2011 FOREST HEALTH REPORT

Yukon

Energy, Mines and Resources

Forest Management Branch

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A Risk-based Approach to Forest Health Monitoring for Yukon

In 2009, the Yukon Forest Management Branch (FMB) implemented a risk-based approach to forest health monitoring that is in line with the National Forest Pest Strategy (NFPS) approved by the Canadian Council of Forest Ministers (CCFM) in 2006. The NFPS is a proactive, integrated response to forest pests that uses a risk-based framework for coping with native and non-native forest pests in Canada. The intent of the NFPS is to reduce forest health impacts by improving coordination across jurisdictions, enhancing capacity for identifying and assessing forest pest risks, and increasing options and effectiveness of responses to forest pest threats (CCFM, 2007).

Forest pest risk analysis uses scientific information to develop and implement programs to reduce risk associated with forest pests, while also accounting for the uncertainty of future events and outcomes (CCFM, 2007).

In response to the NFPS, FMB developed an annual risk-based forest health monitoring program. The objectives of this risk-based forest health monitoring program are:

1. To provide a Yukon-wide overview of forest health issues;
2. To focus monitoring activities on high-risk forest health agents across forested landscapes that are of the most value to Yukon residents; and
3. To contribute to the NFPS goals, one of which is developing early detection and reporting capacity of forest health pests.

Before 2009, FMB relied heavily on the Canadian Forest Service (CFS), Pacific Region, Victoria B.C., to carry out its forest health program. CFS supported the Yukon Forest Health Program through the Forest Insect Disease Survey Program (FIDS), and when this nation-wide program was terminated in 1995, CFS continued its support through a contribution agreement with Government of Yukon.

Through this agreement, CFS contributed the expertise of their forest health technician, Rod Garbutt, to carry out surveys and generate an annual forest health report, and FMB funded the fieldwork. CFS work centred around mapping the spruce bark beetle *(Dendroctonus rufipennis)* infestation in southwest Yukon, which is the largest, most intensive spruce bark beetle outbreak ever recorded in Canada. Currently, CFS does not assist Yukon in the same capacity.

Identification of Major Forest Health Agents of Yukon

In 2009, staff from FMB and CFS and a forest consultant listed 10 forest health agents that pose the greatest risk (i.e. extensive mortality or defoliation) to Yukon forests and can be effectively monitored as part of a risk-based forest health monitoring program. Eight of the nine forest pests that will be deliberately targeted through annual monitoring are insects. These insect pests have the capacity to cause significant damage to forest resources; however, their damage is visible and they can be effectively monitored.

The only pathogen that will be monitored is pine needle cast *(Lophodermella concolor)*, a pest that can impact large forest areas. Pine needle cast can be effectively monitored because its damage to pine foliage can be very visible. Although root rot (i.e. Tomentosus root disease) and heart rot (i.e. aspen trunk rot) fungi cause more significant damage than foliage pathogens, they are more difficult to detect and require specialized ground surveys and expertise. As a result, root and heart rot will not be routinely monitored except in areas affected by timber harvest projects, reforestation efforts, and regeneration surveys. Tree dieback due to drought stress was identified as an additional forest health agent of concern.

Yukon will routinely monitor the following 10 biotic and abiotic forest health agents:[1]

[1] Although annual forest health monitoring will focus on forest pests and abiotic factors that pose the greatest risk to Yukon forests, other forest pest activity will be recorded when it is encountered.

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 this 380,000 ha area.

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 bark beetle 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 material 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 recording in Yukon; spruce engraver beetle infestation was mapped in southwest Yukon across 3,174 ha (Garbutt, 2009).

3. Western balsam bark beetle *(Dryocoetes confusus)*
This beetle attacks subalpine fir *(Abies lasiocarpa)*. Western balsam bark beetle has moved north from B.C. over the last 20 years and has become an active disturbance agent in mature subalpine fir stands in southern Yukon.

4. Budworms *(Choristoneura spp.)*
The budworm guild, comprising eastern spruce budworm, fir-spruce budworm, two-year cycle budworm and western black-headed budworm, cause similar defoliation damage to spruce, subalpine fir and, to a lesser degree, larch *(Larix laricina)* forests in Yukon. In 2008, eastern spruce budworm damage was mapped across 1,003 ha in Yukon, primarily near Stewart Crossing. Historically, eastern spruce budworm damage has been mapped in the extreme southeast portion of Yukon (Garbutt, 2009).

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.

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 sometimes extensive tree mortality. Outbreaks of large aspen tortrix have occurred in several places throughout southern Yukon, including Teslin Lake, Braeburn and Haines Junction.

7. Aspen serpentine leafminer *(Phyllocnistis populiella)*
This insect pest occurs throughout the Yukon range of aspen *(Populus tremuloides)* and also defoliates balsam poplar *(Populus balsamifera)*. Currently, a massive outbreak of aspen serpentine leafminer extends from Alaska, through Yukon, and into B.C.

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. 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, 2009). The most severe damage in these pine stands covered 477 ha (Garbutt, 2009).

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 (Pinus contorta) 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 is currently the most important forest health concern in western Canada. The current outbreak in B.C. is responsible for killing over 13 million hectares of pine forest (Carroll, 2007). Cold-induced mortality is considered the most important factor controlling mountain pine beetle dynamics (Régnière and Bentz, 2007). A warming climate is expected to allow the beetle 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 mountain pine beetle is a high priority because of its severe impact on pine forests during outbreaks and because of its proximity to the southern border of Yukon.

10. Tree dieback due to drought stress
Because trembling aspen occupies the driest sites in Yukon, 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 stands 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, 2009).

Yukon Forest Health Monitoring Strategy

The monitoring strategy focuses on forest stands throughout Yukon which are most susceptible to the 10 forest health agents of greatest concern. The strategy identifies two monitoring priorities for the next five years. When this period ends and the baseline data has been collected, the monitoring strategy will be re-evaluated.

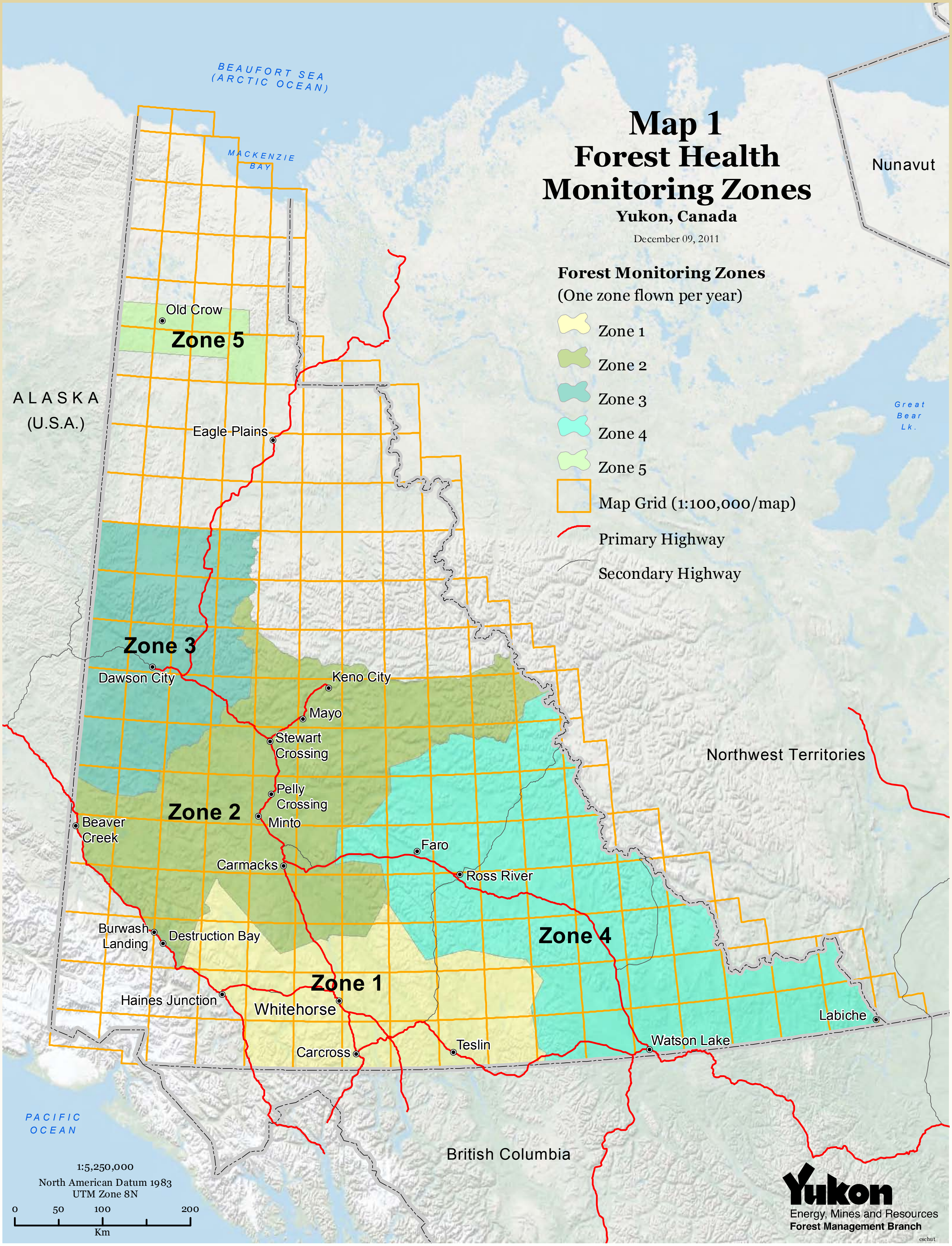
Priorities of the Forest Health Strategy

