QuickNotes
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Introducing: How do the spatial legacies of mountain pine beetle outbreaks affect fire severity in Canadian lodgepole pine forests?

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Wildfire activity is controlled by interactions among weather, ignitions, and fuels. In much of western Canada, fire activity is also influenced by outbreaks of the mountain pine beetle (*Dendroctonus ponderosae;* MPB), which affect the abundance, connectivity, and character of fuels. Despite nearly a century of interest [1], we still know relatively little about how, where, and when wildfire is affected by outbreaks of forest insect pests. Better understanding of the relationship among MPB outbreaks, fuels, and fire activity is essential to maintaining or improving forest health, resilience, and productivity [2].

The effects of mountain pine beetle outbreaks on wildfire are complex. Recent studies have reported positive, negative, or neutral effects of MPB outbreaks on wildfire [3-9]. Absent or negative effects are contrary to our intuition that altered fuel loadings, moisture, and chemical qualities (e.g., terpenes) resulting from outbreaks should increase wildfire likelihood. These contrasting results may stem from the fact that different studies have used different wildfire attributes as a response variable (e.g., ignition, crowning, fire size).

In this project, we will examine the effect of historical MPB outbreaks on one aspect of wildfire: burn severity. Burn severity describes a fire's ecological effect on vegetation, dead biomass, and soils and is closely related to fire intensity. Understanding severity is important because of its effects on forest succession, organic matter, carbon storage, and soil microbial processes. Severity is also relevant to forest resilience, effective fire containment, and firefighter

Federal-Provincial MPB Research Partnership

Mountain Pine Beetle remains a severe threat to Alberta's pine forests despite the province making positive progress in controlling its spread within the province and reducing the risk to the rest of Canada.

Natural Resources Canada and Alberta Agriculture and Forestry have provided funding to a suite of projects with the goals of limiting the spread of Mountain Pine Beetle and mitigating damages where it has already invaded.

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safety. Although previous studies have investigated the consequences of the MPB outbreak on fire in the northwestern United States [e.g., 4, 5, 8] and British Columbia [9, 10], the risk to Alberta's pine forests is yet to be explored.

Objectives

The objective of this research is to test the hypothesis that spatial legacies in forest fuels left behind by MPB outbreaks affect wildfire severity and represent an increase in fire likelihood in the pine forests of Alberta. To address our hypothesis, we will integrate recently developed remotely sensed data products representing burn severity [11] with information on historical MPB outbreaks, fire weather, and other environmental factors to develop descriptive and predictive models of how the timing of MPB outbreaks (e.g., green, red, and grey stages) prior to a fire event affects fire burn severity.

The relationship between MPB and burn severity will be investigated at two different spatial scales. First, we will model the influence of historical MPB activity on mean burn severity within individual fire perimeters while controlling for the effects of fire weather, ecoregion, topography, forest composition and age, and seasonality. We will also relate variation in mean severity with other fire-level metrics such as fire duration and final size. Next, we will construct pixel-level models of how MPB-kill affects severity within fires and use these models to forecast fire severity over the forest regions containing pine in Alberta.

Expected outcomes

Outcomes from this project will include two statistical models to predict burn severity in Alberta given information on fire weather, environmental context, and MPB outbreak history. These models will be used to inform landscape-scale forest simulation models to further our understanding of the complex interactions between forest disturbances, forest vegetation, and climate. Potential applications of these models include informing landscape-scale fire risk, guiding fire management strategies, and providing additional context and measures of uncertainty to inform forest management planning. We will produce several peer-reviewed publications, conference presentations, and train one master's student and one post-doctoral researcher in wildfire science.

Implications for managing the mountain pine beetle or resource management in general

The research will provide much needed information on how mountain pine beetle outbreaks in eastern slopes of Alberta may influence fire severity. Using data from fires in British Columbia that occurred in MPB-affected stands, validated models will be used to predict fire severity in areas of Alberta that have recently experienced, or are vulnerable to MPB outbreaks. In this work, we will also aim to identify the conditions under which MPB-killed forest might ***not*** be of concern for fire severity. For example, under extreme fire weather conditions, insect-killed stands may be less important to fire behaviour than under moderate fire weather conditions.

Value of this research in support of social, economic, ecological expectations

This work will have significant value in improving our understanding the complex eco-evolutionary relationship between insects and wildfire and the impacts of combined disturbances on forest resilience in the context of climate change. Practically, our predictive models will aid forest and fire managers to better forecast the ecological effects of wildfire as well as the consequences for timber supply. This research will help fire managers in forecasting how the timing and intensity of MPB attack might affect severity. Finally, this work will provide greater context and direction for fuel mitigation efforts in the context of current and future outbreaks.

Expected date of project completion:

April 2024

For more information on this project, contact Dr. Patrick M A James at patrick.james@utoronto.ca.

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