

Research Report Kluane
Interim Report – May 2026

Project title: Monitoring tundra shrub growth, plant trait and phenology over space and time

Yukon S&E License No.: 25-42S&E

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Research funding: CERC in Global Change Ecology of Northern Ecosystems (NSERC)
Discovery Grant (NSERC)

This interim report provides a summary of the research conducted by Dr. Isla Myers-Smith and her research group (Team Shrub) from the University of British Columbia in the Kluane Region over the summer of 2025 (for more information see <https://teamshrub.com/>).

This proposed research follows on from fieldwork conducted in the Kluane Region from 2014 to 2025. This research was conducted under the Scientists and Explorers Licences 24-60S&E, 23-57S&E, 22-51S&E, 21-42S&E, 19-63S&E, 18-68S&E, 18-68S&E, 17-41S&E, 16-47S&E, 16-48S&E, 15-48S&E, 15-49S&E, and 23-57S&E. See reports submitted April 2016, April 2017, May 2018, May 2019, May 2021, April 2022, May 2023, May 2024, and May 2025 (<https://teamshrub.com/research-reports/>).

Team Shrub research in Kluane

Team Shrub has been working in the Kluane Region since 2007 conducting research on shrub expansion, tundra plant ecology and boreal forest vegetation change. With the Canada Excellence Research Chair project on the Global Change Ecology of Northern Ecosystems, we aim to build upon a long-term research program from 2023 to 2032. The CERC research program will investigate how warming temperatures and shifting seasonality affect Arctic tundra, alpine, and boreal forest ecosystems, including changes in plant growth, habitat composition, wildlife movement and species range expansion.

Background

Global change impacts the tundra and boreal ecosystems in the Western Canadian North and is a significant threat to sustainable food systems, wildlife populations and resilient communities. High latitudes are warming more rapidly than the global average^{1,2} and Indigenous people of the Canadian North have well-developed knowledge of how the climate is changing³.

As the climate warms, rapid vegetation change is underway, with changes observed in the distribution of plant species and the timing of plant growth⁴⁻⁷. These changes in plant timing and distribution have the potential to impact habitat and resource availability for many alpine wildlife species.

Alpine habitats are critical for wildlife⁸, but it is still unclear how climate-driven changes to vegetation may impact habitat and outcome of focal alpine species such as Dall sheep and collared pika^{8,9}. Understanding vegetation change and its consequences for alpine habitats is the aim of our research,

and our findings may be of use to First Nations, governments, locals and parks with an interest in conserving these wildlife populations.

Research Activities in Kluane in 2025

Over the summer 2025 field season, our team collected data on: 1) rates of shrub growth in a common garden experiment, 2) shrub changes across latitudes under warming conditions, 3) responses of Dall sheep to shrub expansion, 4) responses of collared pikas to climate warming and 5) pollinator and vegetation phenology.

1. A common garden experiment to measure rates of shrub growth in warmer conditions

Objective: Quantify tundra willow growth in a warmer boreal forest environment.

The common garden experiment (Figure 1) was established in 2013 at the Kluane Lake airstrip near Silver City, Yukon. Since its creation, we have propagated over 800 cuttings of three common willow species (*Salix pulchra* - Diamond-leaf willow, *Salix richardsonii* - Richardson's willow, and *Salix arctica* - Arctic willow).

This experiment allows us to directly compare the growth of willow shrubs from two populations (Arctic and subarctic), and test how willow shrubs grow under a warmer climate. The common garden is approximately 5°C warmer than the source populations and simulates future Arctic conditions.

In 2025, following previous years' work on the common garden, we collected data on plant size (e.g., height), various plant traits (e.g., leaf size), and phenology (timing of bud burst and timing of yellow leaves, captured using time lapse cameras). Over the years, the data show that the willows from the southern alpine sites grew taller, wider and up to eight times faster than the northern, Arctic willows, reaching heights above 1 m¹⁰ (Figure 2).

From the data collected in previous years, leaves emerged about a month earlier for all willows in the common garden compared to the alpine and Arctic populations¹⁰. The earlier leaf emergence resulted in a longer growing season for the southern, alpine willow growing in the warmer environment¹⁰. The northern, Arctic willow leaves in the common garden turned yellow earlier than the southern willows, and earlier than at the northern source site, resulting in little change to their growing season length¹⁰.

Our findings suggest that we should expect rapid shrub growth as tundra ecosystems continue to warm and longer growing seasons due to leaf emergence advancement, but not necessarily delayed senescence. However, responses to warming vary by species and population and will vary across latitudes.



Figure 1. Aerial view of the common garden experiment that tests how plants from different latitudes grow in a warmer climate. Each year, we measure the survival and growth of individuals from three willow species commonly found across the tundra biome (photo credit: Iain Myers-Smith).

