Bugs & Diseases

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Alberta's eye on forest health

Issue highlights:

Forest Health Training Opportunity

If you are looking to expand your knowledge of forest pests and their management, look no further. You won't want to miss the Forest Health 100 course being held at the Hinton Training Center from June 20th - 22nd. The purpose of this course is to show participants how to recognize and understand forest health issues as well as the best practices available to deal with them.

This three day, high-paced fun and Informative course offers an excellent balance of 1.5 days of class time consisting of lectures, exercises, and an extensive forest health sample collection and 1.5 days of field tours and activities. This course is intended as an introductory session to familiarize those with an interest in Forest Health and its integration into natural resource management practices.

The course is designed for forest industry professionals responsible for managing forests through the development, review and implementation of forest management and land management plans. It is also applicable to municipal government staff, natural resource professionals, or other individuals interested in the identification of forest health damaging agents and their management.

CAPF/CAPFT continuing competency credits will be available.

For more information contact Tom Hutchison, Course Chair, at tom.hutchison@gov.ab.ca

Pam Melnick—Rocky Mtn. House Forest Area

The Flight of the Spruce Beetle: Using Spruce Beetle Funnel Trap Data to Predict Flight Period

Trapping of spruce beetles (*Dendroctonus rufipennis*, Kirby) has been happening for a long time. However, most of the information that has been collected is just used by the people who collected it; there's not much published literature in regards to their flight periods. In the spring of 2017, Forest Health Officers (FHO's) across the province are setting up traps with the hopes that this might change!

Each FHO is setting up some sites that will have two funnel traps per site. While one trap would work to catch the beetles, there is a danger of it falling over or having wildlife (i.e. bears) get a little too curious about what the trap is doing there. Having two traps at the site will give us some back up in case something happens to the first one. Each trap will have spruce beetle lures placed on it and a collection cup at the bottom to catch all the insects that come to check out the trap. The traps are placed at least 40m away from any susceptible spruce trees to help deal with any spill over trees that could occur.

The traps will be checked weekly from April to the end of July and then every second week from August to October. When checked, all the contents from the collection cup will be put into Whirl-pak bags, labelled (trap number/location, date), kept cool, and then all the samples will be sent to Kathy Bleiker and her team at the Pacific Forestry Centre. They will be identifying all the insects that make their way into the trap. Who knows what they might find!

Jennifer MacCormick—Slave Lake Forest Area

New FHT for Grande Prairie

The Grande Prairie Forest Area would like to introduce the newest member of the Forest Health Team. Originally from Ontario, Michael graduated from Sir Sandford Fleming College as a Fish and Wildlife Technologist. He later completed a BSc in Biology at Trent University and has worked in fish, wildlife, forestry and resource management related positions over the past 6 years for provincial, state and federal governments as well as non-government organizations. Some of his most recent forestry experience has involved whitebark and limber Pine work with Parks Canada here in the province as well as Forest Values and Species-at-Risk work with the Ontario Ministry of Natural Resources and Forestry. Michael has a deep seated passion for working outdoors, enjoying the challenges and rewards that inherently come with field work. Outside of work, Michael pursues a wide variety of hobbies such as fly-fishing, hunting, hiking, cooking, gardening and foraging for wild edibles.

Welcome Mike!

Devin Letourneau — Grande Prairie Forest Area

MPB Summary for 2016/17

The mountain pine beetle control program has wrapped up for the winter. Within the Province's Leading Edge Management Zone, the number of infested trees identified at priority sites for control in the winter of 2016-17 increased only slightly from the 2015-16 control season over the same management area. The Province controlled approximately 92,000 trees this winter at 14,094 sites. Over the winter of 2015-16, 88,761 trees were controlled at 13,517 sites.

Aerial and ground surveys identified some noteworthy regional changes in current attack tree numbers:

- A general decrease in the number of current attack trees identified for control in the Grande Prairie and Whitecourt Forest Areas overall (35% reduction from the previous year)
- A significant increases in the number of current attack trees located for control in the Edson and Slave Lake Forest Areas (approximately 5- and 2-fold increases respectively). Evidence suggests MPB are immigrating into the Hinton region from infested areas within Jasper National Park.
- An increase in the number of current attack trees located for control in the Calgary Forest Area (approximately 835 infested trees controlled in the Bow Valley this year compared to 148 last year).

