, Day, NJ, Turetsky, M, Mack, M, Johnstone, J, Walker, X, Baltzer, JL. The influence of post-fire recovery and environmental conditions on boreal wildlife forage. In preparation for *Ecosphere*.

Jorgensen, A, Cumming, S, Day, N, Alfaro-Sanchez, R, White, A, Degré-Timmons, G, Johnstone, J, Turetsky, M, Mack, M, Walker, X, Schmiegelow, F, Baltzer, J. 2021. Plant recovery and wildlife return to the boreal forest after fire. International Boreal Forest Research Association Meeting.

(2) Lichen Seeding Greenhouse Experiment

Using samples collected between 2017 and 2019, we established a pilot greenhouse-based lichen seeding trial to characterize species specific establishment rates (i.e., hyphae growth rates) and physiological stress



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responses to different surface substrates found in disturbed study sites throughout the NWT. Unfortunately, these lichen samples were no longer viable, and the experiment was not successful. We will collect new lichen samples during summer 2022 to redo this experiment. This will form part of MSc Elise Brown-Dussault's thesis.

(3) Lichen Seeding Field Experiment

During the 2021 field season we established experimental lichen seeding trials in southern NWT at 51 disturbed sites that vary in terms of 1) permafrost presence or absence, 2) 2014 fire burn severity, and 3) stand age at the time of fire (Figure 1).

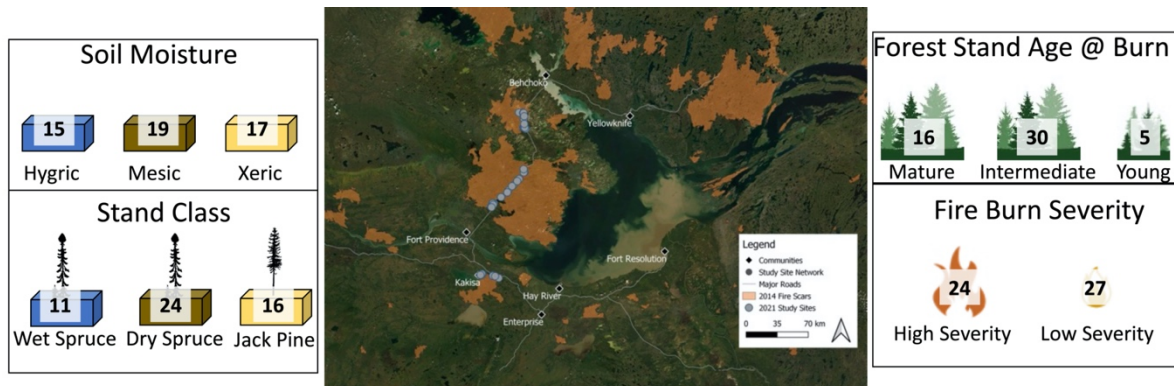
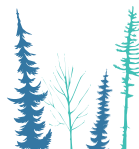


Figure 1. Overview of site selection for our lichen seeding trials in the southern NWT.

For this experiment, we targeted the most common lichen species (*Cladonia mitis*, *C. rangiferina*) to use for seeding. We established eight replicate 1 m × 1 m plots along established 30 m transects previously used to characterize a suite of site characteristics (i.e. soil carbon content, organic layer depth, surface vegetation structure, stand dominance, site drainage). Lichen fragments were applied at high and low densities (3 replicates of each at each site) and two plots were left as unseeded controls (Figure 2).

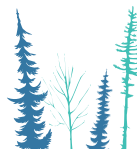


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Figure 2. Left panel: Diagram of experimental design of the lichen seeding experiment. Middle panel: seeded quadrats with high density seeding on the left and low density seeding on the right. Right panel: Catherine Dieleman preparing lichen for experimental application.

During the summer of 2022, we will begin to monitor lichen establishment by using metrics of physical establishment, vigor, and biomass as developed by Duncan (2011). Specifically, we will map the distribution of lichen fragments within the plots and in a 1m buffer around the plot to understand whether fragment displacement is an issue and if so, whether this varies by ground surface type. We will measure the vigor of seeded fragments in three ways. First, we will visually assess the health of a subset of fragments in each plot using existing protocols. Second, we will use a fluorometer to determine the physiological status of fragments. Third, we will take microscopic images of a subset of fragments to quantify new growth (Fig 3).



