Yukon Forest
HEALTH REPORT 2014

Yukon
Energy, Mines and Resources

TABLE OF CONTENTS

WHY WE HAVE A FOREST HEALTH PROGRAM IN YUKON

The Government of Yukon's Forest Management branch (FMB) manages Yukon forests for sustainability and monitors and reports on forest health, which is a major component of forest management. The *Forest Resources Act* (FRA) supports forest health monitoring and recognizes that the long-term health of Yukon's forests must be maintained and protected for the benefit of Yukon people and future generations.

Under section 34-2 of the FRA, the Director of FMB may develop research and monitoring plans and programs to: a) investigate the spread, effect and control of insects and pests as it relates to the protection of forest resources and b) support the advances in forest resource management. This includes monitoring plans such the risk-based Yukon Forest Health Monitoring Strategy adopted by FMB in 2009.

Yukon Forest Health Monitoring Strategy

The Yukon Forest Health Monitoring Strategy focuses on Yukon's forest stands that are most susceptible to the 10 forest health agents of greatest concern. Since its implementation in 2009, the strategy has met the two priorities described below each year.

The objectives of the Yukon Forest Health Monitoring Strategy are:

1. To provide a Yukon-wide overview of forest health issues;
2. To focus monitoring activities on high-risk forest health concerns across forested landscapes that are considered the most valuable to Yukon residents;
3. To monitor and assess forest health concerns and to determine and evaluate forest management responses.

As well, in the FRA Regulations (sections 81 and 82), there is a commitment for the Director to provide a written report on the status of forest health in Yukon (the annual Forest Health Report) to the Minister of Energy, Mines and Resources (EMR).

Rotational Monitoring of Forest Health Zones

Yukon is divided into five forest health zones (Map 1). In these areas, monitoring focuses on forest stands that are the most susceptible to the 10 forest health agents of greatest concern. Each year since 2009, FMB has completed aerial surveys of one of the five zones.

In 2013, the fifth and last of the five zones was monitored. This year, being the sixth year of aerial surveys, marks the first year that a forest health zone has been resurveyed (two years of data). Given that baseline data has already been captured in each of the forest health zones the mapping resolution from 2014 forward will be coarser, moving from eight km gridlines to 12 km gridlines. The only exception will be in years when significant pest activity has been noted.

AERIAL SURVEYS AND GROUND TRUTHING AS THE PRIMARY TOOLS FOR MONITORING

Aerial overview surveys and ground field checks are a relatively simple and low-cost method for effectively monitoring forest health over large areas (Ciesla, 2000; Mitton J.B. and M.C. Grant, 1980). Aerial overview surveys are also adequate for regional and provincial summaries and to meet national requirements for the Forest Health Network (B.C. Ministry of Forests, Lands and Mines and CFS, 2000).

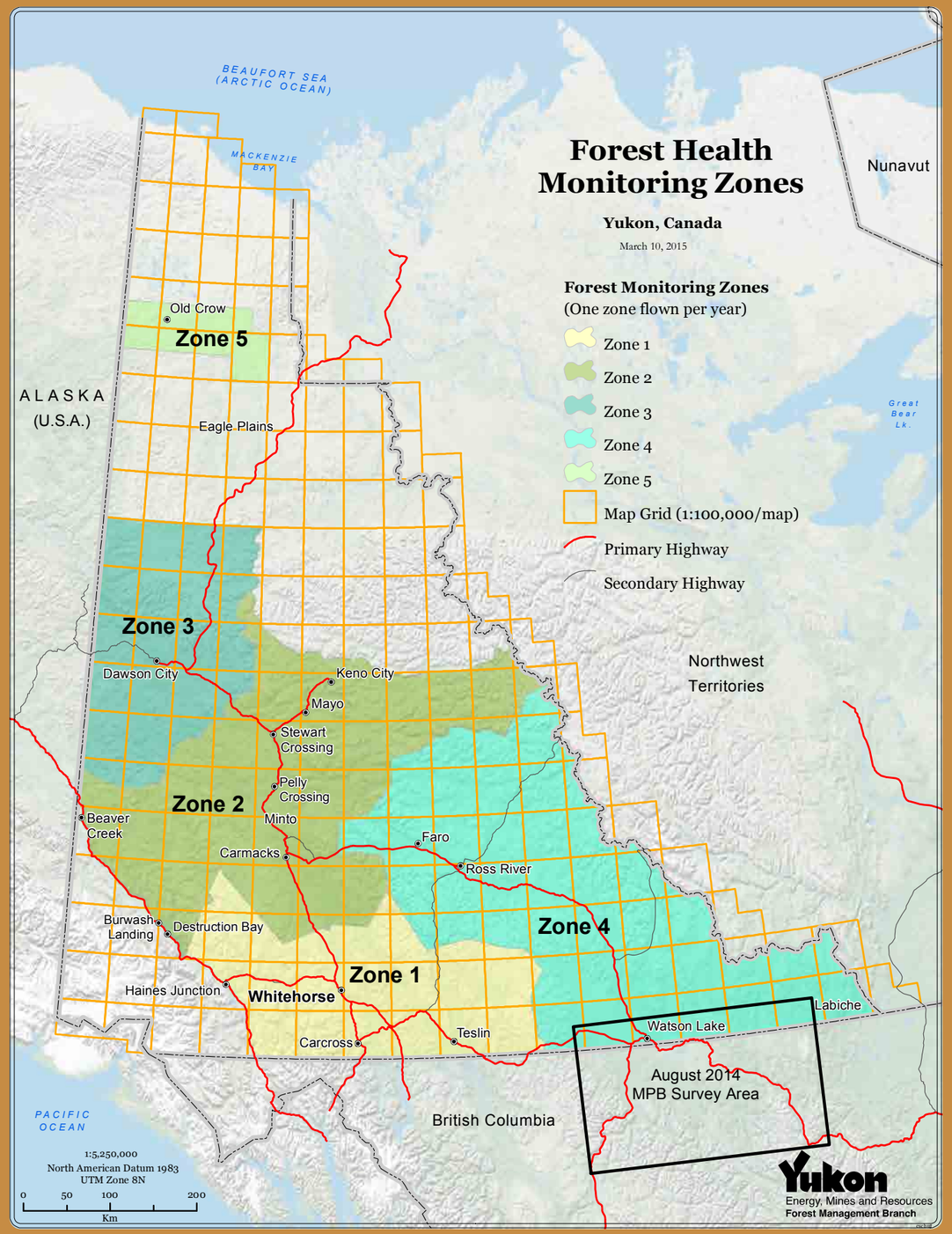
As a result, aerial overview surveys are the primary tool for monitoring forest health in Yukon. The forest health aerial overview survey standards used by the B.C. Ministry of Forests, Lands and Natural Resource Operations are also used in Yukon, which ensures continuity across jurisdictions. Field checks are important for validating the data collected from the aerial surveys. Researchers check a portion of surveyed areas to confirm the identity and severity of the pest or disease disturbance.

Standards for Conducting Aerial Surveys

The following standards are used for conducing aerial surveys in Yukon:

- Use a Cessna 206 or equivalent high wing single engine airplane.
- Flying height of 800m above ground level.
- Aerial surveyors use 1:100,000 scale maps.
- Two qualified aerial surveyors (one positioned on each side of plane).
- Each surveyor oversees a four km wide corridor – in 2014 FMB modified this to a six km wide corridor given that baseline data has been captured for each forest health zone.
- Fly aerial surveys on clear days with sunny skies.
- Aerial surveyors map and record the severity and type of disturbance, such as:
    - Dead and dying trees caused by bark beetles.
    - Defoliation from insects and diseases such as budworm, leafminers or needle diseases.
    - Stressed or dead trees from climatic factors such as flood, drought or wind-throw.
    - Trees damaged by animals such as porcupines.
- Aerial surveyors also use on-the-ground checks to confirm the type of disturbance recorded from the aerial surveys and digitize recorded mapping data and store it in the Government of Yukon Geographic Information System.