Usually around this time of year I am asked how successfully the beetles survived the winter. I could hazard a guess but I would rather wait until the over-winter mortality surveys (r-values) are completed this spring. These surveys will begin in mid-May and results should be available in late June. Looking back, survey results have indicated that province-wide MPB survival was better over the winter of 2015-16 compared to the previous two winters. This was likely the result of a mild winter and unusually warm spring. With this continuing trend of beetle over-wintering success throughout much of their current range, it is very unlikely that populations will naturally decline in the foreseeable future. Sustained and aggressive control action is the only current option to mitigate the environmental and economic impacts occurring in Alberta.

...aggressive control action is the only current option ...

Between the 2004-05 and 2016-17 fiscal years, $486 million has been spent managing mountain pine beetle in Alberta. Approximately 1.43 million infested trees have been controlled over this time period.

Mike Undershultz — Edmonton

Cumulative mortality classification of MPB-attacked stands in northwest Alberta

Quantifying cumulative pine mortality due to MPB is required in order to accurately assess the impact of this insect on Alberta's forests. Without this inventory, the province has limited information with which to assess provincial timber supply, prioritize seed collections for future pine reforestation, measure the impacts to wildlife habitat, predict fire behaviour, and assess hydrological impacts or to plan for the strategic rehabilitation of forests in order to maintain ecosystem function. An inventory of the number of trees infested by MPB does exist in areas of the province where active infestations are actively targeted for control purposes (i.e. the Leading Edge zone), the borders of which change annually depending on provincial priorities.

The goal of this project was to determine the cumulative mortality of pine killed by MPB for the northern portion of the province that has been not continuously surveyed and actively targeted for control purposes. This was accomplished using high-resolution imagery to classify the percent cumulative mortality of pine stands in select townships. This data provided the foundation for a decision support system that will be used to determine rehabilitation priorities.

…a decision support system to determine rehabilitation priorities.

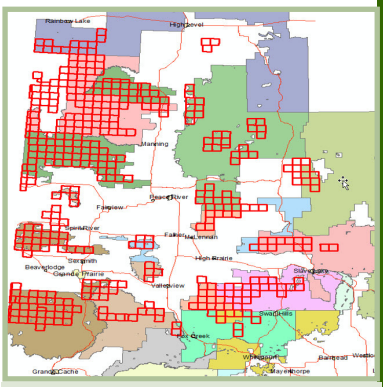


Fig. 1 Project area.

It was first established that single tree red and grey cumulative mortality classification was possible on a large scale using remote sensing technology. The project area was defined according to historic and current MPB presence as well as percent pine; ultimately 412 townships were selected for classification (Fig. 1). High-resolution orthographic imagery (0.3 and 0.4m) had been acquired in 2013 for 74 townships within the project area. Imagery for 278 townships was captured in August and September, 2014 and the remainder in September, 2015.

Fig. 2a

An analysis of the imagery was performed by a contractor and entailed classification of single pine trees as either red or grey (Fig. 2a). The results of the analysis were returned in the form of classified polygons of canopy killed. Polygons in 214 townships were checked for quality to ensure that no more than 15% of the trees were incorrectly classified. On average, data was well below the allowable error with an average of 4% of the dead trees missed during analysis. Image quality did occasionally impact classification ability and therefore some townships were more accurately assessed than others (Fig. 2b).

