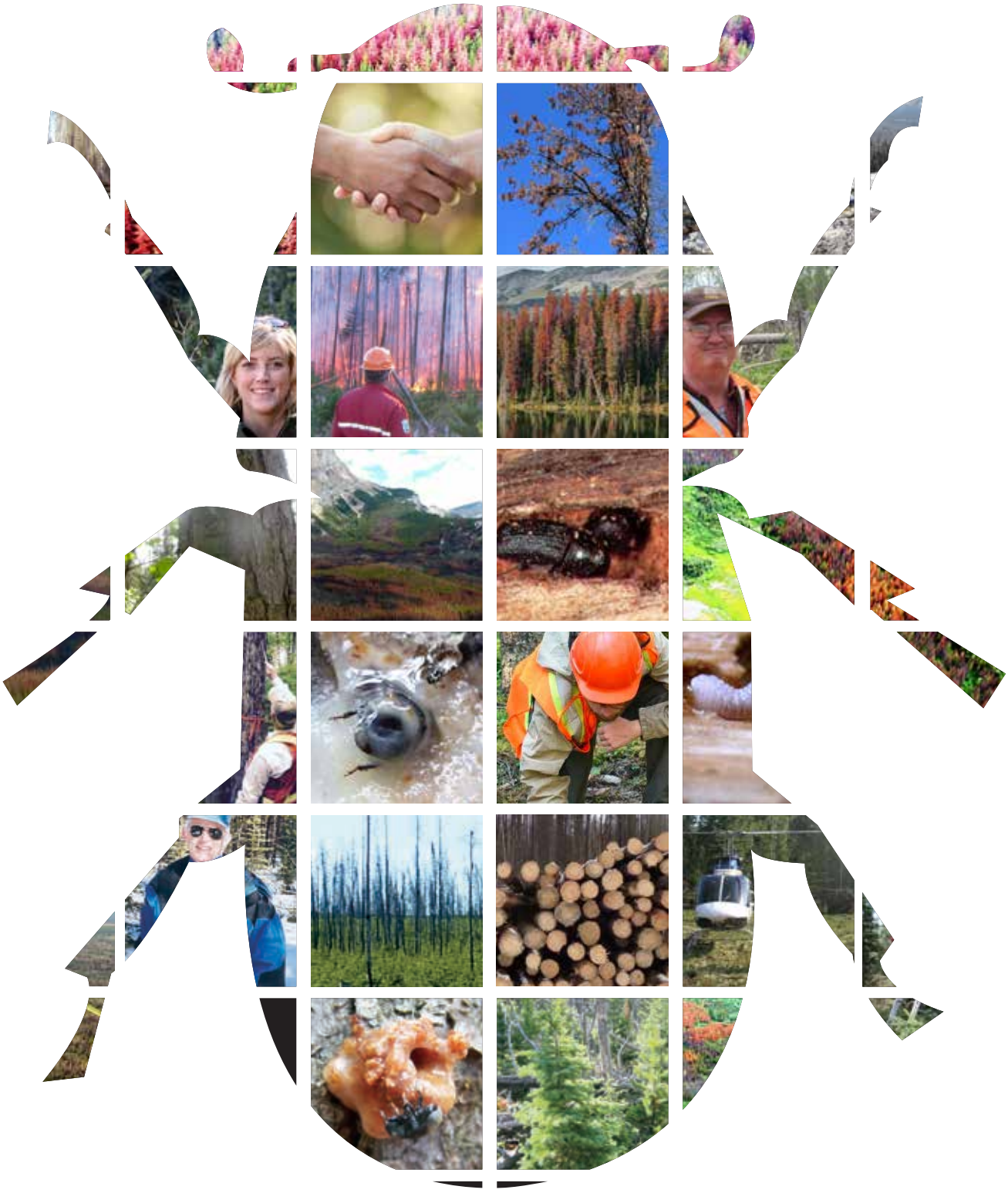
MOUNTAIN PINE BEETLE
RESEARCH FORUM 2023



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Alberta

Acknowledgements

Meetings of this magnitude do not magically come together; they, in fact, are the result of many hard-working individuals who bring their unique skill sets together to provide a learning experience well worth the *"price of admission."* Planning for this forum began almost a year ago, with the date being set for October 2023. Typically, an April date is selected, but with the termination of the Federal-Provincial MPB Research Partnership on March 31, 2024, the planning committee saw advantages to hosting the meeting earlier. Such a decision immediately conjured up issues related to having principal investigators present the results of their work before their research was complete. But this was not the case; we were delighted they brought extra effort to bear on their work to advance it to a point where they could report on it at the forum. We owe each project team a sincere thank-you for their efforts. We recognize and appreciate that not all projects will be completed by the time the Research Forum is convened. Hence, fRI Research commits to having research reports posted to its website as soon as possible following the meeting. We are indebted to the facilitators (Caroline Whitehouse, John Stadt, Rory McIntosh and Chris Stockdale) in keeping their sessions on time and engaging. Behind the scene of this event Fran Hanington worked diligently tirelessly soliciting information from speakers for the agenda booklet, arranging facilities, managing logistical issues such as registration, planning menus, arranging for audio-visual support, requesting poster stands and many other important matters. Ben Williamson, Communication Services Program Manager, did a marvelous job reviewing material, developing and managing the registration site and providing advice surrounding IT. We are grateful for having Penny Snell, BubbleUp Marketing on our team. Penny was able to take research material (sometimes boring) and make it exciting and meaningful through her artistic expressions *(a picture is worth a thousand words).* We thank you all.

Keith M. McClain
Co-Chair, 2023 MPB Research Forum
MPB Program Research Lead
fRI Research

Caroline Whitehouse
Co-Chair 2023 MPB Research Forum
Forest Health Specialist
Forest Health and Adaptation Section
Alberta Forestry and Parks

Fran Hanington
Co-Chair, 2023 MPB Research Forum
Communication Services Assistant
fRI Research

Fran has worked for fRI Research for 23 years in Communication Services. She is the president of the board for the Hinton Historical Society. For many years she was involved with the Hinton Association for the Children of Chernobyl in the role of board member and president, organizing and overseeing the recuperation program for Belarusian children coming to Hinton giving them a break from living in contaminated areas of Belarus. Fran has traveled to Belarus a number of times; attending international conferences, meeting with the Belarusian Charitable Fund in Minsk, and spending time in affected areas of that country.

Welcome to the 2023-2024 Federal – Provincial MPB Research Forum

After a three-year hiatus, the fRI Mountain Pine Beetle Ecology Program is delighted to convene the 2023 Research Forum. We have much to discuss.

As we look back on where we started and how far we have come, the scientific collective has much to be proud of; significant scientific advancements have been made and have influenced operational decision-making and policy development. A direct outcome of our accomplishments has been increased confidence in making the right decisions at critical times and projecting future scenarios that may evolve, prompting immediate well-thought-out action plans. Of course, in the words of my esteemed colleague Dr. Allan Carroll, "there will always be surprises." Still, as we build our knowledge base, we will increase the province's level of preparedness to respond in the event of a future epidemic outbreak and manage endemic populations, which will pose challenges for forest managers.

While addressing the invasion of the MPB, scientists and practitioners have gained insights into population dynamics, primarily from British Columbia. Alberta's forest practitioners and scientists soon concluded that different beetle population behaviours could be expected in Alberta due to differences in stand composition, site conditions, and climactic variables. It would be foolish to think that we could rely totally on the experiences of other jurisdictions as a foundation to manage the invasion of the beetle in Alberta. While helpful, we still needed to use "home-generated" science and adaptive management to contend with the beetle where it was anticipated to spread. To this end, the Mountain Pine Beetle Ecology Program was endorsed by the Strategic Directions Committee[1] (October 29, 2008) to function as a "Science Information Forum" to identify research needs, facilitate knowledge transfer and promote collaboration amongst researchers and managers and work with SDC to inform the public about MPB research. In developing a strategy to generate home-generated science, we took a systematic approach to formulate critical questions within the bounds of four research themes:

1. MPB biology and management.
2. Hydrological impacts of the mountain pine beetle.
3. Landscape and stand dynamics following MPB.
4. Social and economic implications of a changing landscape.

From 2007 to 2021, over forty research proposals were developed by scientists, funded, and implemented. The results derived offered a significant advantage in controlling the spread of the beetle throughout Alberta and minimize potential for eastern spread in the Boreal Forest. Forest industry and government leaders worked together and evaluated actions and outcomes and refined operations for future implementation. There were obvious indications that early detection and single tree removal and burning was a workable (albeit expensive) strategy to manage the beetle. From a biological standpoint, knowing the progression of change in beetle physiology and how environmental factors influenced its development, growth and, ultimately, survival was critical in predicting population levels and potential spread. Significant advancements were made in these research areas, and predictive modelling has added significantly to our ability to forecast spread patterns and make decisions on deploying resources to control spread.

While we recognize the need to explore post-beetle stand response and take appropriate action to ensure healthy future stand conditions, much more time will be required to achieve this goal. Similarly, impacts on hydrological cycles will be a protracted process.

As research efforts guided by the Mountain Pine Beetle Ecology Program declined due to reduced funding, a new initiative emerged in a partnership between the Federal and Alberta Governments. A carefully developed proposal saw additional support for research to contribute to the following outcomes:

1. Limiting the spread of MPB into the eastern boreal forest.
2. Limiting the spread of MPB along the eastern slopes of Alberta.
3. Mitigating damage to Alberta's pine resources in locations where MPB is already established.
4. Generating new knowledge and innovative management techniques through research on MPB.

These outcomes were further defined with the establishment of the following strategic research themes: 1) MPB Biology, 2) MPB dispersal and spread, 3) Detection and management of MPB, 4) Ecological and social impact and 5) Wildfire behaviour after MPB. From 2021 through 2024, 24 projects will have been implemented involving various advanced technologies. Research investigators will illustrate their results achieved at this forum.

Alberta owes a debt of gratitude to all the scientists and graduate students who dedicated their time, energy and intellectual skills to meet the challenge of the MPB infestation head-on.

Forest practitioners also need to be commended for their contributions through creative planning and operations and the Federal and Alberta governments' persistence in providing funding to answer a growing list of questions. Despite our success, we should not slip into complacency; much more still needs to be done. Climate change is a factor that will change "the rules of the game" and, as we have witnessed, threatened public safety with wildfire, community economies and well-being.

Lastly, I extend special thanks to members of the Forest Health and Adaptation Section of Alberta Forestry and Parks for their many contributions. I want to identify Daniel Lux, Erica Samis, Caroline Whitehouse, and Mike Undershultz for their support along the way. It is stimulating to work with such unique and enthusiastic individuals.

The same must be said for the Mountain Pine Beetle Activity Team, whose guidance over the past eleven years has been exceptional.

Of course, the hard work of Fran Hanington, Communication Services, fRI Research, for her intuitive abilities to make things happen on time and better than expected, and Penny Snell of BubbleUp Marketing, Edmonton, for her creativity and applications to make our communications more revealing and exciting.

Keith M. McClain

1. October 29, 2008. Letter from Doug A. Sklar, RPF, Executive Director, Forest Management Branch and Chairman of the Strategic Directions Committee to Don Podlubny, Program Lead, MPBEP.


CAT

Federal-Provincial MPB Research Partnership

Research Advisory Committee

Member	Organization	email
Dr. Anne Hubbs, RPBio	Senior Wildlife Biologist, Alberta Environment and Protected Areas	Anne.Hubbs@gov.ab.ca
Caroline Whitehouse, RPBio, (Chair, FPRP)	Forest Health Specialist Forest Health and Adaptation Section Alberta Forestry and Parks	caroline.whitehouse@gov.ab.ca
Hal Jackson, RPF	Planning Superintendent Hinton and Edson Woodlands West Fraser Mills	Hal.Jackson@WestFraser.com
John Stadt, RPBio	Provincial Forest Ecologist Strategic Forestry Initiatives Section Alberta Forestry and Parks	John.Stadt@gov.ab.ca
Dr. Keith McClain, RPF	Research Program Lead Fed-Prov MPB Research Partnership fRI Research	kmcclain@friresearch.ca
Maria Sharpe, RPF	Fire Science Manager Canadian Interagency Forest Fire Centre	maria.sharpe@ciffc.ca
Michael Wagner, RPF	Forest Hydrologist Forest Resource Management Section Alberta Forestry and Parks	michael.wagner@gov.ab.ca
Lee Woodham, RPF (Ex-officio)	Director Forest Health and Adaptation Section Alberta Forestry and Parks	Lee.woodham@gov.ab.ca
Dr. Rory McIntosh, RPF	Provincial Forest Entomologist and Pathologist Saskatchewan Ministry of Environment	Rory.McIntosh@gov.sk.ca
Dr. Barry White, RPF (Ex-officio)	Executive Director, fRI *Research*	bwhite@rfiresearch.ca
Dr. Taylor Scarr, RPF	Director, Integrated Pest Management Natural Resources Canada - Canadian Forest Service Great Lakes Forestry Centre, SSM	taylor.scarr@canada.ca

Federal-Provincial MPB Research Partnership

Strategic Research Themes

The mountain pine beetle (MPB) remains a threat to Alberta's pine forests. Alberta was successful in acquiring Federal assistance to pursue three objectives of an operational nature to limit the spread of MPB into the eastern boreal forest, to limit the spread of MPB along the eastern slopes of Alberta, and to mitigate damage to Alberta's pine resources in locations where MPB is already established.

Research undertaken was categorized by strategic themes that are provincially and nationally based. They are described below.

1. MPB Biology

Unlike in British Columbia where lodgepole pine has co-evolved with Mountain Pine Beetle, Alberta pine is more vulnerable to mortality due to a lack of co-evolution. As the MPB spreads eastward through the novel habitats of lodgepole, lodgepole pine – hybrid jack pine, and jack pine one can expect to witness unique population dynamics and a range of biological interaction with new hosts. Many uncertainties exist regarding their interaction with novel hosts, fungal associates, natural enemies, and competitors. Moreover, climatic variations will broadly shift our current understanding of biological interactions that will require elucidation to ensure effective operational decisions. Re-exploring MPB biology in eastern habitats is therefore required to better understand the risk to eastern pine forests.

2. MPB Dispersal

The mountain pine beetle expands its range by spreading through the landscape by short and long-distance dispersal flights. In the extended range, MPB populations are challenged with more heterogeneous pine forests of lodgepole pine, hybrid lodgepole-jack pine exhibiting various degrees of resistance and a vastly different climate than experienced in their historical range. All of these factors affect their dispersal capability and impact population expansion.

3. Detection of MPB

Tools to confidently detect the presence of MPB at varying densities are critical to the successful management of populations. Analysis by Carroll et al. (2017) indicates that MPB single-tree control efforts in homogenous stands in western Alberta were effective at limiting spread. Control efficacy is partially limited by effectively detecting green-attack trees and responding within a given timeframe. Historically, provincial detection efficacy ranged between 54-68 percent (Carroll et al., 2017). Provincially, detection accuracy within the 50 metres concentric survey plot averages 98.5 percent and increases only marginally at increased plot radii.

Management of MPB involves short-term beetle-focused (single-tree treatment) actions and long-term host management strategies that target forest composition at a larger scale. These strategies rely heavily on stand susceptibility models, operational decision support tools, and MPB spread models.

4. Ecological & Social Impact

MPB outbreaks cause broad-scale ecological changes in pine forests leading to socio-economic impacts affecting community well-being, safety and security of the forest industry. These changes may be less predictable in the MPB expanded range, but understanding their impact is necessary to develop preparedness and increase community resiliency. Research on the effects of MPB in these new novel habitats is required. Moreover, understanding is needed on the response of endangered species to changes in habitat due to MPB, on hydrologically induced changes across the landscape and on stand regeneration. Research carried out by fRI Research through its Mountain Pine Beetle Ecology Program has provided essential insights to these questions, but more needs to be done. It is essential to incorporate this science-based knowledge into management strategies and to inform future risk assessments.

5. Wildfire Behaviour after MBP

Studies have shown that tree mortality resulting from MPB infestations affects the susceptibility of stands to fire through changes in fuel loading, fuel structure, and microclimates. Changes in fuel chemistry, e.g., the release of highly flammable terpenoids by dying trees and availability of standing dead trees, can have potentially dramatic impacts on fire behaviour (Jenkins, 2014). Parsons et al. (2014) noted that MPB-killed trees may increase the frequency and intensity of wildfires and contribute to a more rapid spread and a greater likelihood of crown fires (as reviewed by Nealis and Cooke 2012, Parsons et al. 2014). However, many knowledge gaps remain, particularly in light of climate change and the movement of MPB into novel habitats.

The GOA and the Canadian Forest Service are currently collaborating with fRI Research to address Mountain Pine Beetle Effects on the wildfire rate of spread and landscape fire risk and assess existing knowledge gaps. One specific goal of current research related to wildfire is to understand how MPB induced mortality contributes to landscape-level wildfires. This research should continue, given its tremendous value to the provincial FireSmart program as MPB impacts more forested communities.

References for Wildfire Behaviour after MPB

Jenkins, MJ, J.B. Runyon, C. J. Fettig, W. G. Page, and B. J. Bentz. 2014. Interactions among the Mountain Pine Beetle, Fires, and Fuels. For. Sci. 60(3):489–501.
Parsons, R., Jolly, M., Langowski, P., Matonis, M., and Miller, S. 2014. Future Forests Webinar Series. United States Department of Agriculture Forest Service Rocky Mountain Research Station Proceedings, P-70: 19-28. Accessed May 31, 2018.
Nealis, V. and Cooke, B. 2012. Risk assessment of the threat of mountain pine beetle to Canada's boreal and eastern pine forests. Canadian Council of Forest Ministers. 31 pp.

2022 Mountain Pine Beetle Status Update in British Columbia

Submitted by Marnie Duthie-Holt, M.P.M., R.P.Bio., Kootenay Boundary Regional Entomologist – Resource Management, BC Ministry of Forests, Cranbrook, BC

Biographical Sketch

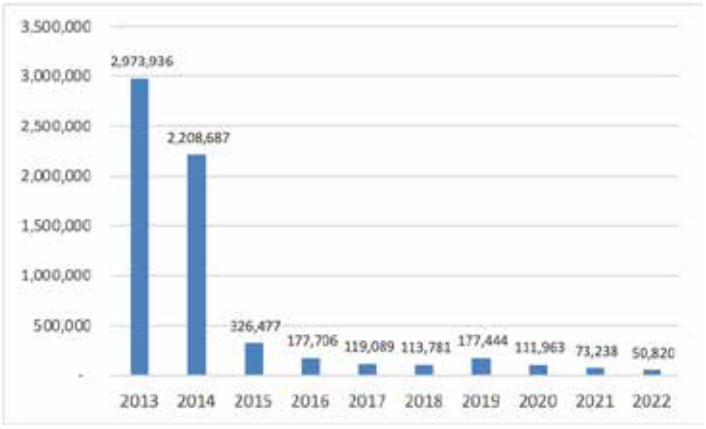
Marnie Duthie-Holt is a Forest Entomologist for the BC Ministry of Forests, based in Cranbrook. She is responsible for managing the Forest Health program in the Kootenay Boundary Region, working closely with Stewardship Foresters in each District. Marnie is a Registered Professional Biologist who started her career in forest health by completing a Masters of Pest Management degree in 1997 from Simon Fraser University, focusing on options for control of mountain pine beetles. She worked for a consulting company in Prince George as their Entomology Department Head, prior to starting her own Forest Health Consulting company in 2001 for over 18 years, where she worked with government, major licensees, and first nations throughout BC and AB. Marnie oversaw the largest mountain pine beetle control program in BC history from 2004-2007, managing an over $30 million budget annually during that time as the mountain pine beetle crossed over the Rocky Mountains into northern AB. Marnie then assisted the AB provincial government develop their contract standards and training program for mountain pine beetle suppression efforts. In 2018, Marnie started her current position with the BC Ministry Forests with a brief interlude in 2022 where she performed a temporary assignment as BC's Provincial Entomologist. Marnie has dedicated her entire career to forest health with a focus on bark beetle management.

