**Implications of climate change for treeline dynamics in the British Columbia Central Interior**

**DRAFT proposed methodologies**

**Date: June 1, 2020**

**Author: Hardy Griesbauer**

*Please note these methods are under development, and may change this summer. I will ensure that BC Parks staff have up to date research plan with any changes to field data procedures.*

**Introduction**

High-elevation forests are strongly limited by severe climatic regimes, and continued climatic warming trends may result in substantial changes in forest composition, structure and processes in these environments. Warmer temperatures and changes in precipitation regimes may result in widespread growth increases and upward shifts in the alpine-treeline ecotone (Holtmeier & Broll, 2007), however, these responses will likely be mediated by fine-scale controls such as topography, soils, local climate, and autecology. Thus, forest responses to climate change will likely show a high degree of spatial and temporal variability. For example, in a meta-analysis of 166 altitudinal treeline studies across the world, Harsch et al. (2009) found that 52% of the studies described treeline advances since 1900; the remainder largely reported stable treelines, despite warmer (and presumably, more favourable) climatic conditions.

Despite an increasing body of knowledge regarding the implications of climate change to high-elevation forests worldwide, there is relatively little information about high-elevation forest responses to climate change in British Columbia. Given that responses will likely be region- and site-specific, it is important to study this phenomenon *in situ* in order to enhance our understanding of potential future forest conditions in these environments. The implications of climate change in BC’s high-elevation forests will affect a number of values, including:

* Timber supply modeling
* Forest carbon stocks and fluxes
* Water from snowmelt
* Biodiversity and habitat for species at risk such as mountain caribou (*Rangifer tarandus*) and whitebark pine (*Pinus albicaulis*).

This project seeks to address knowledge gaps regarding the effects of climate on historical composition, structure, regeneration and growth of high-elevation forests in the Central Interior region of British Columbia, with a focus on the two dominant conifer tree species: subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*). This study will occur in the Engelmann Spruce – Subalpine Fir (ESSF) and Alpine Tundra (AT) Biogeoclimatic (BGC) Zones. Specifically, this project seeks to address the following research questions:

1. What are the historical patterns of composition, structure, regeneration and growth at the alpine-treeline ecotone in the Central Interior of British Columbia?
2. How are these patterns related to historical interannual climate, topography, local site conditions, and other factors?

Information gained from researching these two questions will help us address management questions including:

1. How might future climate change shape the structure, function and processes of these high-elevation forests in the future? And
2. What are the potential implications of changes in high-elevation forests on values including carbon, timber supply, wildlife habitat, and biodiversity?

**Project team**

This project has been initiated by the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development. The team is comprised of the following staff:

1. Hardy Griesbauer, Research Silvicultural Ecologist, Omineca Region
2. Alexandre Bevington, Research Hydrologist, Omineca Region
3. Vanessa Foord, Research Climatologist, North Area
4. Will Mackenzie, Provincial Ecologist, Skeen Region

**Proposed methodology**

Site Location

In Year 1 of this project (2020), we propose to locate study areas in the following potential locations:

1. McBride Peak (near McBride)
2. Lucille Mountain (near McBride)
3. Canoe Mountain (near Valemount)
4. Hudson Bay Mountain (near Smithers)

These areas offer vehicular access (either 4WD truck or ATV) to the alpine, and three of which are located near a FLNRORD alpine climate station data.

