2018 FOREST FORUM

April 24 and 25, 2018 Edmonton Alberta

fRI Research
Informing Land & Resource Management

TRIA-Net

Canadian Institute of Forestry
Institut forestier du Canada

Acknowledgements

The organizers of this year's Forum express their sincere gratitude to everyone in our respective contributing organizations who have devoted countless hours to put all the pieces together to bring this event to fruition. It takes many talents and fortunately there is no shortage of individuals whom, when given a challenge rise to the occasion. As in previous years, Terri McHugh and Ben Williamson, Communications Services, fRI Research managed the many details associated with registration, web design, and content. We are also very thankful again this year for BubbleUp Marketing's Penny Snell's creative contribution to the development of the agenda pamphlet and research banners. It also takes special organizational and logistical experience to avoid the many pitfalls that organizers often experience in hosting a meeting of this type, but with Fran Hanington on our side, we survived. The Lister Conference Centre deserves special mention for their continued effort in making this annual Forum a success. The photos that appear throughout the agenda pamphlet were taken by the many graduate students and scientists during the undertaking of their research; we appreciate being allowed to use them to enhance this agenda pamphlet.

Dr. Keith M. McClain, PhD, RPF

Program Lead, Mountain Pine Beetle Ecology Program, fRI Research

Keith has worked in the realm of forest science for over 40 years, initially in the area of regeneration physiology and later in science management and policy. He has worked in Ontario, British Columbia and in Alberta. Keith has also worked as an independent forest science consultant, but is now with fRI Research as Program Lead of the Mountain Pine Beetle Ecology Program. The principle goal of the program is to ensure information needs for management of the MPB are met and that science is used creatively and effectively to support management decisions and policy development related to MPB. Keith is a Registered Professional Forester in Alberta and Ontario and is a member of the Canadian Institute of Forestry and has a Bachelor and Master's Degree in Forestry from the University of Toronto and a PhD degree from Oregon State University.

Dr. Vic Lieffers, PhD, RPF

Professor, Silviculture and Forest Ecology

Victor Lieffers has been a professor of silviculture and forest ecology since 1983 and is the past chair of the Department of Renewable Resources at the University of Alberta. He is a member of the College of Alberta Professional Foresters. He has published extensively in the areas of forest regeneration, forest ecology and silvicultural practices and policies.

Dr. Sebastian W.K. Lackey, PhD

TRIA-Net Project Manager

Sebastian, a molecular biologist by trade, completed his doctorate working on mitochondrial protein import mechanisms in fungi. Following a postdoc investigating pharmacological treatments for Huntington's disease at the University of Alberta hospital, Sebastian returned to his roots in biological sciences. Since 2015, Sebastian has been working as Project Manager for the TRIA Network (TRIA-Net) MPB project, a research initiative funded by the NSERC Strategic Network Grants program along with partner government, not-for-profit, and industry organizations. The chief objective of TRIA-Net is working to identify and protect forests through science-based strategies to control spread of the mountain pine beetle in Canada. Sebastian obtained his Bachelor's Degree from the University of Canterbury, NZ, and his PhD from the University of Alberta.

Fran Hanington

Fran has worked for fRI Research for 18 years in Communication Services. Prior to that she worked for Bighorn Environmental Design and Alberta Environmental Protection, now Alberta Agriculture and Forestry. She has a BA in History with a minor in Art History from Camosun College and Lakehead University. 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 in order to give 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 2018 FOREST FORUM

There is increasing evidence that Alberta's Forests are experiencing ecological pressures that may result in forest decline. We have all witnessed the march of the mountain pine beetle in British Columbia pine forests and its expanding influence in Alberta's forests, but the beetle is only one of many factors that are affecting forest health in Alberta. Other worrisome agents are pathogens, drought, and fire. Collectively, we are facing a loss of ecological services such as biodiversity, wildlife, water quality and quantity, landscape aesthetics and community well-being. It is impossible to quantify the impact of change from these factors, but when considered against a backdrop of climate change we can only surmise that the challenges ahead for resource managers to modulate change will be immense. Our concerns provided the impetus for developing the theme for this year's Forest Forum: Alberta's Forests Under Threat: a call for action.

In addressing this theme, fRI Research – Mountain Pine Beetle Ecology Program, TRIA-Net and the broad membership of forest practitioners and scientists of the CIF – Rocky Mountain Section have collaborated to bring science and practice together. We are unsure what Alberta's forested landscape will look like in the future, but well-developed scenarios suggest that warming will increase the number of frost – free days and winter temperatures; we will see plant migration creating new stand compositions and a higher incidence of insect outbreaks and pathogenic agents speeding the trends. Under new climate regimes we can expect to see extirpation of some plant and animal species while at the same time exotic species may find boreal habitats increasingly favourable, allowing them to thrive in Alberta's forests and further contribute to the displacement of native species. Developing mitigative strategies requires a clear understanding of the problem, and we must develop strategies that consider forest ecology against the backdrop of climate change. At the same time, we have to be cognizant of social and community issues that will surely influence the decisions we make.

Amidst a changing environment we are often forced to consider alternative outcomes, and at the same time we need to be flexible and adaptable. New knowledge needs to support strategies in response to changing conditions and we must adapt to new realities. Nevertheless, such times are shrouded in risk. It has been said that a management decision can be made regardless of the information available to support it, as long as one accepts the associated risk. We hope that this Forum will take advantage of the knowledge that has been generated through research and assist us in assessing risk and prepare us to respond to unintended outcomes. Responses to mitigate risks to our forests and communities may not be easy to formulate as they must be developed against the collective background of public, industry and government concerns. Unmistakably, we all have a role to play to address our uncertain future.

This Forest Forum has been designed to provide an opportunity for attendees to hear from leading scientists, forest practitioners, community leaders and government executives. Presentations will set the stage for important discussions focused on our forest ecosystem and threats to it. We will also hear and discuss current thinking about new constructs for management that attempt to minimize risks in maintaining ecological sustainability. Our goal in hosting the 2018 Forest Forum will be realized if you leave with an appreciation of the threats and risks facing Alberta's forests, the science that is available to support decisions and a commitment to a collective role in maintaining the continued flow of ecological services, and ensuring industries and communities remain vibrant and sustainable.

Dr. Keith McClain
Dr. Vic Lieffers
Dr. Sebastian Lackey

THANK YOU
TO OUR SPONSOR

The fRI Research Mountain Pine Beetle Ecology Program and the Canadian Institute of Forestry - Rocky Mountain Section in conjunction with TRIA-Net are collaborating on the planning and delivery of this year's Forest Forum. We are pleased to have support from Alberta Innovates to host the 2018 Forest Forum where we will explore the threats to Alberta forests and, with combined science based knowledge, practical experience and consideration of institutional impediments, we will address what we can do as there is a call for action.

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2017 Mountain Pine Beetle Status Update for British Columbia

Submitted by Tim Ebata, MSc, RPF, Forest Health Officer, Resource Practices Branch, BC Ministry of Forests, Lands and Natural Resource Operations, Victoria, BC

Biographical Sketch

Tim Ebata is a Forest Health Officer for the Resource Practices Branch, BC Ministry of Forest, Lands and Natural Resource Operations in Victoria. He is responsible for managing the province's forest health program along with Headquarters and regional pathologists and entomologists and has also been coordinating the provincial aerial overview survey program since we "inherited" it from CFS in 1996 and was fortunate to be able to document the rise and fall of the MPB outbreak in BC. Prior to being posted to Victoria, Tim started his career before completing his MSc in forest entomology program at the UBC Faculty of Forestry in 1986 by accepting the position as the regional entomologist for the former Prince Rupert Forest Region in Smithers in NW BC. His primary function was to implement the MPB suppression program for the region but was also involved in studies on spruce weevil and Warrens root collar weevil.

Excerpt from "2017 SUMMARY OF FOREST HEALTH CONDITIONS IN BRITISH COLUMBIA" (in preparation)

The mountain pine beetle outbreak peaked in BC with 10 million hectares affected in 2007. Since then, infestations have generally been in decline (Figure 3). Damage mapped in 2017 decreased to 119,089 ha from 177,706 ha last year. Intensity of mortality also decreased, with 59,589 ha (50%) trace, 29,772 ha (25%) light, 25,708 ha (22%) moderate, 3,961 ha (3%) severe and 59 ha (<1%) very severe.

Mature lodgepole pine continued to be the primary host for the mountain pine beetle. Mortality in whitebark pine leading stands was observed on 6,142 ha (5% of total area damaged). Mountain pine beetle attack in young lodgepole pine became prevalent from 2004 onwards, and since 2007 it has been noted separately from mature mortality in the database. For the first time since the recording of young mountain pine beetle attack began, no young damage was noted in 2017.

For the second consecutive year mountain pine beetle attack was highest in Omineca Region at 53,511 ha, down from 76,176 ha in 2016. Robson Valley TSA continued to be the most affected with 34,396 ha of damage and the majority of moderate to severe infestations in the region. Most of the attack occurred from Moose Lake south to Ptarmigan Creek, in high elevation stands of lodgepole and whitebark pine. Mackenzie TSA sustained 11,116 ha of mortality, primarily in trace intensity polygons from Spinel Lake south to Bower Creek. For the third consecutive year however a large portion of Mackenzie TSA could not be surveyed, so attack levels could be higher. Prince George TSA contained 7,999 ha of chiefly light intensity infestations, with the majority of the attack occurring in Fort St. James TSA near Driftwood River.

Northeast Region infestations declined to 24,290 ha in 2017 from 36,088 ha last year. Fort Nelson TSA sustained 10,651 ha of damage, mainly mid TSA. In Dawson Creek TSA, most of the 9,335 ha mapped continued to occur along the Alberta border near South Redwillow River. Intensity of mortality was highest in this area as well, with light to moderate polygons delineated. All other attack in the region was rated as trace or spot. The 4,304 ha of damage mapped in Fort St. John TSA was widely scattered.

Mountain pine beetle attack in Skeena Region slightly increased since 2016, from 8,217 ha to 12,492 ha. The majority of the damage continued to be noted in Bulkley TSA with 9,739 ha affected. Most of the disturbances were of trace or spot intensity, with concentrations south of Mount Horetsky, around Tarkelsen Lake and around Hudson Bay Mountain. Infestations in Cassiar TSA accounted for 1,942 ha and were located around Bob Quinn Lake and Pitman River. Most of the 618 ha of attack in Morice TSA were mapped in the northern tip. Minor infestations were noted in Kispiox, Lakes and Kalum TSAs with 155 ha, 25 ha and 13 ha affected, respectively.

Mortality in Kootenay/Boundary Region dropped to a third of that observed in 2016 with 11,371 ha affected. Invermere TSA mortality declined to 4,924 ha, but may be an artificial decrease as the eastern half of the TSA could not be surveyed. Infestations in Kootenay Lake TSA were small and widely scattered, accounting for 2,934 ha. Mountain pine beetle disturbances declined sharply in Boundary TSA to 1,277 ha, though infestations were still widely scattered. A total of 922 ha were damaged in Golden TSA, with small concentrations on Valenciennes River, Bachelor Creek and Columbia Reach of Kinbasket Lake. The 622 ha recorded in Arrow TSA were primarily in two areas near Trout and Summit Lakes.

In Revelstoke TSA, infestations totalling 472 ha were mainly east of Revelstoke, north of Goldstream Mountain, and on Bigmouth Creek. The remaining 220 ha of damage in the region was noted in the western half of Cranbrook TSA.

Mountain pine beetle infestations continued to increase in Cariboo Region, with a rise from 4,298 ha in 2016 to 7,718 ha. Almost all of the attack continued to occur in Williams Lake TSA, where 7,688 ha were affected. The largest, most active area continued to be from Taseko River west to Dorothy Lake. Two smaller infestations were mapped south of Razorback Mountain and around Whitton Creek. Along the northwestern boundary of Quesnel TSA, four small trace polygons and a few spot infestations accounted for 30 ha of damage.

After a slight increase in 2016, mountain pine beetle attack in Thompson/Okanagan Region declined by almost half to 6,903 ha. The majority of the damage continued to occur in the western half of Lillooet TSA, where 6,597 ha were affected. The most active area with the highest intensity of attack continued to be west of Downton Lake. It was noted that host pine supply is becoming depleted in this area, but mortality still is widespread. Attack in Okanagan TSA accounted for 213 ha of mortality, primarily north of Winnifred Creek. Damage in Merritt TSA declined to 93 ha, mainly observed north of Stemwinder Mountain. Only one spot infestation was mapped in Kamloops TSA.

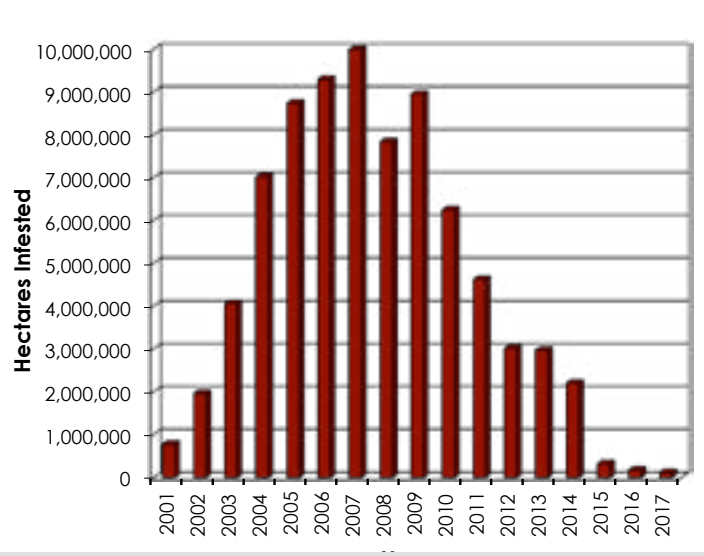


Figure 3. Area infested (all severity classes) by mountain pine beetle from 2001 – 2017 in British Columbia.

Mountain pine beetle mortality remained relatively stable in South Coast Region at 1,391 ha. Soo TSA was the most affected, with 1,005 ha of attack delineated, mainly south of Mount Currie. Almost all the infestations in Sunshine TSA continued to occur south of Bishop River with a total of 1,005 ha mapped. The remaining six ha in the region were scattered in Fraser TSA.

The 1,317 ha mapped in Great Bear Rainforest continued to be found along the eastern edge of North TSA, where small 2016 infestations expanded six-fold. Most of the mortality occurred at high elevations on the east slope of the Coast Range.

In the West Coast Region, all 96 ha of mountain pine beetle attack were recorded in Haida Gwaii TSA, primarily on the south tip of Moresby Island.

2007 Flight over Sigutlat Lake in Tweedsmuir

2017 Mountain Pine Beetle Status Update for Alberta

Submitted by Caroline Whitehouse, Alberta Agriculture and Forestry, Forest Health and Adaptation Section, Forest Management Branch

Biographical Sketch

Caroline is a Forest Health Specialist with Alberta Agriculture and Forestry. She works as part of an interdisciplinary team of scientific and resource specialists to develop and deliver comprehensive forest health scientific programming in forest insects, diseases, and climate change. She started with the Government of Alberta as a Forest Health Officer working in the Peace River and High Level Forest Areas and moved back to Edmonton to start in her current role in fall, 2015. Prior to joining the government she worked at the University of Alberta as a Research Technician in a lab focused on the ecology of insect pests such as mountain pine beetle and forest tent caterpillar. She obtained a Bachelor of Science in Ecology from the University of Alberta. Her Masters in Environmental Sciences was focused on the reproductive biology of a cone-feeding insect pest.

Status of mountain pine beetle in Alberta, 2017

Introduction

In Alberta, forest health monitoring is the responsibility of Alberta Agriculture and Forestry (AAF) and is conducted on forested land under AAF management1. To this end, AAF annually conducts aerial surveys (heli-GPS surveys) in addition to ground surveys to delimit the extent of mountain pine beetle (MPB) infestations in the province. This report provides a summary of the aerial and ground surveys to detect MPB infestations in 2017.

Population forecast surveys

Population forecast surveys are conducted each spring to assess the relative overwintering success of MPB and the potential for the infestation to spread. Approximately 323 trees at 80 sites were surveyed in 2017 (Fig. 1). Overall population success was predicted to be lower in 2017 compared to 2016. Of the sites sampled, 14% showed low success, 46% showed moderate success, and 19% predicted high success. Extremely high MPB success was noted in only one site south of Grande Prairie. Surveys were not conducted in northwestern Alberta due to the lack of ground accessible infested sites.

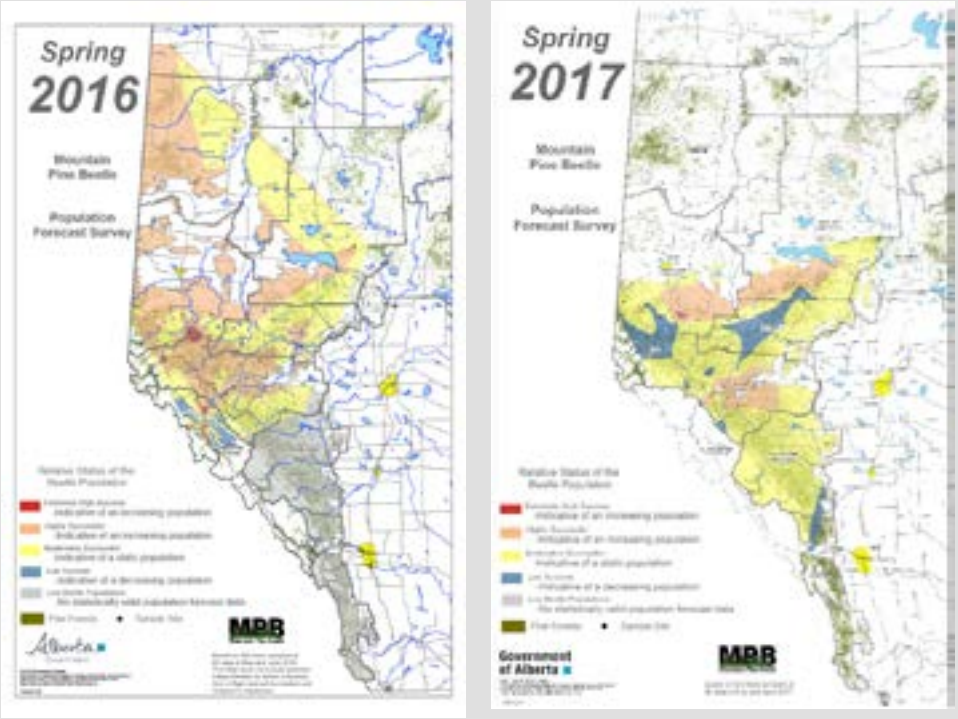


Figure 1. Relative overwintering success of mountain pine beetle across Alberta based on the results of r-value surveys carried out in the spring of 2015 and 2016.

Dispersal bait monitoring

Mountain pine beetle aggregation pheromones are used to monitor the presence or absence of this insect along the eastern slopes of the Rocky Mountains and along the Saskatchewan border. Sites are ranked as MPB being absent (zero attacked trees), present (at least one tree with less than 40 attack starts), or mass-attacked (at least one tree with more than 40 attack starts).

