Annual Report 2017

Forest Health and Adaptation



Alberta

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Executive summary

The 2017 Forest Health and Adaptation Annual Report summarizes provincial aerial and ground survey data. This data is used to assess disturbance caused by biotic and abiotic forest damage agents, and the details regarding the management of insects and diseases. Summaries of forest genetics research, seed research, collection and storage are also included in this report.

Mountain pine beetle is the primary bark beetle causing tree mortality in Alberta. Single tree cut-and-burn control operations were used to remove 92,230 mountain pine beetle infested trees. Spruce beetle activity continued to occur at endemic levels. Aspen defoliation was largely attributed to forest tent caterpillar and large aspen tortrix. Spruce budworm populations continued to decrease since peaking in 2012. Die-back has affected 350,158 hectares of forest which, in aspen stands, can mainly be attributed to drought and repeated defoliation. Pine needle cast affected 354,898 hectares of regenerating and mature pine.

The Alberta Tree Improvement and Seed Centre received 256 new seedlots representing 38 different species for registration and storage in 2017. Over 1,000 kilogram of tree, shrub, grass, and forb seed were withdrawn from the seed bank for reclamation and reforestation projects. Research on whitebark and limber pine seed longevity and rust resistance continued in 2017.

Canada thistle, scentless chamomile, perennial sow thistle and tall buttercup were the most common invasive plants noted during 2017 surveys. In 2017, 95 per cent of prohibited noxious infestations on Forestry Division sites were controlled and overall 68 per cent of the infested survey area was managed. Biological control was successfully employed to manage infestations of hound's tongue, scentless chamomile, and yellow toadflax.

Alberta Agriculture and Forestry participated in Canadian Food Inspection Agency-led surveys to detect gypsy moths and assisted with the Climate Change Impacts on the Productivity and Health of Aspen project led by the Canadian Forest Service. Other collaborative projects included the implementation of plans for the recovery of whitebark and limber pine. Department staff also assisted with forest condition surveys for the Wood Buffalo Environmental Association's Terrestrial Environmental Effects Monitoring program.

Staff participated in and/or led events to increase awareness about forest health damage agents, forest genetics and tree improvement. These events included training courses, community outreach events, and guest lectures at academic institutions. Activities performed by staff ranged from operating information booths to giving detailed public presentations about forest health.

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Introduction

Alberta is covered by approximately 35 million hectares of forest. Natural disturbance caused by insect and disease are crucial for maintaining the health and resiliency of Alberta's forests. These same disturbances can also lead to forest loss and place aesthetic, habitat and resource-based values at risk. Monitoring forest health to determine the extent and intensity of insect and disease disturbance informs government and industry practices to ensure Alberta's forests are resilient and sustainable.

This 2017 report marks the 20-year anniversary of the Forest Health and Adaptation Annual Report. In the late 1980's, the Forest Health Branch carried out pest surveys in collaboration with the Forest Insect and Disease Survey (FIDS), Canadian Forest Service. FIDS reported on the forest insect and disease conditions on behalf of Alberta. Unfortunately, these reports were discontinued when FIDS program concluded in 1995. The first Forest Health Branch report was published in 1997 to ensure that resource managers and the general public continued to receive information about pest detection and monitoring, and management programs carried out within the province.

Since that time, the Forest Health Branch was renamed as the Forest Health and Adaptation Section – Ministry of Agriculture and Forestry (AAF). The Section continues to monitor disturbances in the Green Area (Fig. 1) using aerial and ground surveys. The current annual report stays true to the Branch's original mandate to inform resource managers and the general public, and communicate the expanded mandate of the Forest Health and Adaptation Section.

Alberta Agriculture and Forestry has acknowledged that climate is affecting forest ecosystem dynamics. As such, the scope of forest health surveys conducted by AAF were broadened to include a wider variety of damage agents. AAF maps damage caused by climate/weather (e.g. blowdown, hail, drought stress); agents that have potential for wider-spread impacts (e.g. spruce beetle); and/or, previously innocuous pests that could become more destructive due to changing environmental or host conditions.

The management of forest genetic resources for biodiversity, conservation and the maintenance of forest health and productivity is another important mandate for AAF. Applied research is conducted at the Alberta Tree Improvement and Seed Centre field sites, which drives policy development, forest genetic resource management practices and applied tree breeding to meet program objectives.

This 2017 report provides a summary of major forest damage agents (excluding wildfire disturbance) surveyed in the same year. Forest genetic resource activities performed in 2017 are also reported within this document.

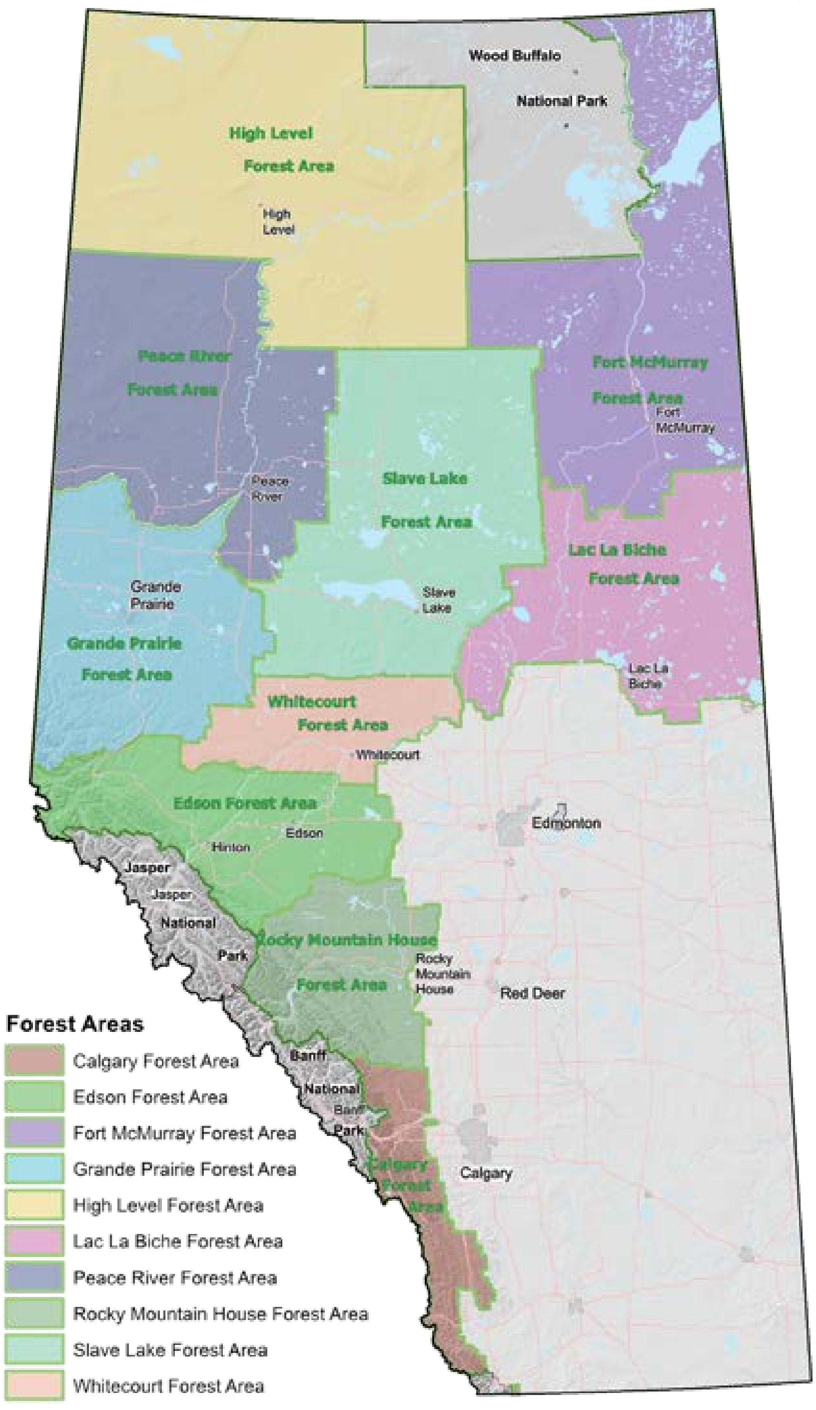

Figure 1. 2017 Alberta Forest Area boundaries.

Bark beetles

Mountain pine beetle

Activities for the Alberta mountain pine beetle (*Dendroctonus ponderosae*) management program occurred between April 1, 2017 and March 31, 2018. Details of which are outlined in Alberta's management strategy.

Mountain Pine Beetle

Population forecast surveys

Population forecast surveys are conducted each spring to assess the overwintering success of MPB and provide a relative measure of potential female productivity. These surveys are based on r-values, which are calculated by summing all live MPB life-stages for each plot and dividing that value by the sum of all attack starts from the previous year.

Surveys conducted at 80 sites (323 trees) in 2017 predicted overall lower population success (Fig. 2) compared to 2016. Throughout the majority of its core range, predicted female reproductive success varied from low to high, which is indicative of decreasing, static, and increasing populations. Of the sites sampled, 14 per cent predicted low, 46 per cent predicted moderate, and 19 per cent predicted high success. Extremely high female productivity was noted at just one site, which was south of Grande Prairie. Surveys were not conducted in northwestern Alberta due to the lack of ground accessible infested sites.