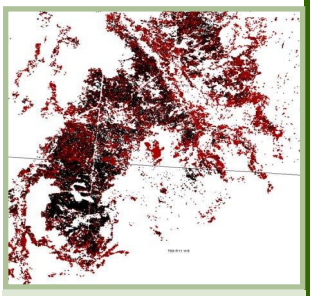
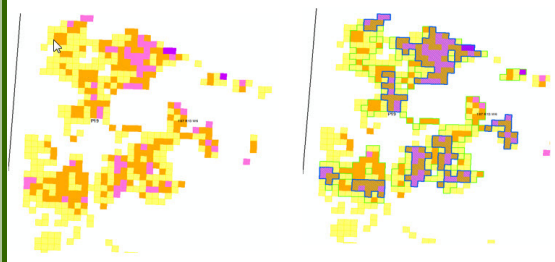


Fig. 2b

The classified polygon data was used to calculate the percent of trees killed in impacted units. To calculate this, the area of killed canopy in each polygon was assessed by 30m x 30m pixel grid over the project area. The mortality polygon numerator was divided by the 0.09 Ha denominator to derive the percent crown impact to the pixel. Pixels above a certain threshold



Pixel Based Est. BA Mortality- Disturbance Unit Creation- minimum 0.5Ha

Fig. 3

were grouped to create the disturbance unit polygons (Fig. 3) that would be considered dead and were ran through a decision support tool to determine which units should be prioritized for rehabilitation. The pixel approach was used as MPB caused pine mortality tends to be very patchy.

A further revision to this process was recently made in order to use estimated merchantable basal area (BA) mortality to define disturbance units rather than crown impact. A network of permanent sample plots in the areas of the province most heavily impacted by MPB was established and measured in 2015 and 2016. By comparing the image-based MPB mortality classification work on each PSP with the ground measurements, a correlation and adjustment factor was established for prediction of % BA mortality in each 30m x 30m pixel. This provides a more useful measure of stand impact than canopy mortality.

Disturbance unit polygons can be built from various % BA mortality thresholds depending on the use. Using a minimum 0.5 Ha size, adjacent pixels meeting the set threshold are grouped to create a disturbance unit.

By using 50% mortality of all merchantable basal area as a measure for a dead stand, the distribution of MPB caused pine mortality can be assessed. The disturbance units created for this threshold are used as an input to the Rehabilitation Candidate Stand Selection decision support tool created by the province to best identify high priority stands for rehabilitation to ensure the flow of ecosystem goods and services. 50% overall mortality to merchantable BA will then be established and utilized in future prioritization efforts. Figure 4 displays the distribution of units above the 50% threshold for BA mortality.

Brooks Horne, Senior Forester - Forest Rehabilitation Edmonton

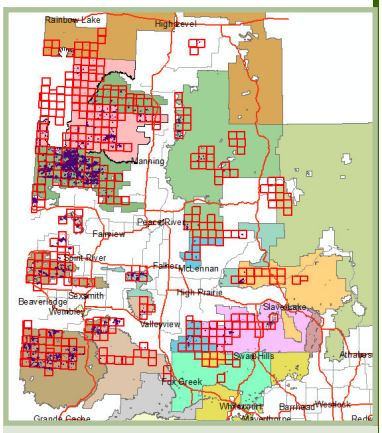


Fig. 4

Forest Health and Adaptation

The Golden Beetle Award

In the Forest Health & Adaptation section, we seek to foster good will and recognition within our group with our own special peer-to-peer award – The Golden Beetle. Each year this prestigious award is given by the previous year's honouree to one of his/her peers in recognition of on the job excellence. It was my honour to choose the recipient for this year's award…Colton Briggs.

Colton Briggs right, Tom Hutchison left.

Colton joined the forest health team as a wage Forest Health Assistant in 2013, working out of Whitecourt. In 2014 Colton successfully competed for the Forest Health Officer (FHO) position in the Whitecourt Forest Area. Colton does a really good job running his forest health program. Things get done (and done well) without a lot of fuss or bother – a well-oiled machine. Over time he has become comfortable with putting forward his opinions, observations, and suggestions to the forest health group. He has also become more involved with working groups and projects which inform forest health policies and operations provincially. I also admired the poise with which Colton handled what has to be the most tragic circumstance a program manager with a fatal MPB contractor helicopter crash in . The circumstance was, no doubt, even more close to Colton as he had been in a helicopter accident himself previously.