1. 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. Every year, researchers do aerial surveys of at least one forest health zone, and they monitor all communities and highway corridors within all five regions. The majority of accessible commercial forest lands and areas where forest management activities occur are within highway corridors and in close proximity to the communities.

2. Ongoing monitoring of areas of concern.

During the monitoring of the five forest health zones, researchers may select disturbances for further monitoring in the same year. If necessary, these disturbances are identified as **ongoing monitoring areas** to be included along with the forest health zones scheduled for monitoring during the current year. These ongoing monitoring areas help set forest health program priorities.


Map 1
Forest Health
Monitoring Zones
Yukon, Canada
December 09, 2011
Forest Monitoring Zones
(One zone flown per year)
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Map Grid (1:100,000/map)
Primary Highway
Secondary Highway
BEAUFORT SEA
(ARCTIC OCEAN)
MACKENZIE BAY
Nunavut
Great Bear Lk.
ALASKA
(U.S.A.)
Old Crow
Zone 5
Eagle Plains
Zone 3
Dawson City
Keno City
Mayo
Stewart Crossing
Pelly Crossing
Minto
Zone 2
Beaver Creek
Faro
Carmacks
Ross River
Northwest Territories
Burwash Landing
Destruction Bay
Zone 4
Zone 1
Haines Junction
Whitehorse
Labiche
Watson Lake
Teslin
Carcross
PACIFIC OCEAN
British Columbia
1:5,250,000
North American Datum 1983
UTM Zone 8N
0 50 100 200
Km
Yukon
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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; McConnell and Avila, 2004). 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 Mines are used in Yukon, ensuring continuity across shared boundaries. 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

- Use a Cessna 206 or equivalent high wing single engine airplane
- Fly aerial surveys on clear days with sunny skies
- Flying height of 800 m above ground level
- 2 qualified aerial surveyors (one positioned on each side of plane)
- Aerial surveyors use 1:100,000 scale maps
- Each surveyor oversees a 4 km wide corridor
- 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 windthrow
  - Trees damaged by animals such as porcupine
- Use on-the-ground checks to confirm the type of disturbance recorded from the aerial surveys
- Digitize recorded mapping data and store it in the Government of Yukon Geographic Information System

Summary of 2011 Forest Health Initiatives

In 2011, Yukon Forest Management Branch activities focused on seven program components.

Component 1: FMB presented a two-day forest health training course in early June. Resource officers from all seven of Yukon's forest districts attended the course, which started with a one-day classroom session in the research building at the Gunnar Nilsson and Mickey Lammers Research Forest, north of Whitehorse. The next day, participants went on field visits to view a range of active forest insect disease and abiotic agents currently causing damage to the forests around Whitehorse. The purpose of the course was to:

1. Learn about the biology and disturbance history of the major biotic and abiotic disturbance agents recorded in Yukon since the mid-1950s;
2. Improve ability to recognize and assess forest pest activity found in Yukon forest districts; and
3. Know how to report sightings to FMB using standardized protocols.

Component 2: In early July, FMB did a 5-day fixed-wing aerial survey of the southern portion of Forest Health Zone 2 (see Map 2) to map recent forest health disturbances.

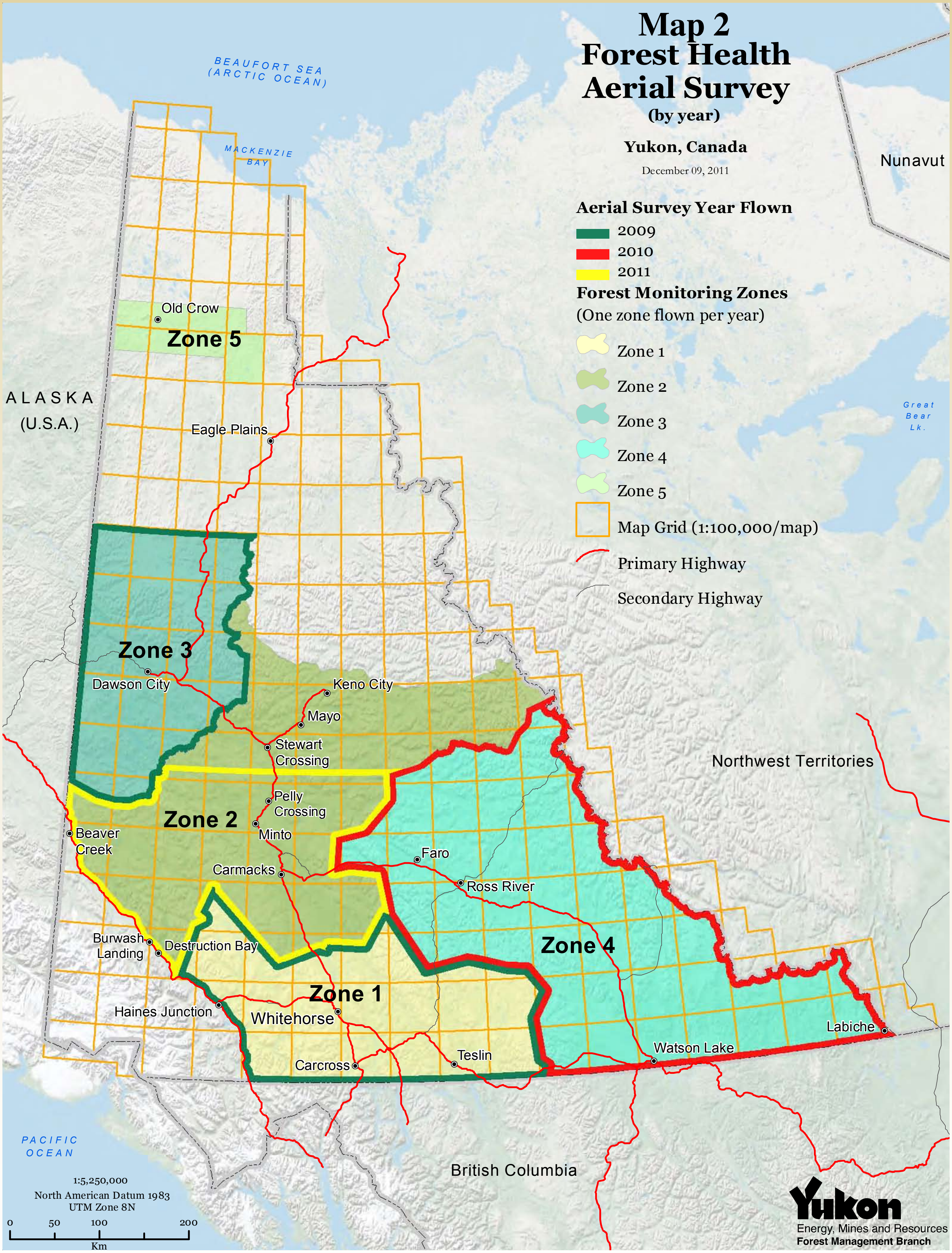
Component 3: Also in early July, FMB did a 3-day aerial survey of the Rocky Mountain Trench area of northern B.C. to map the northward progression of mountain pine beetle (MPB) infestations.

