DAVIS EXPEDITION FUND

REPORT ON EXPEDITION / PROJECT

Expedition/Project Title:	Capturing Belowground Root Traits and Phenology in Sub-alpine shrubland
Travel Dates:	12th-13th June (and upcoming trip scheduled on 2nd October)
Location:	ECN Cairngorms Site, near Aviemore
Group Members:	Elise Gallois, Laura Turner, Maude Grenier, Joe Boyle
Aims:	The project forms a cross-site analysis of above- and belowground plant asynchrony in both productivity and phenology, and how these processes are governed by the microenvironment. In this expedition we aimed to: - Remove the existing soil cores - Carry out additional soil moisture and temperature monitoring - Conduct above-ground vegetation surveys

Outcome (a minimum of 500 words):-

Project Introduction and Aims:

Background: At alpine, subalpine, low Arctic and subarctic sites, the relationship between the timing of above- and below-ground plant growth has been observed to be asynchronous. The below-ground growing season can be up to 50% longer than the above-ground growing season (Blume-Werry et al., 2016; Radville et al., 2016; Sullivan et al., 2007). Potentially indicating that above- and below-ground plant processes are not actually strongly coupled in temperature limited ecosystems where freeze thaw process control plant growth responses above and below ground (Blume-Werry et al., 2016; Radville et al., 2016; Sullivan et al., 2007). However, the observation tools used in these studies (minirhizotrons) cannot be feasibly installed in areas dominated by permafrost, as the tubing could be continuously pushed upwards when the active layer shallows at the end of summer, and securely installing them would be labour-intensive and expensive. As such, we have little understanding of root phenology and drivers of root propagation in areas with more continuous permafrost, and how these processes relate to observed above-ground trends. Therefore, we are employing a field method previously untested in alpine, subalpine and Arctic soils, for observing belowground phenology to answer the following research question:

RQ 1: Is above-ground stem growth asynchronous with below ground root growth in tundra and shrubland ecosystems?

We will use microclimate maps derived from pre-existing drone data to answer the following research question:

RQ 2: How does microclimate influence variation in above-ground plant phenology from bud burst through to leaf senescence?

We will synthesise our collected data to ask the question:

RQ 3: Is above and below-ground plant phenology more asynchronous in cooler versus warmer microclimates and among warmer versus cooler sites?

Methods:

In November 2020 at the Cairngorms ECN site, we installed mesh root in-growth cores to encourage root colonisation through the summer growing season at the points marked in Figure 1. In June 2021, we removed the first set of these cores, and will remove the remaining cores in our second trip in early October. We will then replace the core holes with fresh in-growth cores to ensure the continuation of the experiment into 2022 – we have recently received approval from the ECN site managers to do so.

In addition, we collected soil moisture measurements in close proximity to the planted mesh cores at the time of core installation and again at the time of core extraction. We used a soil moisture probe to determine local soil moisture content and a HOBO logger to measure the surface microclimate at the centre of each cluster of cores.

