This chapter examines dynamics and distributions of fuel loads in reburned stands in boreal Alaska to evaluate subsequent modeled changes in potential fire danger and initial fire behavior. This chapter is an extension of the dissertation, funded with a Graduate Innovation Award from the Joint Fire Science Program (ID 19-1-01-43).

3) assess how modeled fire behavior differs across reburn sequence and between topographic position.

1. What is the effect of short interval reburns on modeled fire danger and initial surface fire behavior?
2. I further hypothesize that modeled fire danger and initial surface fire behavior will be greatest in once and twice-burned stands via the hypothesized increase in fuel loads but will differ according to site type.

#### Fire behavior modeling

To model fire behavior based on estimated fuels structures in reburns, we used the HIGRAD/FIRETEC system, a physics-based fire behavior that represents individual ecosystem components and combustion/atmospheric interactions explicitly. HIGRAD/FIRETEC specifically treats vegetation composition and structure in three-dimensions, accounting for bulk density, surface area to volume ratio and fuel moisture. By treating fuel beds as complex and homogenous (both vertically, and horizontally), HIGRAD/FIRETEC can simulate the effects of fine-scale shifts in fuels structure and composition on subsequent fire behavior.

Using this modeling framework, we modeled predicted fire danger. Fire danger here is defined as the summed stand-level characteristics (both chemical and physical) of fuel elements that favor flame propagation if ignition occurs (Hely et al. 2009). High fire danger would indicate a stand containing an abundance of fuel elements made up of either flammable products or products with the ability to sustain combustion (Hely et al. 2009). Estimating potential fire danger allows for direct insight into management of reburned stands and provides specific guidance for managers making decisions about resource allocations. Furthermore, I intend to translate predicted fire danger produced through the HIGRAD/FIRETEC system into the equivalent Canadian Forest Fire Danger Rating System (CFFDRS) ranking used by land managers and fire crews in Alaska. This will allow insights from this chapter to be shared widely with the Alaska fire science community, a network that includes fire scientists, policy makers and land managers.

Method

Developed as an alternative to the more time- and resource-intensive terrestrial laser scanning approach, 3D sampling will be applied to each plot in both sites to record presence/absence occupied volume for each fuel type present in the plot. Fuel type categories are system-specific, and for Interior Alaska, may include 1-10-hour fuels, 100-1000-hour fuels, general spruce litter, deciduous litter, arctic grass and other sedges, shrubs, forbs and mosses.

An additional strength to this approach is that measurements will not be tied to specific plots, and instead will be stand-level metrics. This makes them more generalizable then stem maps, an alternative approach often used to evaluate fuel distributions.

#### Fire behavior modeling

This chapter takes advantage of existing collaboration with a team of fire modelers at Colorado State University. My specific role in this collaboration is to lead the field-based investigation of fuel characteristics, providing both data and insight into the ecological dynamics of fuel on the boreal landscape. Working with Dr. Chad Hoffman and others at the Western Forest Fire Research Center, we intend to apply these insights produced from this chapter into a physics-based computational modelling approach which will enable us to directly investigate the dynamics of fire-vegetation feedbacks in the boreal.

This chapter will use the HIGRAD/FIRETEC system, a combination of physics-based 3-D fuel models, to produce estimates of fire danger and initial surface fire behavior based on empirically estimated spatial fuel distributions. The combination of HIGRAD and FIRETEC models represents interactions between fire, fuel and atmosphere on a landscape scale, allowing specific investigation of how fire may respond to stand-level or even tree-level shifts in canopy arrangement or understory fuel loads (Koo et al. 2012).