Component 4: Using the aerial survey data, in late August FMB completed three days of ground surveys in the Rocky Mountain Trench to assess the health of MPB populations within 13 infested stands.

Component 5: For the 18th consecutive year, FMB did an aerial survey in late August to map recent spruce bark beetle-caused white spruce mortality in southwest Yukon.

Component 6: Ongoing monitoring of areas of concern.

Component 7: FMB responded to pest incidence reports from the general public and government agencies including: wind desiccation at Kusawa, dead and dying spruce in the Cowley Creek subdivision south of Whitehorse, aspen mortality along the Alaska Highway near Kusawa, aspen serpentine leafminer damage, large-spored spruce-Labrador-tea rust near Dawson City, and comandra blister rust from the Marsh Lake Timber Harvest Area and Sawmill Road south of Whitehorse.


Map 2
Forest Health
Aerial Survey
(by year)
Yukon, Canada
December 09, 2011
Aerial Survey Year Flown
2009
2010
2011
Forest Monitoring Zones
(One zone flown per year)
Zone 1
Zone 2
Zone 3
Zone 4
Zone 5
Map Grid (1:100,000/map)
Primary Highway
Secondary Highway
BEAUFORT SEA
(ARCTIC OCEAN)
MACKENZIE BAY
Nunavut
ALASKA
(U.S.A.)
Great Bear Lk.
Old Crow
Zone 5
Eagle Plains
Zone 3
Dawson City
Keno City
Mayo
Stewart Crossing
Pelly Crossing
Zone 2
Minto
Beaver Creek
Carmacks
Faro
Ross River
Northwest Territories
Burwash Landing
Destruction Bay
Zone 4
Zone 1
Haines Junction
Whitehorse
Labiche
Watson Lake
Teslin
Carcross
PACIFIC OCEAN
British Columbia
1:5,250,000
North American Datum 1983
UTM Zone 8N
0 50 100 200
Km
Yukon
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Forest Health Aerial Surveys in 2011

In 2011, FMB flew the southern half of Forest Health Zone 2 (Map 2). Eight days were committed for aerial surveys in Forest Health Zone 2 this year; however, three of these days were diverted to mapping mountain pine beetle infestations in the Rocky Mountain Trench in northern B.C. because of the MPB threat to southeast Yukon forests. The unfinished northern section of Forest Health Zone 2 will be surveyed in 2012.

In late August, FMB completed an additional aerial survey to map recent white spruce mortality caused by the ongoing spruce bark beetle infestation in southwest Yukon.

In 2011, instances of disturbance by biotic and abiotic agents were mapped over a total area of 118,812 ha. As in previous years, the aspen serpentine leafminer was responsible for the majority (95%) of pest activity (Table 1). The only other significant damage was pine needle cast infection in numerous pine stands in central Yukon.

Table 1. Area of disturbance by pest, mapped during aerial surveys in Forest Health Zone 2 in 2011

Forest Health Agent	Total Area (ha)
Aspen leafminer	113,656
Pine needle cast	4,215
Poplar decline	529
Flood	206
Slide	67
Spruce bark beetle	48
Willow blotch miner	36
Winter wind desiccation	29
Porcupine	26

Table 2. Area of disturbance by pest, mapped during aerial surveys in Forest Health Zone 1 in 2011

Forest Health Agent	Total Area (ha)
Aspen leafminer	5,137
Spruce bark beetle	414
Winter wind desiccation	96

Biotic Pests

Spruce Bark Beetle, *Dendroctonus rufipennis*

The spruce bark beetle infestation in southwest Yukon was first surveyed in 1990 about three years after it is suspected to have started. Now in its 21st year, and covering over 380,000 ha, it is the largest (over a contiguous area), most severe and longest lasting spruce bark beetle infestation ever recorded anywhere.

For the 18th consecutive year, in 2011 researchers conducted fixed-wing aerial surveys to map recent spruce bark beetle-caused white spruce mortality in southwest Yukon. Recent light mortality (<10% of trees in stands killed by 2010 attacks) was mapped over an area totaling 414 ha (Map 3), which is less than half of the 1,311 ha mapped in 2010 (Chart 1). The infestation has declined for seven years and may be coming to an end.

All of the recent mortality mapped from the air in 2011 was in areas of previous infestation. In all cases, infestation levels were significantly lower than in 2010. In areas like the West Aishihik River Valley and the hills just northwest of Kusawa Lake, where most concentrations of red trees were mapped in 2010, only small spots totaling less than 100 ha were mapped this year. These declines were predicted by the low current beetle attack levels recorded during ground surveys in these two areas in 2010. The rest of the red trees were seen between Frederick Lake and Kusawa Lake, extending south along the west shore of Kusawa Lake to south of Devilhole Creek, as well as farther north in the JoJo Lakes area.

The spruce bark beetle normally completes its life cycle in two years. Some one-year cycling was observed in 1994 and again in 2004 when exceptionally warm, dry conditions extended the growing season and accelerated the development of beetle progeny. For the past seven summers, weather has remained within the normal climatic range. Some years, including in 2011, temperatures were cooler and rainfall was higher than normal. Under these conditions, beetle populations are confined to the two-year cycle.

Beetle attack concentrations were low this year, so Yukon did not complete any ground surveys. Last year's ground surveys at West Aishihik and Kusawa recorded very poor survival of beetle progeny from the 2009 attacks. Those that did survive will have emerged this year to attack fresh green trees. The greatly diminished population will likely meet with limited success, as the drought that spawned the infestation is long over and the trees' natural resistance to attacks has been restored. Aerial surveys will continue until beetle populations fall to endemic levels.