Excerpt from the "2022 Summary of Forest Health Conditions in British Columbia" available on the web at:

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/forestry/forest-health/forest-health-docs/2022_aos_report_final.pdf

Bark beetle impacts declined in 2022, with the least amount of area impacted in over ten years (2,308,602 ha total for all bark beetles combined). This is attributed to drastic decreases in mountain pine beetle (Dendroctonus ponderosae; IBM), spruce beetle (Dendroctonus rufipennis; IBS) and Douglas-fir beetle (Dendroctonus pseudotsugae; IBD) activity. At the peak of the IBM outbreak in 2007, 10M ha of pine were killed and as stand susceptibility increases again across the province, impacts will increase as a result. Figure 1 outlines the historical attack levels of mountain pine beetle over the last 10 years.

Figure 1. *Infested area in BC (hectares of attack for all severity classes) by mountain pine beetle from 2013-2022.*



Most IBM attack recorded in 2022 were in the trace category (75%), followed by light (18%), moderate (5%) than severe (1%) as outlined in Figure 2.

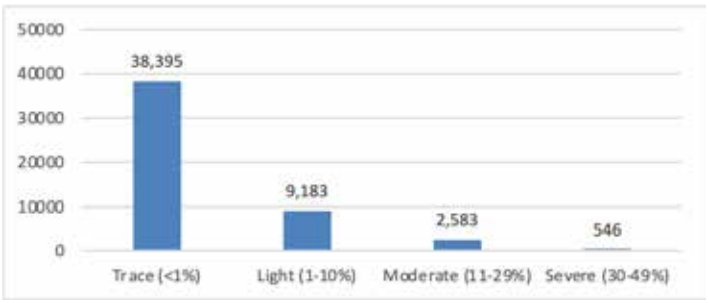


Figure 2. *2022 Mountain Pine Beetle (IBM) hectares of attack in BC by severity class.*

The primary host continued to be mature lodgepole pine. However, attack in whitebark pine stands is increasing, with most of this mortality occurring in Kootenay/Boundary and Thompson/Okanagan Regions. Figure 3 displays previous mountain pine beetle attack in white bark pine near Cranbrook, in the Kootenay Boundary Region.

Figure 3. *Mountain pine beetle (IBM) killed white bark pine trees (Lakit Lookout, near Cranbrook, BC) (Photo credit: Marnie Duthie-Holt).*

The total hectares affected by mountain pine beetle in 2022 was 50,820 hectares with the largest attack noted in the Cariboo Region, concentrated in the Williams Lake TSA (32,919 ha), followed by Thompson Okanagan Region mainly in the Lillooet TSA (6,495 ha), Kootenay Boundary Region mainly in the Invermere and Cranbrook TSAs (5,585 ha), Omineca Region, in the Prince George TSA (2,947 ha), Skeena Region (1919) as well as small amounts of attack in the Great Bear Rain Forest Region (479 ha), South Coast Region (307 ha), and West Coast Region (166 ha) as outlined in Figure 4 and shown on the map in Figure 5. Figure 6 displays increasing populations of mountain pine beetle on Baker Mountain near Cranbrook, attributed to drought stressed trees.

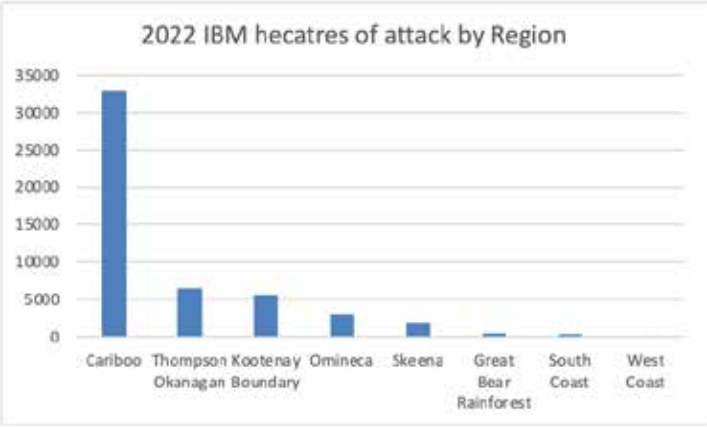


Figure 4. *2022 Mountain Pine Beetle (IBM) hectares of attack for all severity rating by Region in BC.*

Figure 5. *2022 Mountain Pine Beetle (IBM) infestations recorded by severity in British Columbia.*

Figure 6. *Mountain pine beetle (IBM) attack on Baker Mountain, near Cranbrook, BC (Photo credit: Marnie Duthie-Holt).*

2023 – 2024 MOUNTAIN PINE BEETLE STATUS UPDATE IN ALBERTA

Prepared by Devon Belanger, Forest Health Officer– Forest Stewardship and Trade Branch, Alberta Forestry and Parks

Biographical Sketch

Devon is a Forest Health Officer with Alberta Forestry and Parks. He completed a BSc at the University of Alberta. Devon has worked for the Alberta Government in various forestry related roles since 2014.

Introduction

Each year Forest Health and Adaptation (FHA) staff collect data on forest disturbances, excluding wildfire, that occur on forested public land. Mountain pine beetle (MPB) populations are monitored using ground and aerial surveys that primarily span the region of the province where this beetle is actively managed.

MPB Status

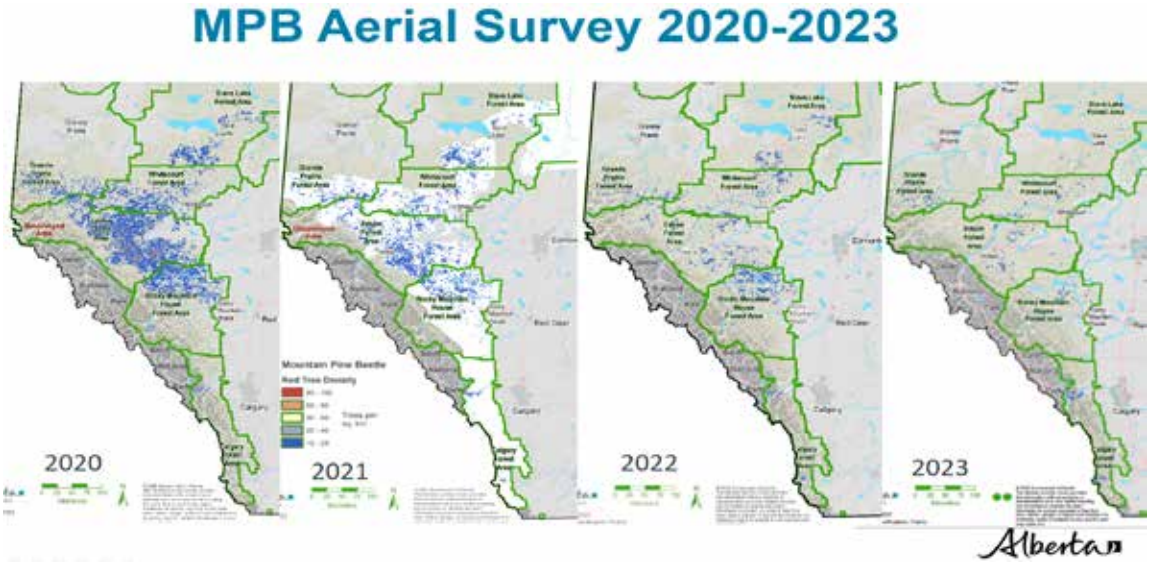
There have been significant MPB population declines across the majority of Alberta. The Calgary Forest area is the only forest area where MPB populations have not declined. MPB populations throughout most of the province have begun to display endemic behaviour and therefore the threat posed by MPB is no longer considered a provincial emergency.

Aerial surveys are conducted in August and September and are used to detect groups of red-crowned pine trees - an indicator of successful mass-attack by MPB. The total red tree sites detected by aerial surveyors has reduced significantly year to year for four years in a row even though the area surveyed remains relatively unchanged. See figure 1 for the number of red tree sites for the past four years. The maps in figure 2 show the red tree site location and density derived from aerial survey.

Figure 1.

Forest Area	Sites				
	2019	2020	2021	2022	2023
Calgary	828	464	1,365	1,074	1,325
Edson	21,292	18,940	3,391	662	131
Grande Prairie	1,936	647	460	259	116
Lac La Biche	136	50	4	7	0
Rocky Mtn. House	5,395	4,120	1,069	954	80
Slave Lake	1,438	1,504	886	387	21
Whitecourt	10,514	1,887	722	485	100
Total	41,539	27,612	7,897	3,828	1,773

Figure 2.



Outlook

Alberta's MPB control program will be transitioning from a geographically encompassing effort to a more targeted program. Future control operations will be localized to areas where MPB populations are building or where MPB poses intolerable risk to other values.

2023 – 2024 MOUNTAIN PINE BEETLE STATUS UPDATE IN SASKATCHEWAN

Prepared by Dr. Rory McIntosh, Provincial Forest Entomologist and Pathologist, Forest Service Branch, Ministry of Environment, Government of Saskatchewan

Biographical Sketch

Rory McIntosh has been involved in forest entomology since 1978. He has worked in forestry and entomology in Germany and England and forest health research across Canada. Rory graduated from the University of New Brunswick and headed to the west coast where he completed graduate work at the University of British Columbia and post-doctoral research at Simon Fraser University. Currently, Rory is the Provincial Forest Entomologist and Pathologist in Saskatchewan Ministry of Environment's Forest Service. Based in Prince Albert, he leads the provincial forest health program. In addition to his work for the ministry, Rory has served as an adjunct professor in the Department of Entomology at the University of Manitoba, and as adjunct in the School of Environment and Sustainability (SENS) and in the Department of Biological Sciences at the University of Saskatchewan.

2023 Mountain Pine Beetle Status in Saskatchewan

The risk of mountain pine beetle (MPB) spreading eastwards through Alberta and establishing in Saskatchewan's boreal jack pine forests remains of concern to Saskatchewan. The potential economic impact of an MPB infestation in Saskatchewan is significant. Mortality due to MPB will affect the long-term health and sustainability of Saskatchewan's forests and forest industry, jeopardizing the sector's recovery. The forest industry is recognized as a significant contributor to the province's economy, and an important source of employment in the north. The most efficient way to control MPB is through early detection and sustained, timely, aggressive response. It is important to remain vigilant and continue to be prepared for sustained and aggressive action.

SK & AB Interprovincial agreement to slow the spread of MPB, in Alberta.

Central to Saskatchewan's strategic approach is to focus on prevention by supporting aggressive detection and control operations in the leading edge, in Alberta and to slow the spread of MPB through the boreal forest and across Canada.

Alberta and Saskatchewan have worked together and shared forest health information for many years. In 2011, Saskatchewan and Alberta established a multi-year agreement to implement a collaborative, coordinated control program to slow the eastern spread of MPB, in Alberta. This very successful partnership was renewed four times with the last agreement ending in 2023. During that time, Saskatchewan invested just over $8.6 million towards control efforts in Alberta that resulted in the detection and control of more than 25,800 high-risk trees. In 2021 Saskatchewan received approximately $1.23 Million through the Government of Canada and Alberta $60 million agreement for slowing the eastern spread of MPB.

With the significant decline in risk of MPB spread, the agreement, in its current form, has not been renewed. Saskatchewan is interested in continuing this partnership and is working with Alberta to develop a Memorandum of Understanding that will continue to formalize our commitment to work together on regional forest health threats of mutual concern.

The provincial MPB program is divided into two distinct areas: the Northern boreal forest and the Cypress Hills Provincial Park (CHPP).

Figure 1. *Left hand column shows the heli-landing site and characteristic forest found in Saskatchewan's boreal forest, the pictures in the right column show typical forest and landscape found in the Cypress Hill Park.*

Northern Boreal Forest Surveys

The Ministry of Environment conducts systematic monitoring in the northwestern Alberta-Saskatchewan border region, with a focus on areas of highly susceptible jack pine. In 2007, in collaboration with the government of Alberta, a stand susceptibility Index was developed, and a map of highly susceptible stands was produced. This helped Saskatchewan focus survey and monitoring efforts in high-risk areas and potential MPB spread pathways.

In 2012, the ministry expanded ground monitoring capacity by extending invasion front tree-baiting monitoring network deployed in Alberta, into western Saskatchewan. To provide access, heli-landing areas were cut in pine and pine-leading stands (Figure 1 top left).

MPB is currently invading pure Jack pine stands in east-central Alberta and is becoming established in pine forests in the Marten Hills area east of Slave Lake

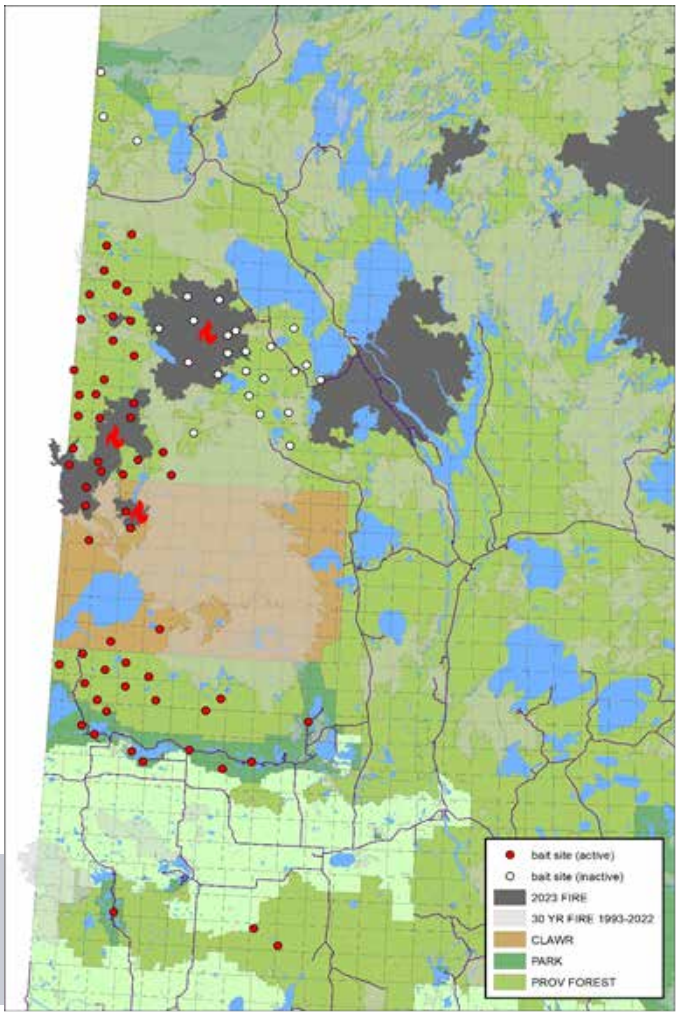


Figure 2. *Distribution of tree bait network sites deployed in western Saskatchewan. In 2023, 31 of the 57 sites (red dots) were baited. White dots represent currently inactive sites, some of which were also burned.*

A network of pheromone baited trees was established in Alberta to monitor the invasion front and detect eastward spread of MPB. In 2015 Saskatchewan extended this detection system into Saskatchewan.

To be consistent with the Alberta program, bait sites comprised three baited trees deployed in a triangular pattern, spaced at least 50m apart, and at a density of one site per township. The network initially included 82 sites, however based on risk and logistics, 25 were set aside as inactive sites leaving 57 active sites including 7 within the Cold Lake Air Weapons Range. Figure 2 shows the distribution of tree bait sites – the red dots show those that are baited and the white dots those that have been established and are currently inactive. Heli-landing areas were cut to at each site to provide ground access to all bait sites and to support response, if necessary.

In 2017, MPB was found 38 km from the border However, since 2019, when Alberta found MPB at three sites west of Fort McMurray, no beetles have been found in any other sites in the Athabasca Forest Region.

In 2023, Saskatchewan continued the tree baiting program. Due to the extreme fire season in May and June, about 10 active sites were destroyed by fire. Furthermore, 15 sites in the far north were not baited due to limitations on helicopter availability. Therefore, in 2023, only 31 sites were baited.

Due to the low populations in east central Alberta and the subsequent reduced risk of eastern spread, the bait sites were deployed for the last time in 2023. A maintenance schedule will be developed to ensure we are able to reinstate the network in the future should the risk become elevated.

Currently No Mountain Pine Beetles Are Found In Saskatchewan's Boreal Forest

Although there have been no MPB found in the northern boreal forests in Saskatchewan the MPB outbreak persists in the Cypress Hills Provincial Park in southwestern Saskatchewan.

Cypress Hills Provincial Park (CHPP)

Saskatchewan Ministry of Environment has been monitoring MPB in the CHPP since the last outbreak declined in 1985/86. Aerial overview surveys are used to locate all red trees. MPB infested trees are then located using intensive systematic ground surveys. Each year, all currently attacked trees that are verified during the ground surveys are marked for control and removed under contract to the Ministry of Parks Culture and Sport.

After reaching a peak in 2013, the outbreak declined for four years in a row until 2018 when the number of trees marked for removal increased to 200, up from 120 the year before. By 2021, the number of successfully attacked trees marked for control had reached a second peak with 534 trees removed (Figure 3). There was a decline in 2022 and we are hoping to see another decline for 2023 once the surveys are complete.

The outbreak in the CHIP remains unpredictable and MPB, as well as forest pathogens and other secondary beetles, still pose a significant threat to the unique, but declining, lodgepole pine forests in the Cypress Hills.