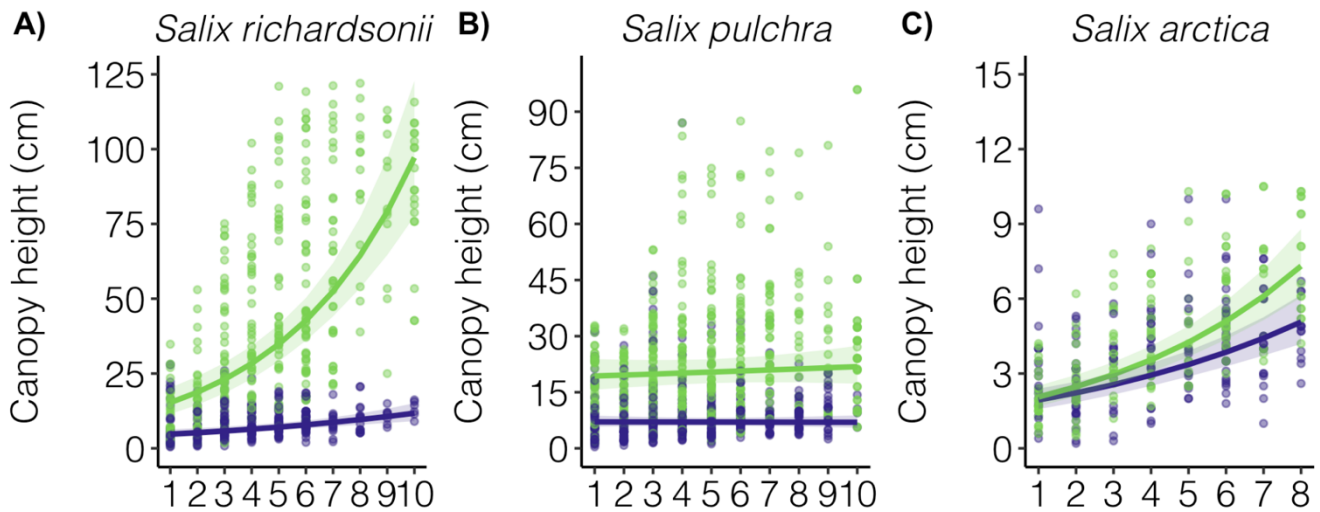


Figure 2. Southern willows grow larger and faster in a warmer environment. Canopy height (cm) over time (age of shrub) of northern (Arctic, dark blue) and southern (alpine Kluane, light green) willow species in common garden experiment¹⁰.

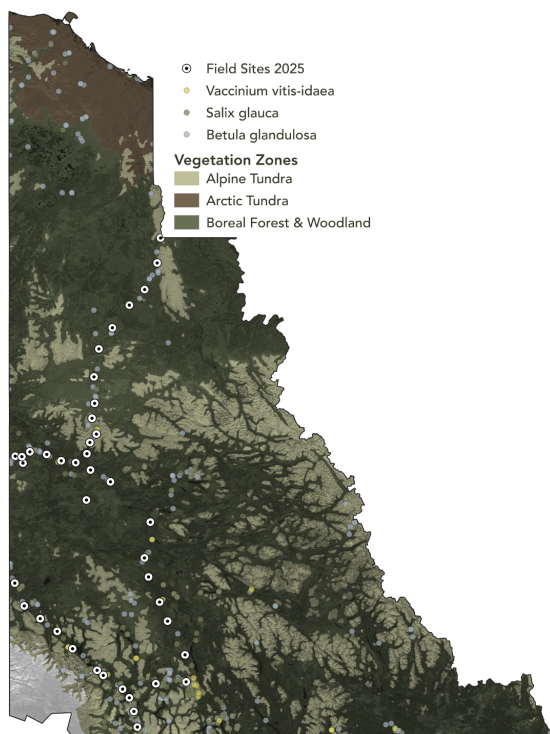
2. Boreal forest vegetation change

Objective: Quantify shrub species distribution across the Yukon to predict species distribution change under climate change scenarios

Vegetation composition of the boreal forest has shifted as species expand northwards, a process referred to as borealization¹¹. Understory vegetation, especially shrubs, play a pivotal role in ecosystem functioning and demonstrate a rapid response to climate change^{12,13}.

Research indicates that climate warming is a key factor driving the latitudinal expansion of shrub species across northern ecosystems⁴. This movement will be most pronounced in ecotones, the transition zones between ecosystems, where shrub growth sensitivity to climate is highest¹⁴. Despite improved knowledge of climate driven movement of vegetation, the trajectories of this movement cannot be accurately predicted without a comprehensive understanding of the climatic drivers controlling species establishment^{14,15}.

Temperature is a well-established primary driver of shrub distribution in tundra ecosystems, but moisture is also an important driver of shrub growth⁵, and thus a potential determinant of rates of future shrub range expansion. In boreal forest ecosystems, moisture limitation is potentially a more significant control on growth than warming. The Yukon includes three major ecosystem types, boreal forest, treeline and tundra, that encompass many climate-responsive shrub species, making this an ideal location for capturing species movement across climate gradients.



Site 39 - 60.12520°N 136.95999°W
 Site 40 - 60.37106°N 137.06869°W
 Site 41 - 60.58391°N 137.21254°W
 Site 43 - 60.71898°N 137.42575°W

Figure 3. On the left, the map indicates the 41 field sites visited in the 2025 field season (points). The other colored points indicate the recorded occurrences of three different shrub species we are looking at from GBIF (Global Biodiversity Information Facility). The coordinates of the sites surveyed in Kluane National Park and a photograph of an example site are indicated on the right.

In 2025, field surveys were conducted across 41 sites in the Yukon (Figure 3), documenting understory shrub presence and absence data spanning boreal forest, treeline, and tundra ecosystems. At four sites surveyed in Kluane National Park indicated in Figure 3, five target shrub species were recorded as present: *Betula glandulosa*, *Empetrum nigrum*, *Salix bebbiana*, *Salix glauca* and *Vaccinium vitis-idaea*. Combining these field observations with circumboreal occurrence records from the Global Biodiversity Information Facility (GBIF), we conducted a principal component analysis (PCA), a type of ordination analysis that looks at the climates where these shrubs are found. We modelled the climate niche space across 19 bioclimatic variables including temperature and precipitation across different seasons. These results revealed distinct but partially overlapping climate niches among three focal species, explaining 71.7% of total variance (Figure 4).

Preliminary species distribution models generated from this dataset produced habitat suitability surfaces across the Yukon for *Betula glandulosa*, *Salix glauca*, and *Vaccinium vitis-idaea*, illustrating clear spatial differentiation in predicted suitable habitat (Figure 5). These initial results suggest that the three species occupy distinct climate spaces, providing a foundation for evaluating the relative contributions of temperature and moisture to current shrub distributions and projecting range shifts under future climate scenarios. This research is ongoing and will be completed over 2026-2027.