In 2017, 248 sites were monitored (Fig. 2) and provincially attack intensities were similar to those observed in 2016 with the exception of increased presence in central Alberta Rocky Mountains. In northeastern Alberta, MPB was absent from most sites (79%) and zero sites were mass-attacked which was similar to the pattern observed in 2016. In the central region of the Rocky Mountains, MPB mass-attacked fewer sites in 2017 compared to 2016 (68% versus 87%) but was present at larger number of sites (25% in 2017 and 9% in 2016). In southern Alberta, MPB continued to be largely absent from the majority of sites (81%), present at 11% of sites and mass-attacking trees at 7% of sites.

Aerial surveys

Aerial surveys are conducted annually in late summer and early fall to determine the number of red-crowned pine symptomatic of MPB infestations. Generally, groups of three or more pine with red crowns are recorded using sketch mapping and heli-GPS techniques. These surveys span the regions that are a priority for control activity that year. The region of the province prioritized for control activity has been similar since 2014, therefore aerial surveys were conducted over comparable areas.

Surveyors detected 89,520 red trees spread over 17,677 sites in 2017 which was an increase of 23% compared to 2016 (72,571 trees at 16,317 sites) (Fig. 3). The greatest increase in MPB populations occurred in the Edson Forest Area; a four-fold increase in the number of red trees and red tree sites compared to 2016. The number of red trees and red tree sites decreased in the Grande Prairie and Whitecourt Forest Areas, and remained mostly unchanged in the Slave Lake Forest Area.

Green to red ratio surveys

These surveys are conducted each fall to assess the relative success of MPB and potential for the infestation to spread the following summer. These surveys are based on a ratio of green attack (trees with current year attacks, retaining green crowns) to red attack (trees with red crowns, attacked the previous year) trees calculated by site.

Surveys were carried out at 468 plots in 2017 (Fig. 4). The majority of plots predicted low population growth in 2017 (36%) while the number of plots that predicted high population expansion remained stable between 2016 at 2017 at 29%.

Single-tree survey and control

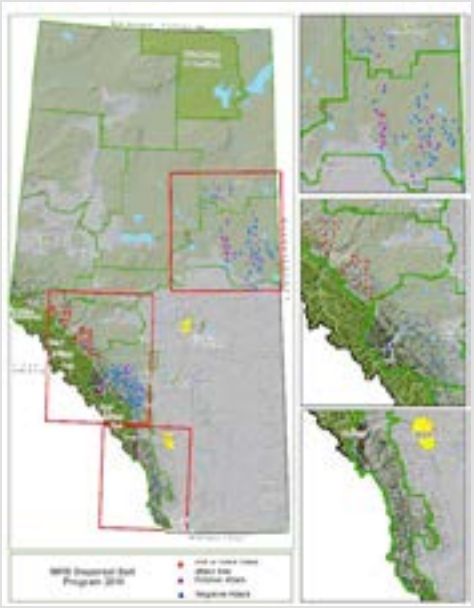
Mountain pine beetle infested trees were assessed for management using concentric ground surveys conducted in late fall and early winter. The majority of these concentric surveys were conducted by external contractors though some of the work was performed in-house. These trees are removed from the landscape during single tree cut-and-burn control operations conducted in the winter.

The number of trees controlled slightly increased between 2016 (91,997) and 2017 (estimate: 95,244). Since 2006, AAF has controlled approximately 1.5 million MPB-infested pine trees.

Acknowledgements

This report was compiled by Caroline Whitehouse, Forest Health Specialist. Forest Health Officers (Colton Briggs, Allison Brown, Megan Evans, Ryan Hermanutz, Devin Letourneau, Jennifer MacCormick, Bart McAnally, Fraser McKee, Pam Melnick, and Andrea Sharpe) and Forest Health Technicians (Devin Abraham, Caroline Charbonneau, Crystal Ionson, Marian Jones, Clint McCrea, and Jarrett Totton) collected the data included in this report. Aaron McGill, Brad Tyssen and David Tellier prepared the maps included in this report.

For further details on forest pest conditions in Alberta, please visit the Forest Health website.



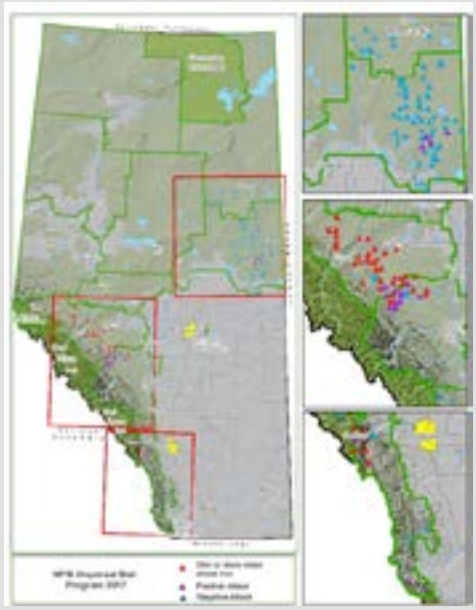


Figure 2. Mountain pine beetle long-distance dispersal baiting survey 2016 and 2017

Figure 3. Locations of red-crowned pines detected during aerial surveys 2016 and 2017.

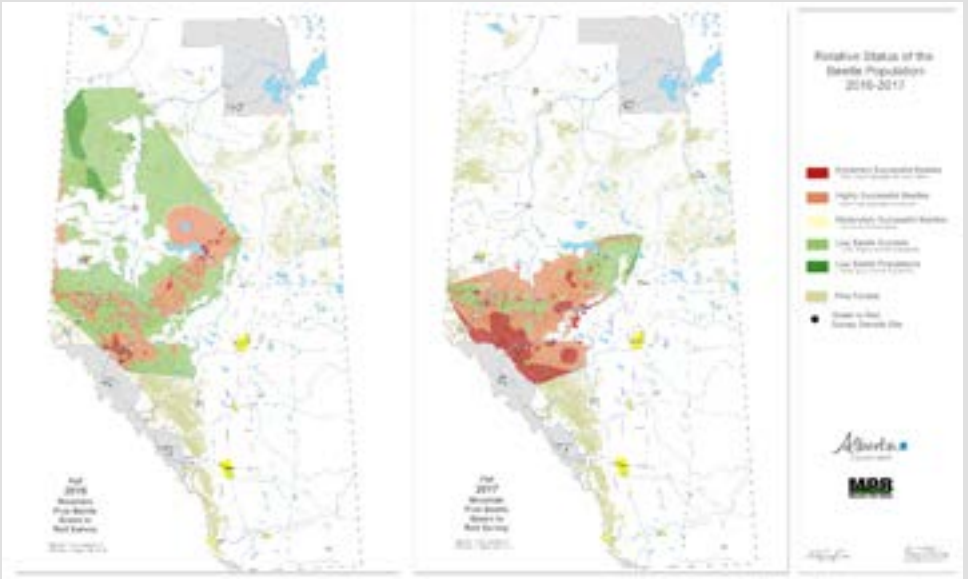


Figure 4. Green to red ratio results from 2016 and 2017 surveys.

2017 Mountain Pine Beetle Status Update for 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. Rory has worked in entomology research across Canada, graduating from the University of New Brunswick and completing 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 insect and disease program. In addition to his work for Saskatchewan Ministry of Environment, Rory has served as an adjunct professor in the Department of Entomology at the University of Manitoba, and currently serves as adjunct professor in the School of Environment and Sustainability (SENS) at the University of Saskatchewan.

2017 Mountain Pine Beetle Status in Saskatchewan

The risk of mountain pine beetle (MPB) spreading eastwards and establishing in Saskatchewan's boreal jack pine forests continues to be Saskatchewan's primary forest health concern. In 2015 and again in 2016 and 2017 the Government of Alberta reported beetles were found in baited trees inside the Cold Lake air weapons range (CLAWR) in Alberta, now within 37 km of the AB/SK border. Currently in Saskatchewan, the MPB outbreak persists in the Cypress Hills Inter-provincial Park in southwestern Saskatchewan.

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

Central to Saskatchewan's strategic approach is to focus on aggressive fall and burn operations in the leading edge in Alberta to prevent or slow the spread of mountain pine beetle into the boreal forest and across Canada. In 2011, the province of Saskatchewan entered into a multi-year agreement to partner with the province of Alberta to develop a coordinated, strategic approach to control the spread of the mountain pine beetle into Saskatchewan's boreal forest. In December 2014, the agreement was renewed for an additional three-year term. The agreement has been renewed gain and in August was signed for a further three years with the term expiring in 2020.

The provincial MPB surveillance program is divided into two areas: the Northern boreal forest and the Cypress Hills Inter-provincial Park (CHIPP).

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 collaboration with Alberta, a stand susceptibility Index was developed and mapped. This helped SK to focus surveys and attention to high risk stands and potential spread pathways.

In 2012, the ministry expanded ground monitoring capacity by extending the leading edge tree-baiting monitoring network, currently in place in Alberta, into Saskatchewan. To provide access, heli-landing areas were cut in pine and pine-leading stands.

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.

A network of pheromone baited trees has been established in Alberta to monitor the leading edge and detect eastward spread of MPB. This detection system has also been extended into Saskatchewan and established on the SK side of the border. Bait sites comprise three baited trees deployed in a triangular pattern; at a density of one site per township. The figure shows the distribution of tree bait sites – the red dots show those that were baited and the white dots those that have been established and are currently inactive. Heli-landing areas have been cut to provide ground access to all bait sites.

In 2017, Alberta Forest Health Officers found MPB in one baited tree at one of the baiting sites inside the Cold Lake Air Weapons Range (CLAWR) approximately 27 km west of the Alberta-Saskatchewan border. In 2017, SK deployed tree baits

Boreal

CHIPP

at 57 locations in the northwest (red dots). White dots represent currently inactive sites. Note seven baited sites were deployed inside CLAWR (orange polygon) in 2017.

Currently no mountain pine beetles are found in Saskatchewan's boreal forest

Cypress Hills Inter-provincial Park (CHIPP)

Saskatchewan Ministry of Environment has been monitoring MPB in the CHIPP since the last outbreak declined in 1985/86. Aerial overview surveys are used to locate all red trees. These observations are then verified by intensive systematic ground surveys. Each year, all currently attacked trees verified during the ground surveys and marked for control, are removed. In 2006 only two trees were identified however, this number started to increase in 2008-09 reaching a peak in 2013. In 2014, 2015 and 2016 the total number of trees removed, declined. In 2017 the number of trees removed (120) declined again for the fourth year in a row. (Figure 1).

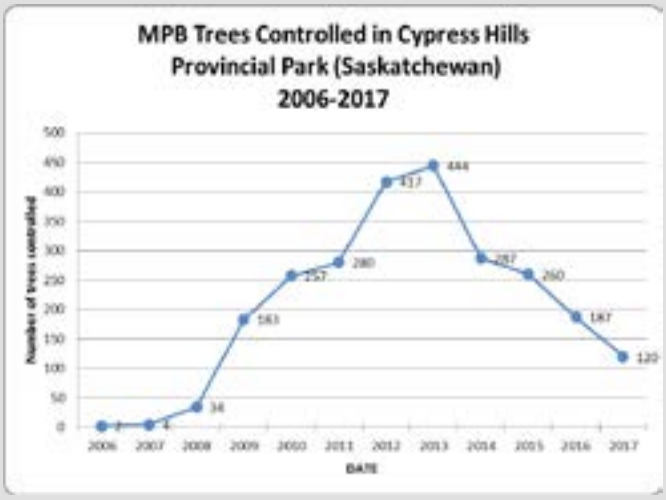


Figure 1. Total number of trees controlled in the Cypress Hills Interprovincial Park 2006 to 2017

2018 Forest Forum

Alberta's Forests Under Threat: *a call for action*

Maple Leaf Room, Lister Conference Centre, University of Alberta

Day 1 Tuesday, April 24, 2018

Time	Presentation	Speaker
7:00–8:15	BREAKFAST AND REGISTRATION	
8:15–8:30	Welcome / Introductions / Recognition of Guests	Dr. Keith McClain, Program Lead, MPBEP, fRI Research, Dr. Vic Lieffers, Vice-Chair, Canadian Institute of Forestry, Rocky Mountain Section and Dr. Sebastian Lackey, Program Manager, TRIA-Net
There is clear evidence that our forests are under threat. Our Key Note Speaker will impress upon you the seriousness of the challenge ahead particularly against a back drop of climate change. Other speakers will be specific about what the threats are and what we stand to lose if action is not taken.		
8:30–9:15	Key Note Address Canada's transitioning forests in the midst of threats and climate change	Dr. Mark Johnston, Distinguished Scientist, Saskatchewan Research Council, Saskatoon, SK
9:15–9:40	Threats from abiotic factors The dynamic relationships between fire, mountain pine beetle, and climate.	Dr. Chris Stockdale, Fire Research Scientist, NRCan, Canadian Forest Service, Northern Forestry Centre
9:40–10:00	Recent decline of Alberta's commercial forests induced by drought and its interactions with insects and diseases: early signs of climate change?	Dr. Ted Hogg, Research Scientist, NRCan, Canadian Forest Service, Northern Forestry Centre
10:00–10:30	**HEALTH BREAK**	
10:30–11:00	Threats from biotic factors Forest pests and damaging agents under climate change and Alberta's program adaptations	Erica Samis, Director, Forest Health and Adaptation Section, Alberta Agriculture and Forestry
11:00–11:30	Threats to boreal forest ecosystem services and biodiversity	Dr. Dan Farr, Director, Biodiversity and Ecosystem Health Sciences, Alberta Environment and Parks
11:30–12:00	Threats to community well-being and security	Rob Friberg, PhD Candidate, University of British Columbia, Okanagan Campus
12:00–12:45	**LUNCH**	
12:45–1:00	CIF – Presentation of Tree of Life Award and other RMS award announcements	

AGENDA - DAY 1

Day 1 Tuesday, April 24, 2018

This afternoon, we will be exposed to some of the latest research on one of the most outstanding threats to Alberta's forests – the Mountain Pine Beetle. Keep in mind that other threats discussed this morning cannot be ignored as they modulate the impact of the beetle or they predispose forests to attack. The research that you will hear about is just a cross section of ongoing research being conducted by fRI Research and the NSERC TRIA-Net.

fRI Research		
1:00–1:20	Chemical ecology of mountain pine beetles: Chemical and anatomical defenses	Dr. Nadir Erbilgin, Professor and Shiyang (Violet) Zhao, PhD Student, Department of Renewable Resources, University of Alberta
1:20–1:40	MPBSpread: modelling the spread of the mountain pine beetle through novel pine forests	Dr. Allan Carroll, Professor and Director, Department of Forest and Conservation Sciences, Forest Sciences Undergraduate Program, University of British Columbia
1:40–2:00	Population state-dependent invasion potential of the mountain pine beetle in Alberta	Dr. Jordan Lewis Burke, Post-Doctoral Research and Teaching Fellow, Department of Forest and Conservation Sciences, Forest Sciences Undergraduate Program, University of British Columbia
2:00–2:20	MPB Winter Survival: how low can they go?	Dr. Katherine Bleiker, Research Scientist, NRCan, Canadian Forest Service, Pacific Forestry Centre
2:20–2:40	Rehabilitation of beetle-killed stands by improving pine seedling performance with mycorrhizal fungi	Dr. Justine Karst, Assistant Professor, Department of Renewable Resources, University of Alberta
2:40–3:00	Discussion	Dr. Keith McClain
3:00–3:20	HEALTH BREAK	
TRIA-Net		
3:20–3:30	Introduction to TRIA-Net	Dr. Janice Cooke, Associate Professor and Co-Director, TRIA-Net, Department of Biological Sciences, University of Alberta
3:30–3:45	Theme 1: Chemical ecology of MPB, hosts, and symbionts - management implications	Dr. Dezene Huber, Associate Professor, Ecosystem Science and Management, University of Northern British Columbia
3:45–4:00	Theme 2: Population genomics of MPB, hosts, and symbionts - management implications	Dr. David Coltman, Professor & Associate Dean/Research Science, Department of Biological Sciences, University of Alberta
4:00–4:15	Theme 3: Dynamics of mountain pine beetle populations in novel habitats: implications for management	Dr. Allan Carroll, Professor and Director, Department of Forest and Conservation Sciences, Forest Sciences Undergraduate Program, University of British Columbia
4:15–4:30	Theme 4: Consequences of mountain pine beetle outbreak on forest ecosystem services and landscape resilience	Dr. Lael Parrott, Professor, BRAES Institute, University of British Columbia, Okanagan Campus
4:30–4:45	Discussion & Introduction to Day 2	Dr. Keith McClain, Dr. Vic Lieffers, Dr. Janice Cooke
5:00–7:00	RECEPTION	fRI Research / CIF / TRIA-Net CIF AGM

Canada's transitioning forests in the midst of threats and climate change

Dr. Mark Johnston, Senior Research Scientist, Saskatchewan Research Council, Saskatoon, SK

Biographical Sketch

Dr. Mark Johnston is currently Senior Research Scientist in the Saskatchewan Research Council's Environment Division, and adjunct professor at the University of Saskatchewan. He has worked at SRC since 2001 in the areas of forest ecology, climate change impacts and forest carbon sequestration. Most recently he helped lead a national study of Canada's forest sector vulnerability to the impacts of climate change, and continues to work with forest industry and government to assist them in understanding climate change impacts and how they can adapt to these changes. Dr. Johnston is a Registered Professional Forester in the province of Saskatchewan, a Certified Senior Ecologist with the Ecological Society of America, and received the Saskatchewan Research Council's Distinguished Scientist designation in 2006.

Abstract

Canada's western boreal forest is under threat from several sources: fire, insects and disease, drought and human disturbance, all potentially intensified by climate change. This presentation will provide a high-level overview of these threats and how climate change may affect them and the interactions among them. I will then provide some ideas about how climate change risks can be assessed using tools specific to Canadian Sustainable Forest Management (SFM), and will show how climate change considerations can be brought into SFM and become part of day-to-day planning and decision making.

Photo Credit: Dr. Allan Carroll, University of British Columbia

THREATS FROM ABIOTIC FACTORS

The dynamic relationships between fire, mountain pine beetle, and climate.