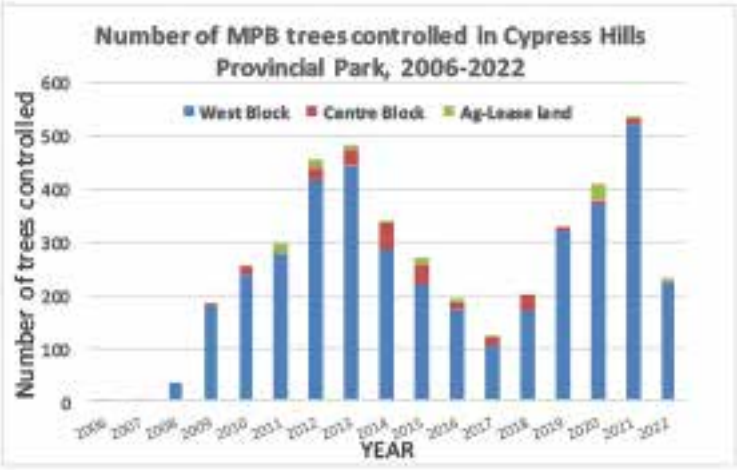


Figure 4. *Total number of trees controlled in the Cypress Hills Interprovincial Park 2006 to 2022.*

FEDERAL – PROVINCIAL MPB RESEARCH FORUM

Coast Edmonton Plaza Hotel, 10155 105th St.
Edmonton, AB T5J 1E2

AGENDA

Tuesday, October 24, 2023

Evening – 4:00PM – 8:00PM
Valley Ballroom and Foyer, Coast Edmonton Plaza Hotel
Registration, Reception and Cash Bar, Poster Setup

Day 1 – Wednesday, October 25, 2023

Valley Ballroom, Coast Edmonton Plaza Hotel

Time		Topic	Speaker
7:00	**7:45**	***Hot Breakfast***	**Foyer and Valley Ballroom**
7:45	8:00	Welcome and opening remarks Scope of the Federal-Provincial MPB Research Partnership (FPRP), Forum structure and objectives	***Dr. Keith McClain***, MPB Research Program Lead, fRI Research ***Caroline Whitehouse***, Forest Health Specialist, Forest Health and Adaptation Section, Alberta Forestry and Parks, and Chair of FPRP
8:00	8:15	An outlook to the future	***Dr. Barry White*****,** Executive Director, fRI Research
8:15	8:45	Reflecting on more than ten years of management and the application of research to control the spread of mountain pine beetle in Alberta.	***Daniel Lux***, ADM, Forestry Division, Alberta Forestry and Parks
8:45	9:30	VIDEO – Evaluating the efficacy of science: Cosmic zoom: How do we know if science is making a difference? Originally presented at the MPB Research Forum 2017.	***Dr. Stanford Blade***, Dean, Faculty of Agriculture, Life and Environmental Sciences, University of Alberta
9:30	9:45	***Introduction and Facilitation of Research Theme 1: MPB Biology***	***Caroline Whitehouse***, Forest Health Specialist, Forest Health and Adaptation Section, Alberta Forestry and Parks
9:45	**10:00**	***Health Break***	

Day 1 – Wednesday, October 25, 2023

Valley Ballroom, Coast Edmonton Plaza Hotel

Time		Topic	Speaker
10:00	10:30	Modelling eastern spread risk of mountain pine beetle using host genetic ancestry	***Dr. Catherine Cullingham***, Carleton University
10:30	11:00	The physiological costs and consequences of overwintering in MPB	***Dr. Heath MacMillan***, Carleton University
11:00	11:30	Improving monitoring tools to detect mountain pine beetle at low densities in novel habitats: incorporating host-tree stress and fungal volatiles in beetle attraction	***Leah Crandall*** and Dr. Nadir Erbilgin, University of Alberta
11:30	12:00	Modelling long-term dynamics of MPB in Alberta under climate change	***Dr. Mark Lewis***, Dr. Micah Brush and Xiaoqi Xie**,** University of Victoria
12:00	12:15	Plenary Discussion	Caroline Whitehouse
12:15	**1:00**	***Lunch***	

1:00	1:15	***Introduction and Facilitation of Research Themes 2 & 3: MPB Dispersal, spread and detection of MPB***	***Dr. Rory McIntosh***, Provincial Forest Entomologist and Pathologist, Government of Saskatchewan
1:15	1:45	Assessment of eastern spread risk of MPB through studies on beetle dispersal	***Dr. Maya Evenden***, Leanne Petro, Antonia Musso, University of Alberta
1:45	2:15	Dynamic species distribution modelling to predict mountain pine beetle boreal invasion	***Drs. Allan Carroll*** **and Vivek Srivastava** University of British Columbia
2:15	2:45	Efficient monitoring of mountain pine beetle outbreak spots using artificial intelligence applied to drone thermal imagery	***Drs. Mojtaba Marvasti-Zadeh*****,** Rudraksh Kapil, Guillermo Castilla, Devin Goodsman, Nilanjan Ray, Nadir Erbilgin, University of Alberta
2:45	3:30	Effects of mountain pine beetle outbreaks on population dynamics of secondary bark and ambrosia beetles	***Dr. Nadir Erbilgin*****,** Shiyang Zhao, Leah Crandall, University of Alberta
3:30	**3:45**	***Health Break***	
3:45	4:15	Toward pre-emptive management of future outbreaks: predicting the distribution of post-epidemic mountain pine beetle populations in the western boreal forest – ***a long view***	***Dr. Allan Carroll*** and Lucas Peng, University of British Columbia
4:00	4:45	**Plenary Discussion**	Dr. Rory McIntosh
4:45	***8:00***	***Reception (appetizers and cash bar) and Posters***	***Valley Ballroom***

DAY 1 **Speakers**

Welcome, Opening Remarks, and Scope of the Federal-Provincial MPB Research Partnership (FPRP), forum structure and objectives

Dr. Keith McClain, fRI Research Mountain Pine Beetle Ecology Program, and ***Caroline Whitehouse***, Forest Health Specialist, Forest Health and Adaptation Section, Alberta Forestry and Parks, and Chair of FPRP

Biographical Sketches

Keith is a Registered Professional Forester and has worked in forest science for his entire career. He has worked in Ontario for the Ontario Ministry of Natural Resources, Thunder Bay, in British Columbia for the Canadian Forest Service in Prince George, and more recently in Alberta with Alberta Sustainable Resource Development (now Alberta Forestry and Parks). During his early career, Keith conducted silvicultural research in Black Spruce focused on physiology and silviculture as a basis for successful reforestation. Later, his endeavours included research management and leadership, technology transfer and science policy. Keith has been the Program Lead of the Mountain Pine Beetle Ecology Program at fRI Research since 2012. Keith is an Honorary Member of the Canadian Institute of Forestry and a recipient of the Tree of Life Award. Keith earned Bachelor and Masters degrees from the University of Toronto and a PhD from Oregon State University.

Caroline is a Forest Health Specialist with Alberta Forestry and Parks. Prior to joining the government, she worked at the University of Alberta in a lab focused on the ecology of various insects. Her MSc was focused on the reproductive biology of a cone-feeding insect pest in conifer seed orchards. Her forest entomology background provided the knowledge needed for her first role with the Government of Alberta as a Forest Health Officer in northwestern Alberta. As a Forest Health Specialist, she helps to deliver a provincial forest health program focused on forest insects, diseases, and climate change with a superb group of co-workers.

An outlook to the future

***Dr. Barry White*,** Executive Director, fRI Research

Abstract

The MPB epidemic has impacted Alberta's forests for much of the past two decades and threatened a range of forest values including the sustainability of rural Alberta. The true extent of ecological threats remained largely unknown creating a strong sense of urgency to develop answers to complex, and often intertwined questions. Today we come together to learn more of fRI Research's Mountain Pine Beetle Ecology Program and its vast discoveries. This day also serves as an important opportunity for us to collectively recognize the many organizations and great individuals, many of whom are students in the early stages of their young careers, who have come together to make impactful innovation possible. It is because of their dedication to innovation that we continue to discover opportunities to enhance our deep understanding of the relationships between MPB and the ecology of Alberta's forests.

Biographical Sketch

Dr. Barry White was appointed fRI Research's first ever Executive Director in April 2023. Barry earned his PhD in forestry from UBC where he also got a certificate in Executive Management from the Sauder School of Business. Dr. White previously joined the fRI Research team in 2021 to lead the Water and Fish Program through its transition from a focus on hydrology to aquatic ecology and fish biology.

Prior to joining fRI Research, Dr. White served in leadership positions within the Government of Alberta, where he championed the concepts of precision forestry and enhanced forest inventories, helped develop lidar-derived planning tools, and provided key advice regarding forest management policy. The leadership he demonstrated at the intersection of cutting-edge technology, academic research, government policy, and industry operations provided an obvious pathway to provide leadership to a broadly recognized research organization boasting of numerous research and support programs to improve land management.

Dr. White is tackling the complex challenges that lie ahead by working with industry, governments, non-governmental organizations, and First Nation communities with the intent of collectively discovering better ways of managing Alberta's diverse landscapes which are draped in multiple land use objectives. Alberta's resources present complex challenges, but supported by science, historical perspectives, and respect for traditional ideas, he is confident significant advancements can be achieved.

In this role as Executive Director, Dr. White's top priorities are finding ways to provide more value for partners, fostering a culture of scientific creativity, ensuring science is integrated into policy and practice, and importantly, encouraging First Nation partnerships.

Reflections on MPB research in Alberta and its impact on management over the past twenty years

Dan Lux, Assistant Deputy Minister, Forestry Division, Alberta Forestry and Parks, Government of Alberta

Abstract

Dan will reflect on the MPB in general from the time he became deeply involved with its management and how operational decisions and research have combined to promote a decline in the rate of MPB infection. Alberta has spent in excess of $10 million to fund research which has provided answers to many important questions on beetle biology, population dynamics, factors affecting spread and beetle physiology. The resiliency of Alberta's pine forests is an important question and is one that will affect the strength of Alberta's Forest economy well into the future.

Biographical Sketch

Dan has been working in the field of Forestry since obtaining a Masters Degree from Simon Fraser University in 1995. After starting his career as a consultant in the interior of British Columbia, Dan moved back to his home province and joined the Alberta Government in 1999 as a Forest Health Officer in Rocky Mountain House. Dan moved to Edmonton to become the Senior Manager of Forest Health for the Province in 2005 where he oversaw the development and delivery of the emerging mountain pine beetle program. In addition to his forest health role, Dan was seconded to lead the Provincial caribou recovery planning process in the fall of 2013. In 2014, Dan became executive director of the Forest Industry Development Branch and expanded his role to oversee the Forest Management Branch in 2019. Dan was appointed Assistant Deputy Minister of the Forestry Division with the Government of Alberta in February 2022.

DAY 1 **Speakers**

Video - Evaluating the efficacy of science: Cosmic zoom: How do we know if science is making a difference? Originally presented at the MPB Research Forum 2017

Dr. Stanford Blade, Dean, Faculty of Agriculture, Life and Environmental Sciences, University of Alberta

Biographical Sketch

Dr. Blade is Dean of the Faculty of Agricultural, Life and Environmental Sciences (ALES) at the University of Alberta. He is also a full professor in the Faculty's Department of Agriculture, Food and Nutritional Science.

Dr. Blade hails from Alberta where he was raised on a dairy and grain farm. He attended the University of Alberta for his first degree (BSc) in genetics. He obtained his MSc (Crop Science) from the University of Saskatchewan for a breeding/physiology study on wheat. Dr. Blade's doctorate was awarded by McGill University (Montreal, Canada) for work done at the International Institute of Tropical Agriculture on a Canadian International Development Agency PhD Scholarship.

Dr. Blade is a 2012 graduate of the Wharton Business School's Executive Development Program (University of Pennsylvania). In 2012 Dr. Blade was named by Alberta Venture as one of "Alberta's 50 Most Influential People".

Dr. Blade has had progressively responsible positions in support of science and its application primarily in the field of biological sciences. He was the founding Chief Executive Officer (2008-2014) of the Alberta Innovates Bio Solutions Corporation (AI Bio) and previously served as the Deputy Director General (Research) for the International Institute of Tropical Agriculture (IITA).

Dr. Blade 's extensive research has resulted in well over 90+ research articles, ten book chapters, 170+ conference abstracts and has edited four books. He has been the winner of several awards from the American Society of Agronomy and the Crop Science Society of America. Dr. Blade is a member of several professional societies and international committees and has served on the editorial boards of several international journals. Dr. Blade has worked and traveled in 90+ countries.

He currently serves as Vice Chair on the Board of Trustees of the African Agricultural Technology Foundation, a Nairobi-based agency supported by the Bill and Melinda Gates Foundation. Dr. Blade also serves as a Trustee of the International Institute of Tropical Agriculture and as a board member for Edmonton Global (regional economic development agency), the Alberta Biodiversity Monitoring Institute and the Alberta Cancer Foundation.

Dr. Blade was recently awarded the Queen Elizabeth II's Platinum Jubilee Medal on January 19, 2023, in recognition of his significant contributions to the province.

Introduction and Facilitation of Research Theme 1: MPB Biology

Caroline Whitehouse, Forest Health Specialist, Forest Health and Adaptation Section, Alberta Forestry and Parks, and Chair of FPRP

Biographical Sketch

Caroline is a Forest Health Specialist with Alberta Forestry and Parks. Prior to joining the government, she worked at the University of Alberta in a lab focused on the ecology of various insects. Her MSc was focused on the reproductive biology of a cone-feeding insect pest in conifer seed orchards. Her forest entomology background provided the knowledge needed for her first role with the Government of Alberta as a Forest Health Officer in northwestern Alberta. As a Forest Health Specialist, she helps to deliver a provincial forest health program focused on forest insects, diseases, and climate change with a superb group of co-workers.

Modelling eastern spread risk of mountain pine beetle using host genetic ancestry

Dr. Catherine Cullingham, Department of Biology, Carleton University, Ottawa, Ontario

Abstract

As mountain pine beetle (MPB) has spread into the central portion of Alberta into the lodgepole-jack pine hybrid zone, a critical question in understanding future eastern-spread risk is whether stands of jack pine can support epidemic populations of MPB. In 2011, we documented infestation in jack pine, yet red-tree data collected by Alberta Agriculture and Forestry over the ensuing decade suggests that eastern spread of MPB beyond the currently defined lodgepole-jack pine hybrid zone has been limited. These data suggest that MPB from lodgepole and hybrid pine may serve as a source population, while pure jack pine may act as a sink. Our work sought to test this hypothesis using tree infestation data, and predicted pine genetic ancestry in Alberta. We examined the accuracy of a previously developed model that predicts pine ancestry based on environmental variable using existing and newly generated genetic data (over 1,400 individuals). We used this model to develop a predictive raster for the province of Alberta. To examine the relationship between pine ancestry and MPB infestation, we calculated MPB hot and cold spots for each year of data using the Getis-Ord General G statistic, and used a logistic regression model to identify parameters that would predict more (hot spot) or less (cold spot) beetle aggregation than you would expect based on the spatial distribution of infestations for each year. We found jack pine and hybrid pine are associated with less beetle aggregation across most years suggesting jack pine may not be a suitable host for epidemic level populations.

Biographical Sketch

Dr. Cathy Cullingham is an Assistant Professor in the Department of Biology at Carleton University. She completed her undergraduate degree at the University of Guelph specializing in molecular biology and genetics and used that knowledge during her PhD at Trent University where she examined the spread-risk of rabies in raccoons using landscape genetics. She has been working on the mountain pine beetle system for over 12 years, and her research has contributed to filling in important research gaps and contributed to our understanding of the spatial genetic diversity of lodgepole and jack pine. She is currently co-leading the TRIA-FoR project, a Genome Canada, Large-Scale Applied Research Program aimed at increasing resiliency, and better predicting risk in the mountain pine beetle system.

The physiological costs and consequences of overwintering in mountain pine beetle

Dr. Heath MacMillan, Department of Biology and Institute of Biochemistry, Carleton University, Ottawa, Canada K1S 5B6

Abstract

Overwintering is a critically important and stressful life stage for many insects, including the mountain pine beetle. Temperatures experienced during overwintering can influence post-winter fitness through their effects on both ionoregulatory and energetic homeostasis. While higher winter temperatures can lead to greater energy drain, sub-lethal (non-freezing) cold stress can instead cause a loss of ion balance (hyperkalemia), and cell death that may limit rates of energy gain (and thus fitness) after overwintering. Energetic stores are critical to cryoprotectant production during winter, as well as adult dispersal (flight) and reproduction after winter, and are therefore directly tied to population persistence and spread. In this talk, I will introduce the ionoregulatory collapse model of insect cold

tolerance, and the impacts of temperature variability on insect bioenergetics, and discuss how these different aspects of beetle physiology may independently and interactively influence beetle fitness and therefore spread.

Biographical Sketch

Dr. MacMillan is an Associate Professor in the Department of Biology and Institute of Biochemistry at Carleton University. Throughout his career, he has worked to build a clear understanding of the molecular, biochemical, and physiological mechanisms governing animal performance and injury caused by thermal stress in insects. In particular, Dr. MacMillan is known globally in the field of integrative physiology for applying approaches across multiple levels of biological organization to determine cause-and-effect relationships between a stressor and measures of arthropod fitness.

Improving monitoring tools to detect mountain pine beetle at low densities in novel habitats: incorporating host-tree stress and fungal volatiles in beetle attraction

Leah Crandall and Dr. Nadir Erbilgin, Department of Renewable Resources, University of Alberta, Edmonton, Alberta

Abstract

Trees under biotic stress release 'stressed volatile chemicals' (SVCs) that are not released otherwise. Stressed or downed trees are rare but can be highly abundant in stands following wildfires or insect outbreaks. SVCs may provide the necessary chemical cues for mountain pine beetles (MPB) to locate the most suitable (i.e., less defended) hosts. Similarly, the potential contribution of fungal volatiles to the MPB attraction is largely unexplored. In nature, we typically find trees infected by the fungal associates of MPB after unsuccessful host colonization; however, due to unusual climate patterns, the numbers and availability of such trees have dramatically increased in recent years. Low-density MPB will likely target these trees; thus, fungal volatiles released from such trees will likely improve host location by MPB. Our objective is to determine the feasibility of using SVCs and fungal volatiles to enhance the efficacy of mountain beetle attractants in low-density populations. We have (1) identified major volatile chemicals emitted from different types of stressed trees, (2) identified and quantified major volatiles emitted from trees colonized by the fungal associates of the mountain pine beetle, and determined the attractiveness of SVCs and fungal volatiles to the MPB in the field. Overall, we found that stressed agents significantly altered the chemical profiles of both tree species. Across disease types (Atropellis canker and Western Gall Rust) tested, we detected a several-fold increase in the concentrations of monoterpenes in the phloem. However, the chemical profiles of tree species varied among stress types. In particular, lodgepole pine trees inoculated with the fungal associates induced the most stress volatile chemicals, followed by the western gall rust and Atropellis canker. (3) Furthermore, the concentrations of individual chemicals were much higher in lodgepole pine trees inoculated with mountain pine beetle-fungal associates than the western gall rust and Atropellis canker. We are currently identifying insects from the field studies.

Biographical Sketches

Leah Crandall is a first year graduate student in the Department of Renewable Resources at the University of Alberta. Her research interests include disturbance ecology, invasion biology and entomology. Her research focuses on mountain pine beetle chemical ecology. More specifically, the role of fungal volatile compounds in the primary attraction of low density mountain pine beetle populations to host trees.

