Bugs and Diseases

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Forest Health and Adaptation

Happy Birthday B and D!

It is hard to believe that the Bugs & Diseases Newsletter is 30 years old this year. In 1989 while the Berlin Wall was being smashed down and pro-democracy protesters rallied in Tiananmen Square, forest health staff in Alberta were busily working on the first issue of this now historical newsletter. The mission of Bugs & Diseases is to inform forestry-related personnel about current forest health issues.

I recently took some time to thumb through the last 20 or so years of the newsletter and was amazed at the treasure trove of articles. It was actually like an Alberta forest health history lesson with a dash of comedy mixed in for good measure.

Looking back, there are a few themes that run deep. Firstly, the newsletter has always been the source of late-breaking news; whether it was a new pest discovery, reporting on unprecedented outbreaks, or describing new technology or policy, Bugs & Diseases always had the scoop. Second theme is the human interest angle, where editors over the years made sure to include updates of staff comings and goings. It is always nice to put faces to names, celebrate achievements and learn something about the personal lives of colleagues. It is not all about work you know! Another theme of course is the forest health poetry corner with Tom Hutchison, the sole inventor of this literary genre. Aside from the sheer entertainment value, Tom's poems are always informative and relevant to current forest health issues.

During my trip down memory lane, it was interesting to read some of the insect population predictions made. Sometimes we got it right and other times the crystal ball must have been a bit fuzzy. Now knowing the extent of the current mountain pine beetle outbreak across the province, it was wild to read in the April 2003 edition about the first control operations on public land in the Bow Valley where 785 trees were cut and burned. That was the same year that a whopping 14 attacked trees were detected in the Willmore Wilderness Park. A December 2003 article predicted that the beetle population in Jasper National Park was "expected to increase". We definitely nailed that one, but we were a bit off when predicting that "beetles may only have limited success except in

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Alberta

the south facing slopes of Jasper National Park." Wishful thinking, I presume.
In the December 2006 interview titled Beetle Coordinator Tells All, Dan Lux was asked "what would be the one word to describe the current (MPB) situation?" His reply was "Challenging. The next time I am asked in a job interview about dealing with change, I will have some story to tell."

In 2015, following the merger of the Alberta Tree Improvement and Seed Center and the Forest Health Section, is was a natural progression to start reporting on all aspects of the newly minted Forest Health & Adaptation Section. Because the newsletter was now about more than just bugs and diseases, we thought a new title was warranted. A contest was organized to allow readers and staff to submit names. Although several good potential names were submitted and a lot of votes were cast, the decision was to stick with Bugs & Diseases. We had not anticipated the level of loyalty and identification of the existing newsletter name, and it seemed that the title was like a brand and had value in itself.

After 30 years and almost 100 issues published, Bugs & Diseases may very well be one of the longest running newsletters in the Government of Alberta.

After 30 years and almost 100 issues published, Bugs & Diseases may very well be one of the longest running newsletters in the Government of Alberta. A big thanks to everyone who has contributed to the newsletter over the years, and also to our loyal readers who have made this a continuing success.

In the December 2004 issue, readers were petitioned to contact their local Forest Health Officer if anyone sees a suspected MPB-attacked tree. For the record, we would now rather hear from you about ideas for improving the newsletter. And don't forget that articles are welcome!

Mike Undershultz - Edmonton

Was this winter cold enough to stop the mountain pine beetle outbreak in western Alberta?

This has been a popular question lately given the cold snap we experienced in parts of the province this winter. My answer has been "it depends!" because there are a number of factors that impact mountain pine beetle (MPB) cold tolerance. Finally, I can talk about this in a bit more detail….

How do insects deal with Alberta's cold winters?

Some insects are able to tolerate freezing, like the woolly bear caterpillar, and spend the winter as ice cubes. Other insects can't tolerate freezing and have evolved mechanisms to avoid it, such as migrating to warmer climates. In the case of MPB, larvae begin to produce glycerol in late fall which replaces water in their cells – this keeps larvae from turning into Popsicles. Antifreeze is energetically expensive to make and maintain so MPB build up their glycerol stores as winter progresses so that peak cold tolerance coincides with the coldest period[1]. This is why abnormally cold temperatures in spring and fall cause greater levels of mortality than do mid-winter cold snaps.

What factors affect cold-adapted insects like MPB?