MAP 1 Yukon Forest Health Monitoring Zones



IDENTIFICATION OF MAJOR FOREST HEALTH CONCERNS OF YUKON


1a


1b

In 2009, FMB determined the top 10 major forest health concerns that pose the greatest risk (i.e. extensive mortality or defoliation) to Yukon forests – ones that can be effectively monitored as part of a risk-based forest health monitoring program. Eight are insects. One is a pathogen and the other is an environmental effect called drought stress.

All these concerns can be effectively monitored with aerial surveys because their damage to trees is very visible.

The following is a rationale (based on Ott, 2008) for the identification of major forest health concerns that pose the greatest risks to Yukon forests:


2a

1. Spruce bark beetle (*Dendroctonus rufipennis*)—This bark beetle is the most damaging forest pest of mature spruce (*Picea* spp.) forests in Yukon. A spruce bark beetle outbreak in southwest Yukon that began around 1990 has killed more than half of the mature spruce forest (primarily white spruce [*P. glauca*]) over approximately 400,000 hectares (ha).

1a Grey trees stand level damage Haines Junction YT
1b Adult Spruce Bark Beetle


2b

2. Northern spruce engraver (*Ips perturbatus*)—The northern spruce engraver acts as both a secondary bark beetle that attacks trees infested with spruce bark beetle, as well as a primary pest that attacks and kills stressed spruce trees (primarily white spruce). The population of the northern spruce engraver beetle has increased in Yukon as a result of the increased availability of host trees associated with the spruce bark beetle outbreak in southwest Yukon. In 2008, infestations by the northern spruce engraver were at their greatest level since the beginning of forest health monitoring in Yukon. Spruce engraver beetle infestation was mapped in southwest Yukon at over 3,000 ha (Garbutt, 2009).

2a Single tree attack
2b Young adults and larva


3a

3. Western balsam bark beetle (*Dryocoetes confusus*)—This beetle attacks subalpine fir (*Abies lasiocarpa*). Western balsam bark beetle moved north from B.C. in the late 1980s and has become an active disturbance agent in mature subalpine fir stands in southern Yukon.

3a Single tree attack Watson Lake
3b Adult Western balsam bark beetle


3b


4a


4b


5


6a


6b


7a


7b

4. Budworms (*Choristoneura* spp.)—The budworm guild, comprising of eastern spruce budworm, fir-spruce budworm, two-year cycle budworm and western black-headed budworm, cause similar defoliation damage to spruce, subalpine fir and larch (*Larix laricina*) forests in Yukon. In 2008, eastern spruce budworm damage was mapped across 1,000 ha in Yukon, primarily near Stewart Crossing. Historically, eastern spruce budworm damage has been mapped in the extreme southeast portion of Yukon (Garbutt, 2009).

4a Defoliation to tips of mature Spruce trees Stewart Crossing, YT.
4b Spruce budworm larva

5. Larch sawfly (*Pristiphora erichsonii*)—This defoliator is the most damaging agent of larch in North America. In the mid and late 1990s, mature larch stands in southeast Yukon were heavily defoliated and experienced some mortality.

5 Larch sawfly larva.

6. Large aspen tortrix (*Choristoneura conflictana*)—This defoliator of trembling aspen (*Populus tremuloides*) periodically erupts into outbreaks that result in severe defoliation, branch dieback and, at times, extensive tree mortality. Outbreaks of large aspen tortrix have occurred in several places throughout Yukon, including Teslin Lake, Braeburn, Haines Junction, Pelly Crossing and Champagne.

6a Stand Level defoliation Haines Junction, YT.
6b Adult moth large aspen tortrix.

7. Aspen serpentine leafminer (*Phyllocnistis populiella*)—This insect pest occurs throughout the Yukon range of trembling aspen and also defoliates balsam poplar (*Populus balsamifera*). Starting in the early 1990s, a massive outbreak of aspen serpentine leafminer extended from Alaska, through Yukon, and into B.C.

7a Stand Level damage in Dawson City, YT.
7b Leaf damage.


8a


8b


9a


9b


10

8. Pine needle cast (*Lophodermella concolor*)—This pathogen is the most common cause of premature needle loss of lodgepole pine (*Pinus contorta*) in Yukon (Garbutt, 2009). Pine stands in southeast Yukon are chronically infected, and the disease is becoming increasingly common in central Yukon. In 2008, pine needle cast occurred from the B.C. border to the Continental Divide, Yukon. The most northern observation of needle cast was observed in young pine stands in the Minto Flats-McCabe Creek area in the Yukon interior (Ott, 2008). The most severe damage in these pine stands covered 477 ha (Garbutt, 2009).

8a Stand level damage of young pine Minto, YT.
8b Damage to needles of young pine.

9. Mountain pine beetle (*Dendroctonus ponderosae*)—Though endemic to North America, this bark beetle is not present in Yukon. Most western pines in North America are suitable hosts, but lodgepole pine and ponderosa pine (*Pinus ponderosa*) are the most important host species (Logan and Powell, 2001). In western Canada lodgepole pine is the primary host of this beetle (Campbell et al., 2007; Li et al., 2005).

Mountain pine beetle (MPB) is currently the most important forest health concern in western Canada. The current outbreak in B.C. is responsible for killing over 13 million ha of pine forest (Carroll, 2007). Cold-induced mortality is considered the most important factor controlling MPB dynamics (Régnière and Bentz 2007). A warming climate is expected to allow MPB to expand its range into higher elevations, eastward, and northward (Carroll et al., 2003; Régnière and Bentz 2007), potentially as far north as Yukon. Monitoring for MPB is a high priority because of its severe impact on pine forests during outbreaks and because of its confirmed proximity (80 km) to the B.C./Yukon border in 2011.

9a Mature Pine tree attack in Rocky Mountain Trench, BC.
9b Surviving larva at base of tree in Rocky Mountain Trench, BC.

10. Tree dieback due to drought stress—Trembling aspen tends to occupy the driest sites in Yukon. Because of this, dry site aspen stands are expected to be the first to exhibit dieback due to drought stress in a warming climate. In 2008, aspen stands exhibiting dieback were scattered along the North Klondike Highway between Whitehorse and Stewart Crossing. Most of these stands were on dry, rocky slopes and bluffs with south and west aspects, although some were located on level ground with well-drained gravel soil. Aspen stands experiencing dieback tended to be in an open canopy and were often stunted. Those on the rocky slopes and bluffs typically were adjacent to treeless steppe plant communities which are found on sites too dry for trees to grow (Ott, 2008).

10 Dieback of Aspen, Mayo, YT.

For further information on these and other Yukon forest health disturbances please refer to the EMR forest health website at **http://www.emr.gov.yk.ca/forestry/foresthealth.html**. This website contains forest health brochures and annual reports prepared by EMR.

SUMMARY OF 2014 FOREST HEALTH INITIATIVES

The following three forest health initiatives were completed by FMB in 2014:

Component 1: Aerial surveys and ground field checks were completed in forest health zone 1, as per the Yukon Forest Health Monitoring Strategy. Ground checks include those initiated by the public e.g. extension work, and are generally regarded as noteworthy pests as they tend to be more urban (yellowheaded spruce sawfly).

Component 2: Yukon FMB took a proactive approach to monitoring the northward expansion of the MPB.

The Five Year MPB Monitoring Strategy, implemented in 2013, describes and outlines monitoring activities for the next five years in Yukon. This plan will guide effective and efficient management for tracking the northern expansion of the MPB population.

Component 3: FMB responded to general forest health and pest incident reports from the public and from government agencies encountered throughout Yukon.