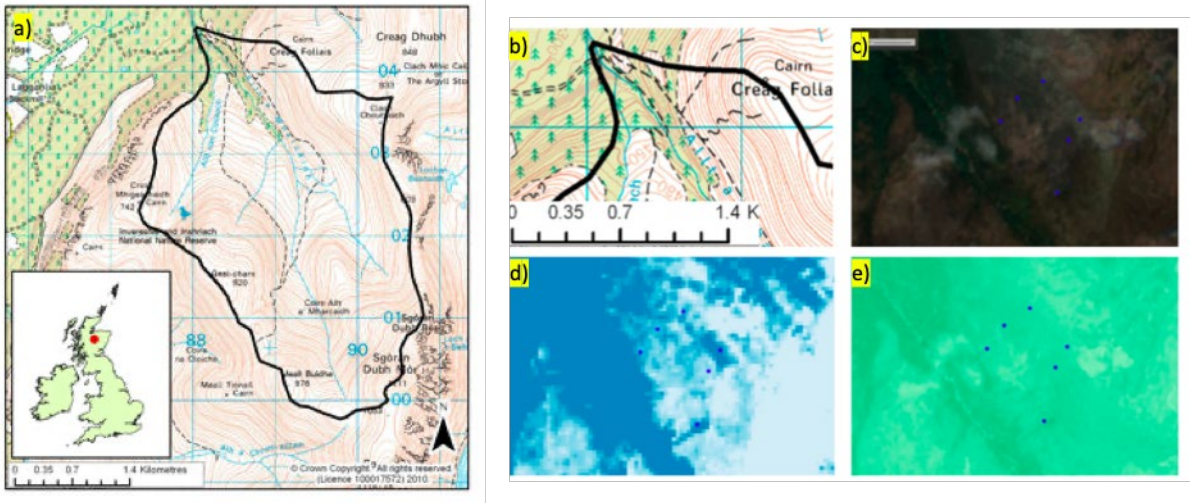

Figure 1: Maps of the fieldsite: (a & b) with walking paths and contour lines, with approximate core sample locations (indicated by blue dots) on (c) RBG satellite map, (d) NDWI and (e) NDVI maps, to demonstrate the range of conditions covered. Maps a & b adapted from: http://data.ecn.ac.uk/sites/ecnsites.asp?site=T12.

Outcomes of summer 2021 fieldwork:

In June 20201, we travelled back to the field site to remove half of the cores buried in winter 2020. Using the soil auger, we carefully removed the cores and transported them back to Edinburgh in freezer boxes where they await further lab analyses. While at the site, we checked the condition of our existing microclimate loggers and conducted soil moisture readings. We also were able to conduct a full above-ground vegetation survey at each plot, and have improved our dataset with a thorough species list and species coverage percentage at each plot. We have also negotiated with the site owners to receive long-term camera data from their pre-existing phenocams, which will allow us to extract data on the above-ground growing season, including flowering and senescence dates across multiple species.

Figure 2: Photo examples of cores prior to and during burial (photos from ECN Cairngorms site pilot study, 22nd & 23rd November 2020). We removed one of each plot-pair during our June fieldwork.

Future Analyses:

We will travel back to the field site in early October to collect the remaining soil cores and install fresh cores in their place. During October-December 2021, Laura and I will conduct laboratory analysis to analyse the rooting depth and biomass across all cores, and examine the root traits of the cores across the two time periods of removal: June and October. This will inform a large part of our international joint protocol, consisting of multiple Arctic and sub-alpine field sites spanning multiple countries (see Figure 3).

Figure 3: Map of supplementary international field locations

Our research will contribute to the Arctic Underground network, a collaboration that was established to research belowground tundra ecology dynamics. Funding provided by the Global Change Institute will help solidify this collaboration and support current and future postgraduate research projects, particularly those of University of Edinburgh PhD students that have been modified due to the Covid-19 pandemic. We expect to publish at least two research papers, and at least two methods papers as a direct result of our proposed research. Our planned manuscripts are as follows:

- 1 x methods paper outlining the protocol for the in-growth core experiment, and some initial insights into the process of analysing the rooting depth and root traits.

- 1 x research paper (lead author: Elise Gallois) reporting on the links between aboveground phenology and belowground rooting activity, and the microclimate controls on both above- and belowground tundra phenology.
- 1 x methods paper (co-lead by Maude Grenier, Elise Gallois, Geerte de Jong & Joe Boyle) focusing on how satellite, in situ, and remote camera data detect phenology differently across spatial scales.
- 1 x research paper (lead author: Laura Turner) reporting on the influence of climate and precipitation on belowground root traits.

We will follow best practice open science. We will make all of our data and metadata open source and readily available through Github repositories.

The collected data will contribute to large grant funding with our collaborative team to fund further research to address our proposed research questions.

We thank you for the generous support from the Davis Expedition Fund, which has made our fieldwork logistically possible and allowed us to use the required equipment.

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