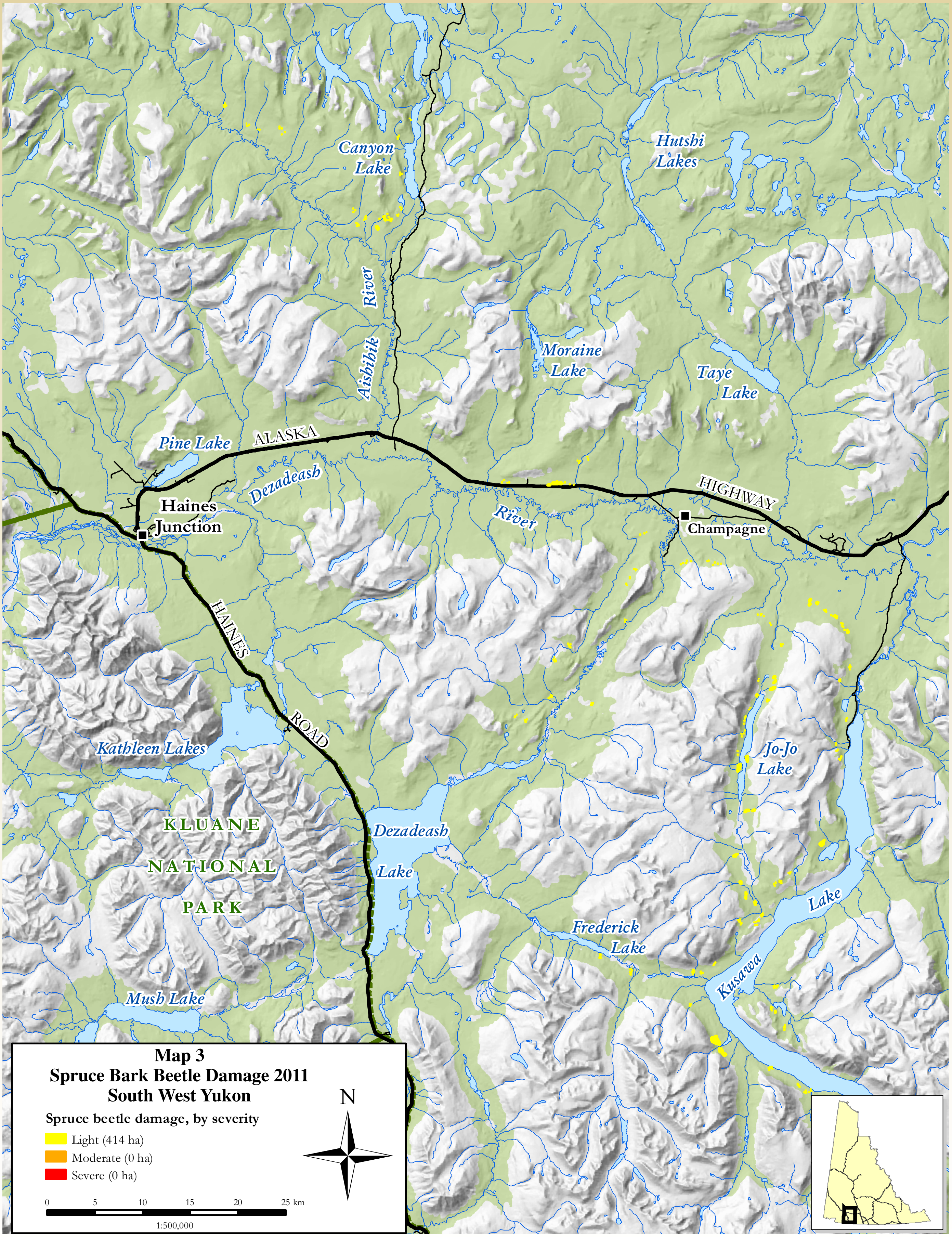
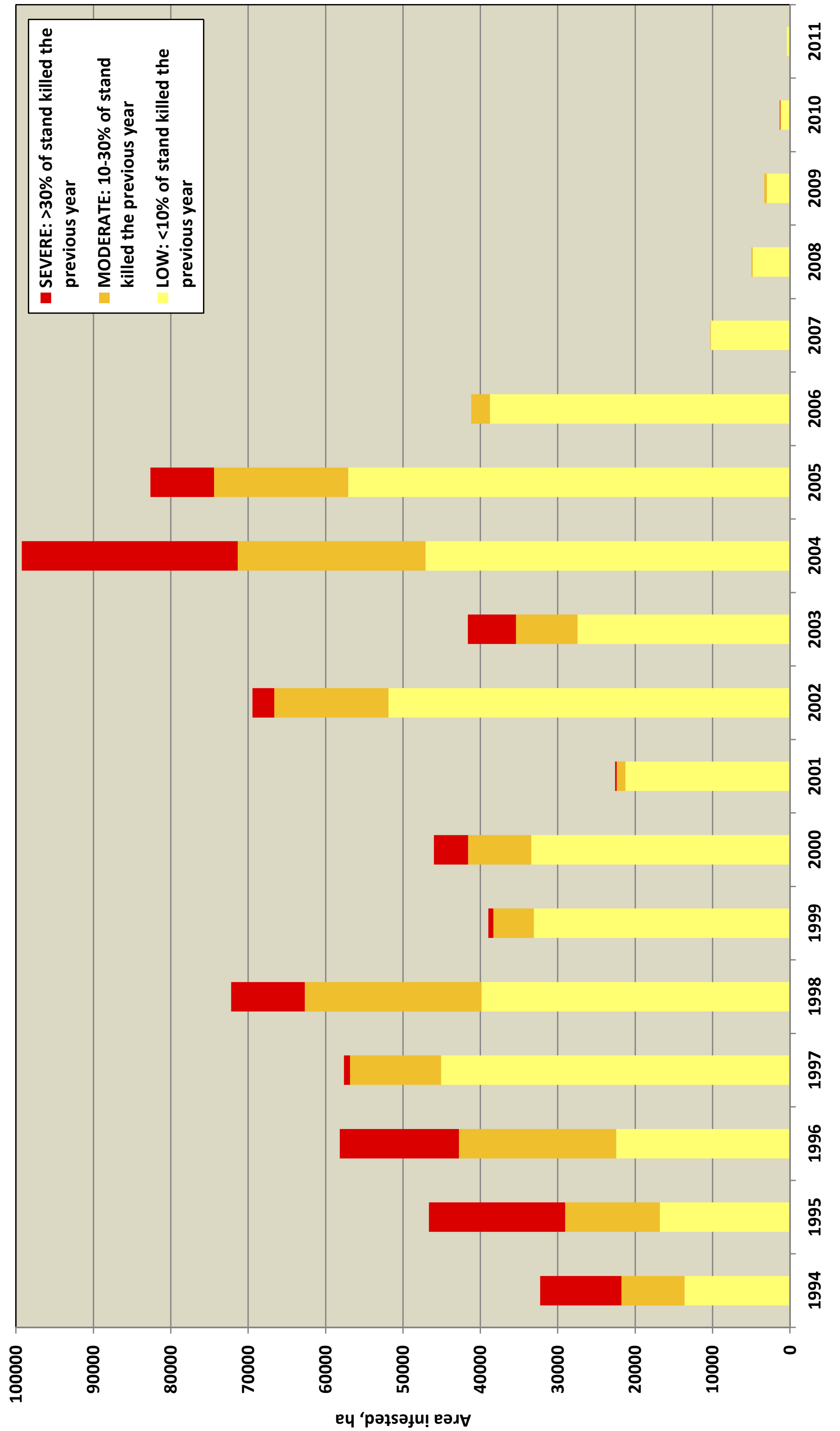

Canyon Lake
Hutshi Lakes
Aishihik River
Moraine Lake
Taye Lake
Pine Lake
ALASKA HIGHWAY
Dezadeash River
Haines Junction
Champagne
HAINES ROAD
Kathleen Lakes
Jo-Jo Lake
KLUANE NATIONAL PARK
Dezadeash Lake
Frederick Lake
Kusawa Lake
Mush Lake
Map 3
Spruce Bark Beetle Damage 2011
South West Yukon
Spruce beetle damage, by severity
Light (414 ha)
Moderate (0 ha)
Severe (0 ha)
N
0 5 10 15 20 25 km
1:500,000

Chart 1: Spruce Bark Beetle Infestation, Shakwak 1994-2011



The legacy of the beetle

Though the decline of this historic infestation is an important event in the history of major forest disturbances in Yukon, it is not the end of the spruce bark beetle story. Conservative estimates show that over 100 million standing dead trees remain across over 380,000 ha of southwest Yukon. The fire hazard posed by such an accumulation of dry standing fuel has long been a subject of concern and debate, both in Whitehorse and the most affected community, Haines Junction.

In the wake of a major infestation of spruce bark beetles, the assumption has been that the fire hazard remains high only until the trees shed the dead needles a few years after the trees are killed. The needles are the fine fuels that can readily transfer (ladder) a ground fire into the tree crowns and greatly intensify the fire (Hawkes, 2004 pers. com). The remaining bare branches are a coarser, less hazardous type of fuel.