Dr. Chris Stockdale, Fire Research Scientist, Natural Resources Canada, Canadian Forestry Service Northern Forestry Centre, Edmonton, Alberta

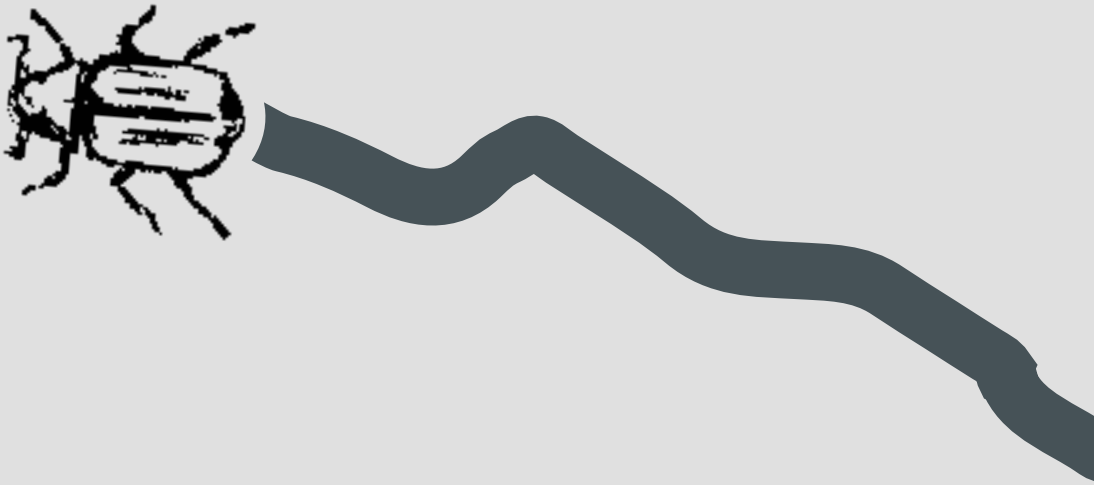
Abstract

Wildfire and vegetation composition have interacted and maintained a dynamic balance for centuries. Even though fires themselves can be highly variable with regard to intensity and size, vegetation tends to recover to what was on a site prior to it burning. Whether it recovers over a period of a few years, or requires decades to go through the various successional steps needed to reach the pre-burn condition. In other words, the landscape is well adapted to its historical fire regime. Fire regimes describe how fire interacts with the landscape over time, and are described by how frequently (and when) fires burn, how big they get, how intense and severe they are, among other attributes. Because fire regimes are driven by climate, vegetation, and topography, whenever one of these drivers changes significantly, so too does the regime, and the "balance" is altered.

In the past several decades we have seen significant changes in both vegetation and climate, which are beginning to fundamentally disrupt and alter fire regimes. While vegetation has changed due to fire exclusion, so too the direct and indirect effects of climate change are causing significant changes in vegetation, other disturbances that affect vegetation, and weather systems that influence fire. This complex series of changes makes understanding the future potential of wildfires and the composition of vegetation on the landscape difficult to predict. We know that a century of active fire exclusion, in conjunction with climate change, is one of the contributing factors to significant increases in forest canopy closure, forest encroachment into grasslands, and increases in coniferous forests relative to broadleaf deciduous vegetation. These changes to vegetation composition over the last century are common in the western Cordillera of North America, and we suspect that the increases in pine forest cover are a contributing factor to the current scale of the mountain pine beetle epidemic. It is less clear how much we have affected vegetation across the boreal forest, however the changes in the cordillera may have built the "bridge" for the beetle to reach this new "front". At the same time, changes wrought by fire exclusion appear to be a contributing factor to recent increases in the mean annual area burned throughout North America. Large areas of beetle killed forests may change fire behavior (and thus fire regimes) across a broad area: but will the potential increases in area burned and increased fire severity perhaps lead to a reduction in available host trees for the MPB to spread? What will grow back in areas that have been killed by beetle and burned by high severity wildfire? With climate change forecasts suggesting that grasslands should be taking over in place of forests in many areas, will we even have forests here again?

Biographical Sketch

Chris is a research scientist working for the Canadian Forest Service where he specializes in the spatial prediction of wildland fire risk as related to ecological values. In addition to this, his main interests relate to historical changes in fire regimes and their subsequent effect on ecosystem structure through time. He has developed novel methods to extract spatial data from historical land based oblique angle photographs from which we can examine ecological changes in vegetation patterns from the turn of the 20th century to the present day. Before beginning his Ph.D. in 2011, he worked for the Canadian Forest Services Fire Group from 2001-2005, with Alberta Sustainable Resource Development from 2006-2009, and as a consultant (contracted through FRI) from 2009-2011. Chris has a BSc Biology (University of Victoria), MSc Forest Science (Oregon State University) and a PhD in Forest Ecology and Management (University of Alberta).



Recent decline of Alberta's commercial forests induced by drought and its interactions with insects and diseases: early signs of climate change?

Dr. Ted Hogg, Research Scientist, Northern Forestry Centre, Canadian Forest Service, Edmonton, Alberta, (Email: ted.hogg@canada.ca)

Abstract

Since the turn of the 21st century, conditions have been exceptionally dry across large areas of the western Canadian boreal forest, especially in Alberta. In our research, we are using a combination of tree-ring analysis and monitoring of forest plots to examine the impact of drought and insects on the growth and health of aspen and white spruce forests across the region. Recent results have revealed that repeated, severe droughts during the period 2002-2016 have led to widespread decline in both of these important tree species across Alberta's forests. The results from 18 years of forest plot monitoring also indicate that drought impacts on aspen mortality are amplified and prolonged by interactions with biotic agents, including forest tent caterpillar defoliation and wood-boring insects. For lodgepole pine, the most obvious threat is massive mortality induced by the recent incursion of mountain pine beetle into Alberta's forests, but related research shows that drought also poses a significant concern. Given the likelihood that climate change will lead to drier conditions in future, successful adaptation may depend on the effectiveness of innovative forestry practices in reducing tree water stress in climatically vulnerable sites.

Biographical Sketch

Ted Hogg grew up in Calgary and completed his Ph.D. at the University of New Brunswick. Since 1992, he has worked as a research scientist in the climate change program of the Canadian Forest Service (CFS) in Edmonton. He participated in several large-scale research programs in the boreal forest, including BOREAS, BERMS and Fluxnet Canada, and he leads the CFS study entitled "Climate Impacts on Productivity and Health of Aspen" (CIPHA). His current research is mainly focused on improving scientific knowledge of climate-related impacts on the growth and dieback of forests in the western Canadian interior.

THREATS FROM BIOTIC FACTORS

Forest pests and damaging agents under climate change and Alberta's program adaptations

Erica Samis, Director, Forest Health and Adaptation Section, Alberta Agriculture and Forestry, Edmonton, Alberta

Abstract

Presence of forest pests and the severity of damage caused has been monitored in Alberta for many years by federal and provincial agencies. Cyclic trends and typical pest disturbance patterns can be discerned from the data. Going forward, the cycles and distribution of these same pests are expected to change under climate change. While change is expected, it is unclear which pests may become important in the future. Native forest pests may expand their historic ranges and the severity of the damage caused to Alberta's forests may increase. Secondary pests that attack weak or dying trees may become primary pests that can cause mortality. As climate changes, an increased number of invasive forest pests may become established if introductions occur. Alberta Forest Health and Adaptation is answering the call for action by taking proactive steps to understand the potential changes in biotic pests that threaten Alberta's forests.

Biographical Sketch

Erica Samis began working seasonally for ESRD in 1997. In 1998 she began working as the Forest Health Officer for the then Northern East Slopes Region which is approximately the Edson and Whitecourt Forest Areas now. In 2006 she moved to Provincial Headquarters in Edmonton to work on developing the Provincial MPB Program. She became the Director of the Forest Health and Adaptation Section in fall of 2014. The Forest Health and Adaptation Section monitors biotic and abiotic forest damage agents, conducts tree breeding programs and manages forest genetic resources.

Threats to boreal forest ecosystem services and biodiversity

Dr. Dan Farr, Director, Biodiversity and Ecosystem Health Sciences Science Branch, Alberta Environment and Parks, Edmonton, Alberta

Abstract

Boreal forests are very resilient ecosystems, having proven their mettle against repeated onslaughts from powerful natural forces. An ecosystem that recovers after being repeatedly pulverized by glaciers, incinerated by fire, and infested by bugs, deserves respect. (More benign and stable environments in other parts of the world have enabled pampered forests to develop that are unable to cope with a bit of drought and the occasional storm. Sad!) Businesses and communities that rely on boreal forest resources also need to be resilient in the face of natural forces that can drastically alter the supply of timber, water, and other ecosystem services. Policies to support such communities should be informed by an understanding of ecosystem response to key threats, namely climate change and anthropogenic activity. Climate is an enabler of fires and pests that alter the provision of timber and water. Stands overdue for a stand-replacing fire may, because of altered climates, transition after disturbance to plant communities more suited for agriculture than forestry. Finally, a combination of anthropogenic activities may reduce the resilience of boreal forests to natural forces. Declines in native biodiversity and invasion by exotics, brought about by a long list of interconnected factors, is a double-whammy with unpredictable effects on both resilience and ecosystem services.

Biographical Sketch

Dr. Dan Farr is an ecologist whose early interest in Manitoba's garter snakes led to several years of graduate school in zoology and conservation, followed by a Biologist job at Foothills Model Forest in Hinton and contract work in biodiversity monitoring, land use scenario modelling, and systematic conservation planning. He spent several years at the Alberta Biodiversity Monitoring Institute leading applied research projects in climate change adaptation, ecosystem services, and biodiversity response to grazing and oil sands development. He is now the Director of Biodiversity and Ecosystem Health Sciences in the Environmental Monitoring and Science Division of Alberta Environment and Parks.

Threats to community well-being and security

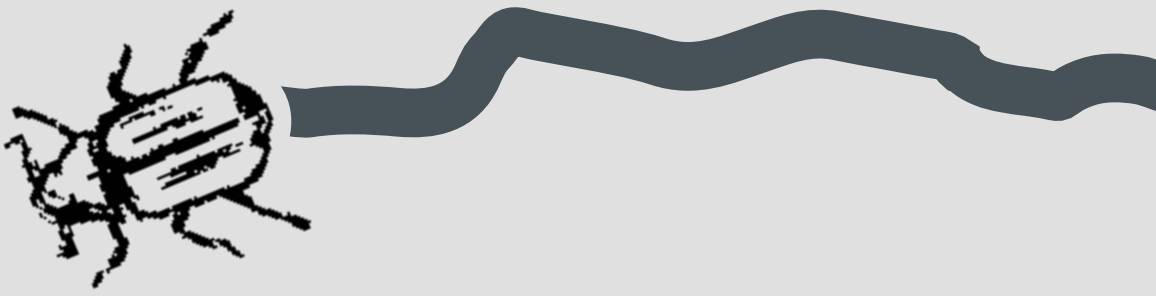
Rob Friberg, RPF, PhD Candidate, University of British Columbia, Okanagan Campus, Kelowna

Abstract

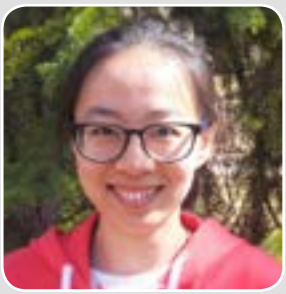
Existing vulnerability research helps us understand factors that influence the susceptibility of rural communities to the social and economic impacts from disturbances like mountain pine beetle. By integrating vulnerability concepts with recent advancements in community resilience theory, ongoing research with Alberta communities seeks to help identify practical strategies for ensuring their social and economic well-being into the future. Priorities for local action may focus directly at pine beetle (a strategy known as specified resilience), and more broadly (general resilience) to other forms of anticipated and unanticipated future change, such as climate change and external economic influences. Vulnerability and resilience features being explored with Alberta communities are categorized for the study as (1) social and economic exposure to the impacts from beetle, (2) stability factors, such as biophysical and economic diversity, redundancy, social cohesion, the latitude for and diversity of response, (3) community assets for adaptation or transformation, including capacity for collective action, (4) institutional adaptive capacity at local, provincial and federal scales, and (5) attributes that facilitate the activation of community adaptive response, such as risk awareness and leadership. The study aims to provide tangible, practical results for Alberta communities and other Canadian communities that rely on adjacent forested landscapes.

Biographical Sketch

Rob's PhD research at UBC Okanagan involves working with rural communities in Alberta to help identify practical strategies for strengthening resilience to pine beetle, and to other types of potential landscape-level change. Prior to his PhD studies Rob worked with forest-based communities to support climate change mitigation and sustainable rural development in Canada and internationally; with the International Model Forest Network in Chile; and in the forest planning and silviculture sectors of the BC forest industry.



Chemical ecology of mountain pine beetles: Chemical and anatomical defenses



Dr. Nadir Erbilgin, Professor and **Shiyang (Violet) Zhao**, PhD Student, Department of Renewable Resources, University of Alberta, Edmonton

Abstract

Host tree colonization by mountain pine beetle involves several stages from host selection to aggregation, establishment (mating and reproduction), and (offspring) dispersal. All these stages are closely linked to the host tree chemistry such as monoterpenes in the tree resin. During the initial phase of host selection, beetles respond to visual or chemical cues, and enter or leave the host based on short-range chemical and tactile stimuli. If the host is acceptable, the beetles bore through the outer bark, excavate a nuptial chamber in the phloem and produce aggregation pheromones that attract conspecifics. After mating, the female excavates egg galleries and deposits eggs along the gallery walls. The developing larvae feed on phloem and/or fungi in the larval galleries. The full development from egg to adult takes a year. In our presentation, we will explain the functional roles of these chemicals on the beetle behaviours that govern host acceptance for mating, oviposition, larval development, and dispersal. Besides defense chemicals, trees also rely on anatomical defenses against mountain pine beetle. Such as the xylem axial resin duct characteristics can be closely linked to resin execution, along with tree chemical defenses. We will provide the roles of resin duct-based defenses in the survival of residual trees during beetle outbreak and post-beetle outbreak phase.

Biographical Sketches

Dr. Nadir Erbilgin is Professor of Forest Entomology and Chemical Ecology in the Department of Renewable Resources at the University of Alberta-Edmonton. He received his Ph.D. in entomology from the University of Wisconsin-Madison, was a postdoctoral researcher at the University of California-Berkeley, and has been on the faculty at the University of Alberta since 2007. He has developed a broad and diversified expertise in entomology and pathology, chemical ecology, plant biology, and soil microbiology. His research group 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. Currently, he leads one NSERC-SPG on "Using the functional traits of soil fungi to improve post-disturbance pine regeneration" and co-leads a Genome Canada project on "Resilient forests (RES-FOR): Climate, pests & policy-Genomic Applications". Nadir Erbilgin was a recipient of a Canada Research Chair Award from the Government of Canada. He currently has two postdoctoral research, 10 graduate students, and two undergraduate students along with one full-time and several part time lab technicians.

Shiyang Zhao is a PhD student working with Dr. Nadir Erbilgin in the Department of Renewable Resources at University of Alberta. Her doctoral research focuses on the healthy conditions of residual overstory lodgepole pine trees in post-mountain pine beetle stands and how resin duct-based anatomical defenses relate to the survival of residual pine trees. She achieved her Master's degree in Entomology from Harper Adams University in the United Kingdom, where she worked on the trade-offs between resistant aphids and parasitoids. When she is not glued to her laptop and microscope, she really enjoys outdoor activities and travelling.

MPBSpread: modelling the spread of the mountain pine beetle through novel pine forests

Dr. Allan Carroll[1], Brad Seely[2], Clive Welham[2], and Harry Nelson[2]

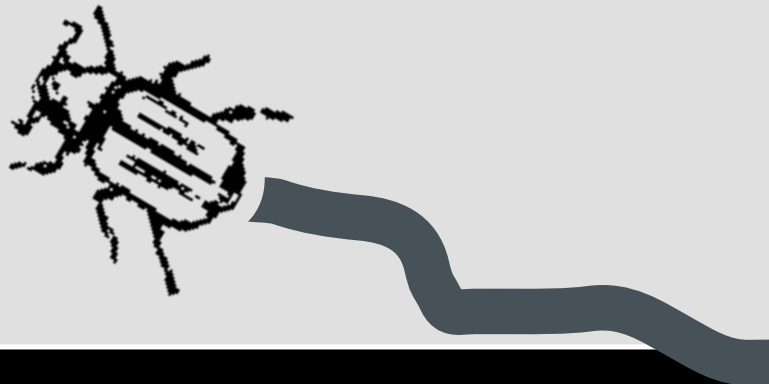
1Department of Forest and Conservation Sciences, 2Department of Forest Resources Management, The University of British Columbia, 2424 Main Mall, Vancouver, BC, V6T 1Z4

Abstract

MPBSpread is a spatially explicit cellular automata model that simulates mountain pine beetle (MPB) spread through application of a series of rules that describe beetle behavior in relation to (i) infestation and host characteristics, and (ii) application of beetle control tactics. Using MPBSpread, we assessed the efficacy of efforts by the Government of Alberta to slow the eastward spread of MPB. Empirical data on area colonized agreed well with MPBSpread predictions under the ongoing "slow-the-spread" strategy. Area colonized by MPB was almost always lower under slow-the-spread than a "do nothing" scenario, and separation between the two scenarios increased over time such that by 2018, slow-the-spread reduced the area colonized to roughly 70% of that predicted to have occurred without control efforts. Area colonized was particularly sensitive to the efficacy of early detection and eradication, and the amount of level 1 control (single tree treatments), but not level 2 control (clear cut harvesting).

Biographical Sketch

Allan is a Professor of Insect Ecology, and Director of the Forest Sciences Program in the Department of Forest and Conservations Sciences of 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 16 years has been on the population dynamics, impacts and management of the mountain pine beetle.



Population state-dependent invasion potential of the mountain pine beetle in Alberta

Dr. Jordan Lewis Burke[1], Richard Hamelin[2] and Allan Carroll[3],

1Postdoctoral Research and Teaching Fellow, 2Professor, Forest Pathology, 3Professor and Director, Forest Sciences Undergraduate Program, Faculty of Forestry, Dept of Forest and Conservations Sciences, University of British Columbia, Vancouver BC

Abstract

Global climate change has led to the migration of many taxa beyond their historic range. In North American forests, bark beetles have proven particularly destructive, with some species expanding their range into previously unavailable forests. The mountain pine beetle (Dendroctonus ponderosae) is of most concern, as it has expanded well beyond historic limits and outbreaks have destroyed millions of hectares of pine forests in the west. Mountain pine beetles are now found in the boreal forest of Alberta, Canada, infesting the novel host jack pine (Pinus banksiana). Evidence suggests that high-density outbreak populations of the beetle should perform better in jack pines. However, widespread outbreaks have not been observed. Here, we conducted a field experiment to examine the role of competition in mountain pine beetle endemic population-phase conditions throughout the current range in western Canada. Mortality was induced in lodgepole pine (P. contorta latifolia) and jack pine trees, and woodboring beetle (Coleoptera: Cerambycidae and Buprestidae) and subcortical fungi activity was measured. Jack pines were found to be attacked and colonized at a greater rate and magnitude, and earlier in the mortality process. We conclude that the invasion potential of mountain pine beetle in jack pine is context-dependent, and sub-outbreak populations are unlikely to persist long-term due to a lack of coevolution with these competitors.

Biographical Sketch

Dr. Burke is a postdoctoral Research and Teaching Fellow at UBC, in the Forest Insect Disturbance Ecology Laboratory under the direction of Dr. Allan Carroll. He completed a BSc in Entomology and an MSc in Forestry at the University of Georgia in the United States, and a PhD in forestry from UBC with Dr. Carroll. His research has focused on the ecology and evolution of forest insects and their interactions with host trees, microbial symbionts, competitors, and climate change. He also teaches classes in Forest Health at UBC. Recently, he has worked on the expansion of mountain pine beetles into novel habitats in Alberta, and the consequences of this migration on the microbial symbionts which the beetle carries with it.