Stand characteristics, snow pack, attack density, brood productivity, and overwintering life stage all factor into how cold temperatures affect overwintering MPB[1]. Deep snow pack and trees with thicker bark insulate MPB from cold ambient temperatures. Additionally, large-diameter trees store more heat than small and cool internally more slowly, keeping MPB warm for longer. The maternal and larval galleries that adults and larvae create make small air pockets that mitigate the effect of cold outside air, so there is less cold-related mortality in trees with high

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attack density and brood production. Late-instar larvae are the most cold-tolerant and tend to be the life stage that overwinters – this reduces the overall susceptibility of a population to cold temperatures in the winter.

So how cold did it get in February?

It was a tad warmer in the central and southern regions which experienced temperatures between -30 to -36°C (Fig. 1). Northern areas reached minimum temperatures between -36 to -42°C. In fact, the lowest recorded temperature was -46.9°C at a weather station 20 km north of Grande Cache on February 4th.

How much mortality is required to impact MPB populations at a landscape level?

During an outbreak, the sheer number of beetles makes a population very resilient to mortality. Consider this - each female produces around 60 eggs and 40 will be female. Therefore, a large percent of each generation must die in order to slow down an outbreak[1]. Dr. Kathy Bleiker, a bark beetle research scientist with the Canadian Forest Service, has extensively studied MPB cold tolerance in Alberta. She found that approximately 50% of larvae die when the temperature under the bark reaches about -35°C. At least 95% mortality is required to suppress an outbreak like the one in western Alberta which could occur at under bark temperatures of -38°C.

How fast can MPB populations recover after a frigid winter?

We are unsure how fast populations can recover but we know that they do. In the 1980's, a large outbreak in the Chilcotin region, British Columbia, collapsed due to two consecutive cold events in 1984 and 1985[2]. The population recovered by 1995, which was the beginning of the last massive outbreak of MPB in British Columbia.

So, was it cold enough?

The good news is that in some areas of Alberta we predict that more MPB larvae died this winter than had in previous years. We will better understand what the effect our cold February had on MPB in spring when we conduct surveys to assess overwintering mortality. Knowing that MPB populations are resilient, it is critical that the province exploit any additional overwinter mortality that may have occurred this winter and aggressively control MPB populations next winter - this will be our best opportunity to slow down the outbreak in the west.

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1Reviewed in Safranyik L., Carroll A. L. 2006. The biology and epidemiology of the mountain pine beetle in lodgepole pine forests, pp. 3–66. In Safranyik L., Wilson B. (eds.), The mountain pine beetle: a synthesis of its biology, management and impacts on lodgepole pine. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC.

2Safranyik, L., Linton, D.A. 1991. Unseasonably low fall and winter temperatures affecting mountain pine beetle and pine engraver beetle populations and damage in the British Columbia Chilcotin Region. Journal of the Entomological Society of British Columbia 88: 17-21.

Caroline Whitehouse - Edmonton

Been there, done that!

While the range of mountain pine beetle (MPB) has expanded in Alberta, folks of a certain age might have a feeling of déjà vu. Did you know that MPB attacks in the Cypress Hills and Crowsnest regions were actioned by the Alberta Forest Service as early as 1982? Then as now, the preferred approach was early detection and aggressive removal of infested trees. Red attacked trees were removed on Crown land as well as in provincial and national parks, which all carefully monitored the outbreak. Pioneering MPB research was also done at this time, including work on semiochemicals like pheromones. MPB was recorded in Willmore in 1997 and in Jasper National Park in 1999.

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The MPB outbreak of the early to mid-1980s also affected forests in the adjacent states and BC. Alberta's control measures included removing nearly 30,000 limber pine trees in southwestern Alberta. That was long before they were listed as Endangered species, although Alberta limber pines were succumbing to white pine blister rust as early as the 1950s.

Today, nobody knows what killed the iconic Burmis Tree marking the eastern gateway to the Crowsnest Pass. Was it MPB? Was it white pine blister rust? Did it waste away after too many admirers stood on its roots in sensitive thin soil to get a great photo? Albertans still treasure this striking snag, a designated provincial historic site along Highway 3.

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Jodie Krakowski - Edmonton

Explain the Connection: Forest Health and Forest Fire

Like all things in the boreal forest, bugs and diseases have evolved in response to the dynamics of disturbance. Insects and forest fire, human –caused or not, have historically been the main contributors to the disturbance regime and we are increasingly aware that the ecological benefits of maintaining fire on the landscape are broad-ranging. This is true within the context of insect and disease management where many parallels exist with the management of wildland fire. Both involve the protection of various forest resource values, occur at multiple spatial scales and rely on assessments of hazard and risk to coordinate decision making processes. Likewise, management strategies are adaptive and guided by science that probes complex issues to increase our understanding and abilities to set accurate objectives.