However, in southwest Yukon white spruce retained fine fuels in the crown after needle drop. These fuels were the fine branchlets retained by the trees long after they shed their needles (Garbutt et. al., 2004). Because of the open growing nature of most stands in the area, the lower tree branches were not shed as the trees grew. These lower branches remained close to the ground fuels (Photo 1). Trees killed by the beetle in the mid-90s and examined 10 years later retained about 80 per cent of their fine branchlets. FMB's ongoing efforts have reduced the fuel continuity around Haines Junction, and FireSmart projects in the Village have significantly reduced fuel loads. Fortunately, due to the lightning shadow effect of the St. Elias Mountains, the Shakwak Trench is a relatively low fire risk area.

Between 2000 and 2003, CFS established 27 long-term research plots to assess the effects of the beetle infestation. These plots continue to be maintained jointly by CFS and Yukon FMB. Ongoing observations and measurements in the plots will closely follow the course of forest recovery and help determine future management decisions.

No one knows how long the dead trees will remain standing, though estimates range from 30 to 60 years. Recently, researchers made field observations of trees near Dezadeash Lake that were killed by spruce and Ips (see page 27) beetles in the late 1930s. Though none of the trees remained standing, those found on the forest floor were still sound after more than 70 years, and bark beetle etchings were still clearly visible in the sapwood. There are many stands, particularly in the Alsek River valley, where more than 80 per cent of the trees were killed in the mid-90s. As these trees come down they will pose an increasing impediment to wildlife (and human) movement within Kluane National Park. The debate about management options to deal with this inevitable outcome will no doubt continue for years to come.

Photo 1. Dense fine branchlets retained by spruce bark beetle-killed trees

Mountain Pine Beetle, *Dendroctonus ponderosae*

The mountain pine beetle (MPB) is a native North American bark beetle that is distributed throughout most of the range of lodgepole pine in British Columbia. The MPB is currently the single biggest forest health concern in western Canada; the current MPB outbreak is responsible for killing over 13 million hectares of pine forest in B.C. alone.

The MPB is one of 10 forest health agents that pose the greatest risk to Yukon forests and can be effectively monitored as part of a risk-based forest health monitoring program. Although the MPB has not expanded into Yukon, it has moved quickly northward in the last few years within the Rocky Mountain Trench in northern B.C. In the next few years, there is potential for a northward movement of a large population of MPB as far north as Yukon.

Climate plays an important role in the population of MPB. The most important factor in controlling the northern movement of MPB is cold weather and an inner bark temperature of -40˚C for at least one week. Mild winter weather allows overwintering MPB populations to thrive and the outbreak to continue.

History of MPB in Northern B.C.

Mountain pine beetle has historically been restricted to the pine forests of central and southern B.C. With its northward movement, MPB presents a threat to Yukon's forests.

- Beginning in 1994, in response to a warming climate, the MPB successfully invaded lodgepole pine forests to the north and east of its traditional range.
- As the MPB moved beyond its traditional range, stands with no historical relationship to the MPB were invaded and they had little or no adaptive resistance. Pine trees with no historical relationship to the MPB are referred to as naïve pine, while pine trees with a historical relationship to the MPB are called experienced pine.
- In the past few years populations of MPB have moved north within the Rocky Mountain Trench. In 2010, B.C. Ministry of Forests aerial surveys mapped infestations within 150 km of the Yukon border.

The first step in developing a pest risk assessment is to identify the risk posed by a specific disturbance agent. In the case of MPB, the potential risk to Yukon forests was recognized as early as 2003 when pheromone baits trapped beetles for the first time on the east side of the Rocky Mountains near Chetwynd, B.C. At that point the Rocky Mountain Trench was recognized as the most direct and geographically most suitable lowland route for the beetle to move northward toward Yukon. Forest inventory data also showed an abundance of susceptible pine within the Rocky Mountain Trench.

The critical question was whether or not the MPB could survive the rigours of climate, particularly the harsher winters as it moved northward. This question was answered in 2010 by aerial survey data from B.C. documenting the northern movement that showed large areas of continuous beetle-caused mortality in the Muskwa-Kechika Management Area 150 km south of the Yukon border.

The Government of Yukon is concerned about the northward expansion of the MPB and has developed a forest health monitoring strategy to track the northern movement of the beetle. Below is a history of response to mountain pine beetle by Government of Yukon:

2007 Risk Assessment at National Forest Pest Strategy

As the focus of CFS' "Risk assessment of the mountain pine beetle threat to Canada's boreal and eastern pine forests" focused on the eastern movement rather than the northern movement of MPB, Yukon carried out a risk assessment focused on northern jurisdictions and issues. With some NFPS funding, Yukon used climate change scenarios to project future MPB climate suitability and develop a stand susceptibility map for the territory. Researchers modeled projected climate and stand structure information to simulate future susceptibility under climate change scenarios. Results showed that areas experiencing climatic conditions suitable for MPB will increase in northwestern Canada, and the Yukon pine inventory will become susceptible to attack (see Appendix 3).

Aerial Surveys in Northern B.C.

In 2009, aerial surveys were conducted in northern British Columbia to detect the northern edge of the MPB range. The aerial surveys were carried out in conjunction with B.C. Ministry of Forests as yearly MPB assessments are not conducted in B.C. Yukon government provided financial assistance and sourced funding through partners such as the NFPS.

In 2010, B.C. Ministry of Forests mapped the 2009 northern movement of the MPB in the Rocky Mountain Trench. They found the main body of the infestation was 150 km south of the BC/Yukon border.

In 2011, Yukon government (with B.C. Ministry of Forests) conducted aerial surveys in northern B.C. In July 2011, they did a 3-day aerial survey in the Rocky Mountain Trench area of northern B.C. Using information from the July aerial survey, three days of ground surveys were completed in the Rocky Mountain Trench in late August to assess the health of MPB populations within 13 infested stands.

Using Bait Traps

Since 2009, FMB has been setting up and monitoring pheromone bait tree stations in southern Yukon to detect beetles. These pheromone baits do not attract MPB over long distances but will draw them to the baits if they are already in the area. No presence of MPB was found in 2011.

Updating the Risk Assessment at the National Forest Pest Strategy

The CCFM has asked the NFPS to provide a descriptive update to the 2007 emergency assessment of the MPB situation. This descriptive update will include annual information on any measures of MPB activity such as baited traps, R-values, aerial overviews, and ground plot information (impact, winter survival). An up-to-date status report was delivered to a MPB meeting in Edmonton in November 2011. An updated risk assessment will also house the information used to complete the risk analysis case study for the CCFM by March 2012.

Interdepartmental Mountain Pine Beetle Committee

The Government of Yukon Interdepartmental Mountain Pine Beetle Committee was formed in 2011. The committee will provide direction and develop strategies to monitor and manage MPB in the future.

Monitoring the MPB in 2011

After viewing the 2010 aerial survey maps from northern B.C., in 2011 FMB took a proactive approach to managing the threat posed by MPB. Yukon government did surveys to determine beetle movement between 2010 and 2011, as well as an assessment of the size and health of the current MPB. The surveys were conducted in two stages; Stage 1 was an aerial survey to map recent mortality, and Stage 2 was a ground-based survey to assess beetle populations.