Nadir Erbilgin is a Professor and Chair of the Department of Renewable Resources at the University of Alberta. He joined the university as a Canada Research Chair in 2007. He has developed broad expertise in forest health indicated by high-quality publications (150), invitations to national and international conferences, an invitation to testify at national and foreign Senates, funding from national and international agencies, and mainstream media interviews. He has trained over 70 students and post-doctoral research fellows. His program investigates how plant primary and secondary metabolites change in response to biotic and abiotic stress agents and how these changes in turn affect tree susceptibility to insects and pathogens. He has been recognized by the Faculty of ALES Teaching Wall of Fame Award numerous times and was the recipient of the 2020-2021 Killam Annual Professorship. He has served the University by sitting in over 20 committees including the Chairs' Council Executive Committee, Director of Field Research Office, Academic Restructuring Working Group, Indigenous Engaged Research Strategy Task Force, Public Health Response Team, and Academic Planning Comm. for the last 16 years.

Modelling long-term dynamics of mountain pine beetle in Alberta under climate change

Mark Lewis[1], Micah Brush[2] and Xiaoqi Xie[2], [1]University of Victoria, [2] University of Alberta

Abstract

In this talk I will describe some new research using models to predict the long-term dynamics of mountain pine beetle in Alberta under climate change. Our approach has drawn on two different model structures: statistical and mechanistic. First, we employ a hierarchical spatiotemporal statistical model to determine empirical relationships between mountain pine beetle outbreaks and climate variables. We parameterize this model to the recent outbreaks in Alberta and then couple this model to climate predictions over the next 75 years to predict the relative risk of mountain pine beetle outbreaks in Alberta in the future. We also show that the relative risk of outbreaks in jack pine, found in eastern Alberta, is about 10 times lower than in lodgepole pine, found in western Alberta. Second, we develop a realistic mechanistic structured population model for mountain pine beetle populations interacting with age-structured forests using integrodifference equations. We use this model to determine how changing climatic conditions will affect the inter-outbreak period, the maximum density of pine beetles and the rate of spread of pine beetles. Our long-term goal in the project is to couple these two modelling approaches to make comprehensive long-term predictions.

Biographical Sketches

Mark Lewis is Gilbert and Betty Kennedy Chair in Mathematical Biology at the University of Victoria. He develops applies new mathematical methods to solve problems in ecology and environmental biology. With a research focus in spatial ecology, he has supervised over 50 graduate students and postdocs and has published 8 books and more than 250 papers. Research prizes include the CRM-Fields-PIMS Prize for Exceptional Research in Mathematics and the Canadian Applied and Industrial Mathematics Research Prize. He is Chief Editor of the Journal of Mathematical Biology, is former President of Society for Mathematical Biology and of the Canadian Mathematical Society. He is a Fellow of the Fields Institute, the Society for Mathematical Biology, the Society for Industrial and Applied Mathematics, the Canadian Mathematical Society and the Royal Society of Canada.

Micah Brush is a postdoctoral fellow at the University of Alberta. He is interested

in theoretical ecology and dynamical systems and works to combine data and theory to solve ecological problems. Over the last two years, his research has focussed on mountain pine beetle in Canada. Before that, Micah did his PhD at UC Berkeley under Prof. John Harte where he worked on macroecology away from equilibrium. He is currently supported by fRI Research in partnership with Mitacs and holds an NSERC Postdoctoral Fellowship.

Xiaoqi Xie is currently pursuing a master's degree working with Dr. Mark Lewis within the Mathematics and Statistics department at the University of Alberta. Her research during this master's program focuses on statistical modeling of the population dynamics of mountain pine beetle in Alberta. Her work involves studying the influence of pine hosts on the host selection process and assessing the potential outbreak risks in the context of climate change.

Introduction and Facilitation of Research Themes 2 & 3 – MPB Dispersal, spread and detection of MPB

Dr. Rory McIntosh, Provincial Forest Entomologist and Pathologist, Government of Saskatchewan

Biographical Sketch

Dr. Rory McIntosh has been involved in forest entomology since 1978. He has worked in forestry and entomology in Germany and England and forest health research across Canada. Rory graduated from the University of New Brunswick and headed to the west coast where he completed graduate work at the University of British Columbia and post-doctoral research at Simon Fraser University. Currently, Rory is the Provincial Forest Entomologist and Pathologist in Saskatchewan Ministry of Environment's Forest Service. Based in Prince Albert, he leads the provincial forest health program. In addition to his work for the ministry, Rory has served as an adjunct professor in the Department of Entomology at the University of Manitoba, and as adjunct in the School of Environment and Sustainability (SENS) and in the Department of Biological Sciences at the University of Saskatchewan.

Assessment of eastern spread risk of MPB through studies on beetle dispersal



Dr. Maya Evenden, Leanne Petro, and Dr. Antonia Musso, Department of Biological Sciences, University of Alberta

Abstract

Global climate change is a significant driver of range expansion of various taxa, including the mountain pine beetle (Dendroctonus ponderosae; MPB) that has recently expanded its range into Alberta. Dispersal and host colonization dictate the spread and establishment of MPB populations. Energy budgeting results in trade-offs between dispersal, host colonization and other life history traits. It is hypothesized that MPB require lipid oxidation through flight exercise in order to respond to the semiochemicals involved in the host colonization process. We tested the effect of energetic condition of MPB on subsequent response to host volatile and conspecific aggregation pheromone. Beetles experienced one of three treatments that resulted in different levels of body condition: 1) a 23 h flight period; 2) 23 h at room temperature, but restricted from flying; 3) 23 h at 4°C, and restricted from flying. Following treatment, we assayed individuals for response to semiochemicals in a 4-way olfactometer before assessing body condition using fat and body size measurements. In addition, we compared the body condition of beetles captured in semiochemical-baited traps across the expanded range of MPB in Alberta. Results from both lab and field studies will be presented.

Biographical Sketches

Dr. Maya Evenden has been a professor at the University of Alberta since 2003. Prior to that, she earned her PhD at Simon Fraser University (1998) and worked at the University of Kentucky and West Chester University (Pennsylvania). She has 112 peer-reviewed publications, of which 89 as first or last author, focusing especially on insect pest chemical ecology. Her research contributes to knowledge on intra-species (pheromone) as well as inter-species interactions at several trophic levels. She and her team apply the knowledge gained in the lab to applications in insect pest management, such as mating disruption, attracticides, and pheromone-based monitoring.

Dr Evenden created a highly-popular MOOC, Bugs 101, that has already been attended by over 40,000 learners from 130 countries in the four years since it went online. For this endeavour, she was awarded the Entomological Society of America's Science Communication Award (2022). She has also been recognized by her employer with a Graduate Mentoring Award (2022), having supervised 30 graduate students. Dr Evenden has also served her professional societies, acting as president of the Entomological Societies of Alberta (2006) and Canada (2010), and the International Branch of the Entomological Society of America (2017)

Originally from Saskatoon, Saskatchewan, Leanne completed her BSc in Biological Sciences with a specialization in Animal Biology at the University of Alberta where she developed a general interest in ecology and ethology. After completing an honours thesis on the effect of flight on mountain pine beetle response to host volatiles in the Evenden Lab, she began her MSc expanding on mountain pine beetle response to semiochemicals, dispersal, and host orientation in September 2022. Her work focuses on better understanding mountain pine beetle behaviour to improve pest modeling and management in Canada.

Dr. Antonia Musso hails from the greater Vancouver area and studied at Simon Fraser University where she received her BSc and MPM. Antonia moved to Alberta in 2016 to study MPB-host interactions supervised by Dr. Maya Evenden and Dr. Allan Carroll. She successfully defended her PhD research (finally) in April 2023 but is still asking questions about MPB ecology in its expanded range as a postdoctoral research fellow at the University of Alberta. Antonia continues to be fascinated by MPB dynamics and behaviour and loves to share this with anyone who will listen. Passionate about communicating biology to everyone, she has received teaching and speaking awards and has consulted on nature documentaries with the BBC and PBS.

Dynamic species distribution modelling to predict mountain pine beetle boreal invasion


Dr. Allan L. Carroll and Dr. Vivek Srivastava[1], University of British Columbia, Department of Forest Sciences, and [1]Current address: Office of the Chief Forester, Ministry of Forests, BC V8V 0C5, Canada

Abstract

Since the mountain pine beetle breached the northern Rocky Mountains, efforts have been directed toward understanding current and future implications of the invasion, and designing and implementing an effective management response. Key to both of these aspects is an annual detection, monitoring and ground truthing program that can quantify the distribution of beetle populations and their potential rate of increase and spread. Unfortunately, the temporal and spatial

resolution required of such a program when applied to the entire area of concern makes it logistically intractable. Species distribution models are a set of analytical tools used to identify suitable habitat for a species' potential establishment by identifying locations with environmental conditions that match observed species occurrence, thereby facilitating more targeted and efficient survey programs. We modified a traditional species distribution modelling framework to incorporate dynamic biotic and abiotic predictors to create a dynamics species distribution model (DSDM) for the mountain pine beetle in Alberta. Our DSDMs provided robust temporal trends of MPB potential distributions while generating predictions that support MPB distributional shifts, thus providing a framework for prioritization of mountain pine beetle monitoring activities.

Biographical Sketches

Allan is a Professor of Insect Ecology, Director of the Forest Sciences Program, and Head of the Forest Insect Ecology Lab in the Faculty of Forestry at the University of British Columbia. Allan's current research interests centre on the impacts of climate change on the dynamics of eruptive forest insect populations. The main focus of his research during the past 20 years has been on the population dynamics, impacts and management of the mountain pine beetle.

Dr. Vivek Srivastava is a Data Scientist at the Ministry of Forests and a researcher in the Forest Insect Ecology Lab in the Faculty of Forestry at the University of British Columbia. Vivek studies forest pests and develops spatial-temporal pest risk mathematical models that are computer-based to help detect and mitigate the spread of forest pests. Invasion ecology, pest risk modelling, mapping, and forecasting future range shifts and impacts are central to his research program.

Efficient monitoring of mountain pine beetle outbreak spots using artificial intelligence applied to drone thermal imagery





Drs. S. Mojtaba Marvasti-Zadeh, Rudraksh Kapil, Guillermo Castilla, Devin Goodsman, Nilanjan Ray, Nadir Erbilgin, Department of Renewable Resources, University of Alberta, Edmonton, Alberta

Abstract

Early and accurate detection of bark beetle infestations is essential to minimize their severe consequences for forest ecosystems, biodiversity, structure, function, and economies. In this talk, we cover various aspects of our research, including the development of an RGB-thermal dataset, high-quality orthomosaicking thermal drone images, semi-supervised learning for tree crown detection, advanced model interpretability using XAI, and preliminary analyses to identify subtle spectral changes. Our data collection involved capturing RGB-thermal images of an 8-hectare forest stand near Cynthia, Alberta. We used a Zenmuse H20T instrument mounted on a DJI Matrice 300 RTK quadcopter to simulate green-attack symptoms by girdling trees. To ensure accurate analysis, we introduced an integrated workflow that co-registers thermal and RGB imagery, preserving radiometric information while achieving high-quality thermal orthomosaic alignment with RGB data. We employed semi-supervised training of well-known object detectors for tree crown detection with limited labeled data to enhance their performance and generalization. Additionally, we provided interpretable class activation mapping for tree crown detection, ensuring the reliability of our detectors. Our RGB and thermal analyses on manually annotated data revealed modest temperature differences between treated and neighbouring control trees. However, differences in spectral indices derived from RGB values were more pronounced, suggesting the potential for detection even before visible fading occurs.

Biographical Sketches

Dr. Seyed Mojtaba Marvasti-Zadeh is a Postdoctoral Fellow at the Forest Entomology & Chemical Ecology lab, University of Alberta. He received his PhD degree with a profound major in Computer Vision from Yazd University, Iran, in 2021. During his PhD, he was a visiting researcher at the Visual Analysis and Perception Lab (VAP), Aalborg University, Denmark, and the Vision and Learning Lab, University of Alberta. His current research revolves around utilizing remote sensing and machine learning techniques for green-attack detection.

Rudraksh Kapil is an M.Sc. Computing Science graduate from The University of Alberta. His primary research area is in the field of computer vision, and his thesis project was based on advancing forest health monitoring through the application of machine learning and deep learning computer vision algorithms using drone remote sensing data.

Dr. Guillermo Castilla is a Spanish Forest Engineer (BSc and MSc from the Polytechnic University of Madrid, 1990) who specialized in Remote Sensing (PhD from UPM, 2003) thanks to a fellowship in the European Space Agency (ESA, 1999-2000). He moved to Canada in 2006 as a Postdoctoral Fellow of the Geography Department of the University of Calgary, where he later became a research associate (2008-2013) and adjunct professor (2010-present). In February 2014 he took a remote sensing research scientist position in the Canadian Forest Service in Edmonton, where he now leads a small group of forest researchers. Guillermo integrates geospatial technologies, including drones, to map and monitor land cover, forest structure and composition, and natural (e.g., fire, insect outbreaks) and anthropogenic (forestry, oil and gas) disturbances to support forest ecosystems and climate change science and pol,icy.

Dr. Goodsman is an Entomologist at the Northern Forestry Centre, Canadian Forest Service, Natural Resources Canada, 5320 122 Street Northwest, Edmonton, Alberta, T6H 3S5, Tel.: (825) 510-1349, devin.goodsman@NRCan-RNCan.gc.ca

Dr. Nilanjan Ray received a bachelor's degree in mechanical engineering from Jadavpur University, India, in 1995, a M.Tech. degree in computer science from the Indian Statistical Institute, India, in 1997, and the Ph.D. degree in electrical engineering from the University of Virginia, USA, in 2003. He is currently a professor in computing at the University of Alberta, Canada. His research interests include computer vision and image analysis. He has published more than 125 peer-reviewed articles in these areas. He served as an Associate Editor for IEEE TRANSACTIONS ON IMAGE PROCESSING (2013–2017) and IET Image Processing (2016–2021). He co-chaired AI-GI-CRV Conference, in 2017. He served as an Organizing Committee Member for BMVC 2022.

Dr. Nadir Erbilgin is a Professor & Chair of the Department of Renewable Resources at the University of Alberta. He joined the university as a Canada Research Chair in 2007. He has developed broad expertise in forest health indicated by high-quality publications (150), invitations to national and international conferences, an invitation to testify at national and foreign Senates, funding from national and international agencies, and mainstream media interviews. He has trained over 70 students and post-doctoral research fellows. His program investigates how plant primary and secondary metabolites change in response to biotic and abiotic stress agents and how these changes in turn affect tree susceptibility to insects and pathogens. He has been recognized by the Faculty of ALES Teaching Wall of Fame Award numerous times and was the recipient of the 2020-2021 Killam Annual Professorship. He has served the

University by sitting in over 20 committees including the Chairs' Council Executive Committee, Director of Field Research Office, Academic Restructuring Working Group, Indigenous Engaged Research Strategy Task Force, Public Health Response Team, and Academic Planning Comm. for the last 16 years.

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



Dr. Nadir Erbilgin, Shiyang Zhao and, Leah Crandall, Department of Renewable Resources, University of Alberta, Edmonton, Alberta

Abstract

Mountain pine beetle (MPB) invasion has resulted in the mortality of many mature lodgepole pine trees and has left a small number of live overstory pine trees. These residual live overstory pine trees (residual trees, hereafter) have become critical for recovering 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. Bark and woodboring beetle species are some of the most abundant species affecting the survival of lodgepole pine trees. 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. 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. To examine the abundance of bark and woodboring beetles, we set up three types of non-baited insect traps across multiple sites. We observed beetle activities for two years: flight intercept, landing, and emergence traps. Traps were set up in May and monitored until September 2022. All our traps in 2023 were burned, and we set up additional traps in different sites, but they were also burned. Because of this reason, we focus on the results from 2022 only. We have identified over 3200 insect specimens in several taxonomic orders. Among bark beetles, Ips species was the most abundant, followed by Hylurgops species. We also have a significant number of woodboring beetles. Interestingly, the species diversity and the number of predators caught were also substantial. The most abundant predators were clerid predators, followed by click beetles. We suspect all bark and woodboring populations were kept below epidemic level and likely controlled by predators.

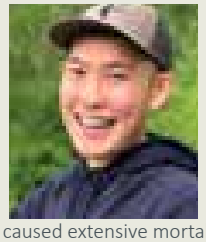
Biographical Sketches

Dr. Nadir Erbilgin is a Professor & Chair of the Department of Renewable Resources at the University of Alberta. He joined the university as a Canada Research Chair in 2007. He has developed broad expertise in forest health indicated by high-quality publications (150), invitations to national and international conferences, an invitation to testify at national and foreign Senates, funding from national and international agencies, and mainstream media interviews. He has trained over 70 students and post-doctoral research fellows. His program investigates how plant primary and secondary metabolites change in response to biotic and abiotic stress agents and how these changes in turn affect tree susceptibility to insects and pathogens. He has been recognized by the Faculty of ALES Teaching Wall of Fame Award numerous times and was the recipient of the 2020-2021 Killam Annual Professorship. He has served the University by sitting in over 20 committees including the Chairs' Council Executive Committee, Director of Field Research Office, Academic Restructuring Working Group, Indigenous Engaged Research Strategy Task Force, Public Health Response Team, and Academic Planning Comm. for the last 16 years.

Dr. Shiyang Violet Zhao is a postdoc at the Northern Forestry Center and currently works on assessing the impacts of climate change on disturbance regimes, particularly wildfire regimes, and vegetation dynamics in Nahanni National Park Reserve in the Northwest Territories. Violet holds a PhD degree in forest biology and management from the University of Alberta with expertise in dendrochronology, entomology, and statistics. When she's not glued to her laptop, she's an avid hiker and snowboarder, harboring dreams of sharing the slopes with her faithful border collie in the future.

Leah Crandall is a first year graduate student in the Renewable Resources department at the University of Alberta. Her research interests include disturbance ecology, invasion biology and entomology. Her research focuses on mountain pine beetle chemical ecology. More specifically, the role of fungal volatile compounds in the primary attraction of low density mountain pine beetle populations to host trees.

Toward pre-emptive management of future outbreaks: predicting the distribution of post-epidemic mountain pine beetle populations in the western boreal forest – a long view

Dr. Allan L. Carroll and Lucas Peng, University of British Columbia, Department of Forest Sciences

Abstract

Epidemic mountain pine beetle (MPB) populations have caused extensive mortality in recent decades within pine forests across western North America. However, the epidemic phase is not normative and populations will collapse as the availability of susceptible pine trees diminishes and/or extreme cold events cause high generation mortality. For MPB populations to persist, they must occupy an endemic niche where they preferentially colonize defensively compromised trees. Recent research suggests that stand density index (SDI), a measure of inter-tree competition, can be used to predict niche availability for endemic MPB. To investigate the potential distribution of endemic MPB populations and the possible source of future eruptions in Alberta once the outbreak collapses, we calculated SDI from vegetation resource inventory datasets, and intersected endemic habitat with projections of climatic suitability to quantify the distribution of suitable habitat for endemic MPB. Results will be discussed in the context of future MPB eruptions in a warming environment.

Biographical Sketches

Dr. Allan Carroll is a Professor of Insect Ecology, Director of the Forest Sciences Program, and Head of the Forest Insect Ecology Lab in the Faculty of Forestry at the University of British Columbia. Allan's current research interests centre on the impacts of climate change on the dynamics of eruptive forest insect populations. The main focus of his research during the past 20 years has been on the population dynamics, impacts and management of the mountain pine beetle.