In addition, we seek to potentially locate study areas in the following BC Provincial Parks and Protected Areas that allow foot access to the alpine via trails:

1. Sugarbowl-Grizzly Den
2. Evanoff
3. Erg Mountain
4. Pope Mountain
5. Ptarmigan Creek
6. West Twin
7. Ancient Forest/Chun T’oh Whudujut
8. Mount Robson
9. Mount Pope
10. Bowron Lake

Field data collection

***Plots***

At each of the study areas, we will establish a target of 3-4 plots to collect stand- and tree-level data (see below). Plot locations will be selected in the field using the following criteria:

1. Plots will be encompass trees growing at the alpine-treeline ecotone. Treeline may be defined as trees with average height of 3m, or other definition (to be determined).
2. Plots will be located in locations where climate is presumed to limit upward tree expansion. In other words, we will avoid sites with obvious site-level constrains to tree establishment, such as very wet or dry soils, rock outcrops, cliffs, anthropological disturbance, etc…
3. Plots will contain good representation (between 10 and 100 individuals) of treeline conifer species (subalpine fir and/or Engelmann spruce) that are relatively free of disease or insect attack.
4. Plots will be area-based, and will be circular plots ranging in size from 50 up to 200m2. Plot size will be adjusted to encompass sufficient trees (between 10 and 100 individuals).
5. Plots will be located in areas away from tourist features (please see below for proposed mitigation measures).

***Aerial imagery***

We propose to collect high-resolution aerial imagery of each research site using remotely piloted aircraft systems (RPAS). The purpose of this imagery will be to produce a high-resolution orthoimage of the study site that will help with mapping tree distribution.

Please see below for proposed mitigation strategies to avoid potential impacts to park users and wildlife from RPAS operations.

***Field data collection***

Within each plot, we propose to collect the following tree-level information:

1. Species
2. Height
3. Diameter at root collar
4. Condition (health, forest health)

As well, we will collect a single increment core from trees with a diameter exceeding 10cm at the root collar. Cores will be collected using a standard 5.2mm increment corer.

Trees smaller than 10cm diameter at the root collar will be cut and a cross-section of the stem at the root collar will be collected.

Samples will be processed at the Omineca Region research laboratory in Prince George.

**Mitigation strategies**

We recognize that this proposed project will occur in alpine environments, which contain plant and wildlife communities that are sensitive to human disturbance. As well, there is potential for interactions with the general public, especially if the research occurs in provincial parks. Given that a component of this research will entail RPAS operation and destructive sampling (cutting small trees), there is a risk of adverse impacts to members of the public who are recreating in the alpine.

Below are some strategies that we will employ to mitigate potentially adverse impacts from this research:

1. Research plots will be located a minimum 200m from park facilities that are used by the public (e.g., shelters, trails, campsites).
2. Research plots will be located in a way to minimize visual impacts from the research (e.g., will be located behind a large grove of trees or rock outcrop where possible).
3. Cut trees will be collected and piled in a discrete location to minimize visual impact from destructive sampling.
4. RPAS will only be operated by Ministry staff who have Transport Canada basic RPAS operation certification and are registered as RPAS pilots with the BC MFLNRORD RPAS Working Group.
5. RPAS will be operated following all Transport Canada requirements and will align with BC Ministry RPAS operation requirements.
6. Before RPAS operations, the area will be assessed for the presence of large wildlife and people not involved with the research within the area. RPAS operations will only be conducted when there are no identified wildlife and humans present.
7. RPAS will be operated in such a way to minimize noise and visual impacts to members of the public.
8. Researchers will carry authorizations and permits from BC Parks at all times.

**Communication strategies**

1. Where research occurs in a provincial park, the project lead (Hardy Griesbauer) will communicate proposed dates and activities within each park.
2. Reports and outcomes will be shared with BC Parks staff.
3. In the event that a member of the public approaches researchers in the field, we will attempt to address any questions/concerns, and will provide appropriate contact information for BC Parks staff for follow up, if appropriate.

**References**

Harsch, M. A., Hulme, P. E., McGlone, M. S., & Duncan, R. P. (2009). Are treelines advancing? A global meta-analysis of treeline response to climate warming. *Ecology Letters*, *12*(10), 1040–1049. https://doi.org/10.1111/j.1461-0248.2009.01355.x

Holtmeier, F. K., & Broll, G. (2007). Treeline advance - driving processes and adverse factors. *Landscape Online*, *1*(1), 1–33. https://doi.org/10.3097/LO.200701