Long distance dispersal monitoring

Aggregation pheromones are used to monitor the presence or absence of MPB along the eastern slopes of the Rocky Mountains and in eastern Alberta 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. 3, Table 1). Provincially, attack intensities were similar to those observed in 2016 with the exception of increased presence in the Edson Forest Area. In the Lac La Biche and Fort McMurray Forest Areas, MPB was absent from most sites (79 per cent) and zero sites were mass-attacked which was similar to the pattern observed in 2016. In

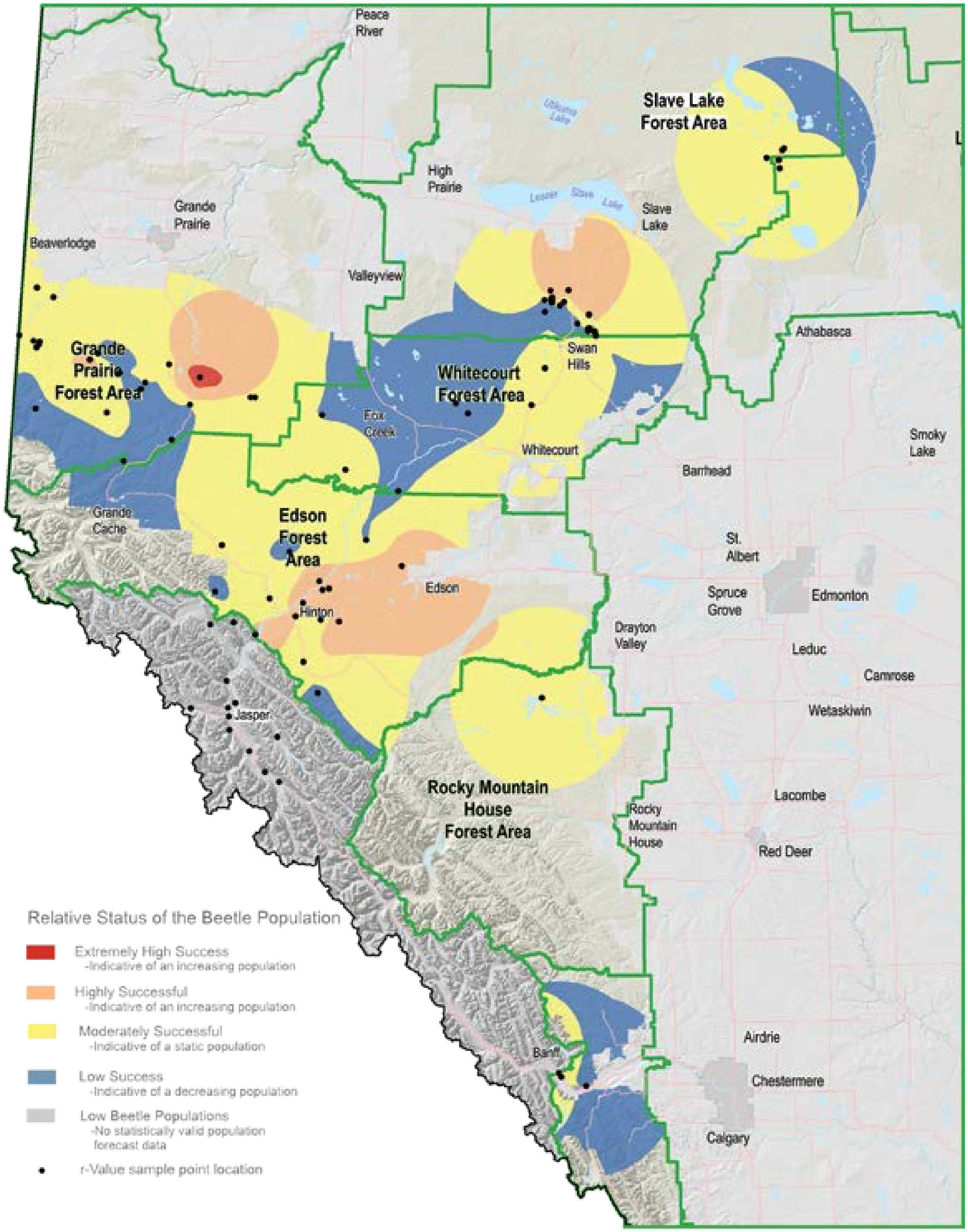

Figure 2. Relative overwintering success of mountain pine beetle based on r-value surveys.

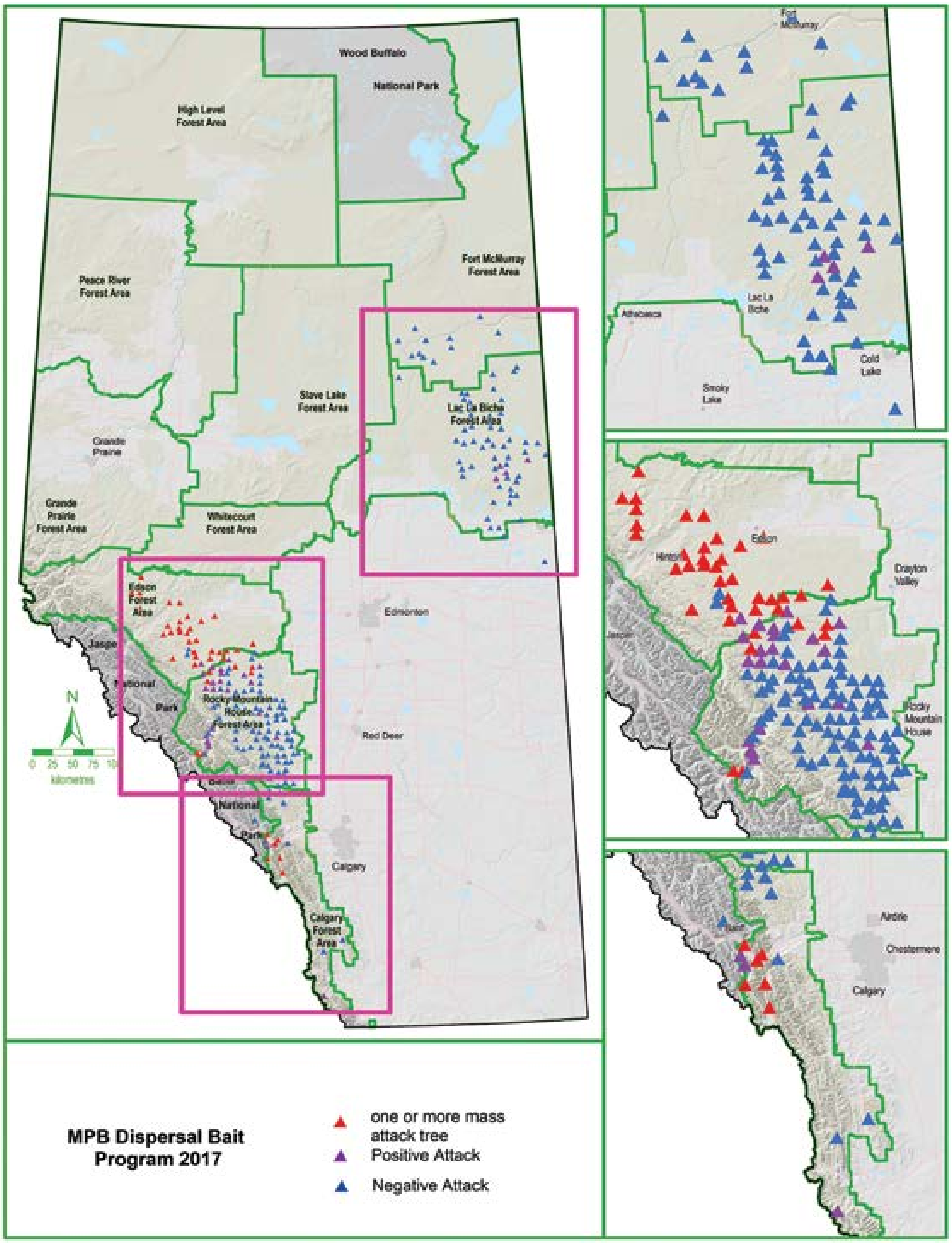

Figure 3. Mountain pine beetle long-distance dispersal bait survey results.

Table 1. The number of sites monitored using mountain pine beetle dispersal baits.

Forest Area	Absent	Present	Mass-attack
Calgary			
2016	10	4	4
2017	6	3	6
Edson			
2016	2	5	46
2017	4	13	36
High Level			
2016	2	0	0
2017	--	--	--
Lac La Biche & Ft. McMurray			
2016	20	9	1
2017	56	15	0
Rocky Mountain House			
2016	82	16	3
2017	95	11	3

*Attack categories: absent (zero trees attacked), present (at least one tree with < 40 attacks) and mass-attack (at least one tree with ≥ 40 attacks).

the central region of the Rocky Mountains, MPB mass-attacked fewer sites in 2017 compared to 2016 (68 per cent versus 87 per cent) but was present at more sites (25 per cent in 2017 and 9 per cent in 2016). In southern Alberta, MPB continued to be largely absent from 81 per cent of sites, present at 11 per cent of sites and mass-attacked trees at 7 per cent of sites.

Aerial surveys

Aerial surveys are conducted in late summer and early fall to detect red-crowned pine trees symptomatic of MPB infestations. Generally, groups of three or more pine trees with red crowns are recorded using sketch mapping and heli-GPS in regions prioritized for control activities. The same region is not necessarily surveyed every year because of changes in control priorities; additionally survey coverage does not span the province. Having said that, similar regions of the province were prioritized for control activity since 2014, and aerial surveys were conducted over comparable areas in 2017 (Fig. 4).

AAF detected 89,520 red trees spread over 17,677 sites, which was an increase of 23 per cent compared to 2016 (72,571 trees at 16,317 sites) (Fig. 5). The majority of population growth occurred in the Edson Forest Area; a four-fold increase in the number of red trees and red tree sites was observed in 2017 compared to 2016. The number of red trees decreased in the Grande Prairie and Whitecourt Forest Areas, and remained mostly unchanged in the Slave Lake Forest Area.