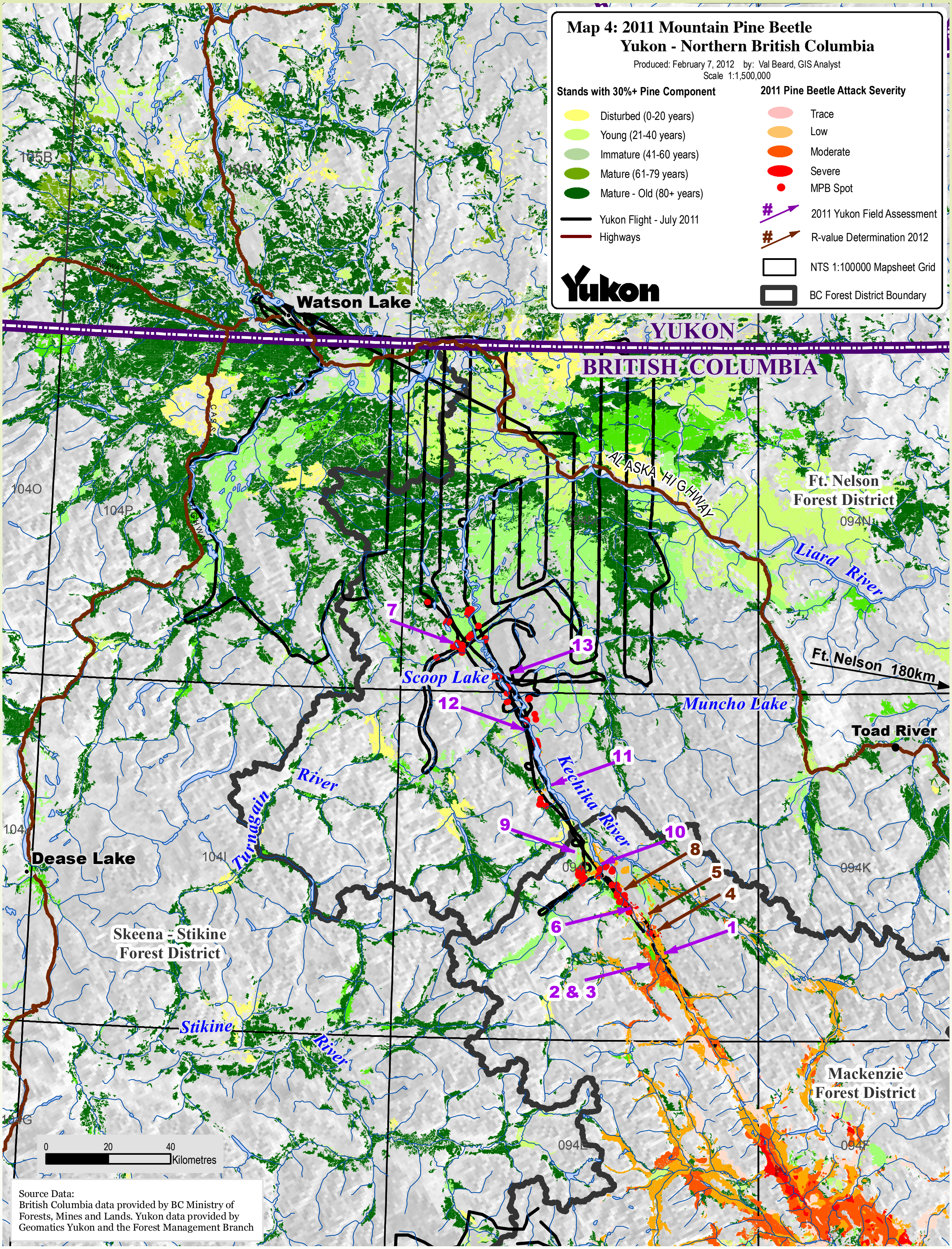
Stage 1: Aerial survey, July 8-11, 2011

In cooperation with B.C. Ministry of Forests, Yukon started an active monitoring program in July with a 3-day aerial survey to map all trees attacked and killed by MPB in 2010 (Appendix 1). These trees, known as faders, were in the process of turning colour from green to red and were clearly visible within the stands. These trees were hosting the beetles that would mature later in the summer to emerge and attack fresh trees and continue the northward advance toward Yukon.

All instances of recent mortality were recorded on aerial survey maps. Aerial mapping began 150 km south of the Yukon border, well within the main body of the infestation. North-south grids were flown to the Yukon border (with 8 km between grids) to ensure full coverage of the infested area. The large number of faders mapped during the aerial survey (Map 4) clearly showed the success of 2009 broods. Small patches of attack now extend to within 80 km of the Yukon border.

The total area of attack by attack intensity was as follows:

- Light (≤10% of trees killed in 2010) – 11,736 ha
- Moderate (>10<30% of trees killed in 2010) – 775 ha
- Severe (≥30% of trees killed in 2010) – 1,535 ha


Map 4: 2011 Mountain Pine Beetle
Yukon - Northern British Columbia
Produced: February 7, 2012 by: Val Beard, GIS Analyst
Scale 1:1,500,000
Stands with 30%+ Pine Component
Disturbed (0-20 years)
Young (21-40 years)
Immature (41-60 years)
Mature (61-79 years)
Mature - Old (80+ years)
Yukon Flight - July 2011
Highways
2011 Pine Beetle Attack Severity
Trace
Low
Moderate
Severe
MPB Spot
2011 Yukon Field Assessment
R-value Determination 2012
NTS 1:100000 Mapsheet Grid
BC Forest District Boundary
Yukon
Watson Lake
YUKON
BRITISH COLUMBIA
ALASKA HIGHWAY
Ft. Nelson
Forest District
Liard River
Ft. Nelson 180km
Scoop Lake
Muncho Lake
Toad River
Kechika River
Turnagain River
Dease Lake
Skeena - Stikine
Forest District
Stikine River
Mackenzie
Forest District
0 20 40 Kilometres
Source Data:
British Columbia data provided by BC Ministry of Forests, Mines and Lands. Yukon data provided by Geomatics Yukon and the Forest Management Branch

Stage 2: Ground Survey, August 22-25, 2011

The aerial survey provided information about the success of the MPB population up to the time trees were attacked and killed in 2010. To determine the current state of the population, a team of three people did a 3-day ground survey at the end of August (Appendix 2). Two members of the crew were from Yukon Forest Management Branch. The third member was Ken White, a B.C. Ministry of Forests entomologist based in Smithers. The team used an outfitting camp at Scoop Lake as a forward operating base and a helicopter to access the stands.

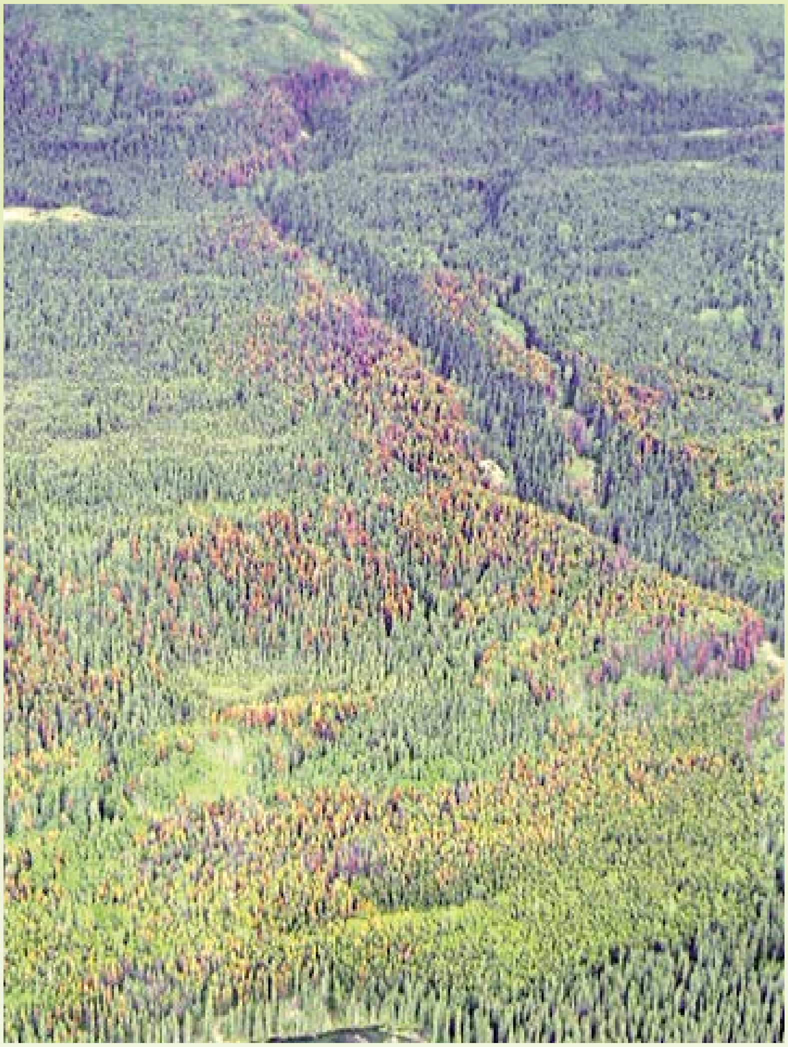
They assessed 13 infested stands over three days. The 13 site locations are illustrated in Map 4.