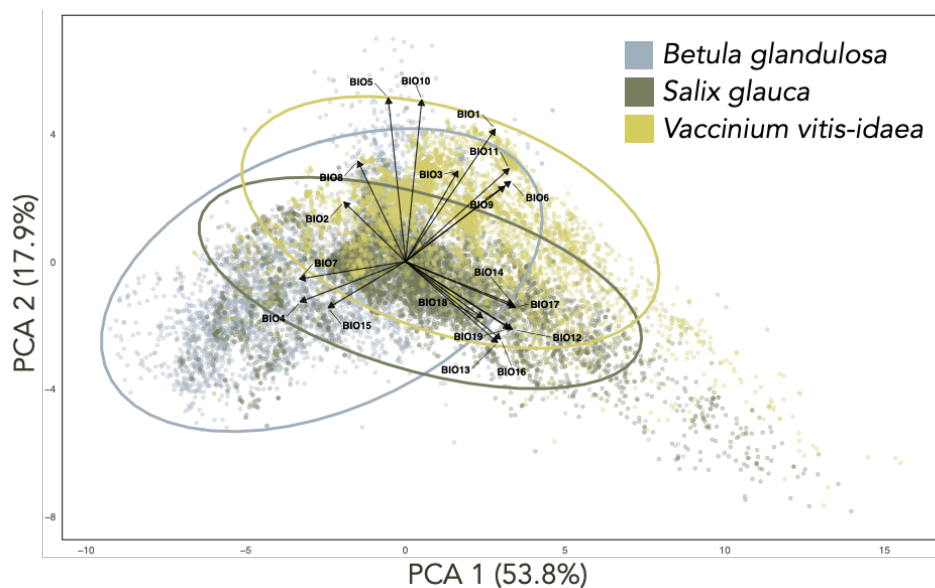


Figure 4. Principal component analysis (PCA) of climate niches for three boreal shrubs showing that species occupy somewhat different climates. PCA using recorded occurrences from field surveys along with GBIF (n=19,255) and 19 bioclimatic variables. Ellipses show 95% confidence intervals. Arrows indicate variable loadings (71.7% variance explained).

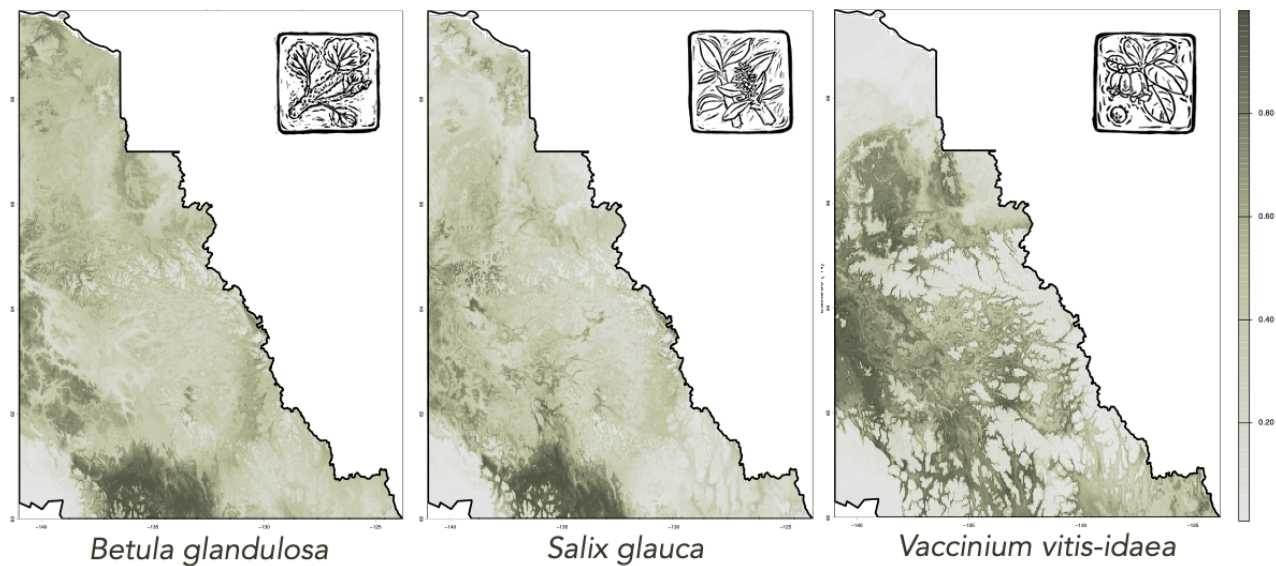


Figure 5. Preliminary species distributions for three boreal shrubs (*Betula glandulosa*, *Salix glauca*, *Vaccinium vitis-idaea*). Habitat suitability is on a scale from 0-1, 0 being unsuitable (light gray) and 1 being suitable (dark green).

3. Monitoring Dall sheep habitat use and change

Objective: Monitor the influence of warming and shrub increase on Dall sheep populations

The alpine landscapes of the Kluane region are experiencing rapid climate-driven vegetation change. As temperatures rise and precipitation patterns shift, tall shrubs are establishing at increasingly higher elevations⁴. This ‘shrubification’ presents a critical challenge to Dall sheep (mbäy in the Southern Tutchone language; *Ovis dalli dalli*).

As shrubification intensifies, tall shrubs are increasingly replacing areas of preferred sheep forage¹⁶, and the clear sightlines that sheep rely on to detect predators are being disrupted⁹. These changes may be contributing to the ongoing sub-population declines of sheep that have been observed in the Kluane region¹⁷. In this project, we seek to understand how shrubs influence sheep habitat use.

