QuickNotes

Science summaries from fRI Research

Introducing: Effects of mountain pine beetle outbreaks on population dynamics of secondary bark and ambrosia beetles

Dr. Nadir Erbilgin

The mountain pine beetle (MPB) has expanded beyond its historical distribution in lodgepole pine forests, invading higher elevations, northern latitudes, and eastern longitudes which were once thought to be unsuitable for beetle survival. This invasion has resulted in the mortality of a large number of mature lodgepole pine trees and has left a small number of live overstory pine trees. These residual trees have become a critical component for the recovery of pine forests in post-MPB outbreak stands. However, it is unknown whether MPB invasion promotes the population density of native bark and woodboring beetles, which can further threaten the residual trees in post-MPB outbreak stands.

Mountain pine beetle is considered a 'primary species' due to its ability to kill healthy trees during intermittent outbreaks. In contrast, other bark and woodboring beetle species are generally considered 'secondary beetles' because they commonly colonize recently dead or dying/stressed trees and tend to increase their populations following outbreaks by the primary bark beetle species. One of the major concerns in post-MPB-outbreak stands is that these secondary beetles may use dead or dying trees as sources to build up their populations and then attack healthy pine trees in the post-outbreak stands, further impeding the recovery of pine forests after the MPB outbreak.

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.

Natural Resources Canada | Ressources naturelles Canada

Canada

Alberta Agriculture and Forestry

Several factors influence the population growth of secondary insects, including the suitability of host trees, intra-and inter-specific interactions, and predation. Bark beetle outbreaks can alter forest stand conditions, including soil moisture, soil nutrients, soil microbial communities, and plant communities. In many cases, these changes last for years. When primary bark beetle species are at the endemic phase, their interactions with secondary beetles can range from competition to facilitation. In addition, predation can also influence the population growth of bark and woodboring beetles. Their top predators prey on both immature and mature stages of bark and woodboring beetles, often inflicting density-dependent mortality. All these factors may complicate predicting lodgepole pine recovery in post-outbreak stands.

A 4-member field crew from my lab.

Objectives and Hypothesis

I expect that the abundance of bark beetles and woodboring beetles would increase with the percent pine mortality as there would be more hosts available in these stands. I also expect that the abundance of bark and woodboring beetles would be higher on stressed or declining residual trees, compared to healthy residual trees as both bark and woodboring beetles tend to colonize stressed or declining trees. I hypothesize that residual live mature pine trees will be subject to increased beetle attacks in post-MPB stands; that post-MPB stands present conditions that will increase bark and woodboring beetles of lodgepole pine trees, hampering future lodgepole pine regeneration.

Our main objective is to investigate whether the current population densities of bark beetles could threaten residual pine trees in post-MPB outbreak stands in Alberta. Specifically, we are interested in determining whether the percent lodgepole pine mortality, the total number of dead trees, or the health conditions of residual trees affects the abundance of bark and woodboring beetles and their predators. Overall, the outcome of this study could help explain the complex interaction among MPB, secondary beetles and their predators after MPB outbreak in novel habitats and may be relevant for the restoration of lodgepole pine forests in post-MPB outbreak stands.

Flight intercept, emergence, and landing traps set up on trees.

Approach

In each plot, we categorize all residuals at least 15 cm in diameter at breast height in one of three categories based on their apparent health conditions as healthy, declining, and survived. Healthy trees show no or only minor symptoms of pathogen or insect attacks while declining trees usually show sparse crowns, yellowish needles, bark lesions or other types of damage (i.e., branch or stem galls). Survivors show no declining symptoms but have visible evidence of unsuccessful MPB colonization, including failed beetle reproduction, (i.e., presence of short maternal galleries), absence of oviposition and larval galleries, and absence of beetle emergence holes.

To examine the abundance of bark and woodboring beetles, we set up three types of insect traps in each plot: flight intercept, landing, and

emergence traps. We placed one flight intercept trap in each plot, hung on a PVC pole with glycol solution in collection cups attached to the bottom of traps. In addition, we set up one landing and one emergence trap on all three categories of residual trees in each plot. Emergence traps catch insects as they emerge from tree stems. For each landing and emergence trap, we attach a cup filled with glycol solution so that we can preserve the specimens between each collection. We set traps in June and monitor them until the end of September in 2022 and then from May 2023 to Aug 2023, transporting specimens back to the laboratory for identification.

Closeup of a trap.

Due to their close association with MPB, we have primarily focused on bark and woodboring beetles. The woodboring beetle group includes individuals from the families Buprestidae and Cerambycidae. We will classify predatory beetles: Cleridae, Histeridae, Nitulidae, Salpingidae, Staphylinidae, Tenebrionidae, Trogrosstidae.

Expected Outcomes

Our study assesses future risks by native bark and ambrosia beetles in pine forests due to increased pine mortality by MPB on the landscape. This will have a significant impact on the health of remaining residual pine trees across the upper and lower foothills. Thus, we propose to determine whether native bark and woodboring beetles pose a risk in post-MPB outbreak pine stands and if so, examine the conditions required for MPB to significantly affect stand health.

The resulting information will determine what stand conditions (i.e., percent tree mortality) and ecosite types are more prone to the population growth of bark and woodboring beetles. One MSc student and several undergraduate students trained through this project will join the workforce with the prerequisite knowledge required for the sustainable management of forests in Canada for future generations. Furthermore, dissemination of the research outcomes in open literature will ensure that the fundamental knowledge produced through this research can be applied to advance the current state of science and technology by scientists globally.

Implications for Land Management

Alberta is facing a future in which large tracks of lodgepole pine forest have died as a result of attacks by MPB. The economic vitality of our forest industry, and the economic and social well-being of forest-dependent communities, depend upon ensuring the future re-development of these forests so that they can continue to deliver a diversity of ecological goods and services. Using the biological and ecological information obtained at different ecosites and MPB attack levels, this project will fill an important gap: the lack of reliable management tools for estimating secondary beetle populations in environmentally and climatically different lodgepole pine forest stands. An understanding of variability in beetle populations will be useful for prioritizing areas for management intervention by identifying areas with higher and lower risks for beetle outbreaks.

Expected Date of Completion

September 2023