A two-way relationship exists between wildfire and forest health whereby disturbances from insects and disease influence potential fire behaviour through modifications to the fuels complex, while fire plays a key role in directly and indirectly regulating insect and disease patterns. Subsequently, forest health disturbance information can be used as a valuable instrument in wildfire management, and fire promoted as an effective tool to manage the impacts of insect and disease agents

Not far away are relevant examples of how insect and disease agents affect wildfire behaviour. In the case of the mountain pine beetle (MPB), the sequential after-effects of severe mortality in pine stands on potential fire behaviour are significant. A major increase in crown fuel volatility occurs initially as needles desiccate and remain on the tree for up to three years (red-phase). After needles drop, beginning the grey-phase, the fuel conditions again change dramatically as the continuity and density of canopy fuels decreases and surface fuels accumulate. Years later, depending on site conditions, trees or parts of them begin falling to the ground, adding coarse woody surface fuels capable of sustaining ground fire and producing large amounts of smoke. Such is the current situation in regions of British Columbia that were ravaged by the supreme beetles. Each disturbance agent (e.g. spruce budworm, lodgepole pine dwarf mistletoe, drought) is capable of contributing to fuel profile modifications in

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a variety of ways; in some cases, we have a good understanding of their impacts on fire behaviour, while more research is required in others.

Direct insect and disease mortality occurs as a result of consumption by fire but can vary depending on factors like intensity, timing and other fire characteristics, location of an insect (e.g. stem, branch, foliage, root, litter), and tolerance to fire. Agent-specific factors are greatly important in determining response to wildfire, but generally wildfire has been described as having a "cleansing effect" on localized occurrences of forest insects and disease. When outbreaks occur across larger scales however, wildfire may not be as effective at reducing populations through direct mortality.

Indirect effects of wildfire on insects and diseases play a larger role in their incidence in the forest. Host mortality has obvious negative outcomes for insect and disease populations relying on live materials, but will conversely provide opportunities to secondary agents more adapted to survival in dying, freshly killed or decomposing material. Low-intensity fire with sub-lethal effects on trees can make them more susceptible to some insects and disease, however new research is also finding that low-intensity fire can have a positive effect on induced defense capabilities in some trees. Fire disturbance reduces landscape-level susceptibility to agents associated with mature forests such as conifer bark beetles (fire suppression leading to increased susceptibility is one of the commonly-cited contributors to the current MPB outbreak), while potentially increasing susceptibility to those that occur in younger-aged forests. Long-term establishment, abundance and distribution of forest insect and disease agents are uniquely affected by large scale wildfire regimes.

Indirect effects of wildfire on insects and disease play a larger role…in the forest

Fire is a valuable management tool for managers of forest insects and disease. Small scale prescribed burning can be used in areas where a known infestation or growing local population occurs and results are safely achievable. For instance, control of lodgepole pine dwarf mistletoe, a widely-occurring parasitic plant, can be achieved through stand-replacing disturbance events that eliminate the living host. Incorporating spatially explicit forest health disturbance information, such as the extent and severity of a dwarf mistletoe infestation, would help to inform wildfire management decisions as to when and where benefits of fire can be applied as a control option.
As we look to the future, projections of drying Alberta landscapes include increased frequency of fire- and insect/disease-based disturbance. No greater has the need been to integrate insect and disease information into current wildfire risk management systems that are driven by the protection of values and the awareness of opportunities to apply fire. Forest health objectives will be achieved more effectively when fire is incorporated as a management strategy.

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Ryan Hermanutz – Peace River/High Level Forest Areas

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Drunken Trees and Hardy Bugs – How Climate Change is Affecting the Northern Forest

According to Environment Canada's records, the Northwest Territories has been one of most rapidly warming jurisdictions in North America. If the warming trend continues, some locations, such as Inuvik, are expected to experience as much as a 5℃ mean temperature increase by 2100. The long-term effects of such a dramatic change on forest ecosystems are yet uncertain, but some changes that are likely related to a warming trend are already being observed.