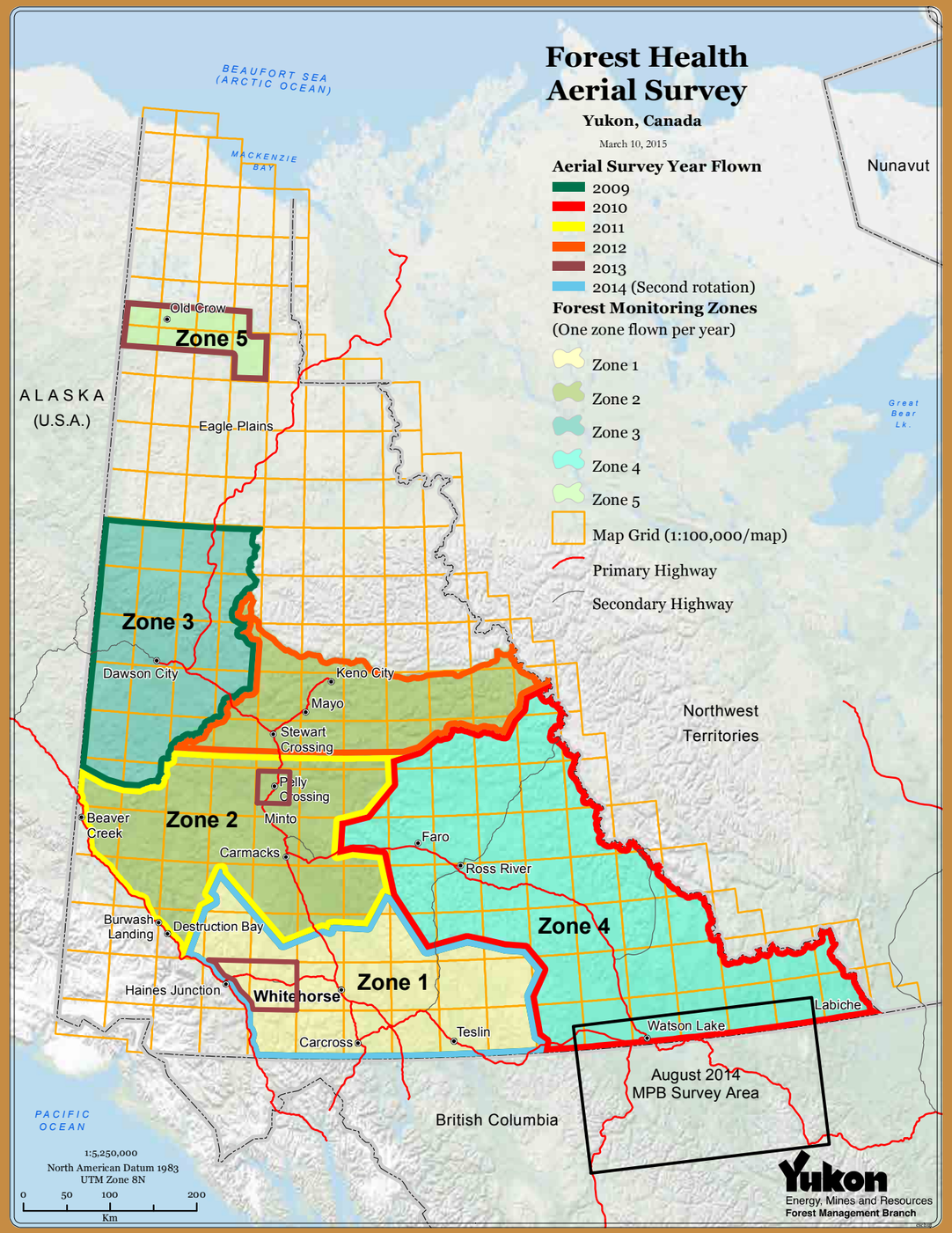
FOREST HEALTH AERIAL SURVEYS IN 2014

In 2014, a total of two separate aerial surveys were undertaken in order to map forest disturbances as described in the Yukon Forest Health Monitoring Strategy (Map 2):

I. A two-day aerial survey was undertaken to monitor the northward movement of the MPB as per the monitoring strategy. Two areas were flown: one was along the Yukon/B.C. border near Watson Lake and one was along the Rocky Mountain Trench (RMT) area of B.C.

II. A three-day aerial survey to map portions of forest health zone 1 (Map 2) – two additional days were also spent doing ground checks, including one via helicopter, to confirm causal agents.

MAP 2 Yukon Forest Health Aerial Surveys by year (2009 – 2014)



MONITORING THE NORTHWARD EXPANSION OF THE MOUNTAIN PINE BEETLE

The MPB is a native North American bark beetle that is distributed throughout most of the range of lodgepole pine in B.C. Historically climate has impeded its expansion northward, and until the current outbreak was only recorded south of 56°N. The MPB is currently the single biggest forest health concern in western Canada. The current MPB outbreak is responsible for killing over 13 million ha of pine forest in B.C. alone.

The MPB is one of 10 forest health agents that pose the greatest risk to Yukon forests. It can be effectively monitored as part of a risk-based forest health monitoring program. As such, FMB has taken a proactive approach to managing the threat posed by the northward expansion of the MPB from BC. Although the MPB has not expanded into Yukon yet, it has moved northward in the last few years within the RMT in northern B.C. The RMT represents a potential pathway of MPB into Yukon given the availability of susceptible host (Photo 1) and lack of geographic barriers.

Climate plays an important role in the population of MPB. One of the most important factors in controlling the northern movement of MPB is cold weather and an inner tree bark temperature of -40˚C for at least one week. Mild winter weather allows overwintering MPB populations to thrive and the outbreak to continue. Unseasonably warm, dry springs and summers have likely also played an important role in the expansion of the beetle, possibly allowing for earlier emergence and mating in the spring and summer (Mitton and Ferrenberg, 2013).

Due to concerns about the northward expansion of the MPB, the Government of Yukon has developed a risk analysis and subsequent monitoring strategy to track the northern movement of this bark beetle. Below is a history of response to MPB by Government of Yukon:

- A national risk assessment of the threat of MPB to Canada's boreal and eastern pine forests was completed in 2007 by the Canadian Forest Service (CFS).
- In 2009, the FMB implemented the Yukon Forest Health Strategy that is in line with the National Forest Pest Strategy (NFPS).
- From 2009 until the present, both the FMB and the British Columbia's Ministry of Forests, Lands and Natural Resource Operations have been conducting aerial surveys together. MPB bait trapping has also been conducted each year.
- The Government of Yukon Interdepartmental Mountain Pine Beetle Committee, formed in 2011, provided direction and developed strategies to monitor and manage MPB in the future.
- The MPB committee completed a Yukon specific pest risk analysis in 2012, "Mountain Pine Beetle Pest Risk Analysis for Yukon Lodgepole Pine Forests."
- From this risk analysis, a five year mountain pine beetle monitoring plan and strategy was developed and implemented in 2013 called "Mountain Pine Beetle Monitoring Plan for Yukon Lodgepole Pine Forests 2013-2018."

Photo 1. Susceptible lodgepole pine in RMT in northern BC, intermixed with patches of trembling aspen and spruce.

MONITORING MOUNTAIN PINE BEETLE IN 2014

Following the strategy outlined in the five year MPB Monitoring Plan, a 30 by 300 km zone was flown straddling the Yukon/B.C. border, as well as the RMT in B.C. The border zone stretches from the Rancheria River in the west to nearly as far east as the Northwest Territories border, and encompasses areas with lodgepole pine as the dominant species (Photo 2). This marks the fifth consecutive year the threat of MPB to Yukon forests was addressed by aerial surveys (Map 3). In 2010 when aerial surveys were initiated, MPB populations and subsequent pine mortality within the RMT of B.C. were very high (within 150 km of Yukon border). Since that time severe winter cold has killed beetle broods within the trees and arrested the northern movement of MPB populations.

Photo 2. Vast expanses of healthy seral lodgepole pine in northern B.C. (border zone) south east of Watson Lake.