Green-to-red ratios

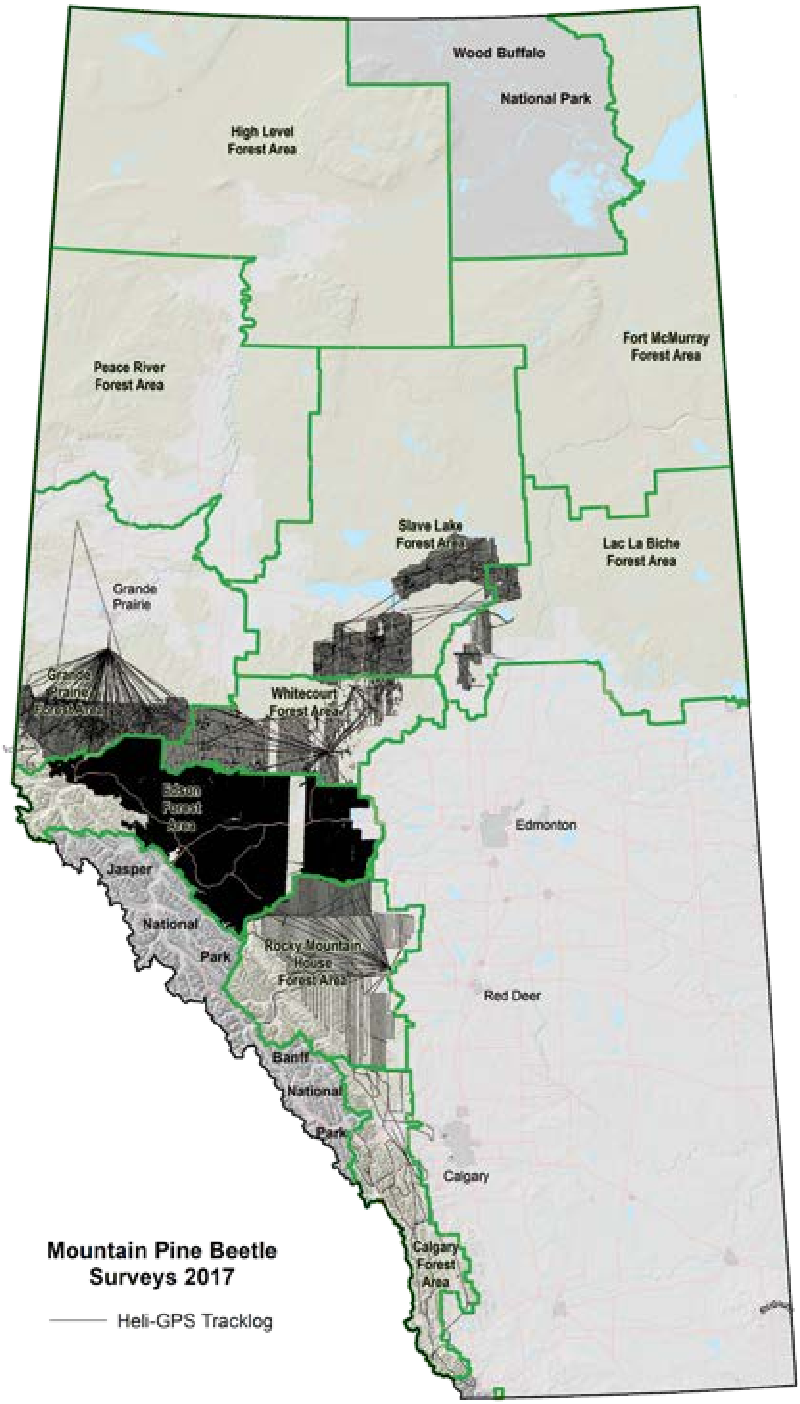

Figure 4. Heli-GPS track log for mountain pine beetle-killed red tree aerial surveys.

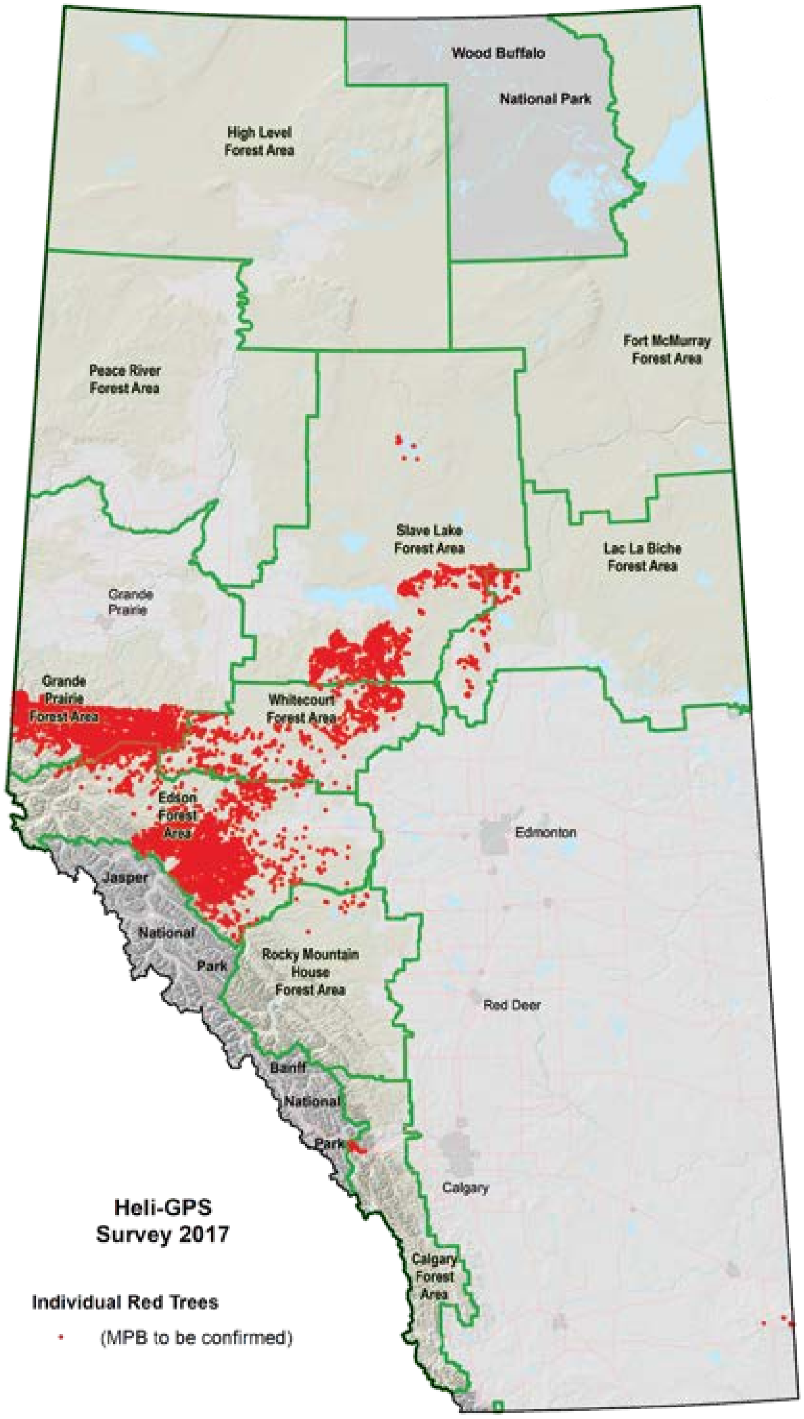

Figure 5. Red-crowned pines, suspected of being killed by mountain pine beetle, detected during aerial surveys.

Green-to-red ratio surveys are conducted in the fall to assess the relative success of MPB during that flight season. These surveys are based on a ratio of green attack (trees with current year attacks which retain green crowns) to red attack (trees with red crowns, attacked the previous year) trees and is calculated by site. A value less than 1.0 suggests a decreasing population; 1.1 – 3.0 indicates a stable population while a value greater than 3.0 suggests that the population is expanding.

Surveys were carried out at 468 plots (Fig. 6). The majority of plots predicted low population growth (36 per cent) while the number of plots that predicted high population expansion remained stable between 2016 at 2017 at 29 per cent.

Mountain pine beetle infested-tree treatment program

AAF uses a spatial Decision Support System (DSS) to prioritize sites survey and control. The DSS categorizes sites recorded during heli-GPS surveys into five spread risk categories, varying from very low to extreme, based on aspects of MPB biology and stand characteristics. The goal is to survey and control trees at 80 per cent or more of the sites in the Leading-Edge and Active Holding zones that rank as moderate, high or extreme spread risk (Fig. 7).

Cut and burn operation Canmore to treat mountain pine beetle infested trees.

<u>Level 1 single-tree survey and control</u>

Concentric ground surveys to assess trees for management are completed each year in late fall and early winter. These trees are removed from the landscape during single tree cut-and-burn control operations conducted in the winter. The number of trees controlled increased nominally from 91,997 to 92,230 between 2016 and 2017. Since 2006, AAF has controlled approximately 1.5 million MPB-infested pine trees.

A portion of the area west of Hinton was initially designated as Inactive Holding zone. As the survey and control program progressed over the winter, all unallocated resources were used to push the Leading Edge zone west. As a result, aggressive control action continued west almost to the Town of Hinton.

<u>Mountain pine beetle municipal grant program</u>

AAF administers a municipal grant program that provides funding support for municipalities in the Leading Edge zone to conduct MPB management activities. During 2016-2017 fiscal year, the counties of Woodlands and Yellowhead, as well as the towns of Canmore, Edson, Hinton and Whitecourt received grant funding to control a total of 1,372 infested trees.