MPB Winter Survival: How low can they go?

Dr. Katherine Bleiker, Research Scientist, Pacific Forestry Centre, Canadian Forest Service, Natural Resources Canada, Victoria, BC

Abstract

Given the presence of a suitable food source, temperature likely has the largest overall impact on mountain pine beetle's (MPB) distribution and population dynamics. Winter is usually the largest single source of mortality even in benign climates like southern British Columbia. Weather during the growing season affects development and MPB needs to maintain an adaptive seasonality – a synchronous one-year life cycle with the most hardy life stage entering winter – to be successful. This presentation reports the results of research on MPB cold tolerance and seasonality (developmental regulation) and what it means for MPB spread east in Canada. The ultimate goal of the research is to improve predictions of annual population trends based on annual weather; and provide the necessary empirical data to improve climatic suitability and spread models to identify areas regions at risk and the potential for eastward spread in Canada.

Biographical Sketch

After earning a BSc from the University of Victoria, Kathy worked with the BC Forest Service and then as a forest health consultant for a number of years before returning to school to earn a MSc in Natural Resource Management from the University of Northern British Columbia and a PhD in Forestry from the University of Montana. Kathy is also a Registered Professional Forester in BC. She has been a Research Scientist in Bark Beetle Biology and Ecology with the Canadian Forest Service, Pacific Forestry Centre, Victoria, BC since 2010.

Rehabilitation of beetle-killed stands by improving pine seedling performance with mycorrhizal fungi

Dr. Justine Karst[1] and Nadir Erbilgin[2], University of Alberta,

1Assistant Professor, Restoration Ecology and 2Professor, Chemical Ecology and Entomology, University of Alberta, Department of Renewable Resources, Edmonton

Abstract

Ectomycorrhizal fungi are critical for pine survival and performance, and species of fungi vary in benefits conferred to host trees. Our previous research demonstrates that fungal communities in soils change following beetle-induced tree mortality, with consequences for pine seedling survival and performance. While novel, this previous research had several limitations: 1) it covered a limited spatial scale, 2) it was correlative, and 3) it did not account for changes in fungal communities due to disturbance *per se*. Our next stage of research addresses these limitations to inform strategies to triage beetle-killed stands for rehabilitation. Specifically, we investigate the response of fungal communities to beetle-induced tree mortality at a regional scale with considerable sampling depth and landscape coverage. Moreover, we experimentally test whether inoculation by mycorrhizal fungi differing in origin influences performance of seedlings planted into beetle-killed stands. And finally, we compare the community composition of fungi in beetle-killed stands to that found in response to disturbances typical in the boreal forest: fire and harvesting.

Biographical Sketch

Justine Karst is an Assistant Professor and NSERC Industrial Research Chair in restoration ecology at the University of Alberta. Justine studies linkages between above and belowground components of forests. Her interests include mycorrhizal ecology, community ecology, and disturbance ecology.

TRIA-Net

Introduction to TRIA-Net

Dr. Janice Cooke[1] and the TRIA-Net Consortium,

1 University of Alberta, Department of Biological Sciences, Edmonton, Alberta T6G 2E9

Abstract

Over the course of nearly 20 years, we have witnessed the spread of mountain pine beetle into regions where this devastating forest insect pest has not been documented in contemporary times. These novel habitats differ markedly from historic mountain pine beetle habitats. Decision support systems that rely on the ability to forecast risk of mountain pine beetle attack are a cornerstone of spread control programmes, but the efficacy of these tools is limited by our lack of understanding of how the differing conditions in these novel habitats might impact mountain pine beetle population dynamics. Over the last decade, members of the Tria consortium of researchers have undertaken novel molecular, genetic and ecological studies to shed new light on mountain pine beetle and the fungi that they carry, the pine hosts that they attack, and beetle-pine interactions in these novel habitats. Different aspects of these studies have been used directly or indirectly to develop several new models of mountain pine beetle spread risk and stand level risk. Researchers have also looked at economic and socioeconomic impacts of mountain pine beetle on communities, forests products and ecosystem services. Findings are provided in real time to stakeholders in Alberta and other jurisdictions, who have used these new insights to guide policy and management decisions.

Biographical Sketch

Janice Cooke is an Associate Professor in the Department of Biological Sciences at the University of Alberta. Janice received her BSc from the University of Victoria, and worked as a technician at the Weyerhaeuser Technology Centre before returning to school to complete her PhD at the University of Alberta. She went on to a postdoc at the University of Florida, and was a research associate at Université Laval before arriving at the University of Alberta in 2005. She has been involved in forest biology research for over 25 years. For the last 15 years, Janice has been using genomics technologies to better understand how trees respond to their environment. Currently, she is the director of the NSERC Strategic Network: TRIA-Net: Turning Risk Into Action for the Mountain Pine Beetle Epidemic. This broadly focused research initiative embraces universities from across the country and scientists and graduate students working in specific fields of research in support of managing and controlling mountain pine beetle. Outcomes of her genomic research are being explored for purposes of increasing the resistance of pines to future outbreaks of the beetle.

SPEAKERS

Theme 1: Chemical ecology of MPB, hosts, and symbionts - management implications

Dr. Dezene Huber, Associate Professor, University of Northern British Columbia, Ecosystem Science and Management, Prince George, BC

Abstract

Our TRIA-Net work and its predecessor project have now been funded for about ten years. During that time we have been able to investigate the genomics of the mountain pine beetle system – host, insect, and fungi – in substantial depth and detail. Our work has provided the first ever bark beetle genome. We have discovered new things about how the insect colonizes its hosts, how the hosts respond to the insect invasion, and how the insects survive and often thrive in the face of those defenses and a hostile environment. Above all we have had the opportunity to train a large number of talented new scientists. We now look forward to continuing our work in new ways, and to seeing how others – including many of our trainees – carry on this research both on the mountain pine beetle system and in other emerging areas of Canada's natural resources sector.

Biographical Sketch

Dr. Dezene Huber grew up in Calgary, Alberta and spent much of his free time exploring and fishing in the Bow River Valley. This exposure to wild spaces gave him an appreciation for the natural world and this is what perhaps led to his pursuit of a career as an entomologist and ecologist. Dr. Huber is a professor in the Ecosystem Science and Management Program at the University of Northern British Columbia in Prince George, BC. His research program is focussed on both basic and applied forest insect ecology. The work in his lab involves insects, plants, and the interactions between them. They use methods ranging from field ecology to genomics to tackle interesting questions.

He is the Editor-in-chief for The Canadian Entomologist as well as sitting as Chair of the British Columbia Council on Admissions and Transfer Biology Articulation Committee and the UNBC Biology Curriculum Committee. He also volunteers as an academic editor for PeerJ (https://peerj.com/) and as a subject editor for the Journal of the Entomological Society of British Columbia.

Theme 2: Population genomics of MPB, hosts, and symbionts – management implications

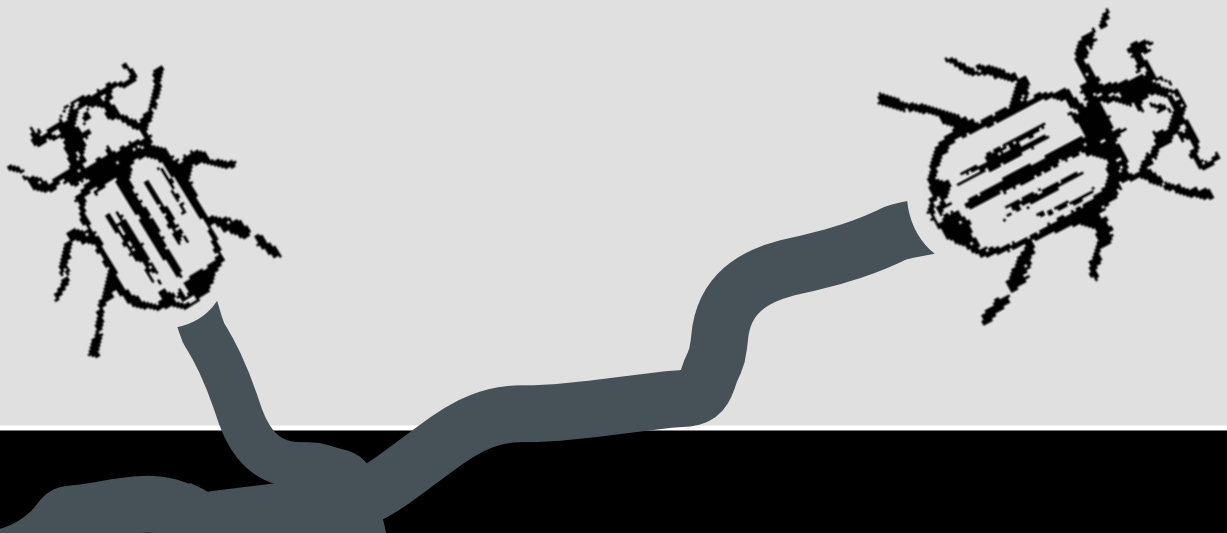
Dr. David Coltman, Professor & Associate Dean, Research Science Biological Sciences, University of Alberta, Edmonton, Alberta

Abstract

Population genomics – the use of high density genetic markers to compare populations - has revealed many new biological insights into the MPB system that may improve forestry management outcomes. We have shown that beetle, fungal and pine populations are genetically structured, show distinct signatures of spatial and environmental correlation, and gene by gene associations among taxa. These findings have two important management implications. First, as it suggests that populations are locally co-adapted, not all populations are biologically equivalent, particularly along outbreak expansion axes. Second, the spatial analysis of genetic signatures provides a better understanding of outbreak dynamics. For example, analysis of beetles in Jasper shows that they are a mixed stock of northern and southern genetic backgrounds. If outbreaks extend eastward from Jasper, we can now identify the origin of new outbreak populations and more precisely monitor outbreak dynamics. For a second example, we now have mapped the lodgepole and jack pine hybrid zone in Alberta, a potential bridge between outbreaking populations in lodgepole and the vast naïve jack pine range, at a much finer resolution. Our new hybrid map reveals a second potential bridge in the northern hybrid zone between lodgepole and jack pine in the Yukon and NWT.

Biographical Sketch

Dr. Coltman is a "molecular ecologist" – a scientist who uses molecular biological tools and population genetic approaches to study ecological questions. He has a broad range of research interests that span fundamental questions in ecology and evolution to more applied topics in wildlife conservation and management. His students and he have used genetics and genomics to study mating systems, kinship, heritability, population structure and phylogeography of many wildlife species that inhabit many regions of North America. This includes bighorn sheep, thinhorn sheep, mountain goats, wolves, red squirrels as well as the mountain pine beetle system (see https://scholar.google.ca/citations?user=3L1oVhgAAAAJ&hl=en).



Theme 3: Dynamics of mountain pine beetle populations in novel habitats: implications for management

Dr. Allan Carroll[1], Maya Evenden[2], Nadir Erbilgin[3] and Mark Lewis[4],

1Department of Forest and Conservation Sciences, The University of British Columbia, Vancouver, 2Department of Biological Sciences, 3Department of Renewable Resources, -4Department of Mathematical and Statistical Sciences, University of Alberta, Edmonton

Abstract

Within its native range, the eruptive population dynamics of the mountain pine beetle (MPB) are a result of its complex interactions with a distinct suite of density-dependent and density-independent agents. The potential for MPB to erupt and spread in recently invaded pine forests east of the Rocky Mountains is unknown. This presentation will summarize the results of a five-year-long investigation initiated to determine (i) if MPB can exist in the endemic phase in novel pine habitats, and if so, what density of beetles is required to transition to the epidemic phase, and (ii) how dispersal/spread of epidemic MPB in novel habitats is affected by population state, invasion status, and host-tree conditions. Implications to management efforts intended to minimize MPB impacts and spread will be discussed.

Biographical Sketch

See Dr. Allan Carroll's biographical sketch on page 18

Theme 4: Consequences of mountain pine beetle outbreak on forest ecosystem services and landscape resilience

Dr. Lael Parrott[1] and Amalesh Dhar[2] Matt Bass[3], Rodolphe Gonzales[4],

1 Professor in Sustainability at the I.K. Barber School of Arts and Sciences and Director of the Okanagan Institute for Biodiversity, Resilience and Ecosystem Services (BRAES), 2 Research Associate, Department of Renewable Resources, University of Alberta, 3 Ph.D. Student, University of British Columbia, Okanagan Campus, 4 Research Associate, L'Université de Montréal, Quebec

Abstract

Ensuring ecologically resilient future forests requires a management approach that maintains the ability of the landscape to provide a range of ecosystem services upon which human communities depend for their livelihoods and well-being. Research in Theme 4 of the TRIA Network has explored the ecological and social impacts and responses to mountain pine beetle (MPB) outbreaks. While management responses to mountain pine beetle (MPB) outbreaks have typically addressed impacts on timber supply, the potential landscape-scale impacts extend beyond this single ecosystem service. We describe the range of consequences that MPB can have on forest ecosystem services and discuss how management approaches might take these into consideration.

Biographical Sketch

Dr. Lael Parrott (PhD, Agricultural and Biosystems Engineering, McGill University) is a Professor in Sustainability and Director of the Okanagan Institute for Biodiversity, Resilience and Ecosystem Services (BRAES) at The University of British Columbia. She is cross-appointed in the Departments of Earth, Environmental and Geographic Sciences and Biology on UBC's Okanagan Campus. Dr. Parrott leads an internationally recognized research program in modelling and characterising contemporary regional landscapes and ecosystems as complex human-environment systems.

Photo Credit: Town of Hinton

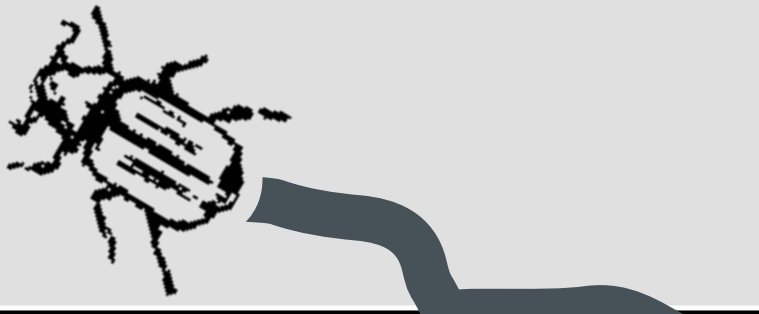
2018 Forest Forum

Alberta's Forests Under Threat: *a call for action*

Maple Leaf Room, Lister Conference Centre, University of Alberta

Day 2 Wednesday, April 25, 2018

Time		Speaker
7:15–8:15	BREAKFAST	
8:15–8:30	Threats from changing conditions - The goal for the day will be to examine risks to our forest and aspects of forest biology, policy and management that will mitigate risks.	Moderator: Dr. Vic Lieffers
8:30–9:15	Key Note Address Managing risk in forest management: Challenges and Policy impediments	Dr. Marty Luckert, Professor, Resource Economics and Environmental Sociology, University of Alberta
9:15–10:00	Are forests threatened? Or are forests evolving in sync with broader, global shifts in climate? Forest Policy: innovative policy to mitigate an uncertain future	Darren Tapp, Executive Director, Forest Management Branch, Alberta Agriculture and Forestry Brian Makowecki, Executive Director, Planning Branch, Alberta Environment and Parks
10:00–10:30	HEALTH BREAK	
	Introduction - Conditions are changing and so must our management – This group of speakers will lay out ideas as to how forest management might be changed to mitigate risks associated with changing conditions	Moderator: Dr. Vic Lieffers
10:30–11:00	Innovation: What drives it? Implementing silviculture strategies to adapt to future climate uncertainty	Andy Shandro, Provincial Silviculture Specialist, and Lee Martens, Forest Reforestation Specialist Forest Program Management Section, Alberta Agriculture and Forestry
11:00–11:30	Ecosite transitions and genetics	Dr. Andreas Hamann, Associate Chair, Department of Renewable Resources, Graduate Programs University of Alberta
11:30–12:00	Genomics and its applications to support forest sustainability	Dr. Janice Cooke, Associate Professor, Department of Biological Sciences, University of Alberta
12:00–1:00	LUNCH	



AGENDA – DAY 2

1:00–1:20	Emerging forest insect threats in Canada: looking beyond mountain pine beetles to what might come next.	Dr. Jordan Lewis Burke, Post-Doctoral Research and Teaching Fellow, Department of Forest and Conservation Sciences, Forest Sciences Undergraduate Program, University of British Columbia
1:20–1:40	How healthy are Alberta's forest landscapes?	Dr. David Andison, Program Lead, Healthy Landscapes Program, fRI Research
1:40–2:00	Social barriers to change: solutions	Dr. Debra Davidson, Professor, Resource Economics and Environmental Sociology, University of Alberta
2:00–2:20	DISCUSSION	Dr. Vic Lieffers
2:20–2:45	HEALTH BREAK	
2:45–4:30	INTRODUCTION TO PANEL - this group of managers, policy makers, and community leaders will describe their respective approaches in Managing Risk to Achieve a Sustainable Future	Moderator: Dr. Vic Lieffers
	INDUSTRY Gord Whitmore, Land Management Superintendent, Daishowa - Marubeni International Ltd., Peace River Pulp Div. Dr. Doug Turner, Forestry Planner, West Fraser Mills Ltd., Sundre Forest Products GOVERNMENT OF ALBERTA Ronda Goulden Assistant Deputy Minister, Environment and Parks, Policy and Planning Division GOVERNMENT OF CANADA Michael Norton, Director General, NRCan, Canadian Forest Service, Northern Forestry Centre COMMUNITY Marcel Michaels, Mayor, Town of Hinton Tom Burton, Board Member and Director of District 4 – Northern, Alberta Association of Municipal Districts and Counties	
4:30–4:45	Concluding discussion and comments	Dr. Vic Lieffers, Dr. Keith McClain
4:45–7:00	TRIA-NET CROSSOVER MIXER	Dr. Janice Cooke

Managing Risk in Forest Management: Challenges and Policy Impediments

Dr. M.K. (Marty) Luckert, Professor of Forest and Natural Resource, Economics and Policy, Department of Resource Economics and Environmental Sociology (REES), University of Alberta, Edmonton, Alberta

Abstract

Though foresters in Canada have historically engaged in long-term planning, such practices have generally not been sophisticated in dealing with uncertainty. Changes in climate and other trends affecting the forest industry, and their potential importance to future forests and their management, suggest new approaches could be considered for dealing with arising uncertainty. But there are a number of forest policies that constrain forest planning and management responses. Though such policies have historically been designed to enhance sustainability, they could actually stand in the way of such objectives in the context of current changes. Potential changes to these policies could improve our ability to alter forest planning and management practices to adapt to climate change.

Biographical Sketch

M.K. (Marty) Luckert is Professor of Forest and Natural Resource, Economics and Policy in the Department of Resource Economics and Environmental Sociology (REES) at the University of Alberta. His research has largely been split between studying livelihoods and development, and domestic forest policy in Canada. Recent interests also include economic dimensions of biofuels and chronic wasting disease. He has been involved with numerous research teams and policy making processes in Canada and abroad.

Threats from changing conditions

Are forests threatened? Or are forests evolving in sync with broader, global shifts in climate?