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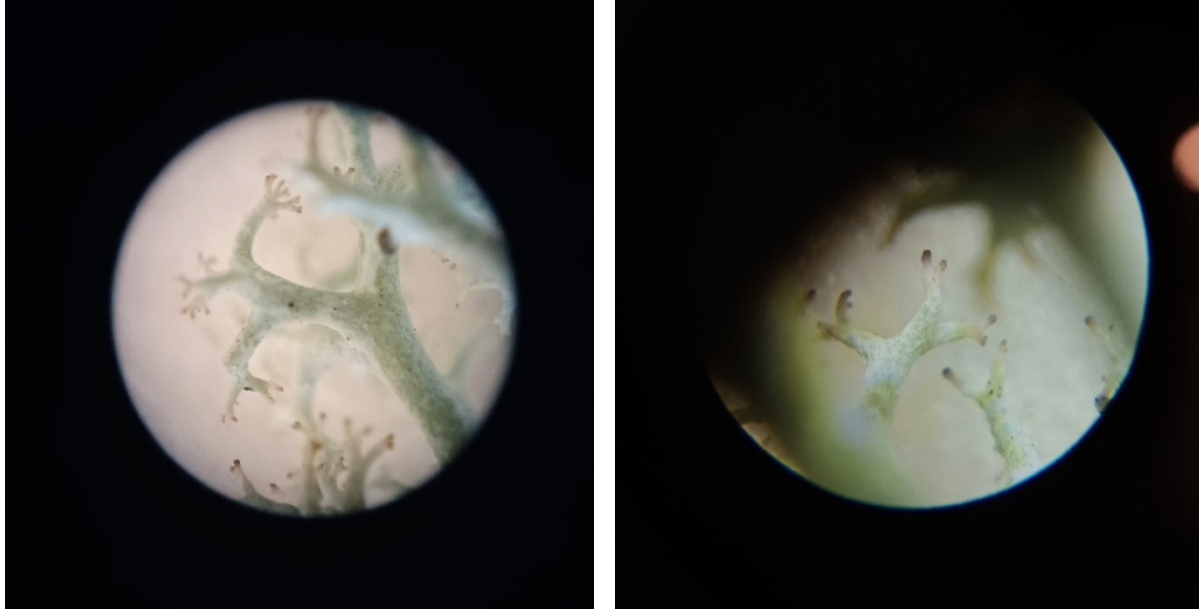


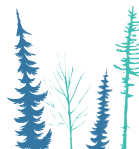
Figure 3. Pictures of *Cladonia rangiferina* taken with a 20x-60x field microscope.

(4) Communication of Results to Date

The results of the aforementioned permafrost and fire synthesis were presented at the international American Geophysical Union meeting, with very positive reception from the academic community and government representatives from USA and Canada. The manuscript itself has been accepted with minor revisions for the high impact journal *Science of the Total Environment*. The aforementioned lichen biomass recovery manuscript was published in 2021 in the journal *Ecosphere*. The results from the lichen biomass recovery paper have also been presented at a range of Territorial and National meetings focused on caribou management. The wildlife forage recovery work is at the late stages of manuscript preparation with one paper in review and the second nearing submission. This work was presented at the International Boreal Forest Research Association Meeting in August 2021.

(5) Community engagement and Knowledge Sharing

Leading up to the 2021 field season, there was substantial engagement of the Tlicho government about this project. This included zoom meetings and presentations to share our plans and hear about research the community is doing to understand the impacts of the Tlicho All Season Road to Whati. During summer 2021, we hired Jody Zoe, a youth from Behchoko, as part of this project. Jody lived and worked with our team, learning methods and contributing to data collection. Our team also spent considerable time in the community of Kakisa, living in the community and contributing to community events. We created a video that includes an overview of this project at the request of and funded by CIMP: <https://www.youtube.com/watch?v=AqdseK1u4lA>



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For summer 2022, we are in discussions with both the Ka'a'gee Tu First Nation in Kakisa and the Tlicho Government in Behchoko to identify community researchers to hire as part of the team. We have leveraged funding from NASA's Arctic Boreal Vulnerability Experiment to support an internship that will target hiring and training a community member as part of the research team and are collaborating with CIMP- and Polar Knowledge Canada-funded projects through which there is funding for a community researcher. Ongoing active involvement in this research by the community will help to facilitate knowledge sharing. If possible, we will engage in knowledge sharing through community meetings and on-the-land events as well as through the development of digital stories and plain language documents. We have been invited to present our research at the Tlicho Government research meeting in Behchoko in November, 2022.