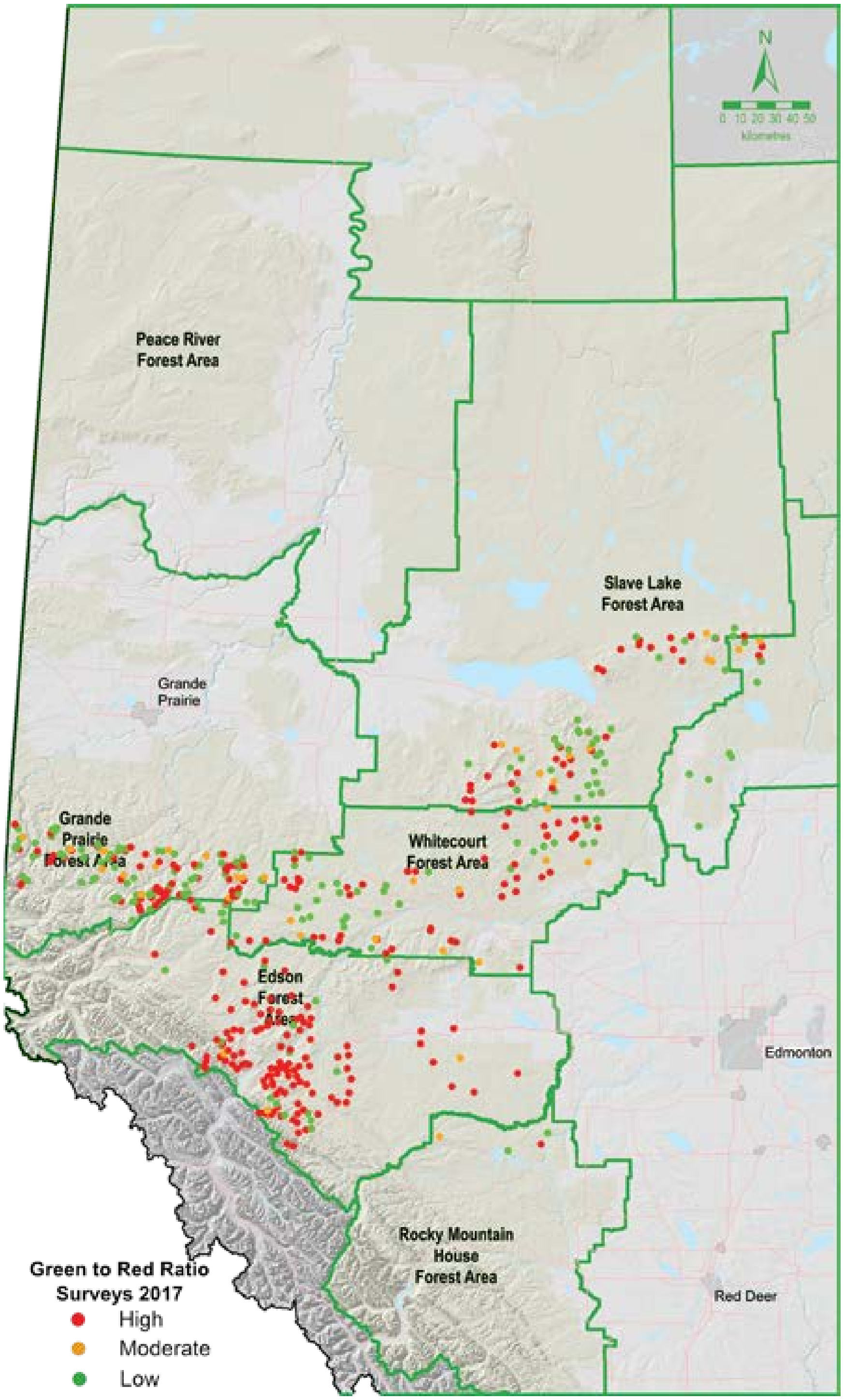

Figure 6. Green to red attack ratio survey results.

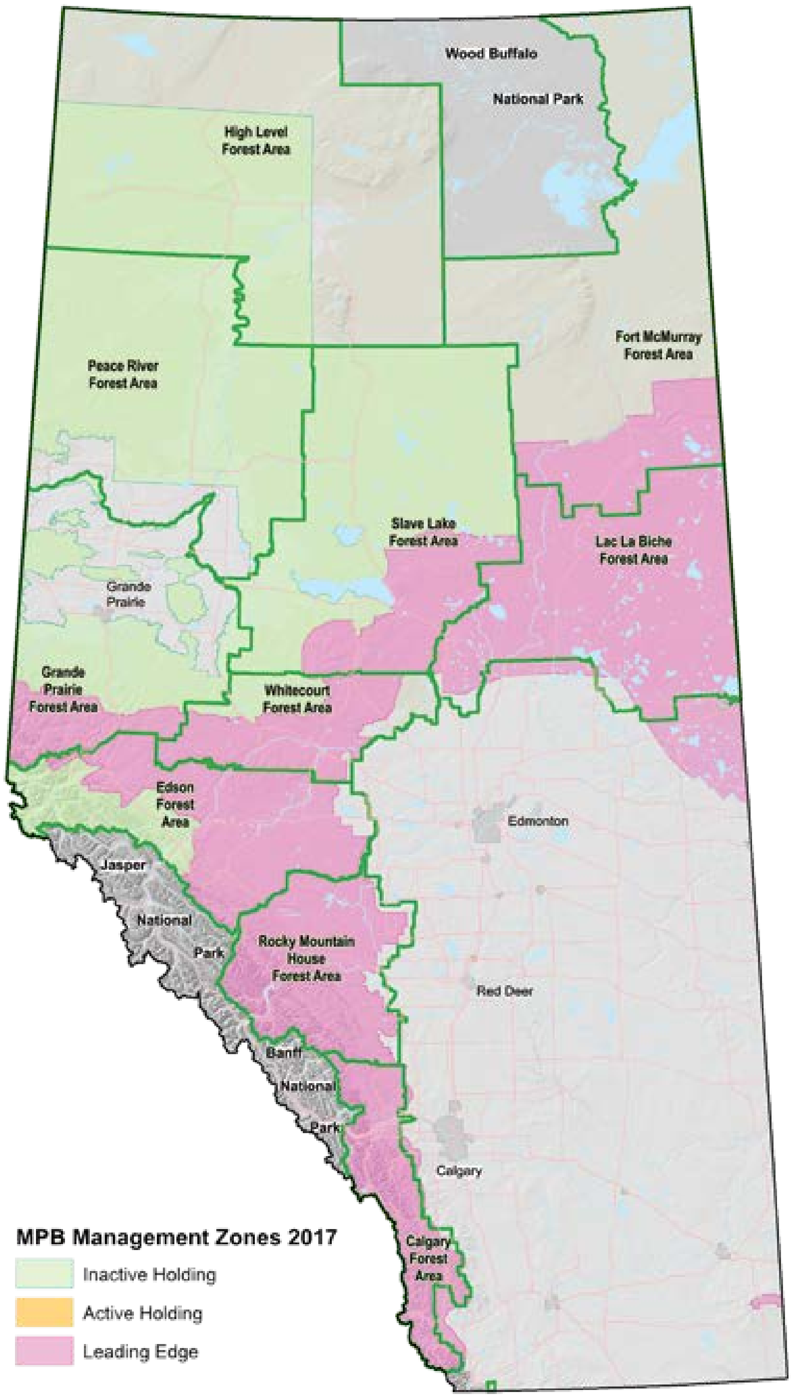

Figure 7. Mountain pine beetle management zones in Alberta.

Eastern larch beetle

Eastern larch beetle (*Dendroctonus simplex*) is endemic to Alberta's forests and is generally a secondary bark beetle that infests stressed larch. Localized infestations of this beetle occur when larch is reduced in vigor, most often by larch sawfly defoliation or abiotic conditions. Eastern larch beetle infestations were identified in the Rocky Mountain House, Whitecourt, Lac La Biche and Fort McMurray Forest Areas in 2017. A total of 3,139 hectares of infested stands were mapped and the severity of these infestations varied widely across all sites.

Eastern Larch Beetle

Spruce beetle

Spruce beetle (*Dendroctonus rufipennis*) is native to the forests across Alberta and prefers white and Engelmann spruce but will occasionally infest black spruce. These secondary bark beetles typically attack low vigour or dead spruce trees that result from natural disturbance events. Localized outbreaks may occur when populations increase to levels that allow spruce beetles to attack and kill vigorous mature trees.

In 2017, 3,139 hectares of spruce beetle-infested stands were scattered throughout the province (Figs. 8) which is characteristic of endemic populations. In 2016, AAF mapped cumulative spruce mortality in order to create a baseline from which to track population expansion. The hectares mapped in 2017 represents recent spruce mortality.

Figure 8. Standing grey-attack spruce trees from old spruce beetle infestation.

Spruce beetle adult and larva

Defoliators

Aspen defoliators

Aspen defoliators were responsible for 40 per cent of all damage observed during aerial overview surveys (Fig. 9, Table 2). Over half of the provincial aspen defoliation can still be attributed to forest tent caterpillar, even though populations have been decreasing since 2015. Large aspen tortrix populations have been on the rise in southern Alberta in recent years, and increased by 27 per cent to 294,123 hectares in 2017. A part of the area defoliated by large aspen tortrix was caused by Bruce spanworm but the overlap in presence of the two species made it difficult to map their activity separately (Fig. 10). Aspen two-leaf tier defoliation dropped from 18,786 hectares in 2016 to undetectable levels in 2017.