Darren Tapp, RPF, Executive Director, Forest Management Branch, Alberta Agriculture and Forestry, Edmonton, Alberta

Abstract

Clearly there are challenges from a management perspective. There are areas of the province that are warmer and drier then they have been at any time in the province's history while, simultaneously, other areas are experiencing cooler, wetter conditions.

Furthermore, human activities have significantly altered the profile of our forested landscapes. Alberta has been highly successful for more than six decades in suppressing wildfire. That good work has resulted in a disruption in the natural disturbance cycle that has shaped our forests for thousands of years. Today the average age class distribution is older than at any time in Alberta's history.

These two factors have resulted in an elevated risk to our forests both from catastrophic wildfires to heightened susceptibility to forest pests including the mountain pine beetle. Managing for these variables is challenging as a stand-alone task; and is increasingly difficult given the growing complexity of integrating industrial, recreational, ecological and Indigenous Peoples concerns.

In addressing these changes from a forestry perspective it is clear that policy development is an important tool; but one that has to rooted in sound science and linked to strong operational practices, including enforcement, to ensure the desired future forest we all seek continues to be a cornerstone of our province.

Biographical Sketch

Darren's roots are in the prairies having grown up on a farm near Biggar, Saskatchewan. The passion for trees got the best of him and he later enrolled in the NAIT Forest Technology program to pursue his interests. Darren started working for the Alberta Forest Service in 1985 doing planting checks. Perhaps his skills at shooting prairie chickens served him well as he stayed employed by shooting scions from trees for the Superior Tree Selection program over the winter and also worked as a Forest Officer in High Level and Fort Assiniboine. He later went back to school to acquire a BSc in Forest Management and worked as a timber supply analyst in Whitecourt. He later returned to school earned an MBA and a Master of Forestry. Darren worked in the Forestry Industry Branch on forest tenures and FMA renewals. In 2011 Darren became the Executive Director of Forest Management Branch and is supported by outstanding staff.

Forest Policy: Innovative forest policy to mitigate an uncertain future

Brian Makowecki, Executive Director, Planning Branch, Alberta Environment and Parks, Edmonton, Alberta

Abstract

Forests are an important natural resource for our province. They provide economic and environmental benefits, in addition to being a source of recreation for residents and visitors. To manage the impact of competing land-use demands and monitor our natural resources in a dynamic and changing environment, the Government of Alberta adopted an integrated and coordinated approach to regional planning under the Land Use Framework. The approach considers policy, planning outcomes, delivery, and monitoring as a system that can be applied at the provincial, regional, and sub-regional level. This presentation explores this system particularly in regional and sub-regional planning and how these approaches are used to respond to current and future pressures, manage for cumulative effects, and ensure sustainable use of land and resources for present and future generations.

Biographical Sketch

Brian was born and raised on a family farm in NE Alberta. He has a Biology degree and has worked in the natural resource management field for 20 years. He has worked on fish and fish habitat management and environmental assessments of variety of industrial projects, working as a consultant on fish assessments in B.C. and Alberta, with Alberta Fisheries Management in North East Alberta, and for more than a decade with Fisheries and Oceans Canada with significant work on Oil Sands projects. Since rejoining the Alberta government five years ago, Brian has worked in a number of positions with the Alberta Government, primarily focusing on biodiversity and ecosystem services policy, and natural resource planning.

INNOVATIVE FOREST MANAGEMENT

Innovation: What Drives it?

Andy Shandro, RPF, Provincial Silviculture Specialist, Forestry Division, Alberta Agriculture and Forestry, Edmonton, Alberta

Abstract

The need to improve or to change can drive innovation. This presentation will discuss what influences the need for innovation and some future scenarios that may require innovation. A look at some of the applications of Lidar will also be discussed.

Biographical Sketch

Andy Shandro got his Bachelor of Science Degree from the University of Alberta in 1997. He has worked in the Woodlands department of Sawmills and in the Forest Operations group of a large Utility Company. In late 2017 he joined the Government of Alberta in the Forest Program Management Section as a Silviculture Specialist.

Implementing silviculture strategies to adapt to future climate uncertainty

Lee Martens, MSc RPF, Reforestation Specialist, Alberta Agriculture and Forestry, Forest Management Branch, Edmonton, Alberta

Abstract

If the objective is to meet desired future forest conditions, then how does the silviculturist confront the challenge of establishing stands in today's climate? The real challenge is to ensure that forest remain healthy and productive as we face uncertainly with regard to climate well into the future? Responding to this uncertainty, developing, implementing and monitoring silviculture adaptation strategies will be key. Silviculture adaptation strategies include resistance, resilience and response (transition) options. However, there are very few analogs of on-the-ground applications of silviculture adaptation strategies, especially in Alberta and at spatial scales relevant to silviculturists. The Southern Alberta Silviculture Adaptation Project (S-ASAP) is a watershed scale semi-operational experiment located at Star Creek. The objective of S-ASAP is to provide process-based research and on-the-ground examples of silviculture adaptation to climate change strategies. We will compare key variables (composition, productivity, health, climate) among the three adaptation strategies of resistance, resilience, and response.

Biographical Sketch

Lee Martens, RPF, is a Reforestation Specialist with Alberta Agriculture and Forestry. He holds a Master of Science in Forest Ecology and Management from the University of Alberta with specialization in silviculture. He is an applied forest ecologist at heart. Lee's interest in forests began as a kid traipsing around the Black forest in Germany. He has worked for a number of organizations including Weyerhaeuser Company Ltd., the University of Alberta, and the Canadian Forest Service. With the Government of Alberta, he leads the development and implementation of reforestation standards.

Assisted migration in reforestation: habitat transitions and genetics

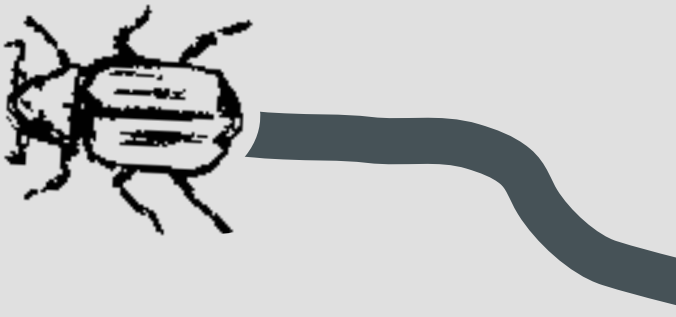
Dr. Andreas Hamann, Professor, Department of Renewable Resources, University of Alberta, Edmonton, Alberta

Abstract

How reliably can we guide assisted migration of forestry species through seed use guidelines in commercial reforestation programs? Such management interventions tend to entail the risks of unintended consequences, and several conditions should be met before implementing assisted migration to address climate change. We bring together results from genetic field trials, remote sensing, tree ring research, and landscape ecology to develop assisted migration prescriptions for western North America. Our intention is to develop more dependable guidelines by synthesizing information from a variety of experimental and empirical data from long-term field trials and historical ecology approaches.

Biographical Sketch

Andreas Hamann's primary field of research is global change biology and ecological genetics of forest trees. He has a MSc from the State University of New York, College of Environmental Science and Forestry, Syracuse and a PhD from the University of British Columbia. Dr. Hamann joined the University of Alberta, Department of Renewable Resources in 2005, where he currently is Professor and Associate Chair of Graduate Programs. Andreas received an Alexander von Humboldt Fellowship in 2011 for collaborative research with the University of Freiburg and received a Fulbright Fellowship in 2012 for collaborative research with the University of California, Berkeley. He has also received a Sir Frederick McMasters Fellowship in 2013 for collaborative research with CSIRO in Canberra, Australia.



Genomics and its applications to support forest sustainability

Dr. Janice Cooke[1], David Coltman[1], Catherine Cullingham[1], Richard Hamelin[2], Nathalie Isabel[3], Patrick Lenz[3], Chandra McAllister[1], Rhiannon Peery[1], Bianca Sacchi[1], Kate St. Onge[1]

1 University of Alberta, Department of Biological Sciences, Edmonton AB T6G 2E9, 2 University of British Columbia, Department of Forest and Conservation Sciences, Vancouver, BC V6T 1Z4, 3 Natural Resources Canada, Canadian Forest Service, Laurentian Forestry Centre, Quebec QC G1V 4C7

Abstract

The first genomic resources for forest trees were developed a little more than 20 years ago. Today, genomic resources have been generated for many of western Canada's economically and ecologically important forest tree species. These resources are being used by a number of research groups to investigate a wide array of questions related to forest resiliency and the sustainability of our forest resources. Importantly, with the maturation of genomics as a science and decreasing costs of using genomic resources, it is becoming increasingly feasible to develop practical genomic tools and applications that can be used to address key issues that impact forest sustainability. A number of examples will be presented from different research groups that illustrate recent application of genomics to pest risk assessment, tree improvement, traceability of genetic stock, diagnostics for insects and diseases, and reclamation. Emerging areas where genomic technologies could be applied to address forest sustainability will also be discussed.

Biographical Sketch

See Dr. Janice Cooke's biographical sketch on page 20

Emerging forest insect threats in Canada: looking beyond mountain pine beetles to what might come next

Dr. Jordan Lewis Burke, Postdoctoral Research and Teaching Fellow, Faculty of Forestry, Dept of Forest and Conservations Sciences, University of British Columbia, Vancouver BC

Abstract

While the threat of mountain pine beetle migration still stands, there are emerging threats from insect pests that are expanding into territory perilously close to the borders of the eastern provinces, as well as those expanding their range and impact in the west. Some of these insects potentially pose a bigger threat to the forest industry than MPB, and we must apply the lessons learned from the MPB situation in BC and Alberta. The most important factor if mitigation efforts are to succeed is early detection and rapid response. This is a difficult thing to accomplish, as often damage to trees might be conspicuous in the first and second year of attack. That means that predictions, based on models and field experiments, are critical to the effort, allowing practitioners to have some idea of where to look. Here, I will present information on insects we consider to be of concern, and some strategies learned from MPB that might aid in efforts to control them.

Biographical Sketch

See Dr. Jordan Burke's biographical sketch on page 19

SPEAKERS

How healthy are Alberta's forest landscapes?

Dr. David Andison, Program Lead, Healthy Landscapes Program, fRI, and Consultant, Bandaloop Ecosystem Services Ltd., Vancouver, BC

Abstract

Threats to forests and landscapes come in many different forms. The most obvious are disturbances such as fires, floods and even MPB that have relatively sudden impacts that tend to demand most of our attention. But over the longer term, Alberta's forested landscapes are slowly changing. Taken as a package, the various forms of human activity are decreasing diversity at both the landscape and stand scales, increasing risk to natural disturbance, and reducing, or even eliminating entire habitat types. Although slow and not particularly dramatic, most of Alberta's forests are well into unfamiliar territory. The real danger is that because change is slow, we tend to not consider it a real threat that requires our immediate attention. The challenge is that by the time it becomes a more noticeable problem - or, more likely when it negatively impacts one or more of our goods and services - the time for effective mitigation may be past. I will use some meta-analyses from our new LandWeb model to demonstrate both actual and potential dangers.

Biographical Sketch

Dr. Andison graduated from the University of Toronto and worked for eight years for the Ministry of Natural Resources in the areas of forest fire science and growth and yield. In 1996 Dave received his PhD from the University of British Columbia (UBC) in landscape ecology and since then he has been the owner-operator of Bandaloop Landscape Ecosystem Services, specializing in wildfire research, ecosystem based management integration, criteria and indicators, modelling, and decision-support tools. Dave is also an Adjunct Professor of Forest Management at UBC where he works with collaborators and grad students.

In his role as program lead for the Healthy Landscapes Program at fRI, Dr. Andison promotes the application of alternative thinking about future forests based on ecosystem-based principles and use of creative landscape decision support tools.

Social barriers to change: solutions

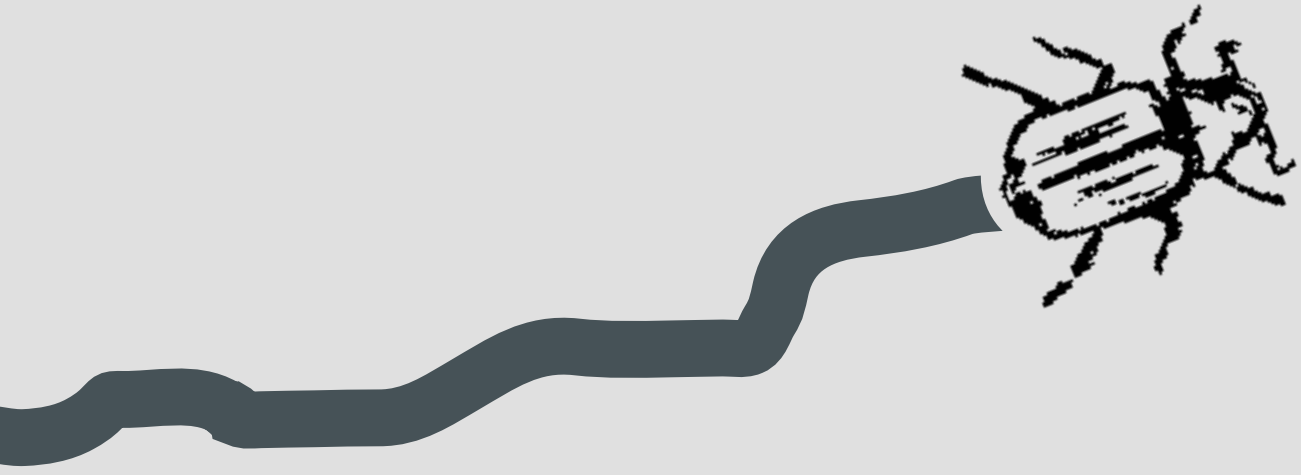
Dr. Debra J. Davidson, Professor, Environmental Sociology, Department of Resource Economics and Environmental Sociology, University of Alberta, Edmonton, Alberta

Abstract

In this presentation Dr. Davidson will provide an overview of the social factors that influence forest management practices, and efforts to change those practices in response to threats. Such factors include political-economic and cultural drivers that affect both the perception of threat, and the perceived appropriateness of response options. Findings from recent research projects in British Columbia and Alberta regarding climate change impacts and adaptation in the forest sector will be shared. The presentation will conclude with a discussion of strategies to pursue more effective policy responses to threat, with a particular focus on communication across science, policy and publics.

Biographical Sketch

Dr. Davidson has an extensive record of research focused on the impacts of natural resource development and social responses to climate change. Recent activities include co-editorship of the Oxford Handbook on Energy and Society, to be published in August 2018, Lead Author on Working Group II of the Intergovernmental Panel for Climate Change, Assessment Report 5, and a current Killam-funded research project on the social impacts of fracking. Her work has been featured in two books and several journal articles including in Science; Global Environmental Change; Social Problems; and Society and Natural Resources.



Managing Risk to Achieve a Sustainable Future

Industry

Gordon Whitmore, RPF, Superintendent Land Management, Daishowa-Marubeni International Ltd., Peace River, Alberta

Abstract

Significant disturbances from mountain pine beetle, spruce budworm and fire are situations that the forest industry is accustomed to dealing with in Canada. Working together with government, our industry has shown itself to be very adept at quickly assessing the level and extent of these events and implementing strategies that mitigate their immediate effects while also minimizing their long-term impacts to maintain sustainability of the forest values. However, in consideration of anticipated future states resulting from climate change and the potential for increases in the level of disturbances, the integration of strategies to manage these risks may be warranted.

While there is merit in a cautious approach to the incorporation of projections of the future into forest policy and planning as a means to manage risk, this methodology does not always balance the risks associated with what may be inappropriate management from leaving it out of the equation. In the case of climate change, one of the challenges is to develop strategies that can be successfully implemented prior to the change. Gordon will present strategies that DMI has implemented on its FMAs for short-term mitigation of disturbances, management strategies being used to provide increased adaptive capacity of the forest and opportunities and needs that his company sees for the development of long-term mitigation strategies.

Biographical Sketch

Gordon leads the Land Management group at Daishowa-Marubeni International Ltd's - Peace River Pulp Division where as part of Woodlands, he and his team are focused on developing strategies and feasible, socially acceptable solutions for sustainable forest management and ecosystem services through research, innovation and analysis. Gord obtained his Bachelor's and Master's of Science degrees in forest management from Lakehead University and is a member of the College of Alberta Professional Foresters. Gord's career in forestry has provided him with experience across the country in a variety of capacities including forestry operations, reforestation, research and innovation, policy, carbon offsets, ILM, sustainable forest management and ecosystem services.

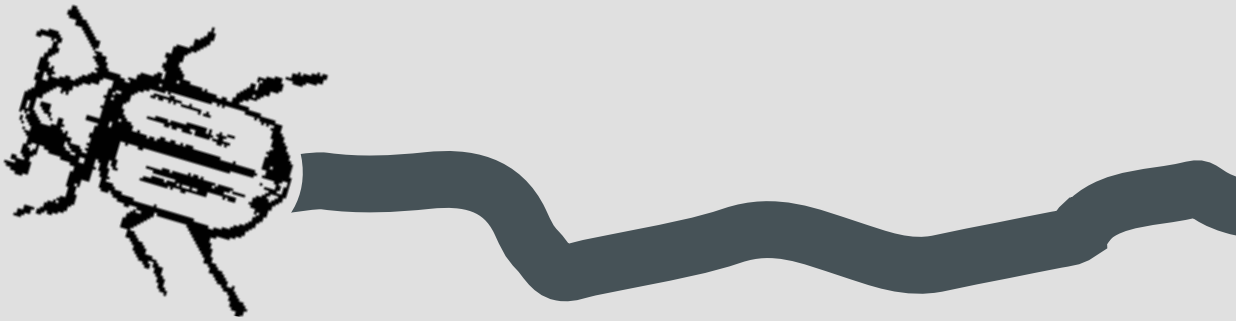
Dr. Doug Turner, Forestry Planner, West Fraser Mills Ltd., Sundre Forest Products, Sundre, Alberta

Abstract

Not available

Biographical Sketch

Originally from the United Kingdom, Doug has been living and working in North America since 1996. During his career, Doug has worked or studied in the UK, Scandinavia, Europe, BC (five years chasing Mountain Pine Beetle around the Cariboo-Chilcotin), Alberta, Saskatchewan, Ontario, the Maritimes, and the US Pacific Northwest (amongst others), and has worked for the forest industry, provincial and federal government, in academia and in research. Doug currently lives in Sundre, Alberta, where he works as a planner for West Fraser's Sundre Forest Products division, his role there including FMP and FHP development, and incorporation of NRV approaches into forest management. Prior to joining West Fraser, Doug worked for the Saskatchewan Ministry of Environment as the Forest Service Branch Science Network Coordinator, where his duties included: implementation of NRV based EBM in the boreal forest; incorporation of NRV based EBM into the Saskatchewan Environmental Code; Saskatchewan representative with the fRI Research Healthy Landscapes Program; supporting boreal woodland caribou recovery strategy development; and provision of scientific knowledge in support of policy development. Doug obtained a PhD from the University of New Brunswick in 2011, a MSc from the University of Idaho in 2004, a BSc (Honours) from the University of Central Lancashire in 1995, and a Tech Diploma from the National School of Forestry in 1993. Doug is an RPF with the ABCPF, and a transferring RPF with the AAFMP.