SBW defoliation in the Mackenzie Delta, 2015. Photo credit: GNWT

The most notable change is a northward shift of spruce budworm (SBW) outbreaks. Eastern spruce budworm (*Choristoneura fumiferana*) is a native and common pest in the NWT with a well-documented record of outbreaks along the Mackenzie Valley dating back to the 1950s. Its primary hosts are mature white spruce growing along major waterways and foothills. Historically, SBW has been present beyond the Arctic Circle at endemic levels and outbreaks have been noted along the Mackenzie River as far north as Fort Good Hope. However, since the early 2000s, severe defoliation started to become more common further north. This trend culminated in 2015 when the first known SBW outbreak was recorded in the Mackenzie Delta—a unique ecosystem of channels, lakes and ponds interspersed with the productive mature white and black spruce forest where the Mackenzie River flows into the Beaufort Sea. Over 100,000 hectares (ha) of moderate to severe defoliation was mapped that year, and it remains the most northern SBW outbreak observed in North America and possibly the world. Interestingly, the outbreak collapsed in the following year and no significant defoliation has been observed in the Delta since then. However, SBW still persists at very high population levels in the nearby high-banked Peel River valley just south of the Delta where it is more protected from the Arctic elements. Recent Canadian Forest Service research out of the Great Lakes Forestry Centre indicates the Delta/Peel River SBW populations are very different from other populations in Canada in respect to their cold tolerance. Populations at this latitude appear to develop faster at cool temperatures and slower at warm temperatures, which is the exact opposite of southern populations found across Canada.

Drunken forest at Scotty Creek, Dehcho Region. Photo credit: Wilfred Laurier University

Another example of a notable northward shift in pest activity is a recent outbreak of forest tent caterpillar (FTC) (*Malacosoma disstria*) observed in the South Slave region. Historically, FTC has been present in the NWT at endemic levels with the exception of an outbreak in the Dehcho region in the mid-1990s. However, in 2015-2018, a significant outbreak was observed in the Slave River basin. It coincided with the northern tent caterpillar (*Malacosoma californicum*) outbreak, which was reported for the first time in large numbers around Yellowknife, Norman Wells and as far north as Inuvik.

The warming climate can also impact our northern forests in a more direct way by affecting ground (and tree) stability as a result of rapidly thawing permafrost. Much of the black spruce-dominated peat plateaus across the NWT are underlain by discontinuous permafrost, which has been deteriorating due to warmer conditions. Thawing ice wedges underneath the peat cause trees to tilt at various angles, giving them a messy appearance. This phenomenon is sometimes called 'drunken forest' and is believed to be directly linked to impacts of a warming climate on permafrost-rich forest ecosystems.

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Evidence of degrading permafrost is even more apparent in non-forested, ice-rich landscapes where so-called thaw slumps can be observed. Slumps develop on hill slopes and usually occur along the shorelines of lakes, rivers and coastlines. Thaw slumps can reach up to 40 ha in area with headwalls up to 25 m high. Over the past few decades, the size and activity of slumps in northwestern NWT has increased, which can have significant ramifications for both infrastructure and water in the affected areas.

Series of thaw slumps in the Richardson Mountains. Photo credit: GNWT

There are other observed impacts that can likely be linked to a warming climate, but their nature is complex and the cause a result of compounding factors accelerated by warming conditions. For example, large areas of flooding have been observed in the southern NWT over the last couple of decades. It is not clear whether high water tables in some areas are a downstream effect of thawing permafrost or rather a result of recent fire activity nearby; or, perhaps, it is a compounding effect of both of these impacts. Another example is aspen decline observed in the Dehcho and South Slave regions. Severe droughts combined with unusually long-lasting outbreaks of aspen serpentine leafminer, along with a brief FTC outbreak in the mid-1990s, are believed to be the main causes of the decline. In lowland areas, a high water table was also identified as a potential cause. All of these root causes are greatly influenced by climate.

Tracking change is just the beginning

Long-term, consistent monitoring combined with targeted research is required to better understand these complex interactions. The northern boreal forest is natural disturbance driven, making it even more challenging to discern climate related impacts from natural disturbance regimes that are also changing due to warming conditions. Tracking change is just the beginning. Forest managers, researchers and policy makers need to know the underlying causes and rates of change to better understand adaptation and mitigation strategies. This also takes substantial commitment to accomplish. The Government of the Northwest Territories has been actively collaborating with federal and academic partners to advance the state of knowledge about the impacts of climate change on our forests. At present, a Vulnerability Assessment of the NWT Forest to Climate Change is currently being undertaken in collaboration with the Canadian Forest Service. This project will summarize current knowledge about the NWT forest and provide an outlook into future climate scenarios allowing for development of adaptation strategies.