For these reasons and more, I believe that Colton is a worthy recipient for the 2016 Golden Beetle Award. Colton has exercised his duties as FHO with competence and professionalism – both in good times and while facing adversity. ***Good work Colton!***

Tom Hutchison - Edmonton

International Day of Forests 2017

The Food and Agriculture Organization (FAO) of the United Nations sent out a call for videos to celebrate this year's theme of 'Forests and Energy" for the International Day of Forests. People were asked to head out into their local forest with their smartphone and create a short video explaining why forests energize them.

Entries from around the globe were posted on Twitter, Facebook, Instagram and YouTube—even one from Aaron with his guitar in the forests of Vancouver, B.C.

Some of the videos can be viewed at the FAO Forestry Newsroom at http://www.fao.org/forestry/news/93019/en/ and many more at https://www.youtube.com/results?search_query=%23loveforests

Check them out!

Marian Jones - Rocky Mountain House Forest Area

Partnering With Jasper

The Edson Forest Area forest health team in Hinton have begun maintenance on their gas powered drills, ensuring the hole saws are sharpened and the spark plugs are replaced. It's an exciting time of year, as all of us are itching to know how the beetles endured the cold this winter or better yet, if the spring caused enough damage to the remaining population.

It's always valuable to know your area's trends especially when adjacent areas have such a significant influence. It can be hard to predict what's to come when the beetles emerge in the summer. This has caused great concern to stakeholders, especially the forest Industry and recreational users. Fortunately for the Edson Forest Area, an agreement between Parks Canada and the Province of Alberta exists. This agreement allows the forest health staff to conduct surveys to monitor mountain pine beetle within Jasper National Park (JNP).

Although population surveys have been done for many years in JNP, none were as extensive as in the spring of 2015. Reports of hundreds of infested trees within Whistler Campground and near the Jasper town site were coming in. Once it was confirmed that the numbers were high, we were asked to assist with population forecasts followed by green to red surveys the subsequent fall.

What is most beneficial about this partnership is that we are able to share resources, equipment and experience. We can collect the data with the same techniques and standards, allowing us to be confident in our comparison to the rest of the province. The information that we're collecting is an extra tool; another piece of the puzzle.

Caroline Charbonneau - Edson Forest Area

Tree Infection and Mortality After MPB Attack

fRI Research has produced a Quick Note on the results of 240 permanent sample plots reserved to monitor the after-effects of mountain pine attack. The purpose of this study is to "*assess the impact of MPB infestation on tree mortality, growth of residual trees, tree regeneration, and development of non-tree vegetation in attacked stands.*"

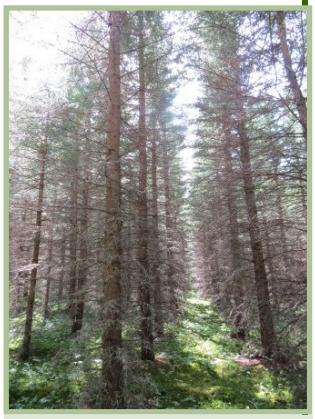
The preliminary analysis of these plots "*are restricted to rates of infection, mortality and fall-down.*" and an be found here https://friresearch.ca/sites/default/files/FGrOW_2017_04_QuickNote-2.pdf

It's hoped that future analysis will provide some insight into the causes of variation in infection and mortality.

Caroline Whitehouse - Edmonton

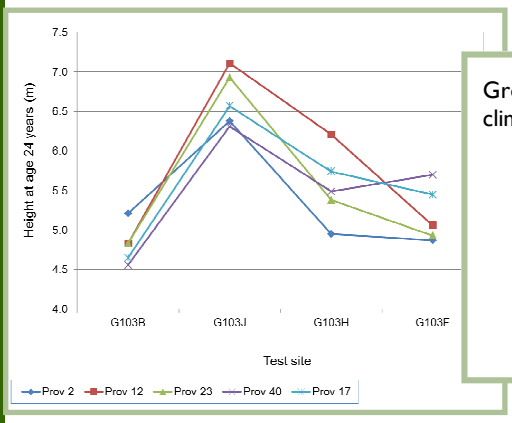
Adapting Alberta Forests to Climate Change Begins With Seed