Sites were selected based on several criteria:

1. The presence of trees attacked in both 2009 and 2010 (red trees and fading trees);
2. A range of attack intensities including:
    - areas of continuous attack at the southernmost extent of the survey (sites 1-3) (Photo 2);
    - large polygons of discontinuous attack just to the north of the continuous zone (sites 4-6 and 8-10) (Photo 3);
    - smaller polygons between .25 and 2 ha in size that extended as far north as 80 km from the Yukon border (sites 7 and 11-13) (Photo 4);
3. A range of elevations; and
4. Helicopter landing sites near attacked stands.

Photo 2. Areas of continuous attack at the southernmost extent of the survey (sites 1-3)

Photo 3. Large polygons of discontinuous attack to the north of the continuous zone (sites 4-6 and 8-10)



At each site the crew removed bark from trees attacked in 2009 and 2010 and made a subjective assessment of brood success. They determined brood success by the number and length of larval galleries radiating outward from the parent galleries and by the number of exit holes made by emerging adults. Where present, they located current (2011) attacks and assessed the progress of brood establishment.

Brood success in the 2009-attacked trees was uniformly poor to moderate. The limited success was due primarily to woodpeckers feeding on the beetle larvae over the winter (Photo 5). Debarking by woodpeckers was evident on all trees attacked in 2009. Nevertheless, the surviving MPB population was sufficient to cause attacks at similar levels in 2010. Brood development in the 2010-attacked trees was poor, largely due to a period of extreme cold weather in January 2011. The complete absence of woodpecker activity provided external evidence of this observation. There was very little adult emergence from these trees and significant numbers (10+) of current (2011) attacks were found only at sites 4, 5 and 8, all within the area of discontinuous attack.

Ongoing monitoring

In June 2012, a third stage of investigation will target trees attacked in 2011. A sampling methodology known as R-value determination will be used to evaluate the surviving larvae. Survey results will determine whether the expected number of future attacks will be higher or lower than 2011 levels. In addition, a second aerial survey is planned for early July 2012 to map the trees attacked in 2011.

Photo 4. Smaller polygons between 0.25 and 2 ha in size that extended as far north as 80 km from the Yukon border (sites 7 and 11-13)

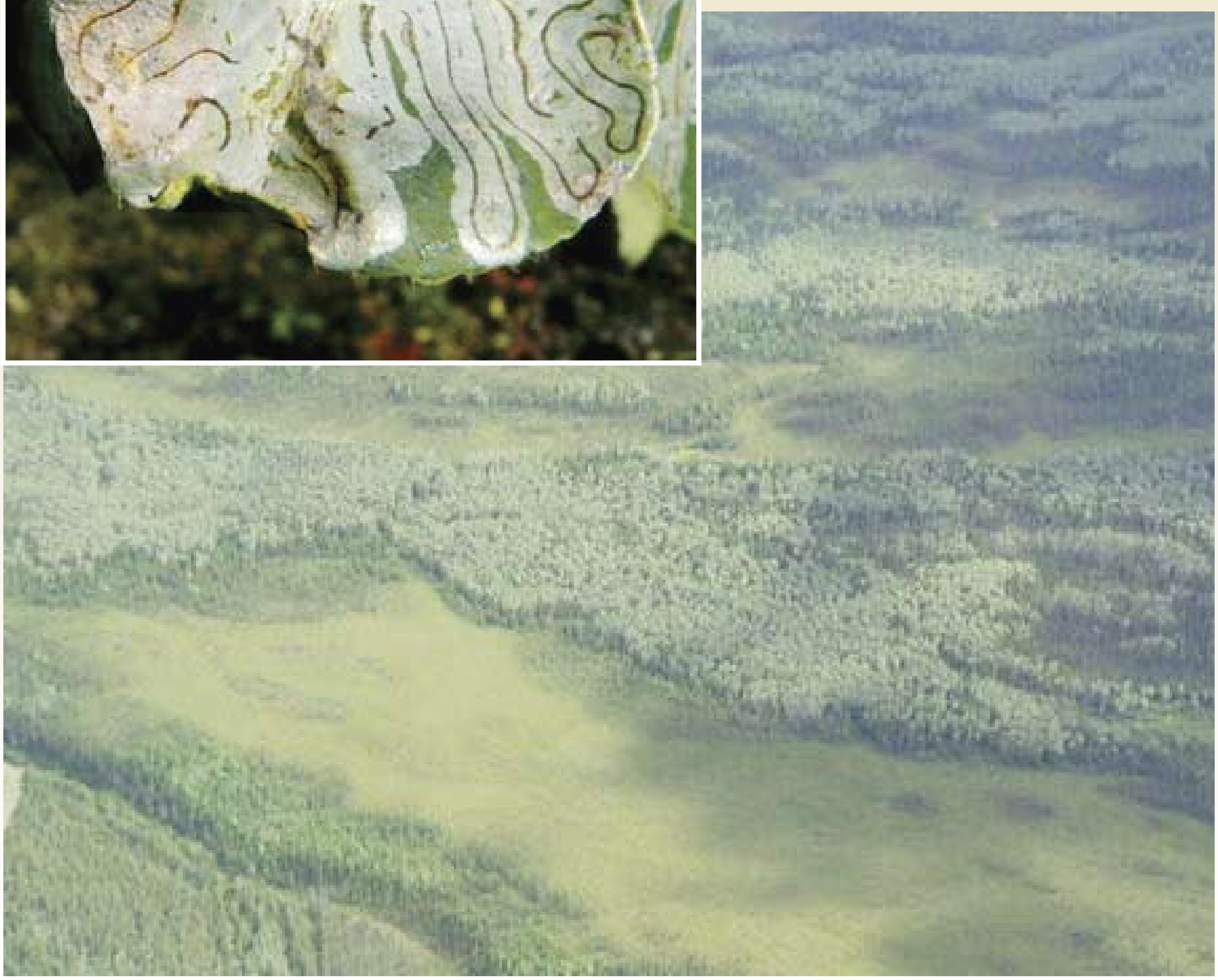
Photo 5. Woodpeckers feeding on the beetle larvae over the winter

Aspen serpentine leafminer, *Phyllocnistis populiella*

During the aerial survey of Forest Health Zone 2, aspen serpentine leafminer defoliation (Photo 6) was mapped over an area of 113,656 ha (Table 1, Photo 7). The area that was mapped reflected the entire region where pure aspen stands occurred on the landscape. The only relief from this insect was in stands in the west near the White and Donjek rivers where defoliation was light-to-moderate, compared to uniformly severe defoliation in stands to the east.

Photo 6. Aspen leafminer galleries in aspen leaf

Photo 7. Aspen serpentine leafminer defoliation in Forest Health Zone 2 east of White River



Large-spored spruce-Labrador tea rust, *Chrysomyxa ledicola*

The moist conditions that prevailed throughout Yukon in the summer of 2011 caused a proliferation of large-spored spruce-Labrador tea rust on the current needles of white spruce in a number of areas. Forestry personnel and members of the public made many reports of orange needles on spruce trees.

Spruce stands just west of Dawson City adjacent to the Top of the World Highway were most severely affected over a large area (Photos 8 and 9), with almost all of the current year's needles lost to the disease. Unfortunately, by the time it was surveyed from the air in late August, most of the infected needles had fallen from the trees and the infection was no longer visible. Severe infection was also reported from the Dempster Highway near Tombstone Campground. In southern Yukon moderate-to-severe current needle loss was observed in white spruce stands at Morley River.