In 2025, we deployed 35 wildlife cameras across seven sites within sheep range (Fig. 6-7). Twenty two of these wildlife cameras were distributed across open areas and shrubby areas, to assess how sheep behaviours (i.e., time spent resting, foraging, vigilant, and moving) change along a gradient of shrub density. Additionally, twelve wildlife cameras were deployed in the burn scar south of Sekulmun lake.

These cameras were deployed five weeks following the wildfire, and will provide a rare opportunity to assess post-fire vegetation recovery and wildlife use in known sheep range, providing potential insights into the viability of prescribed burning as a management intervention to enhance sheep habitat. The wildlife cameras capture motion-triggered data to assess wildlife presence and behaviour, as well as daily timelapse data to capture snow and vegetation phenology. We will retrieve data from these wildlife cameras in summer 2026.

We also collected drone imagery from five sites in 2025, including the two sites within the wildfire burn scar. From the drone imagery, we will quantify important sheep habitat features within the areas observed by wildlife cameras, including shrub extent, forage extent, and slope. Finally, we tested and refined a field protocol for *in situ* measurements of key sheep habitat features in 2025. These field tests were supported by expertise from Yukon Government biologists.

In future years, we will conduct this protocol at each wildlife camera deployment, to supplement drone imagery.

This research will further our understanding of how shrub expansion impacts Dall sheep habitat use, allowing conservation resources to be allocated more efficiently. This research is ongoing and will be continuing over the next three to four years.



Figure 6. Locations of wildlife camera sites. At each site, 4 to 6 wildlife cameras have been deployed on aluminum tripods to observe sheep behaviour in open and shrubby areas. See figure 7 for an example of how tripods are deployed across an individual wildlife camera site.

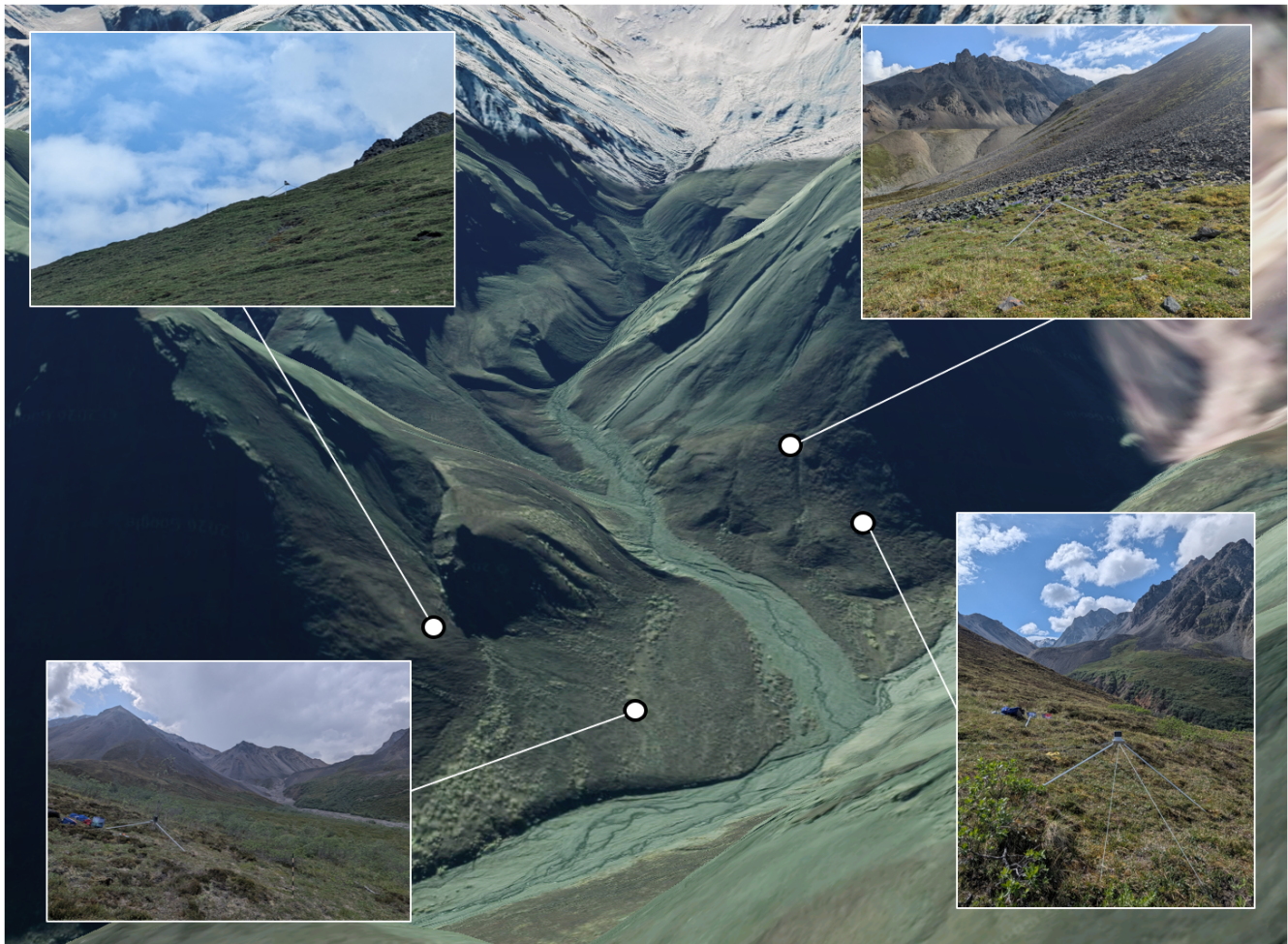


Figure 7. An example of how wildlife cameras are deployed across a site, illustrated by the site at Bock's Creek. Inset images show individual wildlife camera set ups across the site. The top left and top right inset images show examples of wildlife cameras observing open habitat. The bottom right and bottom left images show examples of wildlife cameras observing shrubby habitat. A wooden stake is placed 5m in front of each wildlife camera to record snow depth.