The genetic mosaic of forest tree populations gives us an amazing tool to appreciate the role of climate as a potent agent of natural selection. Through differential survival and reproduction, climate acts as a sieve that sorts native plant populations according to the environments in which frequencies of their suitable genes are maximized. This process called adaptation has been the reason for the choice and use of seed in reforestation for over two hundred years. Foresters understand that artificially regenerated forests must have safeguards to continually adjust genetically (evolve) according to the constraints of their ever-changing abiotic and biotic environments. Choice of an appropriate seed source and retention of adequate genetic diversity in reforestation seed is what it takes to buffer forests against environmental changes.



White spruce provenance trials in Edson Alberta (37 years old).

Monitoring mortality, growth, weather-related damages, phenology and susceptibility to insects and diseases of tree populations planted on a range of climates allows us to choose seed sources for artificial forest regeneration without severely compromising forest health and productivity. Since 1980, Alberta has maintained a series of provenance trials for spruce, pines, tamarack and Douglas-fir that have enabled us to develop seed transfer guidelines in the current climate while infusing climate change adaptation measures in the interim.



Growth of five provenances on four climatically different sites.

Prov 2:	(58°44'N; 335m)
Prov 12:	(54°38N; 610m)
Prov 17:	(54°14'N; 610m)
Prov 23:	(56°34'N; 762m)
Prov 40:	(52°10'N; 1341m)
G103B:	(59°08'N; 370m)
G103J:	(56°23'N; 540m)
G103H:	(55°17'N; 625m)
G103F:	(52°15'N; 1220m)

Beginning spring 2018 and 2019, the Alberta government in collaboration with forest companies and the University of Alberta will establish new series of provenance trials for white spruce and lodgepole-jack pine, respectively. Each series will have about 300 provenances sampled from across the seed zones and breeding regions. The lodgepole-jack pine series will include 20 provenances from British Columbia. White spruce trials will be replicated on five sites whereas pine trials will be on four sites. These sites span a wider range of climates than existing trials and builds on the knowledge gained from the existing provenance and progeny trials. The new trials will give us data to address climate change adaptation for environmental stresses such as drought which will limit forest health and productivity in the future.

...data to address climate change adaptation ...

Deogratias Rweyongeza , Senior Geneticist

Northern Tent Caterpillar—Part Two

An infestation of northern tent caterpillars, *Malacosoma californicum pluviale,* can be determined by the presence of the silken tents constructed by young larvae following bud-break. Young larvae can often be observed on or inside the tent, or in groups near the tent. Once the larvae reach the fourth and fifth instar stage and leave the tent to feed solitarily, defoliation of branches becomes more noticeable as the larvae increase their feeding. On small infestations, single or multiple branches of an infested tree may be stripped of foliage. In larger infestations, entire trees and large areas become completely denuded. Where defoliation is severe, clusters of leaves in which the larvae have pupated may remain visible throughout the late summer, fall, and winter months.[2,4]

Fig 6. Silk and leaf structure

The importance of northern tent caterpillar as a forest health agent varies across its geographic range. Throughout most of its range, defoliation by northern tent caterpillar tends to occur as localized events with the insect being more of a general nuisance than a pest of serious concern.[3,4,5,7] Outbreaks of northern tent caterpillar tend to be more frequent, and of greater extent, in the coastal areas of the insect's range. Increases in northern tent caterpillar activity occur every 5 – 12 years and usually persist for 2 – 3 years before subsiding to low levels.[2,4,7] In southern British Columbia, Canada, large outbreaks with moderate and severe defoliation occurred in the 1930s, mid-1940s, 1955-57, 1961-64, 1968-70, 1974-77, 1984-88, 1992-93.[4,7] During large outbreaks, defoliation by northern tent caterpillar can be very severe, especially on aspen hosts, and cover thousands of hectares that can be easily observed from fixed-wing aircraft.[2] Repeated defoliation on aspen and red alder can result in branch die-back, top-kill, and reduced growth. On fruit-bearing trees, repeated defoliation can lead to reduced fruit production.[2]

Efforts control outbreaks of northern tent caterpillar are limited due to the low economic importance of the species and the small amount of damage generally caused by the insect. Natural control mechanisms include natural enemies such as egg and larval parasitoids, predators, bacteria, and viruses as well as factors associated with plant-insect interactions, density dependent relationships, and weather events.