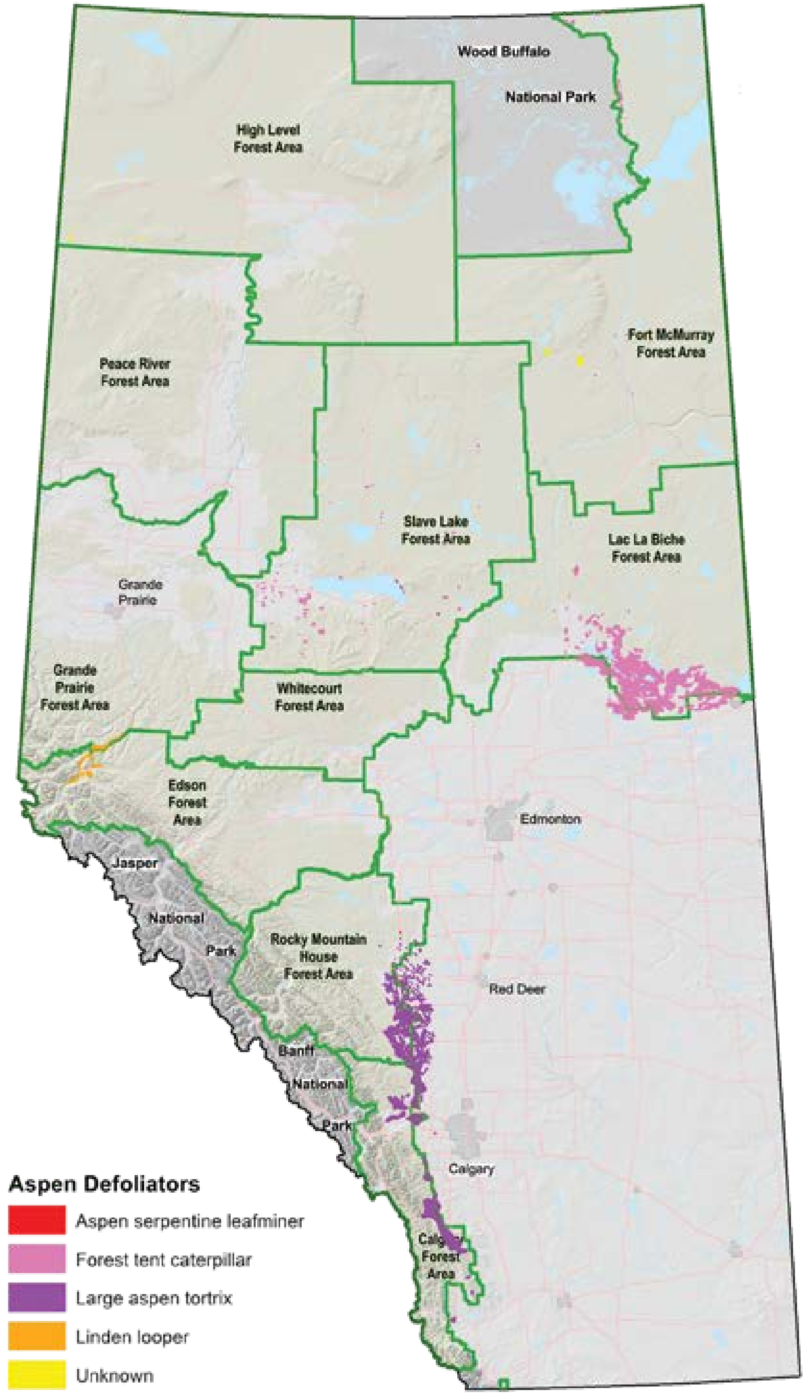

Figure 9. Spatial distribution of visible aspen defoliation detected during aerial overview surveys.

Figure 10. Clumpy, scattered defoliation by large aspen tortrix and Bruce spanworm.

Spruce budworm

Spruce budworm (*Choristoneura fumiferana*) is a native defoliator that co-evolved with white spruce and balsam fir in Alberta. Spruce budworm infestations mainly occur in river valleys of northern Alberta with rare infestations of other closely-related Choristoneura species observed in southern Alberta.

Spruce budworm

Just over 17,000 hectares of visible spruce budworm defoliation was observed during 2017 aerial overview surveys, a decrease of 10 per cent over 2016 (Table 2). Additionally, the area of severe defoliation dropped considerably in 2017 to 229 hectares from 2,336 hectares in 2016. Provincially defoliation activity by spruce budworm has continued to decline since the population peak in 2010 and subsequent collapse the following year.

Other defoliators

Extensive willow damage of varying severities continued to be observed in the northern region of the province (Fig. 11, Table 2). Willow leafblotch miner was noted in locations where ground truthing was performed but is likely just one of a number of agents causing widespread damage. Approximately 144,693 hectares of fir mortality (subalpine and balsam) was mapped in the majority of the forest areas; the direct cause of the mortality is unknown. Isolated patches of dead and dying Douglas-fir were observed in the Porcupine Hills, Calgary Forest Area (Table 2).

Figure 11. Willow with red foliage (A & B). Willow leaf miner larva after being removed from within the leaf. Red areas on the leaf result from feeding by the larva within the leaf (C)

Diseases

Armillaria root disease

This complex of closely-related fungal pathogens attack the roots and base of coniferous and deciduous tree species (Fig. 12). Infected trees decline in vigour but do not exhibit visible symptoms although mushrooms may grow at the base of the tree. The infection spreads from the roots to the tree trunk through the root collar, eventually killing the tree. The fungus remains alive in the rotting wood left in the ground for years and will continue to infect the surrounding live trees. This pattern of fungal infection causes characteristic mortality recognizable as a disease centre.

A total of 9,782 hectares of scattered armillaria-related mortality was mapped (Table 2). Most stands were only moderately affected and balsam fir was the main tree species killed. While armillaria infections weaken the trees which make them more vulnerable to other damage agents, the opposite can also occur. Already-weakened trees are less able to withstand infection and are more likely to die, therefore it is difficult to specify the ultimate cause of mortality for these trees.

Figure 12. The root collar and lower bole of a recently killed balsam fir showing the white mycelial fans of *Armillaria sinipina*.

Dwarf mistletoe

Lodgepole pine dwarf mistletoe berries

Dwarf mistletoe (*Arceuthobium americanum*) is a flowering plant that parasitizes living lodgepole and jack pine in Alberta. The “witches’ broom” that forms on the branches provides the most obvious sign that the tree has been parasitized. The brooms redirect nutrients from the top of the tree which leads to crown thinning and eventual tree mortality.

Approximately 16,370 hectares of dwarf mistletoe-infected pine were mapped in 2017 (Fig. 13 and Table 2). Of the stands mapped, 1,139 hectares of pine were in the early stages of parasitism (noticeable damage to foliage). Most of the pine trees either presented dead crowns (7,047 hectares) or were dead (8,184 hectares).

Pine needle cast

Pine needle cast

Pine needle cast (*Lophodermella concolor*) is a fungal disease that is often widespread in the year following a wet summer. The moisture provides good conditions for spore production and dispersal. Incremental growth and, rarely, tree mortality may occur if there are multiple years of severe infection.

In 2017, approximately 353,861 hectares of pine needle cast were mapped (Fig. 13). This was a large increase over 2016 (36,097 hectares) which reflects the wet, warm weather that occurred throughout much of Alberta that year. Pine needle cast was more prevalent in south and central forests than in the north.