Lucas Peng is a master's student in the forest insect disturbance ecology lab at the University of British Columbia. Lucas's thesis focuses on the predicting suitable endemic mountain pine beetle habitat by calculating stand density index across landscapes with GIS software. Lucas is interested in developing an endemic MPB habitat distribution map to aid in the development of proactive management programs to reduce the economic impact of future outbreak MPB populations.

FEDERAL – PROVINCIAL MPB RESEARCH FORUM

Coast Edmonton Plaza Hotel, 10155 105th St.
Edmonton, AB T5J 1E2

AGENDA

Day 2 – Thursday, October 26, 2023

Valley Ballroom, Coast Edmonton Plaza Hotel

Time		Topic	Speaker
7:00	**7:45**	***Hot Breakfast***	**Valley Ballroom**
7:45	8:00	Opening Remarks	***Dr. Keith McClain / Caroline Whitehouse***
8:00	8:15	***Introduction and Facilitation of Research Theme 4: Social Impact of MPB & managing for resilience***	***John Stad***t, Provincial Forest Ecologist, Forestry Division, Alberta Forestry and Parks
8:15	8:45	Quality vs quantity: spatial patterns of cone abundance and seed quality to support whitebark pine conservation at its northern limit in Alberta	***Jodie Krakowski***, Whitebark Pine Ecosystem Foundation of Canada
8:45	9:45	Using innovative techniques to understand how mountain pine beetle is shifting ecosystem composition and configuration in Jasper National Park (two projects will be discussed)	***Dr. Eric Higgs*** and ***James Tricker***, ***Claire Wright*** University of Victoria
9:45	**10:15**	***Health Break***	
10:15	10:45	Soil carbon stocks in forests recovering from mountain pine beetle outbreak: a possible C sink?	***Nicole Lau*** and **Dr.** Justine Karst, University of Alberta
10:45	11:15	Development of fine spatial resolution tree species information for MPB-impacted ecosystems for species-at-risk habitat assessment	***Dr. Nicholas Coops***, Alex Bastyr, Chris Bater, Dr. Laura Finnegan and McClelland, University of British Columbia
11:15	11:45	Wildlife responses to forest stands impacted by mountain pine beetle in western Canada	Drs. Laura Griffin, A. Cole Burton, ***Laura Finnegan***, *fRI* Research
11:45	**12:30**	***Lunch***	
12:30	1:00	Modeling the hydrological response of Mountain Pine Beetle affected forests in the upper McLeod River watershed, Alberta, Canada	***Drs Siraj ul Islam***, Rajtantra Lilhare, Stephen Déry and Krishna Kafle University of Northern British Columbia
1:00	1:30	Community and First Nation Resilience to Mountain Pine Beetle and Environmental Change	***Dr. Rob Friberg***, New Forest Outlook Ltd.

Day 2 – Thursday, October 26, 2023

Valley Ballroom, Edmonton Plaza Hotel

1:30	1:45	***Introduction: Research Theme 5: Wildfire behaviour in beetle killed forests***	***Dr. Chris Stockdale*****,** Northern Forestry Centre, Canadian Forest Service, Natural Resources Canada
1:45	2:15	Generation of tree level fire fuel information across MPB Infestation mosaics	***Evan Gerbrecht*** and Dr. Nicholas Coops, University of British Columbia
2:15	2:40	Influence of mountain pine beetle outbreaks and subsequent harvesting on large fires in British Columbia and Alberta	***Dr. Hyeyoung Woo*****,** Christopher Bone, University of Victoria. Steve Taylor, Canadian Forestry Service - Pacific Forestry Centre, Khurram Nadeem, University of Guelph
2:40	3:10	Quantifying spatio-temporal variability in post-mountain pine beetle outbreak fuels, in Jasper National Park, using terrestrial laser scanning, and bi-temporal multi-spectral airborne LIDAR	***Drs. Laura Chasmer*****,** Chris Hopkinson**,** ***Zhouxin Xi***, University of Lethbridge
3:10	3:35	Understanding fire behaviour in mountain pine beetle disturbed vs. managed fuel complexes using novel data sources	**Dr. Laura Chasmer** and Tristan Skretting**,** University of Lethbridge
3:35	4:05	How do the spatial legacies of mountain pine beetle outbreaks affect fire severity in Canadian lodgepole pine forests?	***Dr. Patrick James*****,** Doriana Romualdi, and Sophie Wilkinson, University of Toronto
4:05	4:30	Influence of a widespread mountain pine beetle outbreak on fire likelihood in British Columbia 2002-2021, and implications for Alberta.	***Dr. Chris Stockdale***, B.M. Moore, Q. Barber, M. Parisie, J. Axelson, and D. Perrakis Northern Forestry Centre, Canadian Forest Service
4:30	4:45	***Plenary Discussion, and Closing remarks***	***Dr. Chris Stockdale*** ***Caroline Whitehouse*** **and** ***Dr. Keith McClain***

DAY 2 **Speakers**

Opening Remarks


Dr. Keith McClain, fRI Research Mountain Pine Beetle Ecology Program, and ***Caroline Whitehouse***, Forest Health Specialist, Forest Health and Adaptation Section, Alberta Forestry and Parks, and Chair of FPRP

Biographical Sketches

Keith is a Registered Professional Forester and has worked in forest science for his entire career. He has worked in Ontario for the Ontario Ministry of Natural Resources, Thunder Bay, in British Columbia for the Canadian Forest Service in Prince George, and more recently in Alberta with Alberta Sustainable Resource Development (now Alberta Forestry and Parks). During his early career, Keith conducted silvicultural research in Black Spruce focused on physiology and silviculture as a basis for successful reforestation. Later, his endeavours included research management and leadership, technology transfer and science policy. Keith has been the Program Lead of the Mountain Pine Beetle Ecology Program at fRI Research since 2012. Keith is an Honorary Member of the Canadian Institute of Forestry and a recipient of the Tree of Life Award. Keith earned Bachelor and Masters degrees from the University of Toronto and a PhD from Oregon State University.

Caroline is a Forest Health Specialist with Alberta Forestry and Parks. Prior to joining the government, she worked at the University of Alberta in a lab focused on the ecology of various insects. Her MSc was focused on the reproductive biology of a cone-feeding insect pest in conifer seed orchards. Her forest entomology background provided the knowledge needed for her first role with the Government of Alberta as a Forest Health Officer in northwestern Alberta. As a Forest Health Specialist, she helps to deliver a provincial forest health program focused on forest insects, diseases, and climate change with a superb group of co-workers.

Introduction and Facilitation of Research Theme 4: Social Impact of MPB & managing for resilience

Dr. John Stadt, Provincial Forest Ecologist, Forestry Division, Alberta Forestry and Parks

Biographical Sketch

Dr. John Stadt is the Provincial Forest Ecologist with Alberta Forestry and Parks in Edmonton where he provides ecological expertise to decision makers and collaborates on a wide range of forest management related projects dealing with biodiversity, mountain pine beetle, disturbance regimes, wildlife, and strategic planning. John has degrees from the University of Victoria and the University of Alberta. Previous work has included a stint as a research biologist with the Canadian Forest Service in Edmonton followed by nine years with British Columbia's Fish and Wildlife branch.

Quality vs quantity: spatial patterns of cone abundance and seed quality to support whitebark pine conservation at its northern limit in Alberta

Jodie Krakowski, Director, Whitebark Pine Ecosystem of Canada (WPEFC)

Abstract

Temporal and spatial patterns of whitebark pinecone abundance and seed quality were evaluated over 3 years, including at the northern limit of the species' distribution in Alberta. This project aimed to evaluate whether cone abundance was spatially correlated within and/or across regions, to determine whether one could plan cone collections in high-cost remote areas like Willmore Wilderness based on cone surveys in more accessible areas. The project also aimed to determine whether low or high cone abundance was associated with low or high seed viability, respectively, to maximize collection efficiency in these high-cost remote areas. Finally, the project aimed to replenish depleted ex situ seed collections for northern Alberta whitebark pine seed to support provincial gene conservation and future restoration opportunities.

Biographical Sketch

Jodie Krakowski has been Vice President of WPEFC since 2015. She is an independent consultant who has been involved with 5-needle pines since the late 1990s. As co-chair of the provincial whitebark and limber pine recovery implementation team, she collaborates to develop and implement provincial recovery plans throughout Alberta, and also chairs the national recovery working group. Previously as a provincial gene conservation specialist for Alberta and BC governments, she worked on gene conservation of native forest species, and applied forest genetics projects and policy. She has also enjoyed prior stints as a terrestrial ecologist, operational forester, and research scientist with UBC, the BC Forest Service, and Canadian Forest Service.

Using innovative techniques to understand how mountain pine beetle is shifting ecosystem composition and configuration in Jasper National Park



Dr. Eric Higgs, James Tricker *and* ***Claire Wright***, University of Victoria, Victoria, BC.

Abstract

Over the last century, the effects of fire exclusion policies and a warming climate have resulted in the expansion of mountain pine beetle (Dendroctonus ponderosae; hereafter MPB) into novel habitats outside of their historical range. We introduce innovative methods that enable historical and repeat images captured in Jasper National Park to yield land cover information that can be accurately georeferenced for use with GIS software. A significant component is a new suite of tools for the spatial analysis of oblique images as a custom plug-in QGIS comprising four modules: (1) automated image classification, (2) camera calibration, (3) viewshed creation, and (4) mosaicking. Taken together, the tools allow the user to create a landcover map of the area covered by the images at the time of capture. We demonstrate the use of the software for evaluating changes to forest composition and configuration during the recent unprecedented outbreak of MPB in Jasper National Park, Alberta on a subset of images from the Mountain Legacy Project. In addition to lower elevation sites that are the focus of research by James Tricker, Claire Wright is examining how MPB is now causing ecological changes in upper elevation pine forests with significant impacts on sensitive species including whitebark pine (Pinus albicaulis), limber pine (Pinus flexilis), and woodland caribou (Rangifer tarandus). We use these data to quantify the changes that have occurred on the landscape due to fire exclusion and the recent MPB outbreak. The value of this research is to increase the temporal depth of ecological monitoring in the park and allow managers and restoration practitioners to develop a better understanding of how and where the MPB outbreak may be altering ecological processes that could result in key thresholds to be exceeded and cause regime shifts. Regime shifts could substantially alter the flow of ecosystem services in the park and have important implications for human livelihoods and community well-being. Additionally, this research can support a variety of operational decisions including restoration activities (i.e., prescribed burns), fire-smart actions, community relations with the town of Jasper, and visitor education programs. We are grateful to live and learn on the territories of many Indigenous peoples whose historical relationships continue to this day.

Biographical Sketches

Dr. Eric Higgs is a Professor in the School of Environmental Studies at the University of Victoria. His research and teaching focus on ecological restoration, historical ecology, and protected areas. He is the author of Nature by Design: People, Natural Process and Ecological Restoration (MIT Press 2003), co-author of Mapper of Mountains: M.P. Bridgland in the Canadian Rockies 1902-1930 (University of Alberta Press 2005), and co-editor of Novel Ecosystems: Intervening in the New Ecological World Order (Wiley 2013).

James Tricker is a PhD candidate in the School of Environmental Studies at the University of Victoria. His research interests involve understanding the drivers and patterns of rapid ecological change in mountain environments using repeat photography. He holds a BA in History and Geography from Rhodes University, South Africa and a M.Sc. in GIS from the University of Leeds, UK. With the supervision of Dr. Eric Higgs, his doctoral research is focused on developing new classification and georeferencing techniques for historical and repeat images in the Mountain Legacy Project collection. The aim of this research is to identify and map "new natures" (i.e., ecosystems and landscapes that depart significantly from historical patterns and processes) in support of ecological monitoring and management efforts in protected areas.

Claire Wright is a PhD candidate in the School of Environmental Studies at the University of Victoria. Claire is focused on integrating geospatial analysis with practical knowledge of restoration to support responsible intervention on the ground. She believes that all restoration and management decisions should be made collaboratively in a way that respects the inherent rights of Indigenous Peoples. She holds a BSc from Queen's University with specializations in environmental toxicology and spatial analysis. With the supervision of Dr. Eric Higgs, her doctoral research explores instances of rapid environmental and ecological change in mountain protected areas and implications for responsible restoration and intervention.

Soil carbon stocks in forests recovering from mountain pine beetle outbreak: a possible C sink?


Nicole Lau and Dr. Justine Karst, Department of Renewable Resources, University of Alberta

Abstract

Widespread beetle attacks in western Canada have killed many ectomycorrhizal (EM) pine trees while leaving an understory dominated by arbuscular mycorrhizal (AM) shrubs and forbs. Ectomycorrhizal and AM plants form symbioses with different types of mycorrhizal fungi that vary in their influence on key soil processes, including carbon cycling. As such, post-disturbance shifts in vegetation and, by association, fungal group dominance may influence carbon stores in soils, the principle long-term sink in boreal forests. We surveyed 80 field sites dominated by lodgepole pine that differed in disturbance class ('disturbed', where >70% basal area was killed versus 'intact') and soil texture (fine versus coarse). On average, trees had been killed 15 years before the current survey. In disturbed sites, AM shrub abundance was 4× higher compared to intact sites. Yet, despite the loss of dominant EM trees and an increase in AM shrubs, % soil carbon did not differ between disturbed and intact stands. Instead, % soil carbon was greater in fine- than in coarse-texture soil regardless of tree mortality, demonstrating mineralogy as a stronger driver of soil carbon storage compared with changes in stand mycorrhizal type. Our results suggest that the soil carbon storage in stands with high levels of tree mortality may be more resilient than previously forecasted.

Nicole is a MSc student in Conservation Biology. She is supervised by Dr. Justine Karst in the Department of Renewable Resources at the University of Alberta. She received her BSc in Natural Resources Conservation from the University of British Columbia. She is interested in belowground ecology and forest conservation, and is looking forward to working on similar themes post-graduation.

Justine Karst is an Associate Professor at the University of Alberta. For the past ten years, she has studied the role mycorrhizal fungi play in the recovery of Alberta forests following the mountain pine beetle outbreak.

Development of fine spatial resolution tree species information for MPB-impacted ecosystems for species-at-risk habitat assessments.



Nicholas Coops[1], Alex Bastyr[1], Chris Bater[2], Laura Finnegan[3] and Cam McClelland[4], [1]University of British Columbia, [2]Canadian Forest Service-Northern Forestry Centre, [3]fRI Research, [4]Alberta Forestry and Parks

Abstract

This project developed high spatial resolution 30m contemporary, accurate species predictions, for key overstory tree species found in MPB-impacted forested ecosystems (across AB, YK and BC), including individual species of pine, spruce, and deciduous. Layers were built with Landsat imagery, climate and calibrated using Provincial inventory data and all freely available at FRI Research.

Biographical Sketches

Nicholas Coops is a Professor at the University of British Columbia and a Canada Research Chair (Tier 1) in remote sensing. Nicholas is the head of the Integrated Remote Sensing Studio (IRSS) within the Faculty of Forestry at UBC, a research lab at UBC investigating and demonstrating applications of remote sensing data to environmental and forest production issues with PhD, MSc and Postdocs.

Dr. Laura Finnegan has been the lead researcher of the Caribou Program at fRI Research since 2013. She has a PhD in Zoology from Trinity College Dublin, Ireland and completed her postdoctoral research at Trent University, Ontario. Her research interests are wildlife ecology, conservation, and the interactions between wildlife and landscape disturbance, with a specific focus on boreal ungulates.

Cam McClelland grew up in Hinton Alberta. Cam completed his masters in 2020 at UBC in the International Remote Sensing Studio. Cam has worked with the fRI Research Grizzly Bear and Caribou Programs, as a field tech and as a wildlife biologist. Currently Cam is working as a Landscape Ecologist with the Alberta Forestry and Parks.

Wildlife responses to forest stands impacted by mountain pine beetle in western Canada



Laura Griffin[1], A. Cole Burton[1], ***Laura Finnegan***[2] [1]Wildlife Coexistence Lab, Faculty of Forestry, University of British Columbia; 2Caribou Program, fRI Research

Abstract

Effective landscape management in the face of mountain pine beetle (MPB) spread requires information on the ecological impacts of MPB and associated

management activities on wildlife to inform evidence-based decisions. To date there has been limited research on wildlife responses to habitat changes from MPB. The objectives of this project are to assess fine-scale responses of large mammalian wildlife species to changes in forest stands from MPB and MPB management in western Canada. Specifically, we are using caribou (a specialist species) and moose (a generalist species) GPS data from Alberta to understand how these large mammals are impacted by MPB infestations, clear-cut harvesting (as a proxy for salvage logging), and wildfires, as well as their response to forest stand conditions. We are developing Resource Selection Functions (i.e., GLMMs) to compare the effects of these key variables on these two socially and economically important species (n= 115,181 used points for caribou; n=37,963 for moose). These data were collected at the location, and during the period, of early MPB spread into the province (i.e., west central Alberta from 2008-2010). Widescale provincial caribou data (n = 3,710,381 GPS point locations collected over 25 years, i.e., 1998-2023) will then be used to develop a Species Distribution Model using Bayesian statistical methods (e.g. INLA) for areas currently affected by or at risk of MPB spread. The outcome of this project will be information on the response of wildlife to MPB to inform forward-thinking risk-mitigation and dynamic forest management in the face of MPB spread.

Biographical Sketches

Dr. Laura Griffin is a postdoctoral research fellow working with the Wildlife Coexistence Lab, University of British Columbia and with fRI Research on a project assessing the effects of Mountain Pine Beetle and associated management on key ungulate species in western Canada. She has a PhD in Wildlife Ecology from University College Dublin, Ireland. Her PhD research focused on unravelling the effects of recreational human-wildlife feeding interactions on targeted wildlife, using deer in urban parklands as her model species, as well as testing management actions aiming to reduce these impacts. Overall, her research interests involve exploring and mitigating factors which impact natural behaviours in wildlife.

Dr. A. Cole Burton is the Canada Research Chair in Terrestrial Mammal Conservation, an Associate Professor in the Department of Forest Resources Management, University of British Columbia, and leads the Wildlife Coexistence Lab, University of British Columbia. He is a conservation biologist and wildlife ecologist with broad interests in using science to inform biodiversity conservation, environmental management, and human-wildlife coexistence. His recent work has focused primarily on the ecology, management and monitoring of terrestrial mammal communities in the transforming landscapes of western Canada, but he maintains diverse research interests in ecological methodology, carnivore conservation, and human-wildlife relations around the world.

Dr. Laura Finnegan has been the lead researcher of the Caribou Program at fRI Research since 2013. She has a PhD in Zoology from Trinity College Dublin, Ireland and completed her postdoctoral research at Trent University, Ontario. Her research interests are wildlife ecology, conservation, and the interactions between wildlife and landscape disturbance, with a specific focus on boreal ungulates.