Rocky Mountain Trench

In 2014, MPB populations in the RMT were down significantly with only a few spots recorded in locations mapped in 2013 near Scoop Lake/Horneline and Moodie creeks. This coincides with declining populations noted in 2013. Only one spot of 10 trees was noted north of that found in 2013; near Birches Lake, approximately 110 km from Yukon border. FMB will be reviewing whether to continue monitoring of the RMT in 2015.

Border Zone

Mountain pine beetle was not found within the B.C./Yukon border zone. Scattered single red lodgepole pines were mapped in this area, suggesting attack by either the lodgepole pine beetle (*Dendroctonus murrayanae*), pine engraver beetle (*Ips pini*), and possibly porcupine. The beetles are indigenous to Yukon and pose no significant threat to forest health. A "typical" attack from MPB usually involves small groups of trees rather than one single tree. However, given the uncertainty of behavior of MPB in novel habitats (i.e. pine forests that have not had a history of MPB infestation) these spots will be monitored next year. If these spots expand to small groups of affected pine trees, ground truthing may be required to confirm whether the attacks are caused by MPB. An aerial assessment in 2014 (of spots mapped in 2013) revealed that the causal agent(s) are likely those noted above, and not MPB. Currently, MPB is not suspected to be present in the Yukon.

British Columbia

B.C.'s Ministry of Forests, Lands and Natural Resource Operations completed aerial surveys farther to the east and west of the FMB surveys. In 2013 numerous large and small polygons of light-to-severe MPB were mapped in young and middle-aged pine stands in the vicinity of Muncho Lake (Photo 3), and near Looncry Lake, and approximately 80 km south of the BC/Yukon border (Photo 4). FMB accessed several of these from the air in 2014 and decided that the causal agent was not likely MPB, rather the complex of pests mentioned above (Photo 3).

Photo 3. Scattered dying (yellow and red) trees recorded as trace MPB in 2013 near Muncho Lake, and reassessed as a pest complex including porcupine and/or lodgepole pine beetle and/or Ips in 2014.

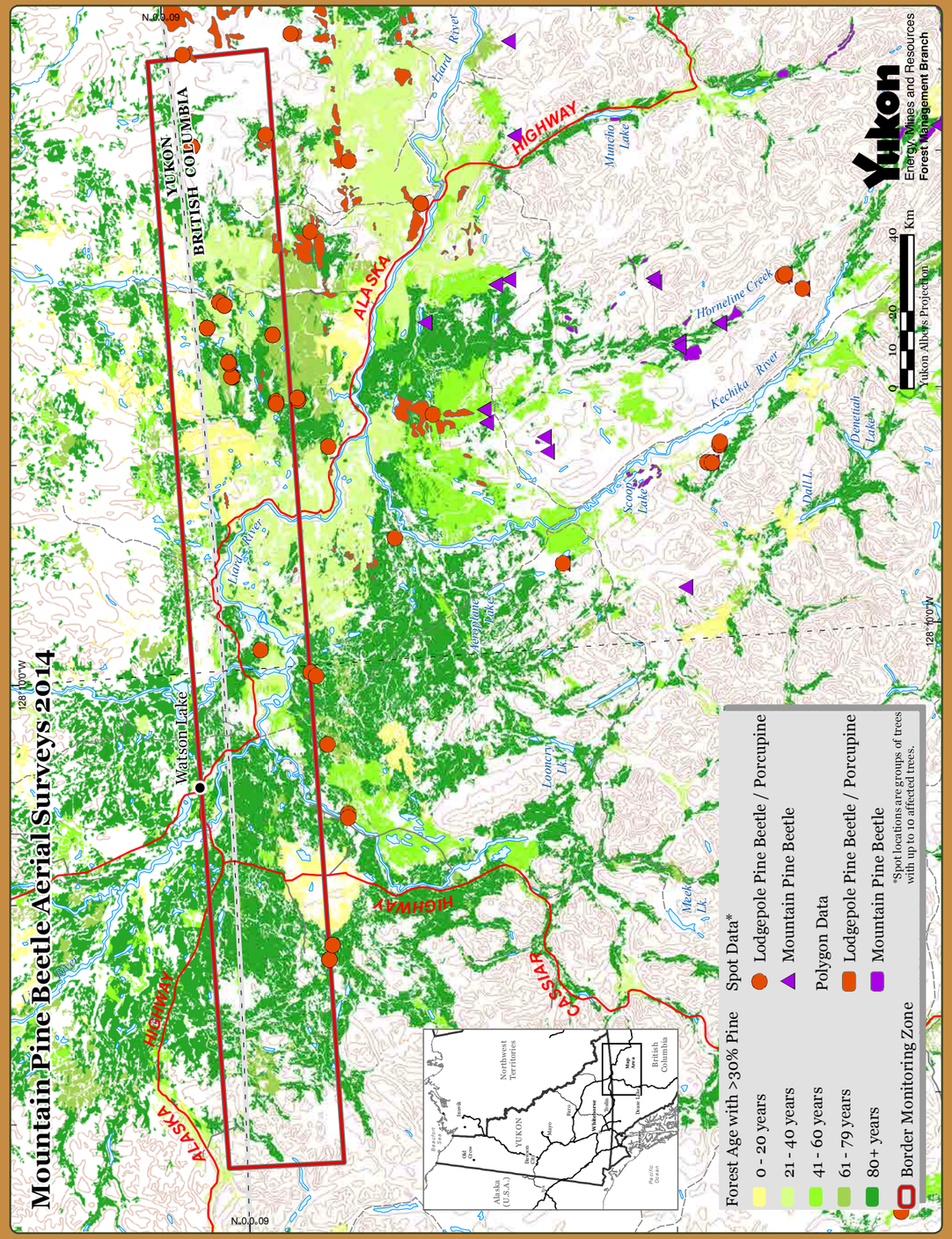
Photo 4. Portion of area mapped as severe MPB in 2013 and reassessed as complex of pests in 2014.

Fortunately, further westward migration from infested areas near the Liard River will likely be halted or significantly slowed by the vast young pine stands that resulted from the 1982 "Egg Fire" that burned over 100,000 ha of mature pine. These young stands will not support an MPB population; they will act as sinks rather than sources given the smaller diameter and thin bark.

During the course of its recent northward advance, MPB has encountered "naïve" pine. These are pine stands that have no prior experience with MPB and thus have none of the genetic defenses of southern pine trees that co-evolved with the MPB. Preliminary research indicates that "naïve" pine trees may have lower resistance and greater MPB production capacity. However the beetle remains susceptible to extended cold periods of -40˚C, which cause high levels of brood mortality, especially if they occur in early or late winter. This has already been witnessed in the RMT, reinforcing the lethal effect of harsh cold winters on beetle populations. This aspect will likely continue to influence the beetle's success or failure as it moves farther north.

While there has been a decrease in the northward movement of MPB for two consecutive years, if favorable weather occurs for a few years in a row, populations could increase (Bleiker, 2012 pers com). MPB is an opportunistic species and a large pool of susceptible hosts is present. A possible future scenario could result in small remnant populations surviving and crossing the B.C./Yukon border into southeast Yukon and killing scattered individual trees or small groups of trees. According to the MPB pest risk analysis conducted for Yukon, this could occur within the next five to twenty years. However, it seems that for now the imminent threat from the current outbreak in B.C. has subsided.