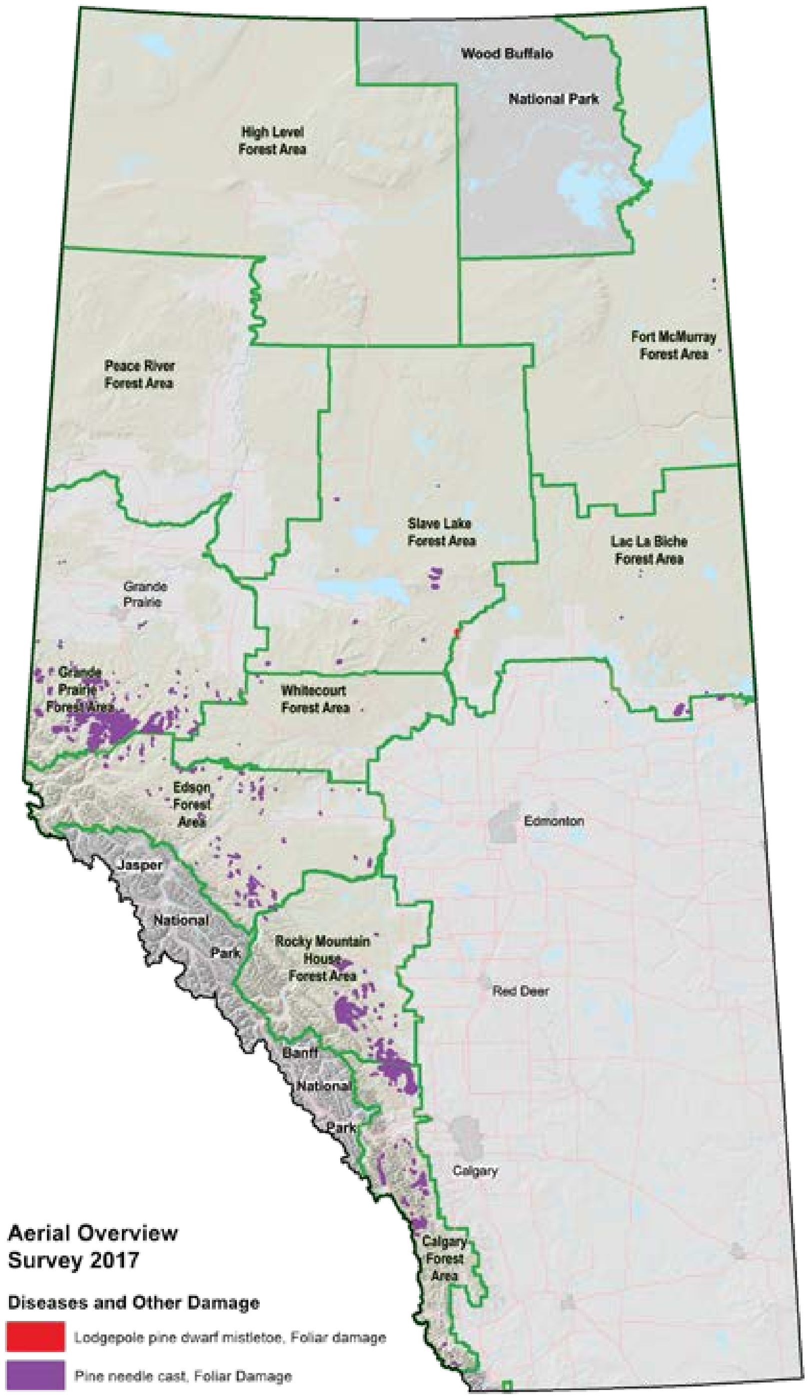

Figure 13. Stands infected with pine needle cast and lodgepole pine dwarf mistletoe mapped during aerial overview surveys.

Abiotic and Other Damage Agents

Abiotic damage agents are also mapped during aerial overview surveys. The total area affected by various abiotic agents has been increasing (Table 2). The upward trend in the extent of these disturbances may be due to increases in both detection efficacy and occurrence of these damage agents across the province.

Dessicated foliage

Table 2. Summary (in hectares) of Alberta forest disturbance agents mapped during aerial overview surveys.

	2015	2016	2017
Bark beetles			
Eastern Larch Beetle	918	6,583	2,459
Spruce beetle	1,405	10,465	3,138
Total bark beetles	**2,323**	**17,048**	**5,597**
Defoliators			
Aspen serpentine leafminer	--*	--*	1,277
Aspen two-leaf tier	536	18,786	--
Bruce spanworm	3,564	--	--**
Forest tent caterpillar	1,586,486	525,135	593,986
Large aspen tortrix	54,444	213,316	294,123
Linden looper	--	--	25,503
Spearmarked black moth	--	--	710
Spruce budworm	51,750	19,265	17,337
Unknown	--	859	8,270
Willow leafblotch miner	--*	--*	16,646
Total defoliators	**1,696,780**	**777,361**	**957,852**
Diseases			
Armillaria root disease	--*	--*	9,782
Dwarf mistletoe	--*	--*	16,370
Pine needle cast	20	36,097	53,861
Other	--	--	3,224
Total diseases	**20**	**36,097**	**83,237**
Other			
Dieback	23,657	115,728	47,659
Flooding	5,457	2,415	9,684
Foliar damage	--*	34,000	37,407
Hail	1,419	1,050	11,840
Mechanical - unknown	--	--	1,872
Mortality	--*	144,693	15,376
Windthrow/blowdown	1,204	1,338	2,534
Winter desiccation	15,341	7,766	--
Total Other	**47,078**	**306,990**	**126,372**
Total Disturbance	**1,746,201**	**1,137,496**	**1,173,058**

* Observed on the ground but not formally assessed from the air.

** Co-occurred with large aspen tortrix and defoliation by the two agents could not be mapped separately due to overlap.

Alberta Tree Improvement and Seed Centre Programs

Seed production, collection and storage

The province owns partial or complete seed shares in six white spruce, two black spruce, one jack pine and two lodgepole pine orchards. In 2017, seed production in these orchards was highly variable (Table 3). White spruce orchards either did not flower or had insufficient flowering in the spring, which resulted in no collectable cone crops. On the other end of the scale, Region J (lodgepole pine - Pl) and Region P1 (jack pine) orchards exceeded previous production records. Region K1 (Pl) cone production increased slightly from the previous year with a genetic worth estimated at 3.0 per cent height gain at rotation, an increase from 2.1 per cent. Maps of the breeding regions are in Appendix 19 of Forest Genetic Resource Management and Conservation Standards document.

Table 3: Volume of cones collected (hectolitre) and seed produced (kilograms) in seed orchards.

Breeding Regions, Orchards, and Species	Volume of Cones (hl)	Weight of Seed (kg)
AAF-owned CPP program seed orchard collections:		
Region H (Sw)	0.0	0.0
Cooperative CPP program seed orchard collections:		
Region P1 (Pj)	18.9	9.8
Region J (Pl)	4.2	1.2
Region K1 (Pl)	12.8	1.5
Total	**35.9**	**12.5**

AAF: Alberta Agriculture and Forestry; Pl: lodgepole pine; Pj: jack pine; Sw: white spruce; Region codes in this section refer to breeding zones for each species.

In 2017, 256 new seedlots representing 38 different species were received at the Alberta Tree Improvement and Seed Centre (ATISC) for registration and storage. Reclamation species continue to be in demand by the oil and gas sector, which added 187 new collections from 31 shrub, grass and forb species for a total of 54 kilogram of seed. A total of 1,007 kilogram of tree seed was added to the provincial inventory, comprised of 69 new seed collections. Of these collections one seedlot (16 kilogram of pine seed) was made through the Forest Resource Improvement Association of Alberta's MPB Forest Rehabilitation Program. This program was established in 2007 to ensure sufficient seed supply for stands identified to be at a high risk for infestation by MPB and have inadequate seed supply. To date, ATISC has stored 59,257 kilogram of seed for tree species (3,370 seedlots) and 295 kilogram (878 seedlots) that represents 88 non-tree reclamation species.

In 2017, 1,558 seed transactions were completed. Forest industry made 431 requests for a total of 714 kilogram of tree seed, an amount similar to previous years. This seed will be used in for the production of approximately 102 million seedlings for reforestation. Seed for direct reforestation seeding projects (326 kilogram) was also withdrawn by forest industry. Oil and gas reclamation industry members withdrew about 38 kilogram of seed of various tree, shrub and forbs species for production of over 2 million seedlings. As well, 35,000 rooted cuttings were produced for reclamation purposes.

Plant propagation

The plant propagation team at ATISC continued to implement improvements in their stock production of seedlings, grafting practices, and propagation techniques. A total of 12,864 seedlings were grown for various projects (Table 4, Fig. 14). A total of 878 grafts were made for clonal archiving (clone banks) and infill for other breeding region seed orchards. Staff at ATISC oversaw the sowing and crop progress of Climate Change and Adaptation trial grown at a local greenhouse.

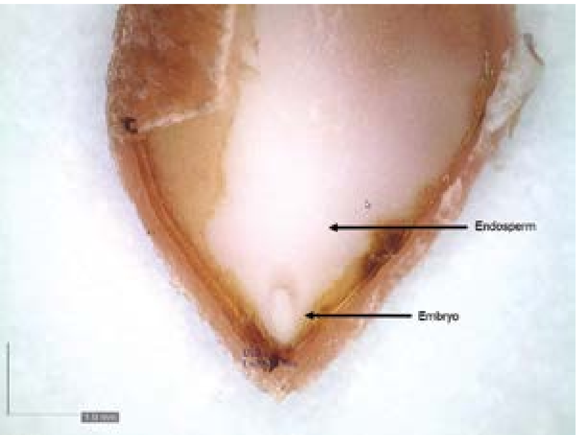

Figure 14. Low bush cranberry seed section showing endosperm and a developing embryo.

Table 4. Total number of seedlings produced at the Alberta Tree Improvement and Seed Centre summarized by project.

Project	Number of seedlings	Remarks
White spruce progeny trial, phase 2 Breeding Region E1	1,650	172 families
Spruce-Up Project, University of Alberta	1,680	Spruce genetic gains
Seedlings – mix of species	2,550	2018 grafting rootstock
Five-needle pine for Alberta Environment and Parks	2,984	Recovery of whitebark and limber pine

Seed technology and research

The seed science and technology program at ATISC manages long-term conservation seed collections which includes Alberta's two endangered tree species, whitebark and limber pine. This seed bank also provides research seed for provincial tree improvement program activities and forest research. The seed bank is also used to conduct internal research that will assist forest industry.

Applied research conducted at ATISC is furthering Alberta's knowledge of seed physiology, which will inform practical methods for seed handling and use by industry. This information is often communicated through presentations. Content presented to industry and academia in 2017 included basic seed viability equation explanations used with examples to drive home the effects and future costs of poor seed handling and storage. Information on changes to the government seed storage program and protocols was conveyed as well as results from the 40-year seed viability monitoring program. Information on improved aspen seed handling and what owners could request in their extraction contracts to cover gaps in Government of Alberta standards was also presented.

ATISC staff prepared 200,000 seeds to fulfil requests for many projects. Among these were seed requests for a pine climate change adaptation trial, whitebark and limber pine seeding in national parks and seed cut tests; limber pine trial at a local nursery; pine and spruce seed for a Resilient Forests genomic project; as well as seed for small internal/external research purposes.

Cones were collected from twelve limber pine trees with visual signs of white pine blister rust resistance, processed and then sent to the United States Department of Agriculture white pine blister screening program in Oregon. ATISC also accepted and processed whitebark and limber pines cones of seven trees from Waterton Lakes National Park but unfortunately, there were no cones available this year at Jasper National Park.