4. Monitoring pika habitat and abundance using audio recorders

Objective: Monitor the influence of warming temperatures and shrub increase on pika populations

Pikas are a cold adapted alpine mammal with a narrow temperature niche, and considered climate sensitive, particularly to heat¹⁸⁻²⁰. Pikas retreat into cooler subsurface spaces among the talus under high temperatures, limiting foraging and potentially affecting survival^{21,22}. Given their limited physiological ability to tolerate warmer temperatures, collared pika have been listed as a species of special concern under the Canadian Species at Risk Act²³.

Quantifying the influence of heat events on the activity and heat-avoidance behaviours of pika will improve our understanding of whether pikas can persist under warming alpine conditions. This research will contribute to Yukon Government's long-term pika monitoring in the Kluane and Kusawa regions of the southern Yukon and Tombstone Territorial Park in the central Yukon.

In 2025, we visited 10 sites across the central and southern Yukon. Three sites were located in the Kluane region, including Auriol Mountain and Hoge Pass sites within Kluane National Park and the Bocks lake site located within the Kluane Wildlife Sanctuary (Figure 8).

At each site, five audio recorders (ARUs) were set up in a 50 by 50 metre diamond shape, with one ARU in the centre (Figure 9). We recorded audio over a period of at least three days to capture pika vocalizations continuously over 24 hours. Alongside ARUs, temperature loggers were deployed above and below the talus at each site. Vegetation and rock talus size surveys were conducted in addition to drone surveys to capture the specific habitats being used by pika (Figure 10).

With these data, we plan to build a species distribution model for collared pika by integrating site-level information with broader-scale remote sensing and climate datasets. Pika occurrence records (presence and absence) from the Yukon Government, community science data and occurrence data we collected in 2025 will be used to assess factors shaping current and future pika distribution across the Yukon.

Initial data analysis from one site (Mt. Adney in Tombstone Territorial Park) shows that pika meeps, short, high-pitched alarm calls made by pikas, have a gradual increase with increasing temperature (Figure 11). This research is ongoing and will be completed over 2027-2028.

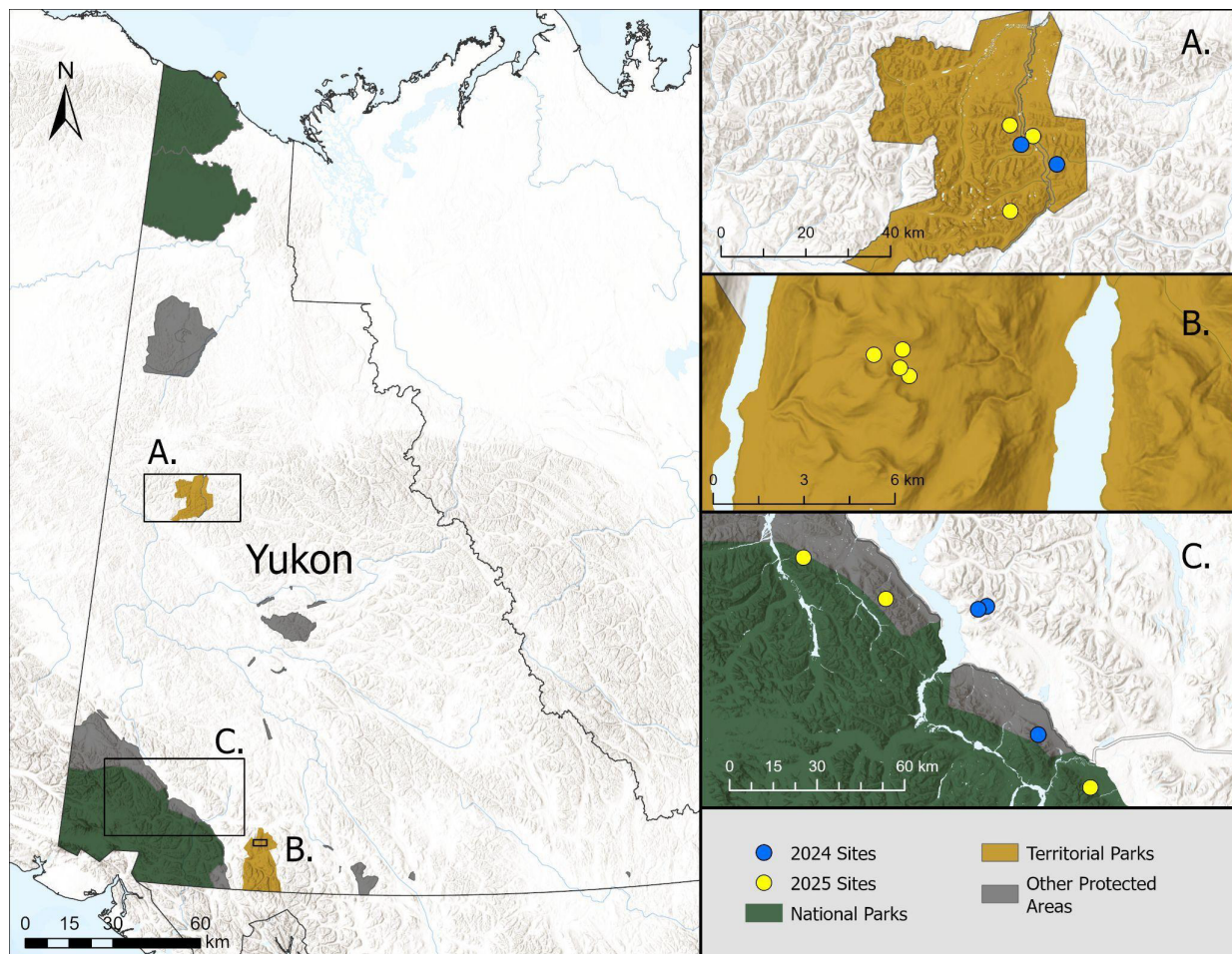


Figure 8. Map of the field sites across the Yukon visited during the 2024 and 2025 field seasons: (A) Tombstone Territorial Park, (B) Kusawa Territorial Park, and (C) the Kluane Lake region.