There are over 36 species of natural enemies that target and feed on northern tent caterpillar.[2] Additionally, a nuclear polyhedrosis virus can infect larvae, cause widespread and rapid larval mortality, and help to end outbreaks.[4] Moreover, sub-lethal infection of larvae by the nuclear polyhedrosis virus reduces the reproductive output of females during the adult moth life-stage, therefore reducing the number of offspring produced by the female, and lowering the number of individuals that comprise the successive generation of insects.[7] Sub-lethal infection of larvae by the nuclear polyhedrosis virus can also manifest as trans-generational reproductive complications such that offspring of virus-infected parents also display reduced pupal mass and reduced reproductive output.[7] Viral infection is transmitted more rapidly in high-density populations of northern tent caterpillar due to increased larval movement throughout the host tree resulting in interactions between larvae and more opportunities to infect other individuals.[7]

Figure 7. Adult NTC. Colour variation of the adults and banding on the forewings.

Other natural phenomenon that may help control outbreaks of northern tent caterpillar include relationships between the insect and the host plant related to foliage quality and quantity. Northern tent caterpillar that feed on the foliage of host plants that have experienced repeated defoliated during a multi-year caterpillar outbreak display significantly smaller body size than larvae that feed on foliage of plants that have not been recently defoliated. The reduction in larval growth and body size may be due to lower nutritional content within the foliage of previously defoliated hosts, or higher levels of defensive compounds.[7,9] The effect of reduced foliage quality on the biology of northern tent caterpillar is complex, but may result in reduced larval growth and reduced adult reproductive success.[9] Reductions in the quantity of foliage available to developing northern tent caterpillar larvae during outbreaks also negatively affects larval survival, developmental rate, larval and pupal mass, and adult reproductive ability.[8]

Weather events are also important for the natural control of northern tent caterpillar. Especially important in regulating populations of northern tent caterpillars are late spring frosts that occurrence after the young larvae have hatched and that result in severe mortality to the young larvae. Such frost events can cause the near-complete collapse of an infestation in a single year.[2,4]

To control infestations that are localized to single trees or small homeowner properties there are options for both physical and chemical control. To physically control northern tent caterpillar on small trees, it is possible to handpick and remove the egg masses from the tree before egg hatch in the spring. After egg hatch, tents containing the larvae can be removed and destroyed. Options for removing the tent include dismantling the tent leaving the branch intact, or, pruning out the branch with the adhering tent. Seal the removed tents in plastic bags to prevent the escape of larvae, or, immerse tents in soapy water to kill the larvae. Young larvae (but not the late instars) return to the tent in the evening for shelter after foraging amid the foliage throughout the day. Therefore, it is suggested to remove tents early in the morning prior to the larvae leaving the tent to forage, or, late in the evening after the larvae have returned from foraging. This will ensure that as many larvae as possible are within the tent at the time it is removed from the tree.[2,4]

While not a control method that is often used, the bio-insecticide *Bacillus thuringiensis kurstaki* may be used to control populations of the northern tent caterpillar on large trees, across large areas of human habitation, or areas required for timber or fibre production. Because *Bacillus thuringiensis kurstaki* is toxic to butterflies and moths (i.e., Lepidoptera) generally, it is highly recommended that homeowners consult with a forest health or tree care professional prior to using the bio-insecticide in order to determine if chemical control is actually required. Homeowner consultation with a forest health or tree care professional will help limit the unintentional killing of non-target butterfly and moth species.

Fig 3. Mature, late instar NTC larvae.

Although the northern tent caterpillar is not encountered in Alberta as often as the forest tent caterpillar, the striking orange and black larvae are worth looking out for and are deserving of a second look if you happen to spot a tree that hosts an infestation of this interesting insect.