MAP 3 Mountain pine beetle in the Yukon/B.C. border zone and Rocky Mountain Trench



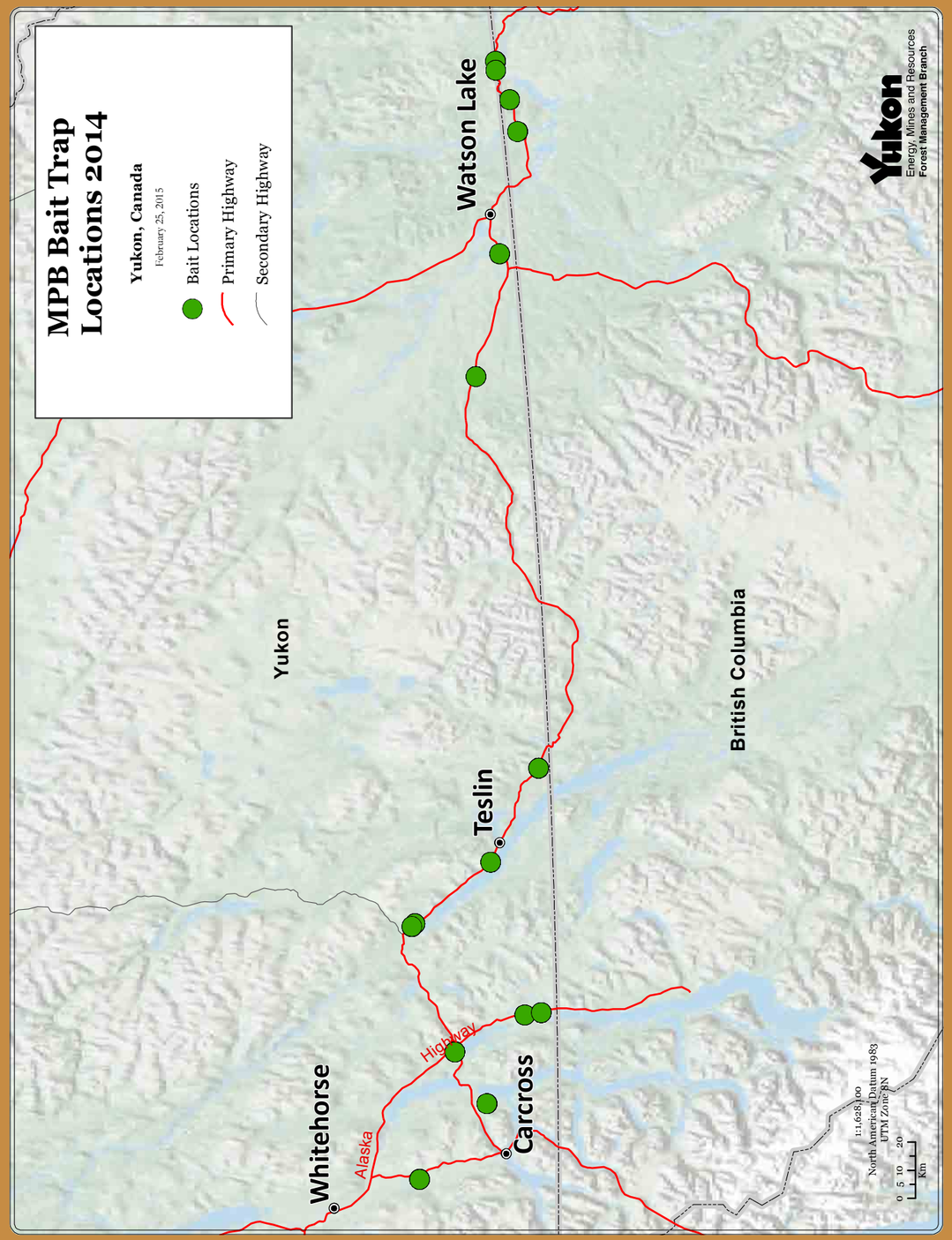
Using Bait Traps

Since 2009, FMB has been setting up and monitoring 15 pheromone bait tree stations in southern Yukon and northern B.C. to detect the presence of MPB (Map 4, photos 5 and 6). These pheromone baits do not attract MPB over long distances, but will draw them to the baits if they are already in the area. They also do not attract other species of bark beetles. No presence of MPB was found in 2014.

Photo 5. MPB bait tree.

Photo 6. Pheromone placed on the north side of the tree.

MAP 4 Mountain pine beetle monitoring bait trap locations in southern Yukon and B.C.



Forest Health Zone 1

A three day aerial survey of the forested area within forest health zone 1 was flown using a Cessna 206 fixed-wing aircraft (Map 5).

The majority of the area was flown in an east-west grid pattern with 12 km between grid lines, though some contour flying was done in mountainous areas towards Haines Junction. Given that forest health zone 1 was surveyed in 2009, it is possible to assess trends over time by comparing pest activity 2009 and 2014. Note the area surveyed in 2014 differed slightly from that in 2009.

Map 5 shows the extent and flightlines from the surveys flown in 2009 compared to 2014. Table 1 shows a summary of forest health disturbances from 2009 and 2014.

Given that forest health zone 1 was surveyed in 2009, it is possible to assess trends over time by comparing pest activity between 2009 and 2014. Note the area surveyed in 2014 differed from the area that was surveyed in 2009 (Map 5).

Table 1. Summary of recorded forest health disturbances in forest health zone 1 in 2009 and 2014 (in ha). Note dash (-) signifies not detected in survey.

DISTURBANCE TYPE	2009	2014
Biotic		
Aspen serpentine leaf miner	111,720	400
Bruce spanworm	-	30
Large aspen tortrix	-	6,120
Spruce beetle	3,130	2
Western balsam bark beetle	1465	2,760
Willow blotch miner	65	-
Abiotic		
Flooding-spruce & pine	640	608
Flooding-willow	-	165
Drought - pine	430	170
Drought - spruce	20	-
Landslide	-	30
Windthrow	40	10
Pest Complexes		
Porcupine/lodgepole pine beetle	180	815
Drought - aspen/Venturia	-	2,910