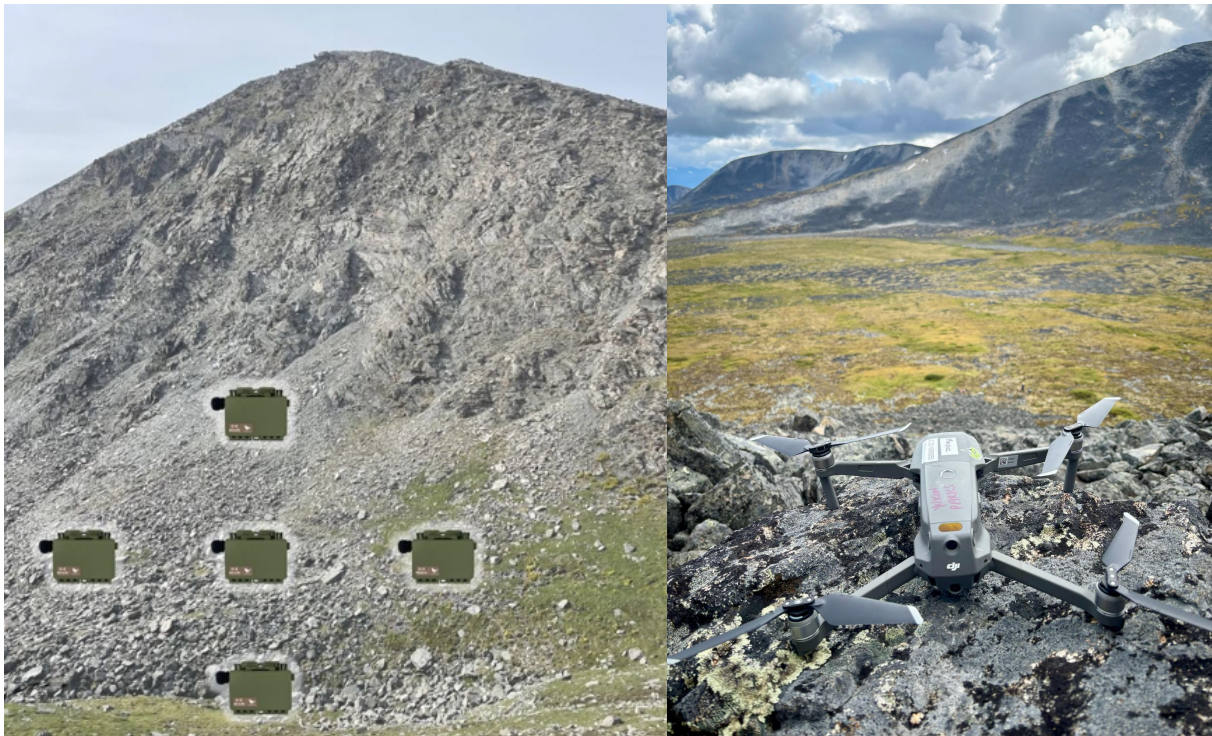


Figure 9. Example of the audio recorder setup in a diamond-dice formation (left), Mavic 3 drone preparing for a survey flight (right).



Figure 10. Recording plant species and talus rocks size data along a transect (left) and an audio recorder elevated off the ground by a tripod at site in Kluane National Park (right).