Native shrubs are important species for land reclamation in Alberta but seedling production is low due to poor germination (less than 50 per cent). Low germination rates translate into high production costs and low genetic diversity of replanted seedlings, thereby resulting in reduced survival and resilience in the field. In 2014, ATISC staff initiated a 6-year project on 13 shrub species used in oil sands reclamation (Fig. 15). This research will improve collection and handling methods, create chemical viability testing methods, and provide estimates of storage timelines for seed use. Another eight seedlots of various shrub species, donated by oil companies and contractors, in 2017 were added to this trial. Shrub seed was picked on site at ATISC which will also be used for this research.

Figure 15. Common aspen decay and canker fungi. Clockwise from top left: *Phellinus tremulae, Peniophora polygonia, Entoleuca mammata* and *Cytospora chrysosperma*.

Invasive Plant Program

Forestry Division's role in the management of invasive plants changed with the reorganization of Government of Alberta ministries in late 2015. Prior to this transition, Forestry Division was involved in a comprehensive invasive species management program for Alberta that focused on invasive plants on vacant public land. The mandate of managing invasive plants on vacant public land remains with the Forestry Division's previous ministry – Environment and Parks.

Invasive plant detection and distribution surveys

Approximately 344 hectares were surveyed and 53 per cent (183 hectares) of that area was found to be infested. In total, 17 noxious and three prohibited noxious invasive plant species were recorded during surveys (Table 5). The survey sites included AAF Forestry Division dispositions such as warehouses, wildfire bases and staging areas, and wildfire lookout sites.

Invasive plant management

Invasive plant management on Forestry Division dispositions occurs annually. Some plants, such as wild caraway, that are not designated under the Alberta *Weed Control Act* can be elevated in status by a municipality. These species of concern are treated by the Province as designated by the municipality that elevates it. Control of invasive plants is conducted by qualified in-house staff, contractors and through cooperative groups using mechanical, biological control or chemical methods.

In 2017, 68 per cent of the infested survey area was controlled. Invasive plants categorized as prohibited noxious are highly competitive and must be eradicated. As such, 95 per cent of all prohibited noxious infestations detected in 2017 were controlled.

Biological control of invasive plants

Biological control (biocontrol) is used to reduce the size and density of invasive plant infestations for which conventional methods are not feasible. Biocontrol employs integrated pest management by taking advantage of natural enemies in order to control the targeted invasive species.

Hound's tongue, *Cynoglossum officinale*, has one approved biocontrol agent, a stem-mining weevil, *Mogulones cruciger*. This agent has been released at sites in the south end of the Porcupine Hills and the Castle Special Management Area. Surveys conducted in 2017 confirm that hound's tongue has been eradicated at the Castle sites and that weevils continue to heavily attack plant clusters at the sites in Porcupine Hills.

Scentless chamomile, *Tripleurospermum perforatum*, has two biocontrol agents available in Alberta: a gall-forming midge, *Rhopalomyia tripleurosperm*, and a seedhead-eating weevil, *Omphalapion hookeri*. Both agents have been released at near Wandering River, Lac La Biche Forest Area, and west of Whitecourt. Monitoring in 2017 showed that these agents continue to decrease the size and density of the camomile patch.

Mecinus janthinus, a stem-mining weevil, is used to control yellow toadflax, *Linaria vulgaris*. Attempts have been made to establish populations in southern Alberta but warm winter temperatures associated with chinooks play havoc with the insect's ability to survive winter. A few adults of the stem-mining weevil were found at the Castle release in 2017, which indicates that brood have survived at least two winters. Absence of *M. janthinus* from the site north of Athabasca suggests that no individuals survived from the 2015 release. Approximately 90 insects were collected from an established release site and put into the tent for a mass rearing attempt.


Yellow toadflax

Rhinusa pilosa, a yellow toadflax stem-galling weevil, was approved for field release in 2014 and Agriculture and Agri-Food Canada is investigating habitat preferences in Alberta. Insects were released north of the town of Athabasca in 2015 and galled plants have been discovered during subsequent surveys.

Larinus minutus and *Cyphocleonus achates* are natural enemies of spotted knapweed. Both are weevils, and *L. minutus* feeds on seeds while *C. achates* is a root-miner. Both species were released in 2016 at a site in the Crowsnest Pass. Establishment surveys conducted in 2017 found one *L. minutus* individual and no *C. achates* but this is likely due to early adult emergence and mating that occurred prior to monitoring.


Spotted knapweed

Table 5. Invasive plant species observed during ground surveys carried out on Forestry Division dispositions.

Common Name	Scientific Name	Occurrence[1]
Black henbane	*Hyoscyamus niger*	1
Bladder campion	*Silene vulgaris*	2
Blueweed	*Echium vulgare*	1, 2, 5
Bluebur[2]	*Lappula squarrosa*	2
Bull thistle	*Cirsium vulgare*	1, 4
Canada thistle	*Cirsium arvense*	1, 2, 3, 4, 5, 6, 7, 8
Common goat's beard[2]	*Tragopogon dubious*	2
Common mullein	*Verbascum thapsus*	1
Common tansy	*Tanacetum vulgare*	1, 2, 3, 4, 6, 7
Dalmatian toadflax	*Linaria dalmatica*	1
Hoary cress	*Lepidium appelianum*	2
Meadow goat's beard[2]	*Tragopogon pratensis*	2
Meadow hawkweed[3]	*Hieracium caespitosum*	2, 3, 4, 6
Narrow-leaved hawksbeard[2]	*Crepis tectorum*	2
Orange hawkweed[3]	*Hieracium aurantiacum*	1, 2, 4
Ox-eye daisy	*Leucanthemum vulgare*	1, 2, 3, 6, 7
Perennial sow thistle	*Sonchus arvensis*	1, 2, 3, 4, 5, 6, 7
Poppy[2]	*Papaver somniferum*	2
Scentless chamomile	*Tripleurospermum perforatum*	1, 2, 3, 4, 5, 6, 7, 8, 9
Spotted knapweed[3]	*Centaurea maculosa*	2
Tall buttercup	*Rananculus acris*	1, 2, 3, 4, 5, 6, 8
Tall hawkweed[2]	*Hieracium piloselloides*	2, 4
White cockle	*Silene latifolia Poiret ssp.*	2, 3, 6, 8, 9
Wild caraway[2]	*Carum carvi*	2
Yellowdevil hawkweed[2]	*Hieracium glomeratum*	1
Yellow toadflax	*Linaria vulgaris*	2, 7

[1] Forest Area: 1. Calgary, 2. Edson, 3. Fort McMurray, 4. Grande Prairie, 5. High Level, 6. Lac La Biche, 7. Peace River, 8. Rocky Mountain House, 9. Slave Lake.
Note that very common species (e.g. Canada thistle) are not always recorded in surveys due to their ubiquitous distribution.

[2] Species of concern

[3] Prohibited noxious weeds

Collaborative Projects

Climate impacts on the productivity and health of aspen (CIPHA)

This project was designed to detect interactions among climate, forest insects and diseases, and trembling aspen. This collaboration between the Canadian Forest Service (CFS), various provincial governments and industry in Canada established a network of monitoring nodes in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario and the Northwest Territories in 2000. The following information is an excerpt from the report submitted by Michael Michaelian, Forest Health Technician, Natural Resources Canada - Canadian Forest Service. More information concerning the Climate impacts on the productivity and health of aspen (CIPHA) program, as well as links to other research and scientific publications related to this project can be found here.

Defoliation at Alberta CIPHA sites in 2017 was relatively low and remained unchanged from 2016 with an average of 6 per cent of crown foliage lost. Forest tent caterpillar caused most of the defoliation.

The incidence of the two most common decay fungi encountered at the CIPHA sites, *Phellinus tremulae* and *Peniophora polygonia*, has changed over the last 18 years (Fig. 15). *Phellinus tremulae*, which is twice as common in the drier parkland than in the boreal ecozone, has shown a slow but steady increase and by 2017, 21 per cent of live aspen trees in the parkland and 10 per cent of the aspen trees in the boreal were infected. The steady increase of *P. tremulae* incidence is related to stand age, however, the rate of increase may be indicative of decreasing moisture in Alberta's aspen forests. *Phellinus polygonia* prefers moist conditions and is historically much more common in the boreal than parkland ecozone. The 2017 rate of *P. polygonia* infection increased slightly in the boreal and decreased slightly in parkland forests compared to 2016. *Phellinus polygonia* infected approximately 12 per cent of live aspen trees in the boreal and 1 per cent of those in the parkland.

The overall incidence of wood borers has increased steadily for the last 6 years. The combined incidence of the poplar borer (*Saperda calcarata*), bronze poplar borer (*Agrilus liragus*), ambrosia beetle (*Trypodendron retusum*), and the flatheaded borer (Dicerca spp.) rose to 50 per cent of all live parkland trees, up from 48 per cent in 2016. In the boreal there was a larger increase in wood borer incidence to 28 per cent from 22 per cent last year.

Moisture is crucial to aspen growth and the lack of moisture is a strong determinant of tree mortality. Available moisture has varied dramatically year over year since the beginning of the CIPHA program but there has been a general drying trend since the mid-2000s averaged over all Alberta CIPHA sites. Compared to the 1961 to 1990 average, moisture levels in the northern third of the Province were significantly reduced in both 2016 and 2017 (Fig. 16).