MAP 5 Forest Health Zone 1

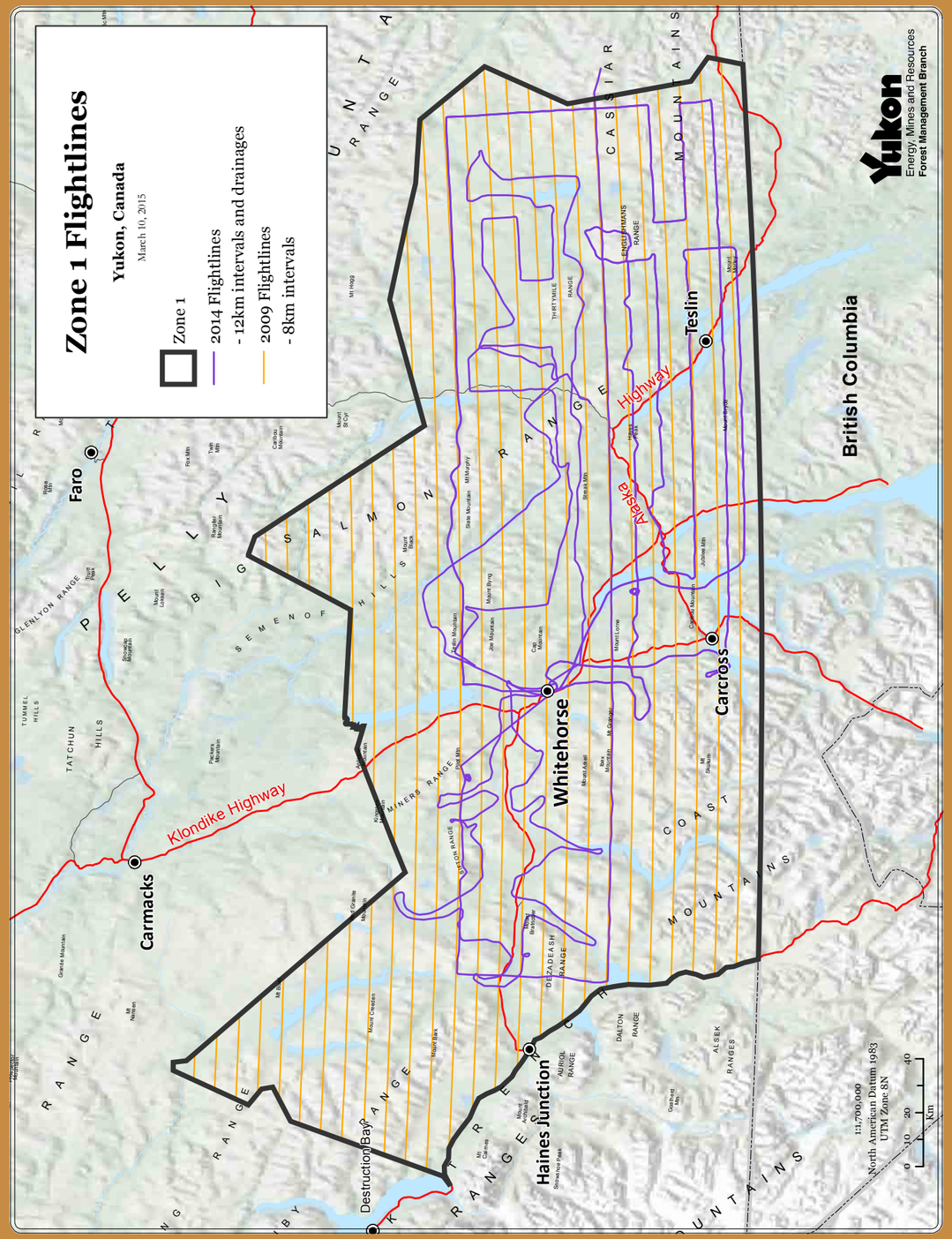


Photo 7. Aerial survey north of Johnson's Crossing Forest Health Zone 1; showing no forest health concerns.

Photo 8. Predominantly healthy lodgepole pine landscape at recreation trails adjacent to Whitehorse.

Biotic Disturbances

Aspen Serpentine Leafminer

The aspen serpentine leafminer is a defoliator of trembling aspen and is common throughout the host range in Yukon. The leafminer's activities were first recorded in the early 1950s along the Alaska Highway. At endemic levels, single leaf infestation is common but whole tree infestation occurs during outbreaks. Current outbreaks in Alaska and Yukon have impacted hundreds of thousands of hectares of mature and immature aspen. Ten to 20 years of unprecedentedly severe leafminer defoliation has occurred in stands of aspen along the Silver Trail between Mayo and Stewart Crossing.

While the leafminer rarely causes tree mortality, tell-tale signs of silvery aspen foliage and reduced growth can be seen along most of the highways in Yukon. In general, trees infested by serpentine leafminer will only die if already stressed by factors such as past infestation by large aspen tortrix.

Photo 9a. Healthy trembling aspens stands.

Photo 9b. Serpentine leaf miner-infested trembling aspen stands.

The area infested by this leafminer continues to decline, with 2014 marking the third consecutive year with minimal activity by this insect pest. This is reflected in the significant decrease from 111,720 ha noted in 2009 to approximately 400 ha noted in 2014 in forest health zone 1, mostly in the vicinity between Jake's Corner and Rosy Lake. Unlike previous years the majority of trembling aspen stands are a vibrant green (Photo 9a), rather than having a serpentine hue characteristic of this pest (Photo 9b).

Large Aspen Tortrix

Native to North America, the large aspen tortrix is found throughout the trembling aspen's range. Before 1990 and the onset of the spruce bark beetle infestation in the southwest Yukon, it was the single most common cause of insect-based disturbance in Yukon forests. The last outbreak was prior to 1990, and occurred north of Haines Junction.

This insect completes its life cycle in a single year. During that time, larvae pass through five developmental stages, known as instars, before reaching maturity. At the end of each instar, larvae shed their skins and re-emerge as the next larger stage. Small second instar larvae emerge from the tents they have spun for winter quarters in late May or early June. Then they feed on the emerging buds and leaves of aspen trees. In some instances, initial feeding damages the buds to the extent that they fail to flush. At the third instar stage of larval development, they roll the leaves and continue until they complete larval development (Photo 10a). Pupation occurs normally at the leaf edge in late June. Adults emerge after about ten days and mate. Then, females lay eggs in small masses on the upper surfaces of leaves (Photo 10b). Eggs hatch in early August. After hatching, early instar larvae feed on leaf surfaces until late August. Then at the second instar stage, they hide in the bark crevices. Here they spin webs (hibernacula) for overwinter shelter and enter a hibernation stage known as diapause. At this stage, the water in their cells is replaced with glycol (antifreeze) which allows them to withstand winter temperatures as cold as -27°C.

The life history of this insect places it in direct competition with the aspen serpentine leafminer. This inter-specific competition (individuals of different species compete for the same resource) is likely the main reason why the decline of recorded tortrix damage coincided with the explosion of leafminer populations. The past three years have seen a decline in leafminer damage throughout Yukon and thus a coincident opportunity for renewed success of the tortrix.

In 2014, a significant increase in area defoliated was noted; from 1,632 ha in 2013 to 6,120 ha in 2014. Stands of trembling aspen were light to severely defoliated west of Whitehorse, with patches near Mendenhall (Photo 11), Champagne, Canyon and Dezadeash Lake. One small polygon was noted near Baker Lake, along the Teslin River. This marks the third consecutive year of defoliation for stands near Champagne and Canyon, while infestations in Haines Junction have collapsed, and those near Dezadeash and Baker lakes are new. Of note, historically, defoliation has not been observed for more than two consecutive years. The most severe defoliation occurred near Dezadeash Lake. As drought damage was also present in many of these stands they also had a brownish hue associated with the defoliation (Photo 12).

Photos 10 a,b,c,d – Typical signs and symptoms of large aspen tortrix. From top to bottom – **a)** rolled leaves, **b)** pupal case, **c)** egg masses, **d)** defoliation.

Photo 11. Moderately defoliated trembling aspen stand near Mendenhall.

Photo 12. Stand lightly defoliated by large aspen tortrix with drought symptoms, near Mendenhall.

Bruce Spanworm

The Bruce spanworm (*Operophtera bruceata*) is a native North American hardwood defoliator. It infests maple (*Acer* spp.), aspen, birch (*Betula* spp.) and other hardwoods throughout its natural range. In Yukon its impact on willow (*Salix* spp.) and trembling aspen is of greatest concern. An outbreak south of Dezadeash Lake in 2002 and 2003 was mapped from the air over an area in excess of 10,000 ha. It was unique in that it occurred in willow in subalpine habitat. Although the Bruce spanworm is common throughout the North, damage of this magnitude had not previously been reported in Canada. The population collapsed in 2004; it is typical for infestations to subside after two years. Parasitized pupae were found in collected samples and this may have represented the mechanism of the collapse.

The Bruce spanworm completes its life cycle in one year. Adult moths appear in October in Yukon. The females are wingless and crawl up the lower portion of the trunk (often late in the day), mate, then lay single eggs in bark crevices and protected openings. Larvae hatch the following spring, timed to correspond with bud-break. As the leaves develop, the larvae first consume the underside of the leaf, excluding the main ribs and veins. Often, larvae form the leaf into a protective sheath by folding it over and securing it with silk. They continue to feed within the leaf shelter. When leaf material is exhausted in one part of the tree, larvae produce a silk thread on which they travel to reach food supplies lower in the crown. This is also a means of dispersal as the silk sometimes becomes dislodged in the wind and larvae are blown to other trees. After five to seven weeks of feeding the larvae are mature and, in early to mid-July, they drop from the tree onto the forest floor where they spin a cocoon in the leaf litter. The pupae will develop in the duff until late fall, when adult moths emerge.

One unconfirmed polygon totaling 30 ha was recorded near the south west end of Little Atlin Lake.

Photo 13. Stand of willow in subalpine habitat severely defoliated by Bruce spanworm.