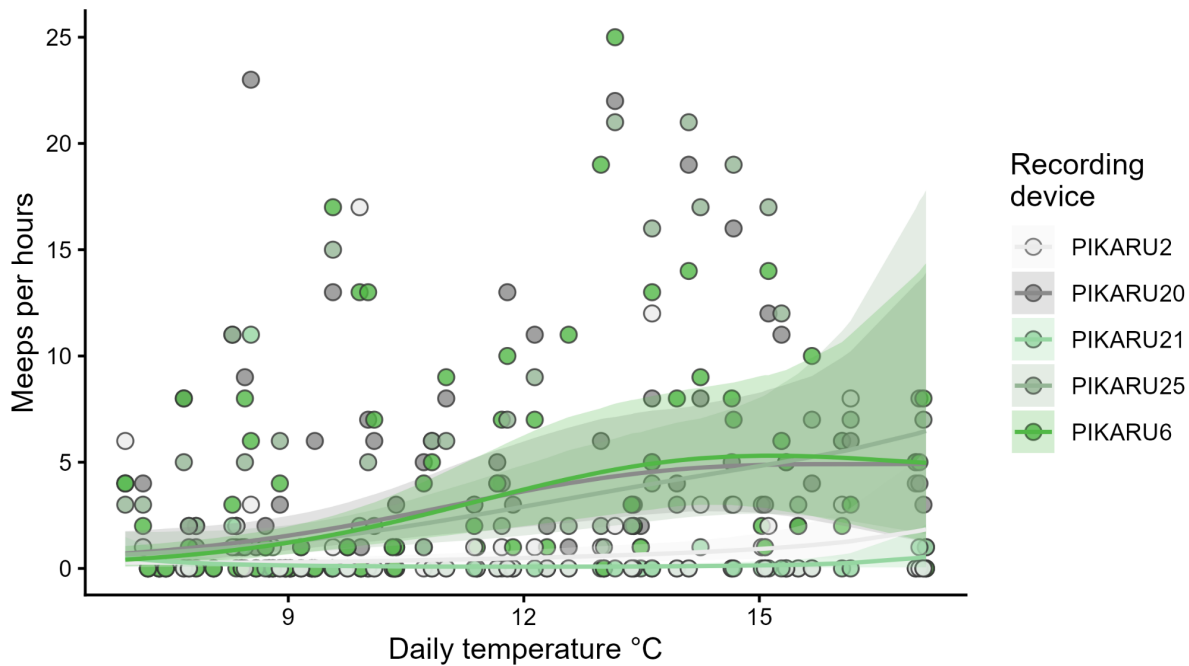


Figure 11. Pika meeps increase with increasing temperature for Mt. Adney site in Tombstone Territorial Park from 2nd - 5th August, 2025. Analysis conducted with a Bayesian model.

5. Monitoring pollinator activity

Objective: Monitor pollinator activity using acoustic recording units and cameras to compare with records of plant phenology and berry productivity.

Insect pollinators play a critical role in supporting biodiversity and food systems. Climate-driven vegetation change affecting the timing of plant flowering and insect activity may lead to mismatched life histories (i.e., phenological mismatches) between plants and key pollinators. These mismatches are likely to impact plant reproductive success and alter resource availability for pollinators²⁴⁻²⁶.

Between June and August 2025, field surveys were conducted across two sites in the Kluane region to document pollinator activity and phenology in relation to environmental conditions and lingonberry (*Vaccinium vitis-idaea*) phenology (Figure 12).

This project included sites in southern and central Yukon. Due to wildfires in June 2025, we weren't able to reach some of the central site so we focused our efforts on the southern sites and particularly the Kluane region with two sites: Duke and Boutlier (Figure 12).

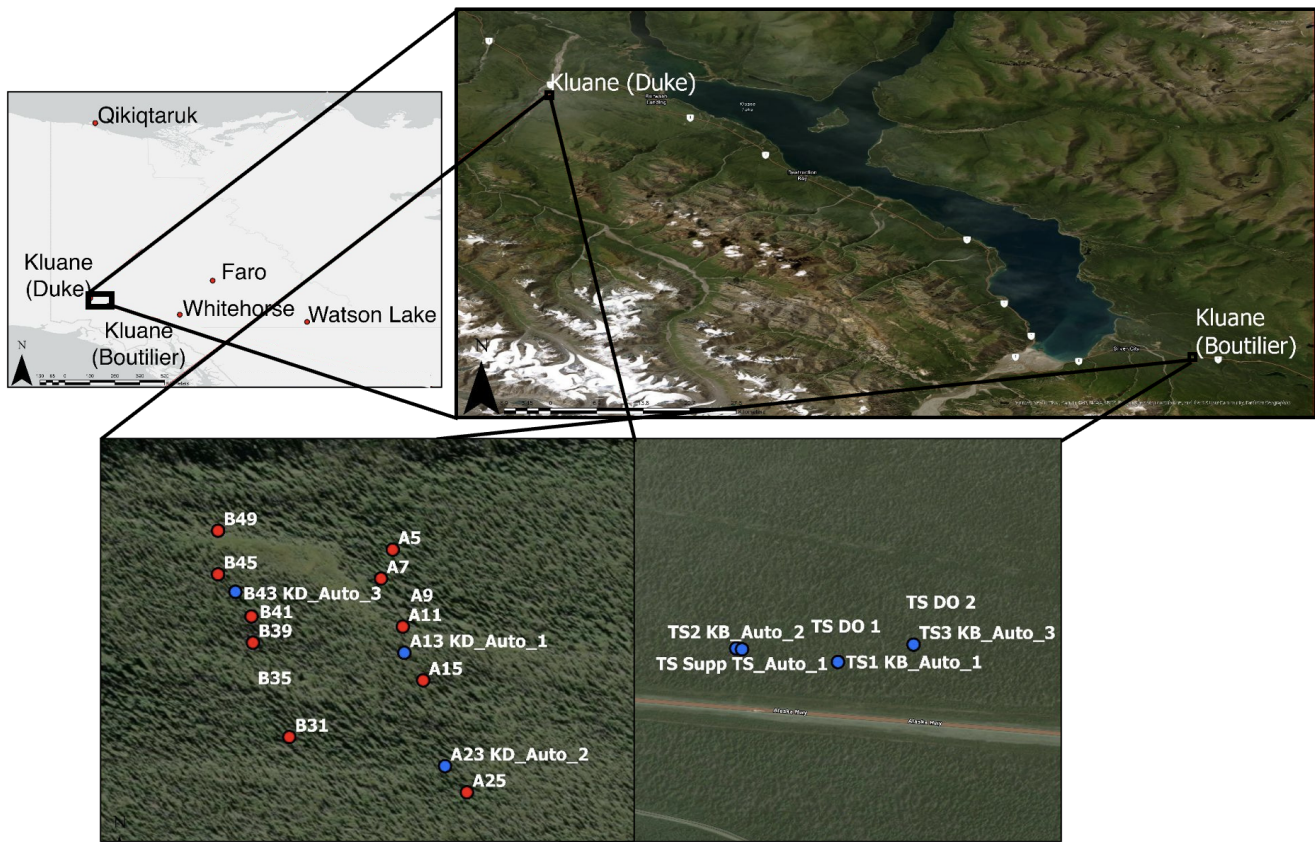


Figure 12. Map of all pollinator sites (A), including those within the Kluane region (B), and plots at the Duke (C) and Boutilier (D) sites.