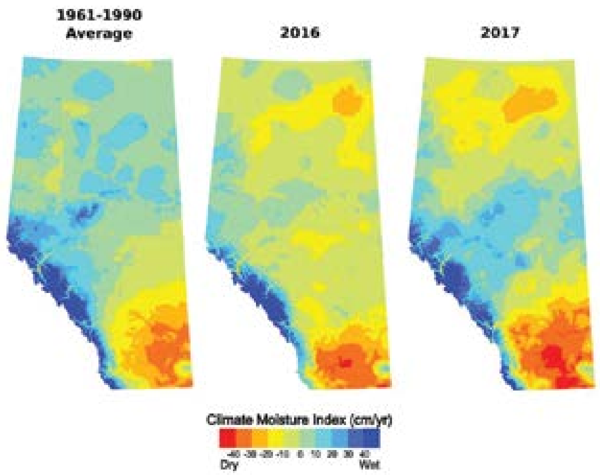

Figure 16. Comparison of the 2016 and 2017 climate moisture index with the average 1961 to 1990 climate moisture index (calculated precipitation – potential evapotranspiration, as cm water/year).

Recent regional defoliation combined with the persistent dry conditions in many parts of Alberta since 2010 (and especially in 2015) have led to higher than normal mortality rates at many Alberta sites. One Alberta parkland site, Dunvegan, experienced not only high levels of defoliation in 2012 and 2013 but also low moisture levels in 2010, 2014 and 2015. In 2016 the annual mortality rate at the Dunvegan site was 35 per cent, the highest ever recorded at any CIPHA site (by comparison, the previous highest annual mortality was 16 per cent recorded at Batoche, Saskatchewan in 2006). In 2017 the mortality rate at Dunvegan decreased to 19 per cent.

When averaged over all sites, the 2017 overall mortality rate was just over 8 per cent. By comparison, healthy sites in the CIPHA network without drought and without defoliation usually experience an annual mortality rate of about 2 per cent. Figure 17 reveals the different trajectories of Alberta and Saskatchewan CIPHA sites. Both experienced drought in 2001 and 2002 leading to increase mortality until 2006. Following 2006, Alberta has experienced much more drought and defoliation.

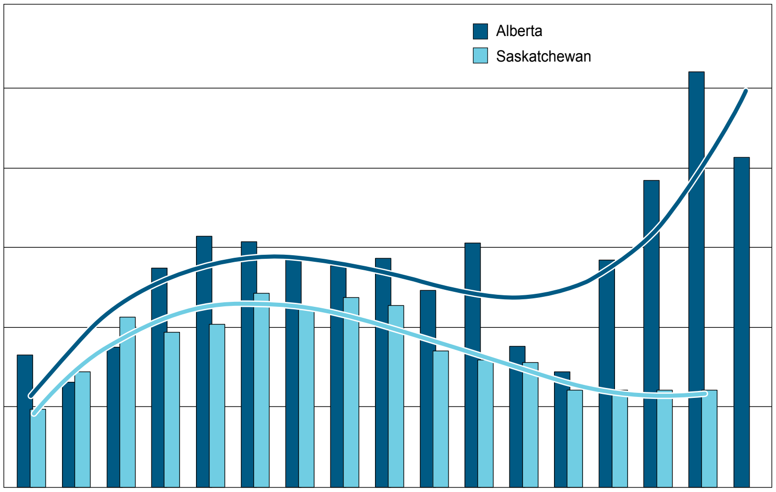

Figure 17. Annual mortality calculated as number of newly dead stems as a percent of the number alive at last assessment.

Aspen forests in many regions of Alberta are presenting declines in health and increased mortality. Although there are many biotic, abiotic factors and interactions between factors affecting aspen forest health, CIPHA results demonstrate the importance of both defoliation and drought on tree mortality. These two factors, more than any others, account for the majority of aspen mortality. Recent drought and defoliation will continue have a negative impact on forest health for the next four or five years. These impacts are expected even if future moisture levels increase and defoliation decreases.

Forest gene conservation

Alberta Agriculture and Forestry Division, Alberta Environment and Parks, the Nature Conservancy of Canada, the British Columbia Ministry of Forests, Lands, and Natural Resource Operations and Rural Development, and dozens of private property owners all helped to advance the whitebark and limber pine recovery program in Alberta in 2017. Two seasonal field staff supported the program across the species' range in Alberta, including numerous provincial protected areas.

Figure 18. Alberta Agriculture and Forestry staff caging limber pine cones on a Nature Conservancy of Canada property

Outreach was a key component of the 2017 whitebark and limber pine recovery program. Messaging and invitations were designed to solicit participation from landowners, lease holders, conservation groups, Junior Forest Rangers, and workshop and conference participants. Trailhead signs and other interpretive material on whitebark and limber pine recovery and cone cages were provided to provincial park regional offices (Fig. 18).

White pine blister rust resistance

"Plus trees", in the case of whitebark and limber pine, are those that appear to be either free of disease or much healthier when compared to the surrounding stand (indicating tolerance to rust). These valuable trees are permanently field marked and documented, so that they can be revisited to collect seeds for health monitoring, disease resistance screening, and restoration (Table 6).

AAF staff collaborate with researchers at the Kalamalka Forestry Centre in Vernon, British Columbia who are conducting blister rust research for the past two years. Seeds from some Alberta trees have been screened (Fig. 19) and results are forthcoming in future years.

Figure 19. Infected *Ribes* leaves drop teliospores on whitebark pine seedlings below in a temperature and humidity controlled chamber.

Table 6. Number of plus pine trees field marked and documented, and the number screened for blister rust in brackets.

Pine Species	2015	2016	2017
Limber	84 (50)	51 (50)	96 (12)
Whitebark	0 (8)	47 (7)	12 (0)

Habitat suitability models

Limber and whitebark pine spatial presence modelling was made publicly available in 2017 for both species Alberta range-wide (excluding national parks) from GeoDiscover Alberta. A density model is being verified based on 177 polygons assessed this field season, which will supplement existing data. Results should be available spring 2018 and posted later in the year.

Long-term health monitoring transects

Five long-term health monitoring transects in Willmore Wilderness Park, were resurveyed. Blister rust occurrence increased sharply since the last assessment but is still well below 50 per cent, too low to reliably select “plus” trees in stands. Abundant whitebark pine regeneration showed that the seed source is still viable. Five additional transects were remeasured in the Saskatchewan Crossing area, east of Banff National Park, with the help of United States Department of Agriculture Forest Service scientists from Colorado. Rust is present at low levels in this area (below 5 per cent). Remeasurement of the remaining 230 transects is planned for 2019.

Operational restoration trials

A silviculture restoration trial was established north of Coleman to look at the effect of thinning on whitebark pine regeneration. This is a replicated, controlled study with permanent sample plots in cutblocks harvested 15-20 years ago and regenerated with 10-20 per cent whitebark pine. Thinning was performed around healthy regenerated whitebark pine at 0, 2, and 5 metre to remove competition in stands of varying densities. Whitebark pine grow very slowly, therefore results will take time to develop.

Gypsy moth detection surveys


Gypsy moth

AAF cooperates in an annual province-wide survey to detect both sub-species of gypsy moth (*Lymantria dispar dispar* and *L. dispar asiatica*). The survey is led by the Canadian Food Inspection Agency (CFIA). In 2017, AAF deployed 87 pheromone-baited delta traps on forested public land and neither sub-species were trapped.

In 2014 and 2015 respectively, gypsy moths were captured at Gregoire Lake Provincial Park and an oil work camp near Algar Fire Tower. Both sites are located in the Fort McMurray Forest Area. In the intervening years since the positive trap captures, the CFIA has conducted intensive grid surveys to detect if populations were able to establish. The final delimitation survey for Gregoire Lake Provincial Park occurred in 2016 and in 2017 near the Algar Fire Tower area. No gypsy moths were captured during the mass delimitation surveys.

Invasive wood-boring species detection monitoring

AAF assists the Society to Prevent Dutch Elm Disease in their efforts to monitor for invasive insect species such as emerald ash borer. In the Lac La Biche Forest Area, locations that are considered to be potential points of entry for invasive species introductions are monitored using baited funnel traps.

Four traps were monitored in 2017 and inspected every two weeks between May to September. Insects collected in the traps were sent to Olds College for identification. As in all previous years of the monitoring program for invasive wood boring insects in the Lac La Biche area, no species of concern were identified.

Terrestrial environmental effects monitoring program

As part of an ongoing commitment, AAF staff assisted with forest condition surveys at approximately 40 pine sites for the Wood Buffalo Environmental Association's (WBEA) Terrestrial Environmental Effects Monitoring (TEEM) program in 2017. This is a multi-stakeholder, not-for-profit organization that conducts air quality and terrestrial monitoring, largely in the Regional Municipality of Wood Buffalo. The TEEM program measures the effects of oil sands emissions on natural ecosystems. Forest health monitoring data is used to quantify the relationship between air emissions and the occurrence of forest damage agents.

Increased awareness and training

Forest Health and Adaptation newsletter

In 2017, the Forest Health and Adaptation program published three issues of the Bugs and Diseases newsletter. These publications included a wide range of forest health topics. Visit this website to access the most recent and archived issues of the newsletter.

Community and industry outreach

Owners of private land frequently contact AAF staff regarding the health of trees on their property. Staff assist the home owner to identify the damage agent(s) contributing to the decline in tree health and often visit the property to diagnose the issue.

AAF staff participate in community outreach events sponsored by AAF, Alberta Environment and Parks, as well as those organized by special interest groups and schools. Activities performed by staff range from manning information booths to giving detailed public presentations. The presence of AAF staff at these events helps to increase awareness about forest health damage agents and the role of the ministry in monitoring and managing the health of Alberta forests.

AAF staff provided a one-day training session for Foothills Growth and Yield association crews. This session was focused on the identification of damage agents typically encountered in young stands. AAF staff were also invited to give lectures at NAIT and the University of Alberta to discuss forest health damage agents in Alberta and to showcase the role of the provincial government in managing forest health, gene conservation, forest genetics and tree improvement.

Alberta