Modeling the hydrological response of Mountain Pine Beetle affected forests in the upper McLeod River watershed, Alberta, Canada

Siraj ul Islam, Rajtantra Lilhare, Stephen Déry and Krishna Kafle, University of Northern British Columbia

Abstract

The Mountain Pine Beetle (MPB) infestation is one of the largest ecological disturbances in Canada that is steadily expanding and affecting vast forest areas in northwestern Alberta. There is growing interest in investigating how the MPB outbreak affects regional ecosystems and water resources in northwestern Alberta. This talk will showcase our ongoing efforts to quantify the impact of MPB on watershed hydrology by implementing the Variable Infiltration Capacity (VIC) hydrological model at a daily time scale over selected sub-basins within the McLeod River watershed. The focus will be on highlighting the VIC modeling framework that used idealized scenarios to estimate the impact of MPB on forests by altering the forest cover in the model setup. The preliminary model results are synthesized by varying the intensity of the MPB attack on forest cover and measuring the corresponding change in the simulated snow depth, runoff, and streamflow. This research is in progress and will further examine the role of interannual climate variability on annual water yield in the MPB-affected watersheds. Overall, this project aims to evaluate the changes that are critical to account for hydrological risks in managing and planning both the watershed infrastructure and water availability.

Biographical Sketches

Dr. Siraj ul Islam is an Assistant Professor in the Department of Geography, Earth and Environmental Sciences at the University of Northern British Columbia (UNBC), Prince George. He is a hydroclimatologist and leads the Hydro-climate Informatics Lab (HCI) at UNBC. His research interests span a broad spectrum of environmental science, including climate dynamics and prediction, snow hydrology, data analysis, and numerical modeling.

Dr. Stephen Déry leads the Northern Hydrometeorology Group at UNBC. His research is geared towards a better understanding of northern hydrometeorological processes and their impacts on surface energy and water budgets. To accomplish this goal, a variety of methods and tools are used, including field observations, reanalysis products, remote sensing data, and intensive numerical modeling.

Dr. Rajtantra Lilhare is a Research Associate at UNBC. His work revolves around hydrological modeling with expertise in climate change, remote sensing, and GIS.

Mr.Krishna Kafle is pursuing an MSc in the Environmental Science program at UNBC. He is working as a Research Assistant in the UNBC Hydro-climate Informatics Lab (HCI) lab under the supervision of Dr. Siraj ul Islam. His thesis research work focuses on the impact of land cover changes on watershed hydrology.

Community and First Nation Resilience to Mountain Pine Beetle and Environmental Change

Rob Friberg, New Forest Outlook Ltd., Kaleden, BC

Abstract

There is substantial debate and confusion about the meaning of community resilience and the varied factors that contribute to it. Views on resilience and well-being in the face of disturbances like pine beetle and wildfire can vary greatly based on individual community and First Nation contexts. This presentation briefly reviews example attributes widely considered to contribute to community resilience; example findings from a recent case study based in Hinton, Grande Cache, and Jasper, Alberta; and the methods and early implications from an ongoing fRI Research funded project with the Swan River First Nation of Alberta. The Swan River project approaches resilience through a perspective of attributes and indicators focussed on the condition of traditional values across

forested landscapes. Indicators relate to values that support cultural practice, knowledge, food security, health and well-being, connection, and identity. The resulting framework will support Swan River First Nation planning processes, impact assessment, conservation of traditional values, and has the potential to serve as a communication tool with industry and government, supporting continual improvement of natural resource management practices.

Biographical Sketch

Dr. Friberg worked for 15 years with the BC forest industry on pine beetle and other forest health concerns, forest planning, wildfire, and silvicultural challenges in the south Okanagan. From 2006 to 2010 Rob supported the model forest program in South America and the Caribbean through CUSO, the Chilean and Cuban forest ministries, and the Canadian government. Since 2010 through his company New Forest Outlook Ltd. Rob has been involved with the implementation of two new provincial parks, the Great Bear (Haida Gwaii) forest carbon initiative, projects with Natural Resources Canada, and REDD+ in Colombia and the Democratic Republic of Congo. Rob teaches half-time at UBC Okanagan and completed his PhD in 2022 at the UBC Center for Environmental Assessment Research.

Introduction and Facilitation of Research Theme 5: Wildfire behaviour in beetle killed forests

Dr. Chris Stockdale, Wildfire Research and Extension Scientist, Northern Forestry Centre, Canadian Forest Service

Biographical Sketch

Chris Stockdale is a Wildfire Research and Extension Scientist for the Canadian Forest Service at the Northern Forestry Centre in Edmonton Alberta. He received a BSc (Honours) in Biology from the University of Victoria in 1998, a MSc in Forest Ecology from Oregon State University in 2001, and his PhD in Forest Biology and Management from the University of Alberta in 2016. His research has covered stand dynamics following mountain pine beetle attack, interactions between mountain pine beetle and fire, historical fire regimes, ecological change, and his current research focuses primarily on wildfire risk modelling.

Generation of tree level fire fuel information across MPB infestation mosaics

Evan Gerbrecht, Masters Student, UBC and Dr. Nicholas Coops, Canada Research Chair in Remote Sensing IRSS: Integrated Remote Sensing Studio, and Head, Department of Forest Resources Management, University of British Columbia.

Abstract

Throughout different stages and magnitudes of attack, the mountain pine beetle (MPB) can both alter the structure of an individual tree, as well as an entire stand with needles drying and turning red in the first year, and the entire tree dying and falling over within 5-15 years. Understanding how MPB changes structures at a plot and individual tree level can provide forest managers valuable information as to how fire fuels are changing in a forest across a study area. To characterize changes in forest structure and corresponding fuels, light detection and ranging (LiDAR) is both an effective and accurate tool for capturing these structural changes. We acquired LiDAR data from remotely piloted aircraft systems (RPAS), as well as a handheld mobile laser scanner (MLS) across a range of MPB-impacted stands in Alberta, Canada. MPB-attacked plots were classified into 3 levels based on the number of trees attacked. Analysis of variance (ANOVA) tests were conducted and found trends of forest fuel as well as LiDAR structure across MPB attack levels. Given the ability to separate between MPB attack classes, a stepwise metric selection linear regression model was developed to predict fuel loads across the study areas on a plot level. Continuing on from this, orthomosiacs were generated from RBG imagery to detect individually damaged and MPB attacked crowns. Once these individual crowns are detected, a tree based fuel look up table can be applied to estimate and characterize tree level changes in fuel across MPB attacked forests.

Biographical Sketches

Evan Gerbrecht is a Masters student at the University of British Columbia (UBC), studying Forestry in the Integrated Remote Sensing Studio (IRSS) under the supervision of Dr. Nicholas Coops. He is originally from North Vancouver, BC, and attended the University of Victoria (UVic) for his undergraduate degree, studying Geography with a concentration in Geomatics.

Dr. Nicholas Coops is a Professor at the University of British Columbia and a Canada Research Chair (Tier 1) in remote sensing. Nicholas is the head of the Integrated Remote Sensing Studio (IRSS) within the Faculty of Forestry at UBC, a research lab at UBC investigating and demonstrating applications of remote sensing data to environmental and forest production issues with PhD, MSc and Postdocs.

Influence of mountain pine beetle outbreaks and subsequent harvesting on large fires in British Columbia and Alberta

Hyeyoung Woo[1], Christopher Bone[1], Steve Taylor[2], Khurram Nadeem[3] [1]University of Victoria, [2]Canadian Forest Service-Pacific Forestry Centre, [3]University of Guelph

Abstract

A key uncertainty in understanding climate change effects on wildfires in western North America is the role of mountain pine beetle (MPB) outbreaks and the subsequent management activity in driving wildfire occurrence and severity. We investigated the complex relationship between MPB outbreaks, fires, and other environmental factors in British Columbia (BC) and Alberta (AB), Canada. We adopted a fire risk analysis method developed for fire occurrence prediction to separate the effect of changing weather conditions when neither post-outbreak fuel conditions, climate, or management are stationary.

We first verified the significant impact of the MPB outbreak on fire occurrence after accounting for the confounded environmental factors using BC data. Based on lasso-logistic regression and a novel variable ranking procedure, we determined that MPB-affected areas had 1.7 times more large lightning-caused fires (≥100 ha), thus they likely contributed to the increased burned areas in BC. Fire weather factors were most influential for both lightning- and human-caused fires, while anthropogenic factors were most influential for human-caused fires.

Secondly, we investigated the impact of the MPB outbreak and the subsequent harvest activity on fire occurrence in AB. Fuel dynamics following MPB outbreaks and forest management vary across the wide distribution of a host species. Furthermore, the effects of MPB and harvest on wildfire is also conditional on, as well as confounded with many other environmental factors that vary across the region. Therefore, a lack of consensus on the impacts of MPB on wildfires is not surprising.

Biographical Sketches

Dr. Hyeyoung is a postdoctoral in the Department of Geography at the University of Victoria. Her primary expertise is in statistical modeling and impact analysis especially associated with wildfires and forest carbon at a landscape level.

Dr. Christopher Bone is an Associate Professor in Geography at the University of Victoria whose teaching and research focus on the use of spatial data science for exploring climate and human-driven natural disturbances and their impacts on diverse human populations.

Steve Taylor is a research scientist in Canadian Forest Service–Pacific Forestry Center, primarily focusing on the effects of fire on forest ecosystems through analyzing experimental data and developing predictive models.

Dr. Khurram Nadeem is an Associate Professor in Department of Mathematics and Statistics at the University of Guelph. Nadeem's research focuses on leveraging innovative techniques and methods in computing and statistical machine learning for massive volumes of high-dimensional data. His work focuses on predictive modeling of ecological and environmental processes via big data analytics.

Quantifying spatio-temporal variability in post mountain pine beetle outbreak fuels, in Jasper National Park, using terrestrial laser scanning and bi-temporal multi-spectral airborne LIDAR



Drs. Laura Chasmer, Chris Hopkinson, and ***Zhouxin Xi***, University of Lethbridge

Abstract

The homogenization of forest age and structure associated with a long history of suppression in Jasper National Park has resulted in significant outbreak of mountain pine beetle in recent years. As trees succumb to mountain pine beetle attack, the distribution of fuels shifts from canopy to the understory and ground surface, where fires are initiated and spread. Quantifying the broad range of variability of fuels associated with mountain pine beetle is difficult using in situ methods. This research characterises and quantifies the spatial distribution of forest fuels across attack phases and time since attack using airborne, drone, and terrestrial laser scanning coincident with Next Generation Canadian Forest Fire Danger Rating System fuel plots at Jasper National Park. Here, we develop innovative artificial intelligence (AI) methods including deep learning (SegFormer) and within object convolutional neural networks to classify and scale fuel attributes from terrestrial to drone to airborne lidar and from plots to the valley scale. Voxel- and least-cost-path methods are used to determine the potential for fire connectivity between fuels in the understory to canopy. The results of this research suggest that vegetation structures varied significantly between phase and years since outbreak. Further, ladder fuels and saplings contributed a negligeable amount to total volume of fuel, however, the gap between ladder fuels and canopy is reduced in regenerating stands, which could impact fire behaviour by increasing fuel connectivity. These relationships are continuing to be explored throughout the valley near the town site.

Collaborators: Saeid Parsian, Jeanne Franco, Chris Watson, Jonathan Boucher, Patrick James

Biographical Sketches

Dr. Laura Chasmer is an associate professor in physical geography and remote sensing in the Department of Geography at the University of Lethbridge. Laura has a lengthy history of working with lidar and remotely sensed data paired with eddy covariance and hydro-meteorological data for understanding vegetation and ecosystem change.

Dr. Chris Hopkinson is a full professor and a Board of Governors Research Chair in Ecosystem Remote Sensing in the Department of Geography at the University of Lethbridge. Chris directs the ARTeMiS airborne lidar lab, which focuses on quantifying and monitoring ecosystem change using remote sensing, field, and in situ monitoring with a mountain hydro-ecology focus.

Dr. Zhouxin Xi serves as a remote sensing researcher for reclamation assessment at the Canadian Forest Service's Northern Forestry Centre in Edmonton. He earned his Ph.D. in fine-scale forest plot inventory utilizing terrestrial LiDAR technology from the University of Lethbridge. He contributed to a research project focused on mountain pine beetle (MPB) dynamics, led by Dr. Laura Chasmer and funded by Mitacs and the fRI program. His research centers on quantifying three-dimensional compositions within forest plots, upscaling below and within canopy attributes, and analyzing their spatial responses to phases of MPB infestation.

Understanding fire behaviour in mountain pine beetle disturbed vs. managed fuel complexes using novel data sources


Dr. Laura Chasmer and Tristan Skretting, University of Lethbridge

Abstract

This study examines how vegetation structures associated with mountain pine beetle attack phase vs. a chronosequence of FireSmart activities (relative to reference sites) influence fire behaviour near the Town of Jasper, Alberta. The objectives are to: a) determine how fuel structure and loading change with different severity phases of mountain pine beetle, and b) quantify vegetation trajectories following fire-management over a period of years, relative to reference sites. Next Generation Canadian Forest Fire Danger Rating System field plots with expansion to airborne lidar data were to parameterize the Canadian Conifer Pyrometrics model using an ensemble approach by altering fire weather and a broad range of canopy and understory characteristics that extend beyond plot measurements. Using allometric fuel approaches, crown bulk density varies significantly per plot based on the number of trees infested by mountain pine beetle. Within managed forests, bulk density is similar to reference sites by year 13, indicating the importance of repeat fuel management after approximately 10 years, though this varies with proximal environmental influences (e.g. slope, aspect, etc). We also found that allometric estimates of bulk density and vegetation structure do not represent the vertical distribution of the fuel profile represented by airborne lidar data. Therefore, significant uncertainties remain with regards to fire behaviour due to the variability of fuel connectivity within the understory to canopy. The next step of this project will be to continue scaling field plots to airborne lidar data and to compare outputs from the Canadian Conifer Pyrometrics model to QUICFire at Canadian Forest Service.

Collaborators: Patrick James, Chris Watson, Dan Perrakis, Chris Hopkinson

Biographical Sketches

Dr. Laura Chasmer is an associate professor in physical geography and remote sensing in the Department of Geography at the University of Lethbridge. Laura has a lengthy history of working with lidar and remotely sensed data paired with eddy covariance and hydro-meteorological data for understanding vegetation and ecosystem change.

Tristan Skretting is a MSc student in Environmental Science at the University of Lethbridge, funded by fRI Research and Canada Wildfire. Tristan led the

acquisition of fuel plots in 2021 and 2022, coincident with airborne lidar data and is currently comparing the use of field (and expanded lidar data) for input into fire behaviour models.

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



Patrick James[1], Doriana Romualdi[1], and Sophie Wilkinson[2]
[1]Faculty of Forestry, University of Toronto, [2]School of Resource and Environmental Management Simon Fraser University

Abstract

Despite great interest and discussion, we still know relatively little about how, where, and when wildfire behaviour and outcomes are affected by mountain pine beetle outbreaks. Better understanding of the relationship among MPB outbreaks, fuels, and fire activity is essential to understanding and maintaining forest health, resilience, and productivity. In this talk, I present results from recent fRi-supported research on MPB-fire interactions, with a focus on burn severity. Severity is important because of its effects on forest succession, carbon, and soil microbial processes. Severity, through its relationship with wildfire intensity, is also relevant to effective fire containment and firefighter safety. First, I will discuss the lack of consensus in the published literature on the direction and magnitude of MPB-severity interactions, and highlight the dearth on studies examining these relationships in a Canadian context. Next, I will present results from our investigations into how median and extreme burn severity, within and among fire perimeters, is affected by the pre-burn MPB outbreak stage (i.e., green, red, and grey), weather, and other environmental co-variates. Here, severity is captured using the relativized burn ratio (RBR). We found that median severity was mostly unaffected by MPB outbreak history, whereas the occurrence of extreme burn severity was associated with red- and old-stage MPB-affected stands. This work will provide greater understanding of the expected ecological effects of compounded MPB-wildfire disturbance in Canadian lodgepole pine forests and provide direction for fuel mitigation efforts in the context of current and future MPB outbreaks.

Biographical Sketches

Dr. Patrick James is an Associate Professor in the Graduate Department of Forestry at the University of Toronto. Previously, he completed a BSc and PhD from the University of Toronto, was a Killam postdoctoral research fellow at the University of Alberta and held the position of Associate Professor at the Université de Montréal. His current research is focused on forest disturbance, with specific emphasis on the spatial and temporal dynamics of outbreaking forest insect pests, the landscape ecology of wildfire, and interactions among insect outbreaks and wildfire in the context of climate change.

Doriana Romualdi is an MScF student in the Graduate Department of Forestry at the University of Toronto. She has completed a BSc from the University of Toronto in Forest Conservation Science, and Biodiversity and Conservation Biology. Her current research is focused on how the spatial legacies of mountain pine beetle outbreaks affect wildfire severity in British Columbia, Canada. This work is supported by an fRi Research grant, and an NSERC CGS M scholarship.

Dr. Sophie Wilkinson is an Assistant Professor of Applied Terrestrial Ecology in the School of Resource and Environmental Management at Simon Fraser University. She held an NSERC postdoctoral fellowship with the FireLab and James Lab in the School of Forestry at the University of Toronto following her doctorate at McMaster University. Her current research focuses on understanding patterns of wildfire severity and identifying ecohydrological tipping points to high-severity fire. This research applies to environmental and wildfire management in peatlands, black spruce lowlands, and beetle-attacked forests of western Canada.

Influence of a widespread mountain pine beetle outbreak on fire likelihood in British Columbia 2002-2021, and implications for Alberta

Dr. Chris Stockdale, Wildfire Research and Extension Scientist, Northern Forestry Centre, Canadian Forest Service, Natural Resources Canada

Abstract

The mountain pine beetle epidemic in western North America has killed an estimated 25M ha of pine forests since the year 2000. MPB killed trees fundamentally change the fuel complex within these forests by altering live foliar moisture, increasing the proportion of dead fuels, affecting vertical and horizontal structure, and changing forest succession pathways. These changes to the fuel complex are expected to affect likelihood of ignition, rates of spread, and fire intensity, which likely have already contributed to the area burned by wildfires. This study focuses on the 2002-2021 period of the MPB epidemic in British Columbia (BC), Canada to examine if fires were more likely to occur in areas that have been affected by MPB than they would be expected to in the absence of MPB. We used the annual Aerial Overview Survey records of MPB presence and wildfire history data from the Province of BC to make these comparisons. We found that MPB presence increases the likelihood of subsequent wildfire by 67% on average over the 20 years of wildfire measured in this study. The rate of fire activity within areas impacted by MPB is 2.91 times higher than it is in areas not impacted by MPB. We also found a significant relationship between the area burned in any given year and this increased fire likelihood in MPB killed areas, so that in years with higher fire activity (largely driven by synoptic weather patterns) there is an increased preference for fire to occur in areas attacked by MPB. These findings underline the elevated wildfire risk posed by epidemic level MPB activity, and that this effect persists for at least 20 years. Enhanced monitoring of MPB attack within areas of concern is strongly advised, as is continued monitoring of the stage of MPB attack (red, gray, stand break-up) due to the way MPB impacts fire differently as time since attack increases. Fuel treatments or enhanced suppression capacity in relative proximity to values at risk is advised.