Wildlife cameras and audio recorders were deployed to monitor pollinator activity over the course of the deployment period, with temperature data loggers recording environmental conditions at fifteen-minute intervals throughout the deployment window. Collectively across the Duke and Boutilier sites, autonomous units were deployed for 133 site-days and recorded 116 site-days of lingonberry flowering.

All project activities were non-invasive and resulted in no lasting disturbance to vegetation, habitat, or wildlife. Site access was limited to existing trails and low-impact foot travel across previously established berry research sites. No environmental damage or adverse impacts were observed during the course of this research. No specimens were collected beyond permit allowances and all work was completed in accordance with permit conditions.

Pollinator activity was successfully recorded across the Kluane region, and lingonberry fruit production was documented at both sites. Preliminary observations indicate variability in lingonberry yields between sites, with yields generally higher in areas of greater lingonberry cover, higher nearby plant species richness, and cooler environmental conditions. Lower yields were observed in areas with higher densities of nearby flowering plants.

Data collected during this field season are currently being analyzed and will contribute to ongoing research examining pollinator phenology, berry production, and climate relationships in northern ecosystems. This research is ongoing and will be completed over 2026-2027.

Recent publications from the research in Kluane (2019 to 2025):

- Anderson MJ, IH Myers-Smith, E Zaja, HJD Thomas, MG Criado, GN Daskalova, E Gallois, JJ Šubrt, M Vellend. 2025. Earlier and increased growth of tundra willows after a decade of growth in a warmer common garden environment. *EcoEvoRxiv*. doi: <https://doi.org/10.32942/X2132Q>
- Gallois E, IH Myers-Smith *et al.* 2025. Tundra vegetation community type, not microclimate, controls asynchrony of above- and below-ground phenology. *Global Change Biology*. doi: <https://doi.org/10.1111/gcb.70153>
- García Criado M *et al.* 2023. Plant traits poorly predict winner and loser shrub species in a warming tundra biome. *Nature Communications* 14: 3837. doi: <https://doi.org/10.1038/s41467-023-39573-4>
- Vuorinen K, *et al.* 2022. Growth rings show limited evidence for ungulates' potential to suppress shrubs across the Arctic. *Environmental Research Letters* 17(3): 034013. doi: <https://doi.org/10.1088/1748-9326/ac5207>
- Lindén E, *et al.* 2022. Circum-Arctic distribution of chemical anti-herbivore compounds suggests biome-wide trade-off in defence strategies in Arctic shrubs. *Ecography*, p.e06166. doi: <https://doi.org/10.1111/ecog.06166>
- Rixen C, *et al.* 2022. Winters are changing: snow effects on Arctic and alpine tundra ecosystems. *Arctic Science* 8(3). doi: <https://doi.org/10.1139/AS-2020-0058>
- Mekonnen ZA *et al.* 2021. Arctic tundra shrubification: a review of mechanisms and impacts on ecosystem carbon balance. *Environmental Research Letters* 16(5), p.053001. doi: <https://doi.org/10.1088/1748-9326/abf28b>
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- García Criado M *et al.* 2020. Woody plant encroachment intensifies under climate change across tundra and savanna biomes. *Global Ecology and Biogeography* 29:925-943. doi: <https://doi.org/10.1111/geb.13072>
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- Thomas HD *et al.* 2020. Global plant trait relationships extend to the climatic extremes of the tundra biome. *Nature Communications* 11:1351. doi: <https://doi.org/10.1038/s41467-020-15014-4>
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- Lembrechts JJ *et al.* 2020. SoilTemp: a global database of near-surface temperature. *Global Change Biology* 26(11): 6616-6629. doi: <https://doi.org/10.1111/gcb.15123>
- Hargreaves A *et al.* 2019. Seed predation increases from the Arctic to the Equator and from high to low elevations. *Science Advances* 5(2):eaau4403. doi: <http://10.1126/sciadv.aau4403>

Databases

We contributed data from Kluane to the following databases:

- **The Below-ground Tundra Phenology database**
In progress
- **The Tundra Phenocam database**
In progress
- **The TRY plant database**
Kattge J, *et al.* IH Myers-Smith... 2020. [TRY plant trait database—enhanced coverage and open access](https://doi.org/10.1111/gcb.14904). *Global Change Biology*. 26(1): 119-188. doi: <https://doi.org/10.1111/gcb.14904>
- **The Soil Temp database**
Lembrechts JJ *et al.* IH Myers-Smith... 2020. [SoilTemp: a global database of near-surface temperature](https://doi.org/10.1111/gcb.15123). *Global Change Biology* 28(9): 3110-3144. doi: <https://doi.org/10.1111/gcb.15123>
- **The Tundra Trait Team database**
Bjorkman AD, IH Myers-Smith, SC Elmendorf, S Normand, Thomas HJD, *et al.* 2018. [Tundra Trait Team: A database of plant traits spanning the tundra biome](http://dx.doi.org/10.1111/geb.12821). *Global Ecology and Biogeography* 27(12): 1402-1411. doi: <http://dx.doi.org/10.1111/geb.12821>

Please contact us on Team Shrub for copies of any of these papers.

Additional information

Team Shrub at the University of British Columbia <https://teamshrub.com/>

The High Latitude Drone Ecology Network <https://arcticdrones.org/>

International Tundra Experiment <https://www.gvsu.edu/itex/>

Canadian Airborne Biodiversity Observatory: <https://www.caboscience.org/>

Herbivory Network <https://herbivory.lbhi.is/>

Team Shrub on Twitter <https://twitter.com/TeamShrub/>

Team Shrub on Instagram <https://www.instagram.com/teamshrub/>

Photography websites: <http://vanishingislandphoto.com/>, <https://arcticabove.com/>

Media coverage: <https://teamshrub.com/media/>

Team Shrub Blog Posts: <https://teamshrub.com/lab-blog/>

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