SPEAKERS

Government of Alberta

Ronda Goulden Assistant Deputy Minister, Environment and Parks, Policy and Planning Division, Edmonton, Alberta

Abstract

Alberta is a province that has immense potential for resource development. Against its unique and beautiful landscape managers face significant challenges for its management. It is often said that decisions can be made with any amount of information as long as one is able to bear the risk. Fortunately, Alberta has planning constructs in pace to ensure a systems approach is taken to all levels of resource decision making to mitigate risk. Such constructs include an Integrated Land Use Management System, the Land Use Framework and Species at Risk Planning among others. Critical to each and all systems employed for managing Alberta's resources, constant monitoring and adjustment are required to ensure we remain on track toward a sustainable future.

Biographical Sketch

Ronda began her career in the Alberta Public Service in 1997 when she articled with Alberta Justice after completing her law degree at the University of Alberta. She moved into law from science where she had won the gold medal in chemistry in 1993 and published a number of scientific articles about DNA sequencing both at the University and the RCMP Crime Lab.

Ronda spent 15 years as a family law lawyer with the Government of Alberta where she represented such government programs as the Maintenance Enforcement Program, the Child Support Services program and Children's Services in court. She then began what became a four year journey in executive management education, including time at the Policy Coordination Office, Executive Director of Policy on the Flood Recovery Task Force, Chief of Staff to Deputy Minister Andre Corbould, Executive Director of Cabinet Coordination and most recently, ADM of Government Operations at Executive Council.

In addition to her BSc and LLB, Ronda holds a Certificate in Conflict Resolution (Mediation and Negotiation) from what was the Alberta Arbitration and Mediation Society. She is also a certified executive coach at the Associate Certified Coach (ACC) level with training from Royal Roads University.

Government of Canada

Mike Norton, Director General, Natural Resources Canada, Canadian Forestry Service, Northern Forestry Service, Edmonton, Alberta

Abstract

Many of the threats faced by Canada's forests are linked to a changing climate. The Canadian Forest Service recently completed a national integrated assessment of the impacts of climate change on forests in Canada. Highlights from that study will be presented to provide a broader context around some of the risks seen in Alberta, such as fire, drought, and pests. National strategies will be described that are designed to mitigate risks or adapt to a changing future. Linkages to forest management in Alberta will be discussed to illustrate specific examples where national level considerations and strategies impact provincial, regional and local issues.

Biographical Sketch

Mike Norton joined Natural Resources Canada in July 2014 as the Director General of the Northern Forestry Centre (NFC), located in Edmonton, Alberta. NFC is a research centre comprising over 100 employees, with particular strengths in wildland fire, forest health, land reclamation, and climate change. Through extensive partnerships with the public, private and academic sectors, NFC supports the sustainable management of forests as a foundation for a vibrant industry. Mike also holds national leadership roles related to wildland fire.

Prior to joining NRCan, Mike was Regional Director, Environmental Services and Contaminated Sites with Public Works and Government Services Canada (2013-2014), where he led a major program remediating contaminated sites across Canada's north and providing other environmental services to federal government departments. Previously, Mike held the position of Associate Regional Director General with Environment Canada (2011-2013). In that role he provided senior leadership and advice on high profile regional issues, managed stakeholder relations, and led several interjurisdictional initiatives on water in addition to senior corporate roles. He started his federal public service career with Environment Canada in 2000.

Mike has a BSc from the University of Guelph and a MSc from the University of Alberta. He lives in Edmonton, and is married with two girls in elementary school.

Community

Mayor Marcel Michaels, Town of Hinton, Alberta

Abstract

I have made my home in the Town of Hinton, a vibrant community that is defined by impressive natural surroundings and wonderful people. I am honoured to represent Hintonites as the Mayor of Hinton, and in this case, to represent their growing concern as the mountain pine beetle invades our forests. Our natural, rugged landscape defines this region, and it has been devastating to watch these pests invade our trees and wreak havoc on our scenery, our citizens, and our industry. Controlling the invasion has been one of Town Council's top priorities, and I am proud to chair the Council-appointed Hinton Mountain Pine Beetle Advisory Committee. Over the past few months, our Committee has been bringing together community and industry leaders, citizens, and mountain pine beetle experts to tackle this daunting issue as we strive to mitigate the effects of the mountain pine beetle by working together to build awareness, obtain resources, and ensure a safe and sustainable future for the place we call home.

Biographical Sketch

In 2011, Mayor Marcel Michaels asked himself a question: "Where do I see my life?" His answer was the Canadian Rockies. Marcel found a media job in the region, and saw a new opportunity in the 2013 municipal election. Marcel was successfully elected to Council in 2013, completing his four year term before being elected Mayor in 2017.

Tom Burton, Board Member and Director of District 4 – Northern, Alberta Association of Municipal Districts and Counties, Debolt, Alberta

Abstract

As a member of the numerous organizations, Tom participates in decision making that affects the viability of municipalities. A municipal perspective will be given describing the challenges communities face with emphasis maintaining healthy forests. Particular concerns to forests include fire, disease, insects, and in some cases policy (e.g. Species at Risk Act). Social aspects to communities resulting from these challenges will be highlighted.

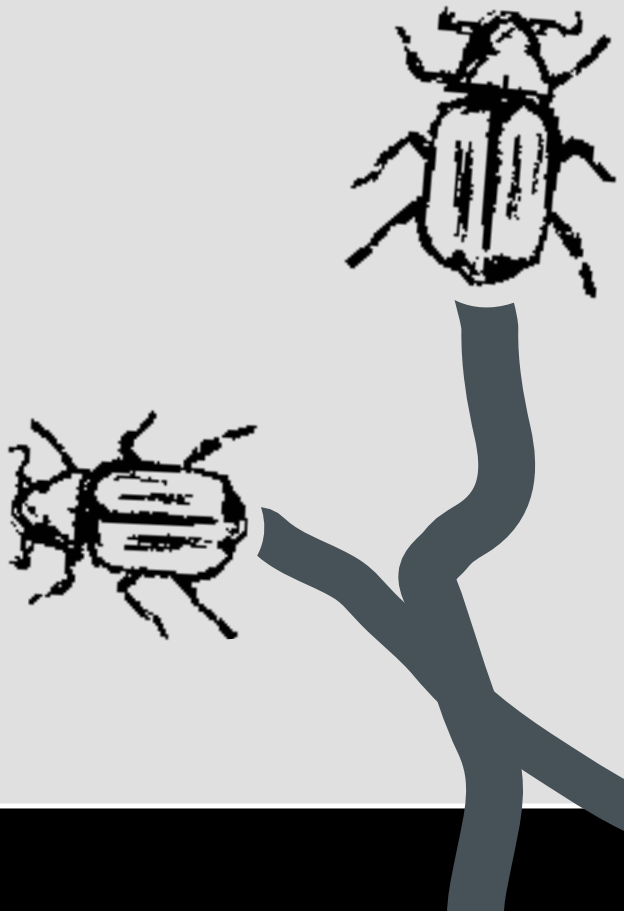
Biographical Sketch

Tom Burton a resident of the Hamlet of DeBolt, was first elected in 2001 to the Municipal District of Greenview, as Ward 6 councillor, a position that he still holds.

During the 2008 Fall Centennial Convention of the Alberta Association of Municipal Districts and Counties, Tom was elected as the Director for the Northern District. A territory from the Municipal District of Greenview, Big Lakes County, Municipal District of Opportunity and the Regional Municipality of Wood Buffalo, then north to all three provincial borders.

Tom joined the DeBolt Fire & Rescue in 1993 as a member, and became the Chief in 1995, a position still being retained today. In 2001 Tom became an Emergency Medical Responder, still practicing today.

Some of Tom's past occupations include surveyor, owner/operator of a trucking company, owner/operator of a service station/restaurant, heavy equipment operator, also a General Manager of an Agricultural Society that operates a Curling Rink, Golf Course, Community Hall and Fair/Sports Day.



Metabolomic variation of larval cold-acclimation in *Dendroctonus ponderosae* Hopkins (Coleoptera: Curculionidae)

Dr. Philip Batista, , P.D.[1], Bleiker K.P.[2] Huber D.P.W.[1]

1 Ecosystem Science and Management Program, University of Northern British Columbia, Prince George, British Columbia, Canada V2N 4Z9

2 Canadian Forest Service, Natural Resources Canada, 506 West Burnside Road, Victoria, British Columbia, Canada V8Z 1M5

Abstract

Mountain pine beetle (MPB) infestation and salvage logging (or increased cut levels) within British Columbia and Alberta's lodgepole pine forests creates a landscape composed of a patchwork of alive, dead (grey-attack) and clearcut forest stands. Subsequent impacts on runoff generation are a function of the proportion of landscape covered by each stand type, but basic information on variations in water cycling between stand types is still needed. In this study, pre-treatment (2008-2009) and post-treatment (2015-2016) hydrometeorological data were collected in the Upper Foothills near Robb, Alberta within four stand types – healthy control, simulated moderate grey-attack (48%), simulated high intensity grey-attack (82%), and salvage harvest. Preliminary results indicate that relative to healthy stands, canopies within the moderate and high intensity grey-attack stands intercepted 26% and 44% less growing season precipitation, respectively. Soil volumetric water content within the grey-attack stands (0-70 cm below surface) has significantly increased during the growing season. Volumetric water content below the root zone increased 11% and 14% in the moderate and high intensity grey-attack stands, respectively. These data will be used to calculate vertical stand water balances. The results will provide key process information for modelling studies to examine the effect of these changes on runoff generation in the Foothills at the watershed scale.

Biographical Sketch

Dr. Philip Batista first joined TRIA-net in 2014 as a postdoctoral fellow working in Dr. Felix Speling's lab at the University of Alberta. His work focused on resolving the population structure of mountain pine beetle (MPB) using adaptive and neutral markers. In 2015 Dr. Batista moved to University of Northern British Columbia to begin a new postdoctoral fellowship with TRIA-net with Dr. Dezene Huber in the Ecosystem Science and Management Program, examining the potentially functional genetic variation and changes in metabolomic profiles of overwintering mountain pine beetle.

Detoxification of Pine Terpenoids by the Mountain Pine Beetle

Christine Chiu[1]*, Christopher I. KEELING[1,3], Jörg Bohlmann [1]

1. University of British Columbia, Michael Smith Laboratories, 2185 E Mall, Vancouver, BC V6T 1Z4

2. Botany Department, University of British Columbia, 6270 University Blvd, Vancouver, B.C., V6T 1Z4

3. Present address: Department of Biological Sciences, Simon Fraser University, 8888 University Drive, Burnaby, B.C., Canada, V5A 1S6

Abstract

Since the late 1990s, over 25 million hectares of lodgepole pine (Pinus contorta) forests have been affected by a continuous outbreak of the mountain pine beetle (Dendroctonus ponderosae; MPB), a bark beetle pest native to North America. This outbreak has seen the extension of the MPB range across the previous barrier of the Rocky Mountains, into a novel habitat of jack pine (Pinus banksiana), which continues through Canada's boreal forest. Pines produce mono-, sesqui- and diterpenoids as components of the oleoresin, an important chemical and physical defense against insect and pathogen attack. MPB is able to tolerate and detoxify high concentrations of the terpenoids and also uses a pine monoterpene as a precursor to its aggregation pheromone trans-verbenol. Through a functional genomics approach, we have uncovered several MPB cytochromes P450s that detoxify pine terpenoids. We have quantified the toxic effects of monoterpenes on MPB and identify a novel mechanism by which MPB both detoxifies and sequesters monoterpenes. We show the role that MPB P450s have in transforming pine monoterpenes through enzyme activity assays with recombinant P450s, transcript levels (qPCR), and gene silencing (RNAi) of P450s in MPB.

Biographical Sketch

Christine Chiu is a graduate student at the University of British Columbia. She studies how the mountain pine beetle interacts with the pine tree resin through the processes of detoxification, olfaction and pheromone biosynthesis.

What role do phenolic chemicals have in tree defenses against mountain pine beetle and their blue-stain fungal symbionts?

Colleen E. Fortier[1]*, Chandra H. McAllister[1], Kate R. St. Onge[1], Bianca M. Sacchi[1], Adriana Arango-Velez, Miranda J. Meents, Janice E.K. Cooke[1]

1. Department of Biological Sciences, University of Alberta, Edmonton, AB

Abstract

During the current outbreak across northern Alberta, mountain pine beetle (MPB, *Dendroctonus ponderosae*) has encountered different pine hosts and climate conditions. We hypothesize that historic MPB host, lodgepole pine (*Pinus contorta* var. *latifolia*), has acquired specialized defenses against MPB and blue-stain fungal symbiont *Grosmannia clavigera,* that differ from those in novel host jack pine (*Pinus banksiana*). Areas of northern Alberta have been subjected to drought since the onset of the current outbreak, and water limitation can compromise tree defenses. In response to *G. clavigera* or MPB attack, pine stems develop lesions that constitute cellular changes such as accumulated phenolics. Phenolics are a class of chemicals which are involved in defense in many plant species. We have demonstrated that lesion length is not well correlated with fungal growth, but instead is indicative of the tree's defense response. Additionally, gene expression for the pathway synthesizing phenolics in stem tissue is strongly regulated in response to *G. clavigera* as well as by drought, which appear to shift synthesis towards certain branches of the pathway, affecting defense chemical profiles. These responses differ between pine species. Understanding differences in host defenses, and how they manifest under different climatic scenarios, can help inform MPB spread models.

Biographical Sketch

Colleen is a PhD candidate in Biological Sciences at the University of Alberta, specializing in Plant Biology. She is originally from Edmonton, Alberta, and completed her BSc at the University of Alberta in Biological Sciences and Chemistry. Colleen is interested in the biochemistry of plants, particularly plant secondary metabolism and how this varies across species. Colleen has a desire to understand the relationship between the expression of genes and the production of chemicals, which underlies these metabolic pathways, and how it may contribute to the varied responses of plant species in different environments and conditions.

Photo Credit: fRI Research Caribou Program

Strengthening the Resilience of Alberta Communities to the Social and Economic Impacts of Mountain Pine Beetle

Rob Friberg, RPF, PhD Candidate in Interdisciplinary Graduate Studies at UBC Okanagan, Kelowna, BC

Abstract

Community resilience has been defined as "the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise" (Magis, 2010). My research, by working directly with the communities of Hinton, Jasper and Grande Cache, seeks to explore and help identify practical strategies for strengthening rural community resilience to the social and economic impacts from mountain pine beetle, and other types of landscape-level change. This is achieved through the development of a uniquely integrated resilience assessment framework based on extensive literature review, and interviews, focus groups with key stakeholders. The project aims to provide meaningful and practical results for Alberta communities facing future uncertainty and change.

Biographical Sketch

Rob's PhD research at UBC Okanagan involves working with rural communities in Alberta to help identify practical strategies for strengthening resilience to pine beetle, and to other types of potential landscape-level change. Prior to his PhD studies Rob worked with forest-based communities to support climate change mitigation and sustainable rural development in Canada and internationally; with the International Model Forest Network in Chile; and in the forest planning and silviculture sectors of the BC forest industry.

Short and long-term cold storage of jack pine bolts is associated with higher concentrations of monoterpenes and nutrients

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Abstract

Studies with conifer-infesting bark beetles commonly use tree bolts to evaluate the effects of host tree quality on various aspects of insect biology. Yet, whether host quality changes between live trees and bolts cut from these trees have not been assessed. Particularly, changes in concentrations of defense chemicals and nutrients have not been compared between live trees and their cut bolts. To determine whether monoterpene and nutrient concentrations differ after cutting, jack pine trees in Lac La Biche (Alberta) were selected and sampled for phloem tissue. Then, these trees were harvested into two bolts per tree and stored at 4°C. Phloem from one bolt was sampled after three months of storage and from the second bolt six months after cutting. We found that major monoterpenes of jack pine were higher in phloem from bolts than live trees. Storage time did not affect the results. Furthermore, some nutrients including nitrogen were also higher in bolts and varied between storage times. We conclude that researchers should be aware of the observed changes in the host quality which may have positive or negative effects on the development of bark beetles.

Key Words – Mountain pine beetle, *Dendroctonus ponderosae*, *Pinus banksiana*, terpenes, macro and micro nutrients, host tree quality

Biographical Sketch

Sydne obtained her diploma as a Biologist from the National University of Colombia. Then, she worked as a research assistant in the Phytopathology department at the Colombian Sugarcane Research Center. Currently, Sydne is a master's student in Nadir Erbilgin lab. In her project, she is evaluating the nutritional benefits of fungi associated to mountain pine beetle as a source of nitrogen and sterols.

Assessing the suitability of jack pine (*Pinus banksiana*) as a host to mountain pine beetle (*Dendroctonus ponderosae*) and the role of soil resources in tree defenses

Altaf Hussain and **Nadir Erbilgin**

Department of Renewable Resources, University of Alberta

Abstract

The recent range expansion by mountain pine beetle (*Dendroctonus ponderosae* Hopkins; MPB) has brought it in interaction with boreal jack pine (*Pinus banksiana* Lamb.). Abiotic factors that could be important for regulating MPB invasion in the chemotypically diverse naïve host are largely unknown. Jack pine often faces challenges like droughts and nutritional deficiencies in its vast range that could benefit MPB in host colonization. To explore how jack pines chemically defend themselves in different soil moisture and nutrient regimes, we simulated MPB attack density by using different inoculation densities of one of its fungal symbionts, *Grosmannia clavigera*. Tree bolts were also tested for MBP host colonization parameters, such as host acceptance, maternal gallery lengths and brood number. The emergence of trade-offs in chemical defenses were compared to understand how different phenotypic traits are prioritized by jack pine. The study will contribute to understanding if trees in certain growing conditions are more vulnerable to MPB, and if some trees are phenotypically more resilient than others.

Biographical Sketch

Altaf Hussain is a PhD candidate in Forest Biology and Management at the University of Alberta. Altaf's research interests include plant and insect interactions, invasion biology of mountain pine beetle, chemical ecology and ecological footprint assessment. He received his master's degree in Agroecology at the Swedish University of Agricultural Sciences, where he studied how different odor signals from host and non-host plants affect the reproductive behavior of polyphagous herbivores. Altaf also worked as a project coordinator for Worldwide Fund for Nature (WWF) where he assessed ecological footprint of different agroecosystems.