For more information on the NWT Forest Health program, please contact Jakub_olesinski@gov.nt.ca

Jakub Olesinski, Ecosystem Forester
Government of the Northwest Territories, Environment and Natural Resources – Forest Management Division

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Native Bee Monitoring Program

In 2018 the Alberta Native Bee Council collaborated with researchers at the University of Calgary, Alberta Agriculture and Forestry, and Alberta Environment and Parks to implement province-wide sampling of native bees. These efforts will inform a more accurate inventory of native bee species and with repeated efforts will indicate changes in populations over time, and inform conservation efforts.

Bombus bohemicus

Photo: Dave Prescott

Our samples yielded almost 12,000 specimens from 70 locations across Alberta. To date, 90% of bumble bees have been processed (washed, dried, pinned, labelled, etc.) and about 40% identified. David Prescott, a Wildlife Biologist with Alberta Environment and Parks' (AEP), sampled an additional 31 sites and yielded 9,000 specimens (all of which are processed and identified). Our sampling when combined with AEP sampling has resulted in the most spatially robust sampling of native bees in Alberta. We added a new bumble bee species to the Alberta record: *Bombus sandersoni.* We now better understand the distribution of our native bees especially those of conservation concern including *Bombus occidentalis* and *Bombus terricola.* The AEP samples confirmed the presence of *Bombus bohemicus*, a federally listed endangered bumble bee species not reported in Alberta since 1997.

Sampling resulted in a new species of bumble bee being added to the Alberta record.

Our next steps are to complete bumble bee identification, process, and identify all other bees and to sample again in three to five years. The bulk of the specimens will be curated and stored at the University of Calgary's invertebrate museum. The Bee Council also intends to put together reference collections of bees and give these to schools throughout the province to facilitate education and understanding of native bees.

The Alberta Native Bee Council is so grateful for the support from all of those who helped realize our goal of implementing this monitoring program. We would like to acknowledge the Alberta Conservation Association, which provided funding for supplies to sample at 71 locations. This truly was a team effort with well over 100 volunteers and participants, the majority of which came from Alberta Agriculture and Forestry's, Wildfire Detection Unit. We would especially like to acknowledge Tim Klein and thank him for supporting this program. Thank you to everyone involved in this program, your efforts are helping to conserve native bees in Alberta!

For more information on native bees in Alberta visit www.albertanativebeecouncil.ca, find us on Facebook or email: info@albertanativebeecouncil.ca

Megan Evans - Alberta Native Bee Council

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Forest Health Officers

Bart McAnally
Calgary
403.297.8846
Bart.McAnally@gov.ab.ca

Andrea Sharpe
Hinton
780.865.6992
Andrea.Sharpe@gov.ab.ca

Jennifer MacCormick
Slave Lake
780.849.7409
Jennifer.MacCormick@gov.ab.ca

Devin Letourneau
Grande Prairie
780.538.5609
Devin.Letourneau@gov.ab.ca

Pam Melnick
Rocky Mountain House
403.845.8277
Pam.Melnick@gov.ab.ca

Ryan Hermanutz
Peace River
780.624.6448
Ryan.Hermanutz@gov.ab.ca

Allison Brown
Whitecourt
780.778.7202
Allison.Brown@gov.ab.ca

Fraser McKee
Lac La Biche
780.623.5393
Fraser.Mckee@gov.ab.ca

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Bugs & Diseases informs forestry-related personnel about current forest health issues.
Articles are welcome.

A Distant Memory

It seems, to me, like a distant memory.
It was (after all) months ago, you see.
The cold was severe,
A crisis was near,
And doom seemed impending, imminently.

Back in the winter of ought nineteen,
Came a cold unlike any our ancestors had seen.
The mercury dipped in February,
To an extent that was downright scary.
And I got colder than I've ever been.

I was just a larva, barely fourth instar.
Thought I was cold hardy, and ready by far.
But nothing prepared me for the coming deep freeze.
The chill bit right through to my poor proto–knees.
I felt my chance of survival was getting subpar.

But just when I thought no more could I bear,
Temperatures rose, and it became much more fair.
So it seems I will make it and keep on with living.
Grow to adult and emerge after spring.
And I wonder if anyone else will be there.

Yes, it seems long ago my demise could well be.
How my cohort has fared, well I guess I will see.
I hope, yes I hope that they aren't all dead,
From the cold that once filled my heart with dread.
And for them, like me, it will all seem to be – a distant memory.

Tom Hutchison - Edmonton