Fraser McKee—Lac La Biche & Ft. McMurray Forest Areas

Part One of this article (December 2016) focused on distribution, hosts and the life cycle of the northern tent caterpillar.

References cited

1 Baker, W.L. 1972. Eastern forest insects. Miscellaneous Publication # 1175. USDA Forest Service.

2 Ciesla, W.M. & Ragenovich, I.R. 2008. Western tent caterpillar. Forest Insect & Disease Leaflet 119, USDA Forest Service.

3 Furniss, R.L. & Caroline, V.M. 1992. Western forest insects. Miscellaneous Publication # 1339. USD Forest Service.

4 Garbutt, R. & Wood, C.S. 1993. Northern tent caterpillar. Forest Pest Disease Leaflet 4. Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, BC, Canada.

5 Ives, W.G.H. & Wong, H.R. 1988. Tree and shrub insects of the prairie provinces. Information Report NOR-X-292. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, AB, Canada.

6 Moore, L.V., Myers, J.H. & Eng, R. 1988. Western tent caterpillars prefer the sunny side of the tree, but why? Oikos 51(3): 321-326.

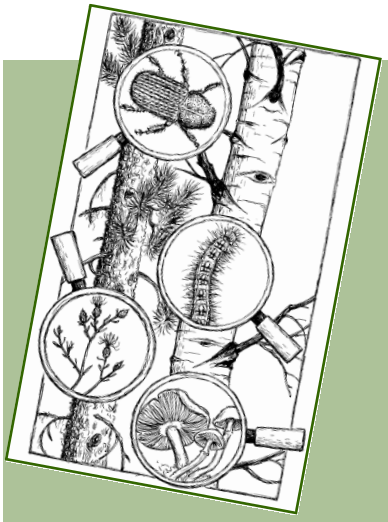
7 Myers, J.H. 2000. Population fluctuations of the western tent caterpillar in southwestern British Columbia. Population Ecology 42: 231-241.

8 Myers, J.H., Cory, J.S., Ericsson, J.D. & Tseng, M.L. 2011. The effect of food limitation on immunity factors and disease resistance in the western tent caterpillar. Oecologia 167(3): 647-655.

9 Sarfraz, R.M., Cory, J.S. & Myers, J.H. 2013. Life-history consequences and disease resistance of western tent caterpillars in response to localised, herbivore-induced changes in alder leaf quality. Ecological Entomology 38: 61-67.

Photo credits

Fig. 3 – Jerald E. Dewey, USDA Forest Service, Bugwood.org
Fig. 6 – William Ciesla, Forest Health Management International, Bugwood.org
Fig. 7 – Jerald E. Dewey, USDA Forest Service, Bugwood.org



The Ballad of Ol' Marty

No spring chicken when he joined the team
Kinda long in the tooth, or so it would seem
A scruffy mountain man, not a suit from academe
Over time he would come to be held in high esteem
His name… Marty, Marty-e-e-e, Ol ' Marty

Didn't claim to have a lot of learnin' from books
Said he'd gotten through life on his wit and his looks
Rules of grammar it seems he sometimes mistooks
Came from a place with a lot of chinooks
His name… Marty, Marty-e-e-e, Ol ' Marty

Pretty good with numbers, or so he would say
'Cept for mixin' 4s and 7s the occasional day
Full of cringe worthy jokes every day
Made quite an impression along the way
His name… Marty, Marty-e-e-e, Ol ' Marty

In recent years he had the odd scare
Flyin' into trees, fightin' off a bear
Needed a change of scene, and a change of underwear
So he bid us adieu, with little fanfare
His name… Marty, Marty-e-e-e, Ol ' Marty

We miss the ol' man, now that he's left
Seems the Forest Health section is somewhat bereft
The source of corny jokes from our group has been cleft
And there's really no one else who could be quite as deft
His name… Marty, Marty-e-e-e, Ol ' Marty
So long Marty, Marty-e-e-e, Ol ' Marty

Tom Hutchison—Edmonton

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