Influence of exposure to host and non-host volatile organic compounds before flight on mountain pine beetle, *Dendroctonus ponderosae* Hopkins, flight propensity and capacity

Kelsey L. Jones, M.Sc. Student, Department of Biological Sciences, University of Alberta

Abstract

The mountain pine beetle, *Dendroctonus ponderosae* Hopkins (Curculionidae; Scolytinae), is North America's most destructive forest pest. In the most recent outbreak the mountain pine beetle has killed over 18 million hectares of pine in British Columbia, and has begun range expansion towards North-Central Alberta. The recent range expansion presents the threat of the mountain pine beetle moving into Canada's boreal forest, and across the country. Although the mountain pine beetle has been of great interest in the last few decades, much remains to be learned about the beetle's dispersal capabilities. It is unknown whether the presence of host and non-host volatile organic compounds influence the beetle's propensity to fly and/or flight capacity. Particular importance falls upon understanding how the mountain pine beetle's flight behaviour changes when emerging from trees in forests of historic and novel hosts. Computer-linked flight mills were used to measure the beetle's propensity to fly when exposed to the phloem from host, lodgepole pine (*Pinus contorta*), and novel host, jack pine (*Pinus banksiana*), compared to a clean air control. Measurements of flight propensity, as well as the distance, speed and duration of flight were recorded for individual beetles over the 23 hour flight assay. This data, paired with other research currently ongoing at the University of Alberta will aid in understanding the potential future range expansion of the mountain pine beetle.

Biographical Sketch

Kelsey is a MSc student at the University of Alberta in the Evenden lab. She grew up in Pickering, Ontario, where she worked as a part-time zookeeper at the Toronto Zoo. Kelsey completed her undergraduate degree in Zoology at the University of Guelph where she found her passion for invertebrates. She completed an honors thesis on diversity of staphylinid beetles in Costa Rica before switching to work on the mountain pine beetle flight.

Recent improvements in the mountain pine beetle genome assemblies

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3 Biological Sciences, University of Alberta

Abstract

Genome sequencing methods and assembly tools have improved dramatically since the draft mountain pine beetle assemblies (both sexes) were completed in 2012 as part of the Tria Project. Recently, we conducted proximity ligation library sequencing using Dovetail Genomics Chicago and Hi-C services followed by HiRise assembly to improve the contiguity of these assemblies. We then used ABySS-Sealer to reduce the number of gaps present in these new assemblies. The resulting "Sealed Dovetail" assemblies have dramatically increased contiguity and dramatically reduced numbers of gaps compared to the original Tria Project assemblies. The N50 values increased 39-fold and 27-fold for the female and male assemblies, respectively, and the number of gaps were reduced by half in both cases. Ninety percent of the content of the assemblies are now contained in the 15 and 16 largest scaffolds for the female and male assemblies, respectively. Thus, these assemblies now have nearly chromosome-sized scaffolds, which are valuable for many aspects of mountain pine beetle genomics.

Biographical Sketch

Christopher Keeling joined the CFS-Laurentian Forestry Centre as a Research Scientist in Forest Genomics in September 2017. He holds an MSc (1996) and a PhD (2001) in Chemistry from Simon Fraser University and is interested in plant-insect interactions using molecular tools. After an NSERC postdoctoral fellowship with Drs. Claus Tittiger and Gary Blomquist at the University of Nevada, where he studied pheromone biosynthesis in bark beetles, Christopher joined Dr. Jörg Bohlmann's lab at the University of British Columbia to examine the roles of conifer terpene synthases involved in the chemical defenses against herbivores and pathogens. Christopher was also a co-investigator in the Genome AB/BC/Canada-funded TRIA-I and II projects focusing on the genomics of the mountain pine beetle system and continues his research in bark beetles.

Speeding up geospatial statistics with mathematical tricks for high resolution gridded data

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Abstract

With recent technological advances, especially in remote sensing, georeferenced datasets on spatial grids are now larger, more detailed, and more widespread than ever before. Some longstanding techniques in spatial statistical analysis are now hindered by the sheer size (extent and resolution) of the data layers. Software for running standard geospatial regression models and kriging predictors will often fail to execute on these larger datasets because of practical limitations on computer memory and CPU time.

Our new statistical theory is designed specifically to solve these big data computational problems. We reduce the computational complexity of model fitting and prediction by orders of magnitude, allowing researchers access to bigger and more detailed data layers in their models. In our case study, we demonstrate the method by fitting a regression model to historical mountain pine beetle red-attack data from BC. We show how autocorrelation is handled explicitly, improving predictions and effect estimates on noisy data. We also show how our method automatically detects directionality in model residuals, providing clues as to the dispersal and large-scale movements of the beetle from year to year.

Biographical Sketch

Dean was born in Victoria, BC. He completed his BSc in math and biology (double major) at the University of Victoria in 2012, with summer projects in partnership with the DFO on Cassin's Auklet population monitoring. In 2013 he joined the Lewis Research Group at the University of Alberta to start his MSc in math, later transferring to the PhD program in 2015 to expand his thesis project on mountain pine beetle outbreak dynamics and expects to graduate at the end of the year. Dean is a member of NSERC's TRIA-Net and CREATE-EI programs and recently completed an internship with ALCES Landscape and Land-Use Ltd as a statistical consultant and programmer. He is interested in ecological modelling, and all things data-science.

Mountain pine beetle outbreak predictions in Cypress Hills, Saskatchewan

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2Forest Service Branch, Ministry of Environment, Prince Albert, SK, Canada,

3Mathematical and Statistical Sciences, University of Alberta, Edmonton, AB, Canada.

Abstract

We studied the mountain pine beetle outbreak in the Cypress Hills Park, Saskatchewan. Cypress Hills is a 400 km2 interprovincial park at the limit between Alberta and Saskatchewan. The local host pine species, the lodgepole pine, sustains an endemic population of mountain pine beetle. However, since 2006, an epidemic has emerged which could serve as a stepping stone for further epidemics in Saskatchewan and central Canada. In order to understand the beetle population dynamics and make predictions in the near future, we used traditional statistics in the form of a generalized linear model, and a machine learning algorithm: a generalized boosted classification tree. Weather variables have been repeatedly reported as having a major impact on the beetle dynamics. Therefore, we explored weather uncertainty under short-term predictions. Weather variables, beetle pressure, topography and vegetation were included as covariates in our two models in order to spatially predict the presence/absence of mountain pine beetle in the area.

Biographical Sketch

Melodie received a Master's Degree in Ecological modelling from Rennes University, France. She is now a Ph.D. candidate with Pr. Mark Lewis at the University of Alberta and she is part of the TRIA Network. Melodie studies the mountain pine beetle, Dendroctonus ponderosae, invading new habitat east of its native range in western North America. She is focusing on the beetle population dynamics and its management using statistical and computational methods.

Effects of population density on mountain pine beetle condition and flight distance

Antonia E Musso[1], Dr. Allan L Carroll[3], and Dr. Maya L Evenden[4]

1 PhD Student, University of Alberta, 2 Professor, Department of Forest and Conservation Sciences, University of British Columbia. 3Professor, Department of Biological Sciences, University of Alberta.

Abstract

The mountain pine beetle (Dendroctonus ponderosae Hopkins; MPB) kills healthy pine trees through pheromone-mediated mass attack. Beetle success varies with attack density. At low densities of attack, the trees will win the battle against the beetle using chemical and physical defences. At very high attack densities, larval offspring of the attackers run out of space under the bark during development. Between these two points is an optimal attack density, where the trees defences are defeated but competition between the developing larvae is minimal. In a field experiment over two years, we manipulated MPB attack densities in Alberta lodgepole pine trees. We compare MPB attack success, parent beetle reproductive output, and resulting offspring condition/flight capacity, between three attack densities treatments. We found that MPB are capable of killing trees at all the densities we tested over two years but have mixed results in reproductive output. Female offspring weight was not effected population density but male beetle weight was, however, there was no difference in flight distance between all these groups. Understanding MPB attack dynamics and dispersal capacity in Alberta is integral in understanding it's spread and behaviour within its expanded range.

Biographical Sketch

Antonia Musso is a PhD student in the lab of Dr. Maya Evenden at the University of Alberta. Hailing from the Greater Vancouver area, she completed her BSc and Master of Pest Management degrees at Simon Fraser University in Burnaby BC. While studying rodent chemical ecology for her masters' research, Antonia took a forest pest management field course and set her heart on returning to her first and truest love, entomology.

Transcriptomic analyses of responses of Pinus contorta to Grosmannia clavigera under contrasting levels of nitrogen availability

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Abstract

The Mountain Pine Beetle (Dendroctonus ponderosae, MPB) has decimated pine forests across North America since 1999, including over 1 million hectares in Alberta alone. Lodgepole pine, Pinus contorta ssp. latifolia, has a range that overlaps extensively with that of MPB, and it is one of the main hosts of MPB. The microbial community hosted by MPB facilitates the beetle in overcoming tree defenses and successfully colonizing the tree. This includes the necrotrophic blue-stain fungus, Grosmannia clavigera, which also contributes to tree mortality. Lodgepole pine have evolved both constitutive and inducible defense measures to repel or eliminate this pathogen chemically as well as physically. Nitrogen availability has been shown to affect both the upregulation of carbon-based secondary metabolites and nitrogen-rich defense related proteins in response to pathogen attack. RNA-Seq transcriptomic analysis is used to identify genes that are differentially expressed in Pinus contorta in response to Grosmannia clavigera in trees subjected to low and high amounts of soil nitrogen availability. The relative proportion of resources that are invested in carbon-intensive defenses versus nitrogen-intensive defenses is shown to be influenced by the relative amount of nitrogen availability, and nitrogen fertilization could alter the efficacy of lodgepole pine defense against G. clavigera.

Biographical Sketch

Louisa Normington moved from Dover, New Hampshire to Edmonton, Alberta in 2015 to study the devastating effects of the Mountain Pine Beetle and its fungal associate, Grosmannia clavigera, on Canadian forests. Her master's thesis project in Janice Cooke's lab at the University of Alberta uses transcriptomic techniques, where she relies on her background in Mathematics (BA from the University of North Carolina) while performing differential gene expression analyses. Outside of school, she enjoys gardening and is an avid ice skater.

Genomic signatures of lodgepole pine survival after mountain pine beetle attack

Bianca M. Sacchi, Rhiannon Peery, Kate R. St. Onge, Catherine I. Cullingham, David W. Coltman and Janice E.K. Cooke

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Abstract

Mountain pine beetles (MPB) overcome tree defenses through a mass attack strategy: trees are killed when numbers of attacking beetles are greater than the tree can defend against. Even when MPB populations are extreme, some lodgepole pine individuals survive the outbreak by evading detection, resisting beetle attack, or preventing colonization. My goal is to determine whether trees that survive an epidemic have a genetic makeup that helps them resist MPB detection and attack. Based on previous studies, I predict that there is a genetic basis to surviving extreme MPB outbreaks. To test this hypothesis, I am conducting analyses on a unique genomic dataset representing thousands of single nucleotide polymorphisms (SNPs) collected from the offspring of beetle-killed and surviving trees from central British Columbia. I have performed population genetic analyses to determine the underlying genetic variation in this group of trees. My next objective is to conduct a genome wide association study (GWAS) to identify specific SNPs that are associated with the trait of parental survival. SNPs associated with survival to MPB attack may be located in or close to genes that allow a tree to defend itself or avoid attack.

Biographical Sketch

Bianca Sacchi is completing her BSc in Molecular Genetics (honors) at the University of Alberta. Her honors research project in Janice Cooke's Lab is focused on investigating the genetic differences between the offspring of mountain pine beetle-killed and surviving lodge pole pine. I have also worked on a project investigating qPCR as a means of detecting blue stain fungi within pine. This fall, Bianca will be attending the University of Toronto to pursue a Masters in Ecology and Evolutionary Biology.

Effects of population density on mountain pine beetle condition and flight distance

Morphology and functional genes associated with dispersal capacity n the mountain pine beetle

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1Department of Biological Sciences, University of Alberta

2Ecosystem Science & Management Program, University of Northern British Columbia

Abstract

Dispersal by mountain pine beetle is poorly understood and increasing our knowledge of the beetle's dispersal capabilities could allow for more efficient allocation of management resources. While some flight morphology (primarily wing size and body weight) is correlated with flight capacity, there is still a large amount of unexplained variation in flight performance that is likely genetic. This study aims to identify genes associated with flight capacity in MPB. Beetles were flown on flight mills to collect flight data, and RNA-seq was used analyze gene expression levels relating to flight. So far, patterns of differentially expressed genes indicate a reallocation of resources to maximize flight capacity. Some of the systems associated with the differentially expressed genes include: muscle function, metabolism, pheromone detection, immune response, detoxification, and reproduction.

Source populations for mountain pine beetles in Hinton

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Abstract

The mountain pine beetle (*Dendroctonus ponderosae*) has expanded its range into several regions of Alberta, and two routes may be contributing to a recent outbreak in the Hinton area. Northern populations from the Grande Prairie region are expanding eastward and southward, while a genetically distinct mixture in Jasper National Park has recently undergone a rapid population increase. We sampled beetles in 2017 from two affected sites that are currently being controlled and harvested on the east edge of the Town of Hinton. We extracted DNA from these specimens and are using DNA sequence variation to identify the source populations for the Hinton samples. This information can potentially inform further policy development regarding control of mountain pine beetle.

Biographical Sketch

Victor Shegelski is currently a 3rd year PhD student in the Sperling lab at the University of Alberta. He has highly developed laboratory skills, but enjoys working in the field. Before university, he gained experience during 5 years of military service, including two active tours. After this I pursued further education, graduating from Concordia University, Edmonton with a double major in Environmental Sciences and General Biology. After which, he spent a year teaching field research techniques and labs for several courses. Victor's graduate research focuses on functional flight genetics, morphology, and population genetics of mountain pine beetle. This research will contribute to our understanding of dispersal capacity and range expansion by mountain pine beetle.

What is happening in Alberta's grey attack stage lodgepole pine forests?

Julie Steinke[1], Vic Lieffers[2] ,Ellen Macdonald[3], Anne McIntosh[4], Lori Schroeder[5], Northern Vegetation Ecology Research Group, University of Alberta

1 Master's Student, 2 Professor Emeritus, Silviculture and Forest Ecology, 3 Professor and Chair, 4 Assistant Professor, Augustana – Sciences, 5 Lori Schroeder, Research Assistant, Department of Renewable Resources, University of Alberta

Abstract

Mountain pine beetle (MPB), a native bark beetle that kills mature lodgepole pine trees, is expanding into novel areas further east into west-central Alberta, where pine forests differ from historical MPB habitat. To gauge how forests in Alberta will respond, we visited lodgepole pine-dominated, grey-attack stage MPB-killed stands in west-central Alberta to assess the potential for natural lodgepole pine regeneration in stands and examine what might best explain this regeneration. We also conducted an experiment, in which MPB attack was simulated, and assessed responses of understory vegetation and soil nutrients. Less than half of the post-MPB sites assessed had any evidence of pine regeneration, and a variety of ground, overstory, and location variables seemed to explain regeneration in these sites. Notably, drier and poorer ecosites had higher levels of regeneration. In the experimental study higher mortality resulted in larger increases in vegetation richness and cover, and larger changes to community composition. While higher levels of canopy mortality might provide a better light environment for pine regeneration, this effect could be negated by competitive effects arising from the responses of understory vegetation. The severity of MPB attack in Alberta will determine the ensuing succession of a stand, and thus the potential transformations in forest composition, structure, and diversity that are likely to develop on this changing landscape. This can help us to make future management decisions regarding the need for rehabilitation of lodgepole pine.

Biographical Sketch

Julie Steinke is currently a MSc student with Dr. Ellen Macdonald and Dr. Vic Lieffers at the University of Alberta. Julie received her BSc in Conservation Biology from the University of Alberta. She currently serves on the planning committee for CONFORWest and sits on the Canadian Institute of Forestry – Rocky Mountain Section council. Julie has a strong passion for forest-related ecology, and is currently studying the effects of mountain pine beetle attacks in Alberta.

Repurposing population genetics data to discern genomic architecture: linkage block detection in mountain pine beetle (*Dendroctonus ponderosae*)

Stephen A. L. Trevoy[1], Jasmine K. Janes[2,3], Kevin Muirhead[1], Felix A. H. Sperling[1]

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3 Vancouver Island University, Biology Department, British Columbia, Canada

Abstract

Genetic surveys for population structure research can provide a valuable resource for exploring the genomic architecture of species. By adjusting filtering assumptions, genome-wide single nucleotide polymorphism (SNP) datasets can be reused to give new insights into the genetic basis of divergence and speciation without targeted re-sampling of specimens. Filtering only for missing data and minor allele frequency, we used a combination of principle components analysis and linkage disequilibrium network analysis to detect two cohorts of variable SNP markers, one sex-linked and one geographically segregated, in the mountain pine beetle in western Canada. These marker cohorts indicate genomically localized differentiation, and their detection demonstrates an accessible and intuitive method for discovering islands of genomic divergence without a priori knowledge of a species' genomic architecture.

Biographical Sketch

Stephen Trevoy is a Masters student at the University of Alberta, studying under Dr. Felix Sperling. His work looks at population genetics and genome architecture in the mountain pine beetle. Stephen has completed a Bachelor of Commerce degree from the Alberta School of Business, and has previously worked on redbacked cutworm under Dr. Maya Evenden, and diamondback moth under the late Dr. Lloyd Dosdall. He currently lives in Edmonton, Alberta.

Research Themes for Mountain Pine Beetle Ecology Program

Research Theme No. 1: **MPB Biology and Management**

Importance of Research Theme

Understanding the various aspects of MPB biology, population growth and spread is necessary for managing beetle infestations effectively. Most of what we know about MPB biology stems from studies conducted in BC. Although there are several well documented endemic population of beetle in Alberta the current situation stems from in flights from BC in 2006 and 2009. Several anecdotal observations suggest that these new populations exhibit different behavior, infestation dynamics, and survival and growth patterns than in their native range. Alberta's forests are different to those in BC in terms of stand structure and they do not share a co-evolutionary history as observed in BC. In addition, Alberta's climate differs from the interior BC or USA where outbreaks have mostly been studied. Management tools employed in Alberta are mainly predicated on an understanding of beetle biology as observed in its historic range. It is yet unclear how these tools can be adapted to improve their relevance, accuracy and predictive power in Alberta's landscapes.

The efficacy of current management aimed at slowing the rate of spread of Mountain Pine Beetle infestation needs to be continually evaluated in order to manage prescriptions to suit changing conditions. Early detection and aggressive action are crucial for timely control of MPB populations. When populations are still small the chances of eradicating spot infestation are highest. Accurate detection methods are necessary for any management action.

Implications if information needs are not addressed

MPB biology, population dynamics and spread potential can have major implications for forest managers and the communities that depend on the forest industry. Harvest plans need to be adjusted to prevent beetles from spreading, new containment measures need to be taken to transport and store infested wood adding to processing costs. Where, when and how much harvesting is necessary for slowing the spread can be improved with more accurate spread models.

If the effect of current control actions cannot be measured it is difficult to be accountable to tax payers, to request more funding and to evaluate the merits of different strategies. When low populations are missed it is more difficult to control them once they have grown into large epidemics. Forest industry may lose its immediate to mid-term timber supply. Communities may lose their main source of income and natural heritage. Drinking water supply may be jeopardized and wildlife may lose critical habitat.