Biographical Sketch

Chris Stockdale is a Wildfire Research and Extension Scientist for the Canadian Forest Service at the Northern Forestry Centre in Edmonton Alberta. He received a BSc (Honours) in Biology from the University of Victoria in 1998, a MSc in Forest Ecology from Oregon State University in 2001, and his PhD in Forest Biology and Management from the University of Alberta in 2016. His research has covered stand dynamics following mountain pine beetle attack, interactions between mountain pine beetle and fire, historical fire regimes, ecological change, and his current research focuses primarily on wildfire risk modelling.

Posters

Living in a lonely world: Population phase-dependent dispersal of mountain pine beetle (Dendroctonus ponderosae Hopkins)

Authors: *Musso AE*[1], Rosvold A[1], Carroll AL[2], Evenden ML[1]. [1]Department of Biological Sciences, University of Alberta; [2]Faculty of Forestry, University of British Columbia

Abstract

Mountain pine beetle (Dendroctonus ponderosae Hopkins) has two stable population phases, the high-density epidemic phase, and the low-density endemic phase. Much of what we know about MPB behaviour is from studies in the epidemic phase because it is when they cause economically important damage and are easy to locate. Very little is known about how endemic MPB behave and past research as focused on characterizing the endemic niche and host selection. Dispersal and flight behaviour of MPB is also difficult to study and has been limited to beetles that are part of the epidemic population phase. We used new methods for simulating the endemic niche in the lab and compared the dispersal capacity and flight behaviour of MPB to epidemic lab simulations and beetles from naturally infested trees. Beetles from these three conditions were flown on computer-linked flight mills in a 23-hour bioassay that recorded various flight characteristics. After the flight bioassay we measured and compared body, wing, and energetic condition of responders. We found that beetles that were reared in an endemic condition flew further than beetles from naturally mass attacked bolts even though they were the same size and had similar amounts of fat after flight. Mountain pine beetle populations are currently decreasing on the landscape in Alberta and the populations will be or are entering the endemic phase. Our data on dispersal capacity of MPB in the endemic population phase can help others predict how MPBs range size might change between now and the next outbreak.

Biographical Sketch

Dr. Antonia Musso hails from the greater Vancouver area and studied at Simon Fraser University where she received her BSc and MPM. Antonia moved to Alberta in 2016 to study MPB-host interactions supervised by Dr. Maya Evenden and Dr. Allan Carroll. She successfully defended her PhD research (finally) in April 2023 but is still asking questions about MPB ecology in its expanded range as a postdoctoral research fellow at the University of Alberta. Antonia continues to be fascinated by MPB dynamics and behaviour and loves to share this with anyone who will listen. Passionate about communicating biology to everyone, she has received teaching and speaking awards and has consulted on nature documentaries with the BBC and PBS.

Efficient monitoring of mountain pine beetle outbreak spots using artificial intelligence applied to drone thermal imagery

Authors: *Drs. S. Mojtaba Marvasti-Zadeh*, Rudraksh Kapil, Guillermo Castilla, Devin Goodsman, Nilanjan Ray, Nadir Erbilgin, Department of Renewable Resources, University of Alberta, Edmonton, Alberta

Abstract

Early and accurate detection of bark beetle infestations is essential to minimize their severe consequences for forest ecosystems, biodiversity, structure, function, and economies. In this talk, we cover various aspects of our research, including the development of an RGB-thermal dataset, high-quality orthomosaicking thermal drone images, semi-supervised learning for tree crown detection, advanced model interpretability using XAI, and preliminary analyses to identify subtle spectral changes. Our data collection involved capturing RGB-thermal images of an 8-hectare forest stand near Cynthia, Alberta. We used a Zenmuse H20T instrument mounted on a DJI Matrice 300 RTK quadcopter to simulate green-attack symptoms by girdling trees. To ensure accurate analysis, we introduced an integrated workflow that co-registers thermal and RGB imagery, preserving radiometric information while achieving high-quality thermal orthomosaic alignment with RGB data. We employed semi-supervised training of well-known object detectors for tree crown detection with limited labeled data to enhance their performance and generalization. Additionally, we provided interpretable class activation mapping for tree crown detection, ensuring the reliability of our detectors. Our RGB and thermal analyses on manually annotated data revealed modest temperature differences between treated and neighbouring control trees. However, differences in spectral indices derived from RGB values were more pronounced, suggesting the potential for detection even before visible fading occurs.

Biographical Sketch

Dr. Seyed Mojtaba Marvasti-Zadeh is a Postdoctoral Fellow at the Forest Entomology & Chemical Ecology lab, University of Alberta. He received his PhD degree with a profound major in Computer Vision from Yazd University, Iran, in 2021. During his PhD, he was a visiting researcher at the Visual Analysis and Perception Lab (VAP), Aalborg University, Denmark, and the Vision and Learning Lab, University of Alberta. His current research revolves around utilizing remote sensing and machine learning techniques for green-attack detection.

Comparing the resilience of avian communities to three disturbed forest types in the Canadian Rockies and Foothills

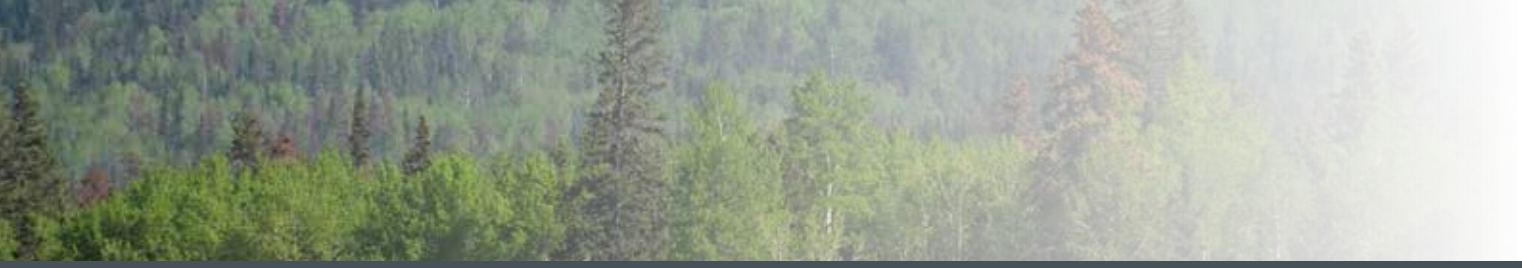
Author: ***Emily Swerdfager***, University of Alberta, Edmonton Alberta

Abstract

Emily Swerdfager started her MSc project this year investigating how avian communities are responding to the mountain pine beetle (MPB) outbreak in Alberta. The objective of this research is to compare the resilience of avian communities to three disturbed forest types in the Canadian Rockies and Foothills; standing MPB-attacked forests, burned MPB-attacked forests, and salvage-logged MPB-attacked forests; in order to provide guidance on best management practices for biodiversity in post-MPB-attacked forests. She will quantify the resilience of avian communities to these forest-disturbance types by testing for the effect of time since disturbance on changes to the following community metrics; species richness, community composition and functional diversity. To meet this objective, Emily collected bioacoustic data in each disturbed-forest type across four age categories, from zero to 30 years post-disturbance, in order to measure the forest recovery trajectory over time. This year she collected data at 150 locations across the Canadian Rockies and Foothills and she will return to the field in 2024 to expand on this dataset.

Biographical Sketch

Emily Swerdfager recently started her Master's of Science degree in Ecology in 2023 under the supervision of Dr. Erin Bayne at the University of Alberta. She is a recipient of the NSERC Canada Graduate Scholarship and aims to investigate the response of avian communities in post-mountain pine beetle attacked forests in the Canadian Rockies and Foothills. Previous to starting her MSc,



Emily completed an Honours Bachelor of Environmental Studies (Co-op) at the University of Waterloo in 2021. Over the past five years, Emily has gained valuable field experience doing ecological monitoring, restoration and species-at-risk work in all of the mountain National Parks, including positions in Jasper, Banff, Yoho, Kootenay, Waterton Lakes, Mount Revelstoke and Glacier National Parks. Her experience has ranged from avian point-counts, to amphibian surveys and climbing whitebark pine trees. She is thrilled to continue working in the field during her current MSc research.

Interactions and Impacts of Endophytic Fungal Communities on Mountain Pine Beetle and Its Symbiotic Fungi

Authors: ***Jahanzaib*** and Dr. Nadir Erbilgin, Department of Renewable Resources, University of Alberta

Abstract

In western North America, large area of pine forests have been decimated by the mountain pine beetle (MPB). In this study, we will examine the interactions between four primary pine species, their endophytic fungal communities, and the MPB and its symbiotic fungi. The first step is characterizing these communities with the hypothesis that each pine species hosts a unique endophytic fungal community. This study aims to investigate how these endophytes influence the MPB and its associated fungal organisms, both separately and in combination. Also, these endophytes will be tested for their antagonistic effects on pathogenic fungi like Trichoderma and Aspergillus. In addition, a novel investigation will test whether MPB infestations alter the diversity of endophytic fungal community in pines. We will combine rigorous field sampling with advanced molecular identification techniques and controlled lab experiments. Insights from this research could reshape our understanding of forest ecology, offering strategies for preserving these vital ecosystems against formidable adversaries. By comprehending these intricate relationships, we can better devise strategies to combat and mitigate the detrimental effects of the MPB and promote forest health.

Biographical Sketch

My name is Jahanzaib, and I am from Pakistan. I am currently doing a PhD at the Department of Renewable Resourses at the University of Alberta. I am working on “Interactions and Impacts of Endophytic Fungal Communities on Mountain Pine Beetle and Its Symbiotic Fungi”. I have earned an MSc (Hons.) in Agriculture from University of Agriculture, Faisalabad, Pakistan. For my MSc (Hons.) I worked on “Optimization of NPK to enhance biomass and nutritional value of Moringa oleifera as multicut fodder crop”.

Effects of Seed Separation, Species, Year, and Latitude on Seed Weight of Whitebark and Limber Pine

Authors: ***Jodie Krakowski (WPEFC),*** Terri Fox (independent consultant)

Abstract

We evaluated seed collections of limber pine (n=186) and whitebark pine (n=109) following seed separation processing to determine differences in seed weight for future restoration planning. Seeds were collected during various years and elevations, and weighed before and after seed processing to remove abnormally light seeds that were assumed to be deformed and/or empty. There were 35 trees with multi-year collections. Whitebark pine had significantly heavier seeds than limber pine (mean ± SD, whitebark: 13,795 ± 3,679 seeds/kg; limber: 8,775 ± 1,981 seeds/kg). Seed separation had no significant effect on seeds per kg, on average (limber: before 14,146 seeds/kg vs. after 13,795 seeds/kg; whitebark: before 8,727 seeds/kg before vs. 8,775 seeds/kg after). There was considerable variation between trees. Seed separation significantly increased the number of seeds/kg of limber pine during one medium cone crop year (2021), where many empty seeds were removed. Several parent trees had very small seeds compared to the average seed weight, leading to a significant and unexpected increase in seeds/kg. Latitude did not significantly affect seed weight of limber pine (R2 = 0.0016), but whitebark pine had slightly larger seeds further north compared to southern sources (R2 = 0.145). This trend is likely driven by two factors: the broader latitudinal distribution of whitebark pine compared to limber pine, and the extremely high mortality of limber pine in the southernmost populations. Limber pine mortality is due to multiple stressors, including drought, that likely limits seed development compared to northern populations from wetter climates. Two caveats pertain to these results: 1) pre-separation seed variables were derived from manual counts that may have varying accuracy; and 2) weight-based separation does not eliminate non-viable filled seeds with no embryos, nor does it identify seeds with uniformly underdeveloped embryos. Seed viability was not tested in this study.

Biographical Sketch

Jodie Krakowski has been Vice President of WPEFC since 2015. She is an independent consultant who has been involved with 5-needle pines since the late 1990s. As co-chair of the provincial whitebark and limber pine recovery implementation team, she collaborates to develop and implement provincial recovery plans throughout Alberta, and also chairs the national recovery working group. Previously as a provincial gene conservation specialist for Alberta and BC governments, she worked on gene conservation of native forest species, and applied forest genetics projects and policy. She has also enjoyed prior stints as a terrestrial ecologist, operational forester, and research scientist with UBC the BC Forest Service, and Canadian Forest Service.

The role of antagonistic fungi in developing anti-aggregation volatiles against mountain pine beetle

Authors: ***Leah Crandall*** & Nadir Erbilgin, Department of Renewable Resources, University of Alberta

Abstract

Mountain pine beetles (MPB) overcome host tree defenses with the aid of symbiotic ophiostomatoid fungi, most commonly Grosmannia clavigera and Ophiostoma montium. During beetle colonization, antagonistic fungi such as Aspergillus and Trichoderma species can also colonize attacked trees and are known to negatively affect MPB fitness. Recent work by Zaman et al. (2023) found that MPB are strongly attracted to fungal volatile organic compounds (FVOCs) emitted by symbiotic fungi. However, little attention has been given to the VOCs emitted by antagonistic fungal species. Given that MPB attraction is known to be influenced by VOCs emitted by symbiotic fungi, it is plausible that a similar phenomenon may occur with VOCs from antagonistic species. Therefore, we will be investigating whether FVOCs emitted from antagonistic fungal species may play a role in the inhibition of MPB attraction. We will characterize the volatile profiles of Aspergillus and Trichoderma species and compare them with the profiles emitted by

symbiotic fungal species. We will then conduct choice assays in order to determine the impact of those individual FVOCs on MPB attraction. This work will allow us to better understand interactions between MPB and FVOCs during host selection and could expand MPB monitoring tools.

Biographical Sketch

Leah Crandall is a first year graduate student in the Renewable Resources department at the University of Alberta. Her research interests include disturbance ecology, invasion biology and entomology. Her research focuses on mountain pine beetle chemical ecology. More specifically, the impact of fungal volatile compounds on mountain pine beetle primary attraction.

Enhanced receptivity of beetles to host semiochemicals

Author: ***Leanne Petro***, University of Alberta

Abstract

Global climate change is a significant driver of range expansion of various taxa, including the mountain pine beetle (Dendroctonus ponderosae; MPB) that has recently expanded its range into Alberta. Dispersal and host colonization dictate the spread and establishment of MPB populations. Energy budgeting results in trade-offs between dispersal, host colonization and other life history traits. It is hypothesized that MPB require lipid oxidation through flight exercise to respond to the semiochemicals involved in the host colonization process. We tested the effect of energetic condition of MPB on subsequent response to host volatile and conspecific aggregation pheromone. Beetles received energetic manipulation treatments before being assayed for behavioural response to semiochemicals in an olfactometer. We then assessed body condition. Enhanced receptivity of beetles at low energetic states to host semiochemicals may contribute to polyphenic flight behaviours in MPB and assist in the development of models to predict spread across the boreal forest.

Biographical Sketch

Originally from Saskatoon, Saskatchewan, Leanne completed her BSc in Biological Sciences with a specialization in Animal Biology at the University of Alberta where she developed a general interest in ecology and ethology. After completing an honours thesis on the effect of flight on mountain pine beetle response to host volatiles in the Evenden Lab, she began her MSc expanding on mountain pine beetle response to semiochemicals, dispersal, and host orientation in September 2022. Her work focuses on better understanding mountain pine beetle behaviour in order to improve pest modeling and management in Canada.

Unraveling Symbiotic Threads: Multipartite Relationships of the Mountain Pine Beetle (Dendroctonus ponderosae) and Its Symbionts

Authors: ***Muhammad Faizan Naeem*1,** Nadir Erbilgin1 1 Department of Renewable Resources, University of Alberta, Edmonton, AB, Canada

Abstract

Mountain pine beetles (MPB) (Dendroctonus ponderosae) are among the most destructive bark beetles in western North America. It plays an important role in complex ecological interactions within forest ecosystems. It is evident that pine trees, fungi, and nematodes have an intricate and dynamic relationship with MPB in such ecosystems. While many studies have been conducted on the relationship between microorganisms and MPBs, few investigations have involved multipartite relationships, especially in the case of nematodes. There are several species of nematodes that are either commensal, mutualistic, or parasitic. It remains to be seen how these nematodes behave in the presence of other MPB symbionts. We can devise control strategies for MPB by understanding the details of such relationships, such as biopesticides, by understanding the details of such relationships.

Biographical Sketch

Muhammad Faizan Naeem is a Ph.D. student at the Erbilgin Lab within the Department of Renewable Resources at the University of Alberta. His research is centered around the intricate multipartite relationships between the mountain pine beetle and microorganisms, specifically fungi and nematodes. Before embarking on his Ph.D. journey, Faizan earned his M.Sc. degree in Ecology from the University of Bremen, Germany. He has been actively engaged in both research and teaching for over five years, leveraging his expertise to contribute meaningfully to the field of ecology and the study of forest ecosystems.

Navigating Climate Complexity: Mountain Pine Beetle and Symbiotic Fungal Interaction and Adaptation

Authors: ***Rashaduz Zaman***, Aziz Ullah, Ateeq Shah, Aftab Shah, and Nadir Erbilgin, Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3, Canada

Abstract

Mountain pine beetles (MPB) pose a significant threat to pine forests due to their unique ability to breach tree defenses and establish fungal partnerships. However, the impact of climate change on MPB biology and the symbiotic interactions between beetles and fungi remains poorly understood. To address this, we introduced pairs of beetles into freshly cut lodgepole pine logs placed in climate-controlled chambers. Five chambers were used: one with elevated CO2 (1,000ppm), one with elevated O3 (100ppb), two with varying humidity levels (65% and 33%), and one control with no modifications After one month, emerging offspring were collected. We found that low humidity improved MPB reproduction, having more larger-sized offspring produced and also enhanced fungal growth. Elevated CO2 expedited larval growth and emergence, with variable effects on fungal growth depending on the species and isolate of fungi used. Conversely, O3 hindered MPB reproduction, offspring emergence, and fitness but improved survival against entomopathogenic fungi. Moreover, elevated O3 limited fungal growth. These results highlight the potential impact of climate change on MPBs and their symbiotic fungi, underscoring the need for adaptive forest management in the face of shifting environmental conditions. Understanding these effects on forest pests and their microbial partnerships is crucial for safeguarding forest health.

Biographical Sketch

Rashaduz Zaman is a 3rd year PhD candidate studying Forest biology and management in the department of Renewable resources, University of Alberta. His research interests are host-insect-microbe interaction, insect olfactory behavior, symbiosis, climate change impacts and forest resilience. He did my MSc in Molecular life sciences from University of Jena, Germany. After his MSc he worked for one year on bark beetle biology as a Junior Scientist at Max Planck Institute for Chemical Ecology in Germany. Rashaduz did his Bachelor of Pharmacy from International Islamic University Chittagong, Bangladesh. Throughout his academic studies, he published 24 peer reviewed articles in various Journals. He also reviewed many articles for peer reviewed Journals. Apart from academic works, Rashaduz also served in various student organizations at the University of Alberta, Edmonton, Canada.