Spruce Bark Beetle

This year marks the second year since 1994 that aerial surveys were not conducted to map white spruce mortality due to spruce bark beetle in the southwest Yukon. Aerial surveys were suspended this year because recent surveys had suggested that the infestation has ended. The spruce bark beetle infestation in the southwest Yukon has been the largest, most severe and long lasting infestation in Canada. It has extended across 400,000 ha of white spruce forest for the last 23 years.

In 2014, only two ha were recorded, consisting of seven small spot infestations.

Western Balsam Bark Beetle

The western balsam bark beetle is a woody tissue feeder of subalpine fir. It is found throughout the host range in Yukon and, over the past two decades, light to moderate infestations have been observed in the southern part of the territory. The beetle works in concert with a symbiotic fungal pathogen (*Ceratocystis dryocoetidis*) to overcome tree defence mechanisms. At endemic levels, the beetles prefer trees weakened by age or climatic stress (e.g., drought, wind-damage or snow-damage), but during outbreaks healthy trees are susceptible to attack. Endemic beetle populations can cause single tree mortality; however, outbreak populations can cause extensive group tree or stand-level mortality over successive years of attack.

Over the last 20 years, the western balsam bark beetle has advanced north from B.C. into southern Yukon. Surveys from the mid-1980s to the early 1990s recorded the beetle's northerly spread across the 60th parallel. With the change in climatic conditions, extensive amounts of mature and semi-mature trees, and successive years of attack, the balsam bark beetle has become an active stand-level disturbance agent in southern Yukon. Surveys indicate that the most affected areas have been high elevation stands with concentrated subalpine fir components. In the mid-1990s, hundreds of hectares of light (<10%), current-year mortality were mapped in the LaBiche River area in southeast Yukon. Years of successive attacks have removed a large proportion of the subalpine fir overstory. In 2010, mortality was mapped near the upper Pelly River at 62°26'N latitude.

In 2006, an extensive area of light, current-year mortality was mapped in the hills south and west of Teslin Lake. In 2009, light scattered mortality has also been seen on east-facing slopes above Bennett Lake, south of Carcross. Since 2007 aerial surveys have evolved to deal with scattered landscape level incidences of MPB, and a new bark beetle severity code of trace (<1% of host trees in polygon infested) has been added. This coding is ideal for western balsam bark beetle as it characterises its signature on the landscape. Hence the change in coding in 2014 to trace from light, and approximately 2,760 ha of trace infestations mapped. The largest concentrations occurred between Nitsulin River and Morris Lake.

Abiotic Disturbances

Flooding

Trees along waterways, both rivers and lakes, are particularly prone to flooding damage due to prolonged exposure to high water levels. In 2014, approximately 775 ha were damaged, mostly spruce, pine and willow along rivers (Photo 14).

In many cases flooding has occurred in areas which experience repeated flooding, hence pushing back the shoreline as the waterway continually changes its course.

Drought

Trees on dry sites, south-facing slopes, or those with a shallow taproot system are particularly prone to drought damage. Drought often predisposes trees to attacks by secondary bark beetles, such as Ips spp., leading to tree mortality. In 2014, approximately 170 ha of lodgepole pine mortality was mapped, mostly on hillsides around Tagish and Teslin.

Landslide

Only two small areas in spruce stands were mapped with slides, totaling 26 ha. Landslides in spruce stands have the potential to lead to an increase in local spruce beetle populations, as this bark beetle prefers downed over standing material.

Photo 14. Flooding damage in spruce stands previously affected by spruce beetle along Arkell Creek, south of Ibex Valley. Note the gradual change from chlorotic to healthy trees in the center of the photo, an indication of high water damage.

Pest Complexes or Multiple Pests

Very few biotic and abiotic disturbances kill trees outright, with the exception of primary bark beetles and root diseases. Most disturbances predispose trees, making them susceptible to a variety of other secondary pests which are otherwise not capable of overcoming a tree's defence mechanisms. Similarly pests are generally indifferent to other pests, with some exceptions; therefore more than one pest can occur on a tree at a time.

Wind Desiccation/Drought/Poor Site

A large polygon totalling, 520 ha of wind desiccation/drought was mapped right along the Y.T./B.C. border, south of Watson Lake and west of Porter Lakes (Photo 15a). The majority was on the B.C. side, with approximately 40 ha on the Yukon side. Trees were likely suppressed already due to the xeric site conditions (Photo 15b). Low-elevation flying over the affected area noted thin red crowns (Photo 16), ongoing mortality as noted by the fallen dead trees, and virtually no flora in the understory.

Generally, wind desiccation or winter drying does not affect all aspects of the tree; dependent upon the direction of the exposure to the cold wind. However, it is likely that these nutrient and water-deprived lodgepole pine have been dying gradually for some time, and the cold winter wind event further desiccated the foliage.

Similar damage on lodgepole pine was noted over a much smaller area (96 ha), and at a much lower intensity, in 2011 near Mount Vanier eastside of Kusawa lake, and on sub-alpine fir near Thomas Creek south of Faro in 2010.

Photo 15a. Area of discoloration just west of Porter Lakes along the YT/B.C. border, south of Watson Lake as viewed heading north.

Photo 15b. Satellite imagery denoting approximate area affected and the xeric site conditions.

Photo 16. Affected area with dying trees and thin red crowns, just west of Porter Lakes. Note fallen dead trees, indicating that mortality has been ongoing, likely due to dry conditions of site.

Photos 17 a,b,c,d,e – Signs and symptoms of porcupine and secondary bark beetle damage From top to bottom: **a)** girdled tree showing advanced signs of girdling damage, **b)** girdling visible on upper stem, **c)** lodgepole pine beetle at base of porcupine-damage infested tree, **d)** pine engrave beetle boring dust on stem of porcupine-damage infested tree, and **e)** severe stem girdling caused by porcupines.

Porcupine and/or Lodgepole Pine Beetle

Porcupines feed on the nutrient-rich inner bark of all species of coniferous and deciduous trees, but they prefer pine (Photo 17). This feeding generally takes place in the winter, when their favoured foods are scarce, but can occur throughout the year. Some of the trees are girdled by the feeding and subsequently die, or are predisposed such that secondary bark beetles, such as lodgepole pine beetle or pine engraver beetle attack and further weaken or kill the trees (Photo 17). Rocky slopes tend to be favoured by porcupines due to the abundance of potential denning sites. Areas like these allow for the relatively large populations that are required to cause the degree of damage observed this year.

In 2014, 815 ha were mapped as containing light to moderate incidences of porcupine damage. The areas affected occurred throughout forest health zone 1, wherever lodgepole pine occurred, with scattered tree mortality also observed. Similar damage was mapped in 2009 over a small area (9 ha) in forest health zone 1, as well as in forest health zone 2 (26 ha) in 2010.

Initially there was concern that the mortality was due to MPB as the signature on the landscape looks very similar (Photo 18 and Photo 19). Ground checks on several sites revealed mortality due to porcupine solely, or a combination of porcupine and lodgepole pine beetle, and in some cases pine engraver beetle. Given these findings it was decided to apply this label to all similar mapped polygons in forest health zone 1, recognizing that the damage could be caused by one or a combination of these pests.

Upon closer examination of affected areas via helicopter subtle differences were noted with the discoloration of these trees compared to MPB, in that the yellow fade was more yellowish then yellow-orange, typical of MPB. Also given that the surveys were completed in mid-August trees infested with MPB are typically no longer in the yellow-orange stage but more of a bright red-orange stage. However given the naïve habitat and latitude, it is possible that a range of fading conditions could occur, and vary from those witnessed in the historic habitat.

Photo 18. Mortality caused by porcupine (and possibly lodgepole pine beetle and/or pine engraver beetle) in lodgepole pine stands south of Whitehorse. Note the yellow fading, not typical of MPB in mid-August in the historic habitat.

Photo 19. Porcupine complex induced mortality on a dry ridge west of Whitehorse, YT.