Economic, social and ecological benefits derived from addressing information needs

Government and industry will be able to make well informed decisions about managing the infestation. Detection of low MPB populations would enable early management action before populations grow, reducing the overall cost of control. Knowing when, where and how much to harvest will enable forest companies to stay in business and secure the future of the communities that depend on them. Understanding the growth and spread potential of MPB populations enables identifying risk to key forest values. Vulnerable watersheds can be prioritized for protection so drinking water quality is sustained. The people of Alberta will be able to enjoy the beauty of the forest. Wildlife will persist if its habitat is maintained and created for the future. Spread through the Boreal forest to other provinces of Canada might be prevented. Other provinces in Canada will be in a better position to manage MPB infestations as more knowledge becomes available.

Urgency of addressing information needs

Finding answers to priority questions is urgent as the window of opportunity for managing the infestations is narrowing with populations growing across Alberta. Since large-scale management is conducted every year it is urgent to be able to evaluate its effectiveness at slowing MPB spread.

Early, rapid and accurate detection of beetle infestations are essential if containment and control of the beetle is to occur. Accurate detection of low level populations is most critical on the eastern and northern edge where MPBs are crossing the borders to SK and NWT. Knowledge on MPB survival and population growth in northern latitudes is increasingly critical.

Priority Research Questions

Research Theme 1: MPB Biology and Management	
1	What is the efficacy of current control measures applied to MPB in Alberta?
2	Can a composite spread model that incorporates key variables and is broadly applicable be developed that significantly improves spread predictions against a backdrop of climate change?
3	What drives local and long distance beetle dispersal, promotes beetle establishment and affects population dynamics of MPB in novel host environments? Do indicators of stand susceptibility to beetle attack vary eastward and can they be exploited to curb expansion?
4	Can models / indicators of tree physiology be developed and incorporated in spread models?
5	What are the critical thresholds in terms of population dynamics of beetles that can be defined and used to guide operational management of infestations in novel habitats?
6	Detecting populations of MPB at low densities is a critical step in managing the beetle. Can baits and protocols for its placement with respect to endemic populations be developed and successfully deployed?
7	What can we expect from secondary injurious insect populations following MPB attack? Should we be concerned about residual pine and other species?
8	Demonstrate / evaluate the efficacy of genomic science to support management's response to mountain pine beetle (CF Research Theme No 3)

Research Theme No. 2: **Hydrological Impacts of Mountain Pine Beetle**

Importance of Research Theme

Mountain Pine Beetle infestation is one additional risk to water and water-associated values in a changed landscape. In many cases, MPB management may challenge traditional rules of thumb for watershed level disturbance (e.g., 15% increase in modeled annual water yield, 30% area disturbed, change to sensitive areas such as riparian habitat, high road densities), and the result in the eastern slopes and foothills is unknown. Most MPB research to date has focused on understanding how MPB affects stand level processes relative to healthy stands and salvage logged stands. Research has shown that ecological functions within MPB-killed stands are intermediate between healthy stands and salvage logged stands (e.g. more snow, faster melt, decreased interception). Although there are additional affects following salvage logging, there is an arguable benefit of faster hydrological recovery.

The scientific literature clearly demonstrates that disturbance plays an integral role in maintaining ecological systems. What we do not know, but are in the process of learning, is the extent to which MPB-associated disturbance affects ecological resiliency. Ecological resiliency is the ability of ecosystems to withstand perturbations (both natural and anthropogenic) without switching to an alternate (less desirable) state. Management decisions must be informed by an understanding of ecological resiliency and the different watershed and riparian values that are at risk. Moreover, hydrological function of watersheds must be understood within the context of contributing to ecological resiliency.

In a Mountain Pine Beetle environment management decisions need to be made at a watershed scale to ensure balanced management of multiple values. One common approach to deal with decisions in watersheds with multiple pressures is to conduct watershed assessments to help inform difficult decisions on trade-offs amongst social, economic and environmental values. To be effective, assessments have to account for: i) values (e.g., fish and fish habitat, drinking water, regional water supply, flood risk, natural range of variability), ii) watershed processes (e.g., hydrological, sediment, riparian ecosystem function), and, iii) all pressures (roads, past forestry, wildfire, etc.). These assessments rely on professional judgment to interpret the best available scientific knowledge of watershed processes and response to disturbances. The presence MPB makes this assessment process difficult because infestations cause unique and significant changes to vegetation, which over time is in a dynamic sate of recovery. Recovery, may assume a myriad of trajectories that may be naturally initiated or may arise from salvage logging with or without subsequent intervention by planting. In any case, the scale of the disturbance pushes the boundaries of current knowledge on the interaction of vegetation and hydrology within a context of disturbance by Mountain Pine Beetle. We can extrapolate to plausible outcomes based on observation of situation occurring elsewhere (e.g. BC), but ultimately research needs to be conducted in Alberta watersheds to determine thresholds of disturbance that minimise risk to values.

Over the last few years, watershed research has shifted focus to understanding the potential impact of MPB infestation on various watershed processes at a stand and watershed scale. Most of this research was conducted in BC, where the information found its way into well-established watershed assessment procedures. In Alberta, some key research has recently provided an understanding of how MPB will affect watershed processes on the eastern slopes and foothills. However we lack the assessment procedures (or comparable procedures) to effectively implement this knowledge in changed landscapes. Unless such procedures are developed management strategies will be ill-informed and risk to resource values will be high.

Implications if information needs are not addressed

While full understanding of the effects of Mountain Pine Beetle on watershed will not be known, the obvious issue in hydrological impact are manifested in parameters such as, water yield, peak flows, channel morphology dynamics, water quality, change in aquatic habitat, erosion potential etc. Enhanced understanding of the change in watershed features resulting from broad scale

Mountain Pine Beetle disturbance is critical for all management decisions. Post beetle silviculture strategies set the stage for watershed recovery and either the strategy will be effective or not. Addressing the information needs noted above will provide a basis for informed decision making to ensure adequate opportunities to achieve social, economic and ecological outcomes.

Economic, social and ecological benefits derived from addressing information needs

If it is assumed that an unaffected watershed provides a continuous flow of ecological services, which provide economic and social benefits, a decline in the flow of these services will have a variable impact and negative impact. Quantification of these impacts is difficult, but by adopting outcomes from other jurisdictions such as a decline in water quality due to sedimentation and organic matter contamination, the additional costs for water treatment can be high. Moreover, it can negatively affect aquatic habitants and biodiversity. Such outcomes are unacceptable to the general public, which enjoy their environment, or just knowing that watershed ecologies are and remain intact.

Urgency of addressing information needs

At the present time, watershed assessment procedures and the interaction of all the variables at play on the Mountain Pine Beetle affected landscape are far from being understood. Yet, managers are faced with having to make decisions. Delays in address information needs will relegate management decision making to experience and extrapolated research from unlike terrain, eco-regions and ecosites. Science based knowledge is needed in the short term. The need is urgent.

Priority Research Questions

Research Theme 2: Hydrological Impacts of Mountain Pine Beetle	
1	What are the specific thresholds (forest cover, tree condition) in MPB affected watersheds that are indicative of pending negative conditions such as, changes in water quality and quantity, deterioration of aquatic habitats, flood potential?
2	What is the range of hydrological impacts at stand and watershed levels from variable MPB attack; can hydrological recovery be effectively determined using indicators of real-time forest cover and stand condition against a backdrop of predicted climate change?
3	Can currently available watershed assessment procedures be refined to accurately reflect the state of Alberta's watersheds affected by the dynamic nature of MPB and allude to remedial management options to ensure the flow of ecological services? (*)

Research Theme No. 3: **Landscape and Stand Dynamics Following MPB**

Importance of Research Theme

The growing mountain pine beetle (MPB) infestation in Alberta provides significant challenges for forest managers. While controlling MPB spread is a first priority, forest managers will be required to make decisions on how to manage pine dominated forests following extensive MPB caused mortality. These decisions will require an increased understanding of natural and managed stand development after the MPB infestation, and how these dynamics affect social, economic, and environmental values (ecosystem services), and what management strategies can be used to mitigate these impacts.

There are few historical MPB impacted areas in Alberta to guide our predictions of the current outbreak's outcomes. Successional pathways followed by pine dominated stands after beetle disturbance will likely be very different than pathways followed after fire or timber harvest disturbance. Different climate and site conditions in Alberta may result in different post MPB successional pathways being followed in Alberta from what has been observed in British Columbia. Information on natural stand development is currently lacking for Alberta, but is critical for decisions regarding timber salvage, timber supply analysis, fire risk assessment, hydrologic recovery, rehabilitation strategies, and wildlife habitat management. Forest managers in both government and industry require this information to mitigate and plan for the range of impacts the mountain pine beetle will create.

Impacts to ecosystem services will be significant. The rate of increase of dead and dying pine forests is likely to exceed forest industries' capacity to salvage dead timber in a profitable manner and, therefore, reforestation will not occur promptly. Research to date (Lewis and Hrinkevich 20131) demonstrates that timber quality declines quickly following red attack with a commensurate decline in economic recovery.

An equally troubling aspect of a rapidly increasing inventory of dead and degraded forests is that recovery (i.e., regeneration lag) could be delayed significantly posing risks to timber supply, watersheds, fish and wildlife habitat, recreation opportunities, and forest dependent community sustainability and risk of wild fire.

Rehabilitation of selected MPB impacted pine stands is required to mitigate risk to ecosystem services and to restore ecosystem function. There is a suite of silviculture tools than can be used to do rehabilitation at the stand-level. However, developing appropriate rehabilitation strategies and performance measures will be necessary to determine if the mitigation objective are achieved. This is largely demonstrated at the landscape-level. Thus, developing an understanding of the impacts of stand-level treatments at the landscape-level is key. The next step is then to develop an understanding of how these managed stands will develop into the future.

Exacerbating our lack of understanding of natural and managed pine stand dynamics in this MPB environment are the issues of wildfire threat and climate change. While not affecting pine forest succession initially, the occurrence of wildfire in MPB killed pine stands will be very problematic. The availability of fine fuels and the low moisture content of standing dead trees could result in increased fire intensity and rates of spread, which could lead to consumption of the LFH layer, degradation of soil structure, carbon, biota, mycorrhizae, and increased soil erosion due to hydrophobicity. Under these conditions, any silviculture investments (i.e. underplanting) would be at risk of loss. Future climatic conditions will favour a narrow array of successional pathways, which may not lead to an acceptable economic outcome within a specified time span. For industry, this consequence may make timber flow forecasts inaccurat**e.**

Implications of not addressing information needs

There is much that is not known about post beetle pine forest succession and this lack of understanding can easily translate into poor decisions regarding management. The understory may be primarily non crop species and without considerable investment for control purposes, the site may not contribute to future timber supply, but the site may have value from a habitat and biodiversity point of view. In managed forests, tolerance of random succession that does not support long term wood flow objectives is inconsistent with current forest policy and goals of managing forests for the benefit of Albertans. However, over the long-term natural succession may eventually result in a productive forest.

1. Lewis, K. and K. Hrinkevich. 2013. 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. Final Report submitted to the Foothills Research Institute, Mountain Pine Beetle Ecology Program. January 2013. Unpublished.

What are the direct economic, social and ecological benefits of addressing this theme?

Addressing these questions and information needs posed in this theme will increase our understanding and knowledge about post-MPB pine forest recovery at the site- and landscape-level. We will gain a better understanding of the system and the relationships with one of the key ecological drivers of change. In addition, modeling forest growth will be important in addressing mid-term timber supply issues, understanding future forest conditions, and mitigating risks to ecosystem services and risk of wildfire. Knowledge gained under this Research Theme will enhance decision-making capacity of forest managers.

Constraints in addressing information needs?

Alberta is currently six years into the MPB infestation and there are currently thousands of hectares of dead and dying pine stands. Decision-makers have an immediate need to understand the current state of these forests, so as to select and rehabilitate these forests to mitigate risks to ecosystem services and risk of wildfire. However, a conundrum is faced in that this immediate decision-making need requires information that is long-term in nature. Strategy development; therefore, will have to be based on a combination of targeted research on high priority information needs supplemented with science gathered from other areas. When these strategies are filtered / vetted through ecologists, wildlife managers and foresters, they can be implemented and outcomes monitored.

Priority Research Questions

Research Theme 3: Landscape and Stand Dynamics Following MPB	
1	What are the vegetation dynamics in managed and natural pine dominated stands across Alberta's ecosites following variable MPB caused mortality? Can interventions be applied to modify species compositions to make future stand more resistant to beetle attack?
2	How is soil chemistry and soil biology altered following MPB attack and how do these changes influence stand rehabilitation? (added May 6, 2016)
3	In order to achieve future site objectives what terrestrial and aquatic parameters ought to be evaluated to determine candidacy for treatment (including salvage) versus those that ought to be left for natural succession? What are the thresholds of these parameters by ecosite that suggest treatment success?
4	What operational measures can be taken to restore landscapes severely altered by MPB to ensure the flow of ecosystem services?
5	Can genetic traits of Alberta's pine species be efficiently identified and captured operationally to promote the development of healthy forests following mountain pine beetle and its consequences?
6	What level of overstory mortality in a spatially defined area indicates a level of thermal loading detrimental to threatened cold water fish? What kind and level of intervention would mitigate against potential impacts?
7	How is wildlife habitat for grizzly bear and caribou affected by landscape change due to MPB, and what rehabilitative measures can be taken to restore their critical habitat?
8	How is population behavior of species at risk such as grizzly bear and caribou affected by MPB induced habitat change?
9	How does fire risk and fire behaviour change following MPB?
10	How will the anticipated increase in soil water affect choice of silviculture options and what are the potential implications to the flow of ecosystem services?
11	How will the site ecology of beetle killed stands change with respect to carbon fluxes? Is there a need to take mitigative action to achieve a desired forest future condition while minimizing carbon losses?
12	What is the potential impact of managing net down areas versus no management to the spread of the beetle (scenario analysis / risk determination)?
13	Can proactive measures, apart from harvesting, be taken to slow the spread of the beetle and how can the impacts of these measures be evaluated.

Research Theme No. 4:
Social and Economic Implications of a Changing Landscape

Importance of research theme

When considering potential research needs related to the mountain pine beetle infestation, forest practitioners intuitively consider the biological and ecological aspects of the issue. The magnitude of the infestation is precedent setting and the scientific community has conceded that the mountain pine beetle will continue to impact Alberta's forests for the foreseeable future. Whereas it is fundamentally important to know as much as possible about the beetle in order to manage its progression through the forest, it has become increasingly apparent that research related to potential socio-economic outcomes following a forest health-based epidemic is critically important. Inevitably, significant social and economic changes occur at a broad range of scales during and following a mountain pine beetle epidemic and research that will help the province and local communities prepare for those changes is essential.

Implications if information needs are not addressed

Forest based communities, particularly those with wood products manufacturing facilities have typically evolved synergistically with the forest industry. Because the forest industry is a "sustainable" industry with relatively predictable sources of raw material, significant capital investments in equipment have been made and stable workforces have been established in many forest based communities. This has led concurrently to public investments in those communities in the form of schools, hospitals, roads and utilities. If public and private decision-makers have not adequately anticipated and prepared for the significant changes in the economy and social climate that occur during and following a mountain pine beetle infestation, the existing public and commercial infrastructure may be entirely inappropriate for ensuing demographic changes. Sustainability of communities in those situations will be seriously jeopardized.

Economic, social and ecological benefits derived from addressing information needs

The most significant benefit of adequately addressing this theme is the maintenance of sustainable rural communities in the province. Vibrant rural communities are an integral component of Alberta's diverse economy and provide an attractive lifestyle for individuals and families that are dependent on one or more of the province's natural resource industries. Whereas the mountain pine beetle infestation will inevitably change some fundamental aspects of the forest industry, implementation of effective mitigation strategies based on well-founded research can help ensure sustainability of the industry and forest-dependent communities.

Urgency of addressing information needs

Time is of the essence in order to realize the opportunities that can be addressed through appropriate application of research results. While some communities in Alberta have already experienced impacts from the mountain pine beetle infestation there is still time to provide essential information that may be derived from research under the program for implementation at both the provincial and local level.

Priority Research Questions

Research Theme 4: Social and Economic Implications of a Changing Landscape	
1	What are the characteristics of resilient communities that are able to ensure their social and economic stability in the midst of a landscape changing due to MPB, and what steps can be taken to enhance resilient capacity of communities?
2	How is fibre quality related to shelf life of MPB killed trees across ecosites across Alberta and what are the subsequent implications for manufacturing?
3	As a result of MPB in Jasper National Park, how do visitor perspectives and their behaviour influence local economies?

Canadian Institute of Forestry
Our Story

Established in**1908,** the CIF-IFC is the oldest forest society in Canada! The Institute serves as the *voice of forest practitioners* representing foresters, forest technologists and technicians, ecologists, biologists, educators and many others with a professional interest in forestry.

Mission, Vision & Motto

Vision: To inspire confidence and pride in Canadian forestry - nationally and internationally

Mission: Provide national leadership in forestry, promote competency in forest professionals, and foster public awareness of Canadian and international forestry issues

Motto: Voice of Forest Practitioners

Guided by its Vision and Mission, the Institute is dedicated to the principles of:

- Providing national leadership in forestry;
- Promoting competency among forestry professionals; and
- Fostering
- public awareness of forestry issues.

The strength and foundation of the Institute, which is in its 110th year, flow from its Sections. The Institute has 19 National Sections with 2200 members. The Sections give the Institute a strong local, regional, and provincial network and presence. Each Section is comprised of a Director, a Chair and a Council, all of whom hold these positions voluntarily and dedicate their efforts to host over 120 Section events annually including workshops, seminars, tours and socials. The 2018 Forest Forum which has been collaboratively hosted with fRI Research and TRIA-Net is an notable example of steadfast regional commitment and contribution towards achieving the Institute's goals and objectives.

Forests Without Borders

On an international scale, the Canadian Institute of Forestry is committed to the fulfillment of its mission through its support of **Forests Without Borders**. Forests Without Borders is a registered charity in Canada established by members of the Canadian Institute of Forestry.. Its mission Forests is to work with people who wish to restore or improve their forest landscapes for health, security, the economy and the environment. Thus far, Forests Without Borders has assisted with projects in eight locations throughout the world. For more information please visit www.fwb-fsf.org/.

Clearly, membership in the CIF has countless advantages and offers numerous opportunities enabling one to achieve professional and personal goals while being part of a national body. You are invited to visit the CIF Website (www.cif-ifc.org) for details regarding membership.

Forests without Borders
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TRIA-Net

Turning Risk Into Action for the Mountain Pine Beetle Epidemic

The NSERC TRIA-Network (TRIA-Net) is an initiative under the NSERC Strategic Network Grants program which works to protect forests through science-based strategies to control spread of the mountain pine beetle in Canada. Our goals are to:

- *Generate new knowledge that improves the ability to monitor, assess and predict MPB risk, particularly in novel habitats.*
- *Use this knowledge to develop new tools for MPB management: novel stand susceptibility indices, spread risk models, and socioeconomic impact models.*
- *Provide outcomes to our Partner Organizations to guide policy development, spread control planning, and forest management planning.*

We invite you to explore the project website www.thetriaproject.ca and check out our research efforts to date.

TRIA-Net funders and partner organizations:

NSERC CRSNG

Canada — Natural Resources Canada, Canadian Forest Service

FRI Research

Alberta — Agriculture and Forestry

Northwest Territories — Environment and Natural Resources

Government of Saskatchewan

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