Monoterpene Responses of Lodgepole Pine Trees to Fire: Implications to the Mountain Pine Beetle

Authors: Yanzhuo Liu, Nadya Citra, Federico Antonioli & Nadir Erbilgin,

Presenter: ***Yanzhuo Liu***, Ph.D. Student, Department of Renewable Resources, University of Alberta; Email: yanzhuo@ualberta.ca

Abstract

Monoterpenes play a pivotal role in pine, serving as natural defence compounds against herbivores and pathogens including bark beetle species. Forest fires represent a vital ecological process in Western North American pine ecosystems, with an increasing trend in both the number and area of fires observed in Canada since 1989. However, the post-fire recovery and alterations in concentrations and composition of monoterpenes within pine trees remain unclear. In this study, we conducted chemical analyses on lodgepole pine phloem samples collected in July 2022 and July 2023 from trees that had survived a May 2022 fire in Jasper National Park. We aimed to ascertain the range of monoterpene variations relative to the original forest profile in nearby areas. While some similarity was detected in the monoterpenes across samples from different years, significant disparities emerged in the relative proportions of specific compounds known for their high toxicity towards Mountain Pine Beetle (Dendroctonus ponderosae). The concentrations of certain monoterpenes of surviving pine trees exhibited a significant post-fire increase with a higher variation, gradually returning to normal levels thereafter. These findings suggest that shifts in the chemical profiles of surviving trees post-fire may have implications for interactions with other plants and organisms in the surrounding ecosystem, including their interaction with the mountain pine beetle.

Biographical Sketch

Yanzhuo Liu, a third-year Ph.D. Student specializes in the intricate interplay of fungal symbionts in mountain pine beetle host range expansion and host suitability assessment. Holding a Bachelor of Science degree in Geographic Science, Yanzhuo has garnered extensive global research experience, offering valuable insights into environmental chemistry and ecology. Additionally, he demonstrates proficiency in chromatography, and mass spectrometry for chemical detection, and excels in constructing geographic models across various spatial scales.

Quantifying Vegetation Structure and Fire Fuels in Montane Pine Forests impacted by Mountain Pine Beetle Using RPAS Multi-Spectral, Photogrammetric, and Lidar Systems

Authors: ***Saeid Parsian***, Chris Hopkinson, Craig Coburn, Chris Watson, Laura Chasmer

Abstract

Over the last decade, the proliferation of mountain pine beetle (MPB) in Jasper National Park has contributed to the mortality of pine trees and the accumulation of dead and dry biomass resulting in a large amount of fuel for wildland fires. Consequently, this change in fire fuel distribution amplifies the hazard of fire ignition and the possibility of active crown fires. Quantifying and mapping of the vertical and horizontal distribution of vegetation is fundamentally important for predicting wildfire behavior. Field data collection is a necessary method required for quantifying forest fire fuels. However, this method is expensive, labor-intensive, and can be difficult to implement in remote areas. In contrast, Remotely Piloted Aircraft Systems (RPAS) offer various advantages including high spatial resolution spatial data collected within a user-friendly, cost-effective, and repeatable approach. The aim of this research is to develop methods to quantify a variety of forest fire fuels utilizing three different types of RPAS datasets including photogrammetric and lidar point clouds as well as multispectral RPAS data compared with field data. New methods are described and the quantification and accuracy of fuel attributes associated with MPB attack phase are discussed.

Biographical Sketch

Saeid Parsian received an MEng degree in photogrammetry from Tafresh University, Tehran, Iran in 2015. As a MSc student in the Department of Geography and Environment at the University of Lethbridge, Saeid's research focuses on the quantification of vegetation structures and fire fuel distributions following the mountain pine beetle outbreak, utilizing multispectral, photogrammetric, and LiDAR point clouds on Remotely Piloted Aircraft Systems (RPAS) within Jasper National Park, Alberta, Canada.

Investigating fine-scale morphological responses of individual lodegpole pines to the mountain pine beetle infestation with terrestrial laser scanning

Authors: ***Zhouxin Xi***, Laura Chasmer, Chris Hopkinson, Tristan Skretting, University of Lethbridge

Abstract

The mountain pine beetle (MPB) outbreak significantly accelerates forest succession and fire cycles. Responses to MPB vary spatially at the individual tree level, complicating consequence assessments. While intricate fine-scale morphological interactions with MPB have been underexplored, this research offers a 3D morphological perspective, analyzing twelve TLS plot scans and extracting geometric features with branch details. A random forest classifier was employed to categorize MPB phases with an overall accuracy of 0.96. The geometric analysis revealed the diverse impacts of MPB on individual tree shapes and plot structures. Taller trees had a higher mix of both thriving and dead trees. Gray trees exhibited increased tilt and clustering compared to alive and red counterparts. Red trees, mainly within the 20-25cm DBH range, were marginally larger and spaced further apart than living trees. While branch angles remained consistent, foliage notably decreased across infestation stages. MPB-affected tree proportions were consistent across different plots. Trees with greater spacing and competition exhibited intensified MPB effects. Interestingly, plots with medium species diversity had the highest mortality rates, and increased forest layer diversity correlated with higher MPB mortality. While spatial factors had minimal impact on individual trees, they significantly affected overall plot dynamics. Red trees were more dispersed from living trees, and gray trees predominantly clustered around both living and red trees. Saplings were interspersed among mature trees. The MPB outbreak amplified both horizontal and vertical fuel connections. Gray trees had a 27% lower LCBH than the average of red and living trees. The presence of ladder fuels, such as leaning trees and fallen logs, boosted plot-level spatial connectivity, quantified by the reduction of resistance from 0.29 to 0.25 (-11%), 0.13 (-50%), and 0.02 (-84%). This study underscores the increased fuel connectivity and fire risks but also highlights the accelerated species growth in mortality zones, fostering forest diversity.

Biographical Sketch

Zhouxin Xi serves as a remote sensing researcher for reclamation assessment at the Canadian Forest Service's Northern Forestry Centre in Edmonton. He earned his PhD in fine-scale forest plot inventory utilizing terrestrial LiDAR technology from the University of Lethbridge. He contributed to a research project focused on mountain pine beetle (MPB) dynamics, led by Dr. Laura Chasmer and funded by Mitacs and the fRI program. His research centers on quantifying three-dimensional compositions within forest plots, upscaling undercanopy attributes, and analyzing their spatial responses to phases of MPB infestation.

fRI Mountain Pine Beetle Research 2007 – 2024

The following table lists research projects that were deemed essential in addressing strategic research themes. Research themes were approved by the program's Research Advisory Committee and were used to guide the selection of projects submitted in response to several Requests for Proposals. Each project resulted in published research papers / technical reports and other outputs. Further details regarding reports can be accessed by viewing the annotated bibliography (Project 246.13.1) and by visiting the fRI Research Website under publications.

Project Number	Principle Investigator	Title of Proposal	Research Theme	Project Duration
2007 –2021 Mountain Pine Beetle Ecology Program				
246.01	Drs. Uldis Silins, Ellen Macdonald	Effects of Mountain Pine Beetle attack on hydrology and post-attack vegetation and hydrologic recovery in lodgepole pine forests in Alberta; Phase 1	Hydrological Impacts of MPB	2007-2012
246.02	Robert Udell, Dr. Dick Dempster	Monitoring and Decision Support For Forest Management in a Mountain Pine Beetle Environment	Landscape and stand dynamics following MPB	2007-2011
246.03	Don Podlubny (MPBEP Lead)	Alberta Forest Research Institute Funding to the MPBEP	General - Start-up	2008-2010
246.04	Drs. Bonita MacFarlane, John Parkins	Public and Expert Understandings of Mountain Pine Beetle in Alberta	Social and Economic Implications of a Changing Landscape	2009-2011
246.05	Dr. Nadir Erbilgin	Does prescribed fire affect population dynamics of mountain pine beetle? Evaluating population success and fitness on fire-injured trees	MPB Management and Biology	2010-2014
246.06	Dr. David Langor	Mountain Pine Beetle Phenology and Success in Whitebark Pine in Alberta	MPB Management and Biology	2009-2011
246.07	Dr. Chris Stockdale	Using Oblique Historical Photos to Determine Past Mountain Pine Beetle Susceptibility	MPB Management and Biology	2009-2011
246.08	Drs. Kathy Bleiker, Barry Cooke	MPB population dynamics in new habitats and climates following range expansion: The potential for eastern and northern spread in Canada	MPB Management and Biology	2010-2014
246.09	Drs. Vic Lieffers, Soung-Ryoul Ryu	Comparison of understory burning and mechanical site preparation to regenerate lodgepole pine stands killed by mountain pine beetle	Landscape and stand dynamics following MPB	2010-2013

Project Number	Principle Investigator	Title of Proposal	Research Theme	Project Duration
2007 –2021 Mountain Pine Beetle Ecology Program				
246.10	Drs. Rene Alfaro, Brad Hawkes, Jodi Axelson	Ecological impacts of the mountain pine beetle on pine forest of the Foothills, Alberta	Landscape and stand dynamics following MPB	2010-2011
246.11	Dr. Kathy Lewis	Post mortality rate of wood degradation and tree fall in lodgepole pine trees killed by mountain pine beetle in the Foothills and Rocky Mountain regions of Alberta	Social and Economic Implications of a Changing Landscape	2011-2012
246.12	Dr. Axel Anderson, Dr. Allan Carroll, Dr. Nicholas Coops, Dr. Vinod Mahat , Dr. David Roberts, Dr. Scott Nielson, Gordon Stenhouse	Impacts of climate and landscape change on forest resources	MPB Management and Biology	2013
246.13	Dr. Keith McClain / Fran Hanington	MPBEP Communications	Communications	2007 - 2024
246.13.1	Fuse Consulting – Matthew Pyper	MPBEP Annotated Bibliography	General - Communications	2020
246.14	Dr. Katherine Bleiker	Cold tolerance of MPB: Implications for population dynamics and spread in Canada	MPB Management and Biology	2012-2020
246.15	Dr. Nadir Erbilgin	Development of monitoring tools to detect MPB at low densities on the eastern and northern edge of beetle expansion into Saskatchewan and NWT - Part 1	MPB Management and Biology	2014-2015
246.15	Dr. Nadir Erbilgin	Development of monitoring tools to detect MPB at low densities on the eastern and northern edge of beetle expansion into Saskatchewan and NWT - Part 2	MPB Management and Biology	2015-2018
246.16	TRIA Network: Dr. Allan Carroll	Dynamics of endemic MPB populations in novel pine habitats	MPB Management and Biology	2013-2018
246.17	FGrOW - Sharon Meredith	Stand dynamics after MPB attack	Landscape and stand dynamics following MPB	2014-2019
246.18	Drs. Allan Carroll, Harry Nelson	Assessing the effectiveness of Alberta's forest management strategies against the MPB – PART 1 - COMPLETE	MPB Management and Biology	2013-2015
246.18	Drs. Allan Carroll, Harry Nelson	Assessing the effectiveness of Alberta's forest management strategies against the MPB – PART 2	MPB Management and Biology	2014-2016
246.19	Drs. Ellen Macdonald, Uldis Silins, Axel Anderson	Impacts of the MPB on the hydrology and vegetation development in lodgepole pine forests of west central Alberta Phase II	Hydrological Impacts of MPB	2014-2016

Project Number	Principle Investigator	Title of Proposal	Research Theme	Project Duration
2007 –2021 Mountain Pine Beetle Ecology Program				
246.20	Dr. Ellen Macdonald	Beyond Beetle: Natural and facilitated lodgepole pine regeneration after MPB outbreaks in Alberta (co-funded with FRIAA, AB-Bio, AAF	MPB Management and Biology	2013-2018
246.21	Dr. Laura Finnegan, Gordon Stenhouse, Terry Larsen	Mountain Pine Beetle Attacks Alberta: assessing trade-offs in food supply for two species at risk. (Support to the Caribou Monitoring Program) Part 1	Landscape and stand dynamics following MPB	2014-2015
246.21	Dr. Laura Finnegan, Gordon Stenhouse, Terry Larsen	Mountain Pine Beetle Attacks Alberta: assessing trade-offs in food supply for two species at risk. Part 2	Landscape and stand dynamics following MPB	2015-2017
246.22	Robert Udell	Forest History – Landscape dynamics	Communications/History	2015-2016
246.23	Dr. Justine Karst	Rehabilitation of beetle-killed stands by improving pine seedling performance with mycorrhizal fungi	Landscape and stand dynamics following MPB	2016-2020
246.24	Dr. Axel Anderson	Extending the information from the Tri Creeks and MPB Eco-hydrology projects with hydrological modelling.	Hydrological Impacts of MPB	2016-2019
246.25	Dr. Allan Carroll	Persistence or extinction? Quantifying the fate of invasive mountain pine beetles in eastern pine forests	MPB Management and Biology	2015-2018
246.26	Drs. Eliot McIntire, Alex Chubaty	Simulating MPB spread management in Alberta and beyond using SpaDES	MPB Management and Biology	2016-2018
246.27	Dr. Lael Parrott	Assessing community resilience to MPB outbreaks	Social and Economic Implications of a Changing Landscape	2016-2020
246.28	Dr. Nadir Erbilgin	Development of new formulations to monitor MPB at low and high densities	MPB Management and Biology	2018-2020
246.29	Dr. Maya Evenden	Identification of the optimal attack density of MPB in hybrid and jack pine in its expanded range in Alberta	MPB Management and Biology	2018-2020

Project Number	Principle Investigator	Title of Proposal	Research Theme	Project Duration
2007 –2021 Mountain Pine Beetle Ecology Program				
246.30	Dr. Allan Carroll	Alternative approaches for integrated area-wide management of the MPB epidemic in Alberta	MPB Management and Biology	208-2020
246.31	Dr. Chris Stockdale	MPB effects on wildfire rate of spread and landscape fire risk	Landscape and stand dynamics following MPB	2018-2019
246.32	Terry Larsen	Caribou and Grizzly bear response top pine forests killed by MPB	Landscape and stand dynamics following MPB	2018-2020
246.33	Dr. Janice Cooke	Pine genomic signatures of resiliency to MPB	Landscape and stand dynamics following MPB	2018-2020
246.34	Brenda Shepherd	Effectiveness of verbenone and green-leaf volatiles in protecting high-value Whitebark Pine trees through a MPB outbreak in Jasper National Park	MPB Management and Biology	
246.35	FGRoW / Dr. Brian Roth	Upper Foothills MPB permanent sample plot network	Landscape and stand dynamics following MPB	2020-2023
246.36	Dr. Maya Evenden	Phase-dependent dispersal of mountain pine beetle reared in lodgepole and jack pine hosts	MPB Management and Biology	2020-2022

2021 – 2024 Federal – Provincial MPB Research Partnership

Project Number	Principle Investigator	Title of Proposal	Research Theme	Project Duration
2021 – 2024 Federal – Provincial MPB Research Partnership				
247.01	Dr. Catherine Cullingham	Modelling eastern spread risk of mountain pine beetle using host genetic ancestry	MPB biology	2021 - 2023
247.02	Dr. Heath MacMillan	The physiological costs and consequences of overwintering in Mountain Pine Beetle	MPB biology	2021 - 2023
247.03	Dr. Nadir Erbilgin	Improving monitoring tools to detect mountain pine beetle at low densities in novel habitats: incorporating host-tree stress and fungal volatiles in beetle attraction	MPB biology	2021 - 2023
247.04	Dr. Maya Evenden	Assessment of eastern spread risk of Mountain Pine Beetle through studies on beetle dispersal and host colonization	MPB dispersal and spread	2021 - 2023
247.05	Dr. Allan Carroll	Dynamic species distribution modelling to predict mountain pine beetle boreal invasion	MPB dispersal and spread	2021 - 2023
247.07	Dr. Nadir Erbilgin	Efficient monitoring of mountain pine beetle outbreak spots using artificial intelligence applied to drone thermal imagery	Detection and management of MPB	2021 - 2023
247.09	Dr. Allan Carroll	Toward preemptive management of future outbreaks: predicting the distribution of post-epidemic mountain pine beetle populations in the western boreal forest	Detection and management of MPB	2021 - 2024
247.09	Jodi Krakowski	Gene conservation to mitigate impacts of mountain pine beetle on endangered whitebark pine at its northern limit in Alberta	Ecological and social impact	2021 - 2024
247.10	Dr. Nicholas Coops	Development of fine spatial resolution tree species information for MPB-impacted ecosystems for Species-at-Risk habitat assessment	Ecological and social impact	2021 - 2023
247.11	Dr. Eric Higgs	Using innovative techniques to understand how mountain pine beetle is shifting ecosystem composition and configuration in Jasper National Park.	Ecological and social impact	2021 - 2024
247.12	Dr. Justine Karst	Soil carbon stocks in forests recovering from mountain pine beetle outbreak: a possible C sink?	Ecological and social impact	2022 - 2023
247.13	Dr. Nicholas Coops	Generation of Tree level Fire Fuel Information across MPB Infestation Mosaics	Wildfire behaviour after MPB	2021 - 2023

Project Number	Principle Investigator	Title of Proposal	Research Theme	Project Duration
2021 – 2024 Federal – Provincial MPB Research Partnership				
247.14	Dr. Christopher Bone	Assessment of Risk Factors Influencing Landscape Level Fire in MPB Forests	Wildfire behaviour after MPB	2021 - 2024
247.15	Dr. Laura Chasmer	Quantifying spatio-temporal variability in post-mountain pine beetle outbreak fuels, in Jasper National Park, using terrestrial laser scanning, and bi-temporal multi-spectral airborne LIDAR	Wildfire behaviour after MPB	2021 - 2024
247.16	Dr. Patrick James	How do the spatial legacies of mountain pine beetle outbreaks affect fire severity in Canadian lodgepole pine forests?	Wildfire behaviour after MPB	2021 - 2024
247.17	Dr. Laura Chasmer	Understanding fire behaviour in mountain pine beetle disturbed vs. managed fuel complexes using novel data sources	Wildfire behaviour after MPB	2021 - 2024
247.18	Dr. Laura Finnegan	Wildlife responses to forest stands impacted by mountain pine beetle in western Canada	Ecological and social impact	2021 - 2024
247.19	Dr. Nadir Erbilgin	Effects of mountain pine beetle outbreaks on population dynamics of secondary bark and ambrosia beetles	Detection and management of MPB	2022 - 2024
247.20	Dr. Eric Higgs	Using novel approaches to understand mountain pine beetle impacts on upper elevation sites in Jasper National Park	Ecological and social impact	2022 - 2024
247.21	Dr. Mark Lewis	Modelling long-term dynamics of MPB in Alberta under climate change	MPB biology	2022 - 2024
247.22	Dr. Siraj ul Islam	Impacts of the Mountain Pine Beetle on the snow hydrology of the Peace and Athabasca River basins	Ecological and social impact	2022 - 2024
247.23	Dr. Rob Friberg	Part 1: Project Proposal: Community Resilience to Mountain Pine Beetle and Other Forms of Environmental Disturbance and Change*	Ecological and social impact	2022
247.24	Dr. Rob Friberg.	Part 2: Swan River First Nation Criteria and Indicators for the Monitoring and Conservation of Traditional Values and Practices	Ecological and social impact	2023 - 2024

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