Drought/Venturia Leaf and Shoot Blight of Trembling Aspen

Over 2,900 ha of discolored trembling aspen stands were mapped in 2014 throughout the host range in forest health zone 1. Ground checks, locally in Whitehorse and those associated with other forest health concerns, found some stands affected by drought, some with Venturia leaf and shoot blight, and some with both (Photos 20 and 21). This pathogen has been recorded annually throughout the host range in northern B.C. since the early 2000s, with a peak of over 837,000 ha in 2013.

Affected areas tended to be small in size, indicating a potential for a clonal relationship (Photo 22). However two larger polygons (889 ha and 565 ha) of lightly affected areas were noted near Lake Laberge and Ibex Valley, respectively. As abiotic damage tends to be more landscape level in nature there is tendency to lean towards a pathogen, however the clonal aspect of trembling aspen could result in changes in phenology such that abiotic damage could be more pronounced at a clonal level. For the purposes of future historical references and in the absence of significant ground truthing of these polygons, it was decided to tag them as affected by drought, with a comment that venturia leaf and shoot blight could also be present.

Given the extent of this disturbance and the uncertainty around the causal agents, follow-up monitoring will continue as part of the 2015 forest health surveys. This will include a ground truthing component.

Photo 20. Venturia leaf and shoot blight (and serpentine leaf miner) near Watson Lake, YT.

Photo 2 1. Drought damage – Whitehorse City, YT.

Photo 22. Discolored trembling aspen patch within a healthy stand, possibly a distinct clone, due to drought and/or Venturia tip and shoot blight.

OTHER NOTEWORTHY DISTURBANCES IN 2014

This section includes pests which are either mostly urban in their occurrence, or those observed on the ground; but 1) not visible during aerial surveys or 2) outside forest health monitoring zone 1.

DISTURBANCE	HOST	SETTING	LOCATION	COMMENTS
Large-spored spruce-Labrador tea rust, Chrysomyxa ledicola	Spruce	Urban/Forest	Host range	Photo 23
Spruce broom rust, Chrysomyxa arctostaphyli	Spruce	Urban/Forest	Host range	Also of significance in 2011 west of Dawson City
Aspen bladdergall mite	Trembling aspen	Urban/Forest	Unknown – likely host range	Photo 24
Slide	Spruce	Forest	Morley River/Teslin Lake, Granite Creek	25 ha
Windthrow	Lodgepole pine	Forest	Mt. Vanier Area	10 ha

Photo 23. Large-spored spruce-Labrador tea rust on young spruce, west of Whitehorse; near Little River.

Photo 24. Dead spruce infected with spruce broom rust on recreation trails near Whitehorse.

REFERENCES

Alberta Department of Agriculture and Rural Development. 2006. Yellowheaded spruce sawfly.

B.C. Ministry of Forests and Canadian Forest Service. 2000. Forest health aerial overview survey standards for British Columbia. Prepared for the Resources Inventory Committee. 36pp.

B.C. Ministry of Forests and Range. Forest Practice Branch. Pest Guide.

Beckwith, Roy. The Large Aspen Tortrix. Forest Pest Leaflet #139. U.S. Department of Agriculture.

Bleiker, Kathy. Research scientist, Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.

Canadian Council of Forest Ministers. 2007. National Forest Pest Strategy. 13pp.

Campbell, E.M., R.I. Alfaro, and B. Hawkes. 2007. Spatial distribution of mountain pine beetle outbreaks in relation to climate and stand characteristics: a dendroecological analysis. Journal of Integrative Plant Biology 49: 168-178.

Carroll, A.L. 2007. When forest management and climate change collide: The eruption and spread of mountain pine beetle populations in western North America. Page 11 in Climate change impacts on boreal forest disturbance regimes; Conference program & abstracts. Disturbance dynamics in boreal forests, VI International Conference, Fairbanks, Alaska, 30 May – 2 June.

Carroll, A.L., S.W. Taylor, J. Régnière, and L. Safranyik. 2003. Effects of climate change on range expansion by the mountain pine beetle in British Columbia. Pages 223-232 in Shore, T.L., J.E. Brooks, and J.E. Stone (editors).

Ciesla, W.M. 2000. Remote sensing in forest health protection. USDA Forest Service, Forest Health Technology Enterprise Team, FHTET Report No. 00-03. 266pp.

Digweed, S.C., R.L. McQueen, J.R. Spence and D. W. Langor. 2003. Biological control of the Ambermarked birch leafminer, Profenusa thomsoni (Hymenopters: Tenthredinidae) in Alberta. Northern Forestry Centre Information Report NOR-X-389.

Hanson, T., and E. B. Walker. [n.d.] Field guide to common insect pests of urban trees in the Northeast. Waterbury, VT: Department of Forests, Parks and Recreation.

Kusch, D.S. and H. F. Cerezke. 1991. Forest Leaflet #7 - Yellow-headed spruce sawfly. Natural Resources Canada, Forestry Canada, Northern Forestry Centre.

Furniss, R.L. and V.M. Carolin. 1977. Western Forest Insects. Miscellaneous Publication No. 1339. U.S. Department of Agriculture.

Garbutt, R. 1995. Yukon Forest Health Report. Canadian Forest Service, Pacific Forestry Centre, Victoria, B.C.

Garbutt, R. 2005. Yukon Forest Health Report. Yukon Energy Mines and Resources, Forest Management Branch.

Garbutt, R. 2009. Yukon Forest Health Report: 2008. Government of Yukon, Energy, Mines and Resources, Forest Management Branch.

Garbutt, R 2010. Yukon Forest Health Report. Yukon Energy Mines and Resources, Forest Management Branch.

Government of Yukon, Energy, Mines and Resources. Forest Management Branch. Budworm. http://www.emr.gov.yk.ca/forestry/pdf/forest_health6.pdf

Li, C., H.J. Barclay, B.C. Hawkes, and S.W. Taylor. 2005. Lodgepole pine forest age class dynamics and susceptibility to mountain pine beetle attack. Ecological Complexity 2: 232-239.

Logan, J.A., and J.A. Powell. 2001. Ghost forests, global warming, and the mountain pine beetle (Coleoptera: Scolytidae). American Entomologist Fall: 160-172.

McQuarrie, C. J. K. 2008. Invasion History, Population Dynamics and Biological Control of Profenusa thomsoni. Dissertation. University of Alberta.

Mitton J.B. and M.C. Grant. 1980. Observations on the Ecology and Evolution of Quaking Aspen, Populus tremuloides in the Colorado Front Range. Amer. J. Bot. 67 (2): 202-209.

Mitton, J. and S.M. Ferrenberg. 2012. Mountain Pine Beetle Develops an Unprecedented Summer Generation in Response to Climate Warming. The American Naturalist 179 (5): 163 – 171.

Natural Resources Canada. 2012. Research at the Laurentian Forestry Centre of Natural Resources Canada – Spruce budworm. NRCan, CFS, Laurentian Forestry Centre, Québec, Que. 16 p.

Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, Information Report BC-X-399. Mountain pine beetle symposium: challenges and solutions.

Ott, R.A. 2008. RAO Ecological Consulting Services trip report for the 2008 Yukon forest health survey. RAO Ecological Consulting Services, Bennington, Vermont. Government of Yukon Contract Number GN08533048-55495. 19pp.

Regniere, J., and B. Bentz. 2007. Modeling cold tolerance in the mountain pine beetle, Dendroctonus ponderosae. Journal of Insect Physiology 53: 559-572.

USDA Forest Service, Alaska Region, State of Alaska Department of Natural Resources. Forest Health Conditions in Alaska-2006. Protection Report R10-PR-11.

Westfall, J., and T. Ebata. 2013 Summary of forest health conditions in British Columbia. British Columbia Ministry of Forests and Range, Victoria, BC. 80 p.

Published April 2015
Government of Yukon
Energy, Mines and Resources
ISSN 1708 - 9360

100%

www.emr.gov.yk.ca/forestry