In mid-summer there were reports from Dawson that the surface of the Yukon River was bright orange. The colour resulted from the millions of spores shed from rust-infected needles from upstream spruce stands. The spores formed a thin layer on the surface, suspended by surface tension.

Photo 8. Current needles infected by needle rust on Top of the World Highway

The specific locations of these stands were unreported, but the sheer volume of spores suggested widespread infections along the river and its tributaries.

This common rust attacks the needles of white spruce throughout its range as well as the rust's alternate host, Labrador tea (Allen, 1996). Needles become infected when the mature spores from the previous year's infection are transferred by rain splash in late spring to newly-flushed needles. A second species of rust, the small-spored spruce-Labrador tea rust, *C. ledi* may also have been involved, but *C. ledicola* is far more common.

The widespread nature and severity of these infections are unprecedented in Yukon's pest history. It is unclear if the phenomenon is related to climate moderation. Climate scientists have predicted that one characteristic of climate moderation will be increased rainfall in many areas, so more widespread spruce rust infection may be present in the future.

Photo 9. Needles infected with large-spored spruce-Labrador tea rust

Pine needle cast, *Lophodermella concolor*

During aerial surveys of Forest Health Zone 2, discoloured young pine was mapped over a total area of 4,215 ha (Map 5). Depending on the intensity of the red colour, a subjective assessment of infection severity was made from the air. An area of 3,693 ha was mapped as light intensity and the remaining 521 ha was moderate. Though not verified by on-the-ground checks, pine needle cast was considered the most likely cause. Most of the damage was mapped in 22 separate polygons in young and middle-aged stands of pure pine that had regenerated following wildfires northeast and northwest of Carmacks. Seven areas of light intensity and about half of the total infected area were mapped just north of McCabe Creek surrounding Leger Lake. Fifteen separate areas, all of moderate intensity, were located farther east, near Tatlmain Lake (Photo 10). Another 200+ ha stand in the hills just north of Stewart Crossing was also lightly discoloured.

In 2009 damage was seen for the first time in young stands near Little Atlin Lake and in fire-regenerated stands on the Minto flats. All of these 2009 and 2011 infections are range extensions of a disease that has traditionally been seen only in the Watson Lake area.

The disease infects the needles shortly after the spring flush. The following year the needles die and turn red, but by that time the tree has produced another green flush. Therefore, one of the telltale signs of pine needle cast is the red year-old needles (Photo 11). It also produces a singular aerial signature.

Climate change has resulted in an increase in average temperatures throughout Yukon, as well as increased rainfall in many areas. To be successful, this disease relies on rainfall in the spring to coincide with the maturation of the spore-laden fruiting bodies from the previous year's infections. The released spores are transferred by rain splash from the old needles to the newly-flushed needles. Through this process the disease intensifies, especially if similar high moisture conditions prevail in two or more years in succession. At high intensity the disease can kill all of the current needles over large areas and significantly reduce growth potential. Successive years of severe infection result in a phenomenon known as "lions tailing" (Allen, 1996) where the current year's needles are all that remain on the trees.

Like the spruce rust, the increased incidence and more widespread distribution of pine needle cast may be related to increased rainfall brought on by climate moderation. We may see more of this disease and another pine needle disease known as Dothistroma needle blight, *Mycosphaerella pini*, in the future. The latter disease has moved rapidly northward in the last 10 years. A B.C. forest pathologist identified it three years ago infecting pine at the Dease River Crossing, just south of the Yukon border (A. Woods, 2009 pers. com.). It has not yet been detected in the Watson Lake area, but it will likely be present within a few years.

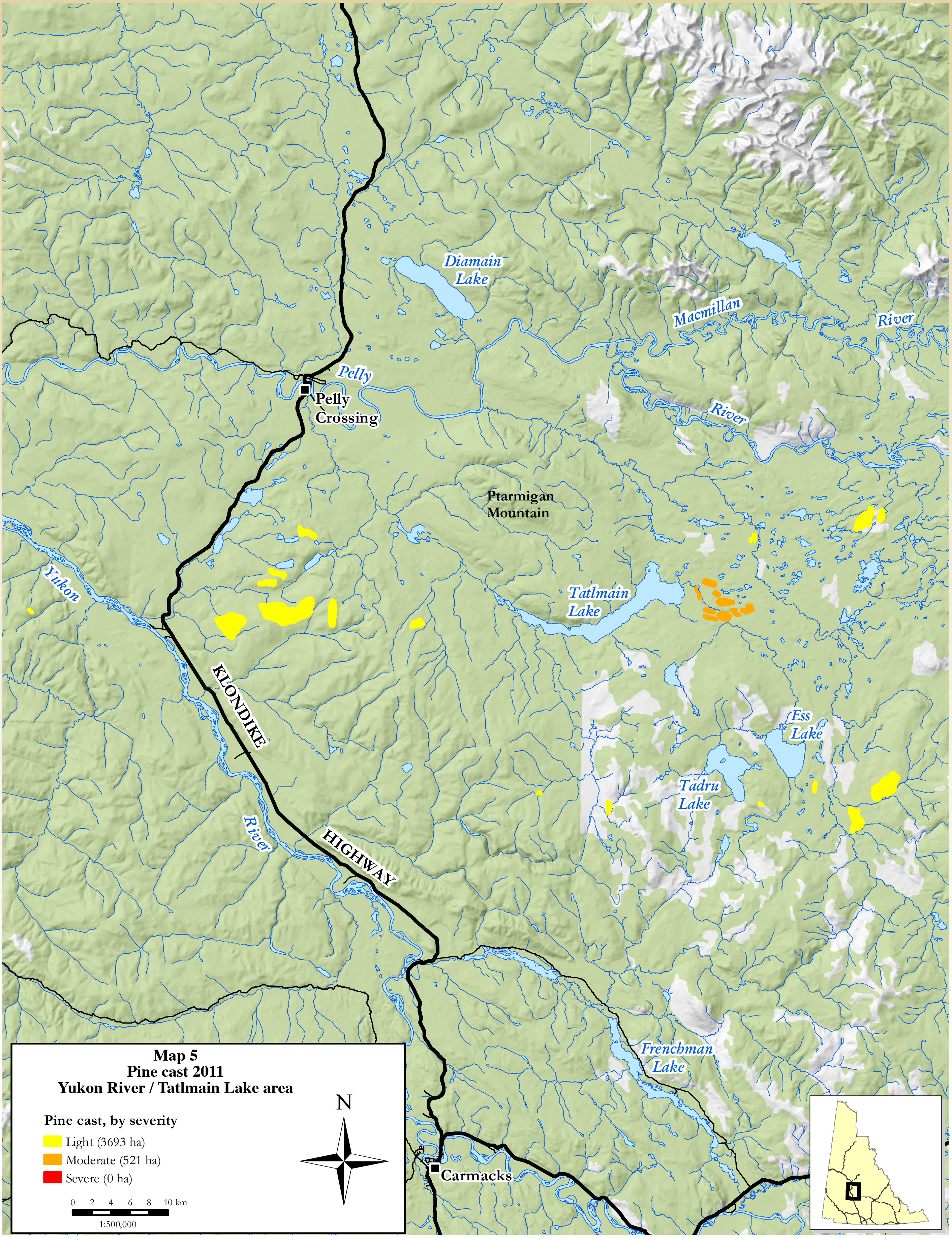

Diamain Lake
Macmillan River
Pelly River
Pelly Crossing
Ptarmigan Mountain
Yukon River
Tatlmain Lake
KLONDIKE HIGHWAY
Ess Lake
Tadru Lake
Frenchman Lake
Carmacks
Map 5
Pine cast 2011
Yukon River / Tatlmain Lake area
Pine cast, by severity
Light (3693 ha)
Moderate (521 ha)
Severe (0 ha)
N
0 2 4 6 8 10 km
1:500,000

Photo 10. Pine needle cast discolouration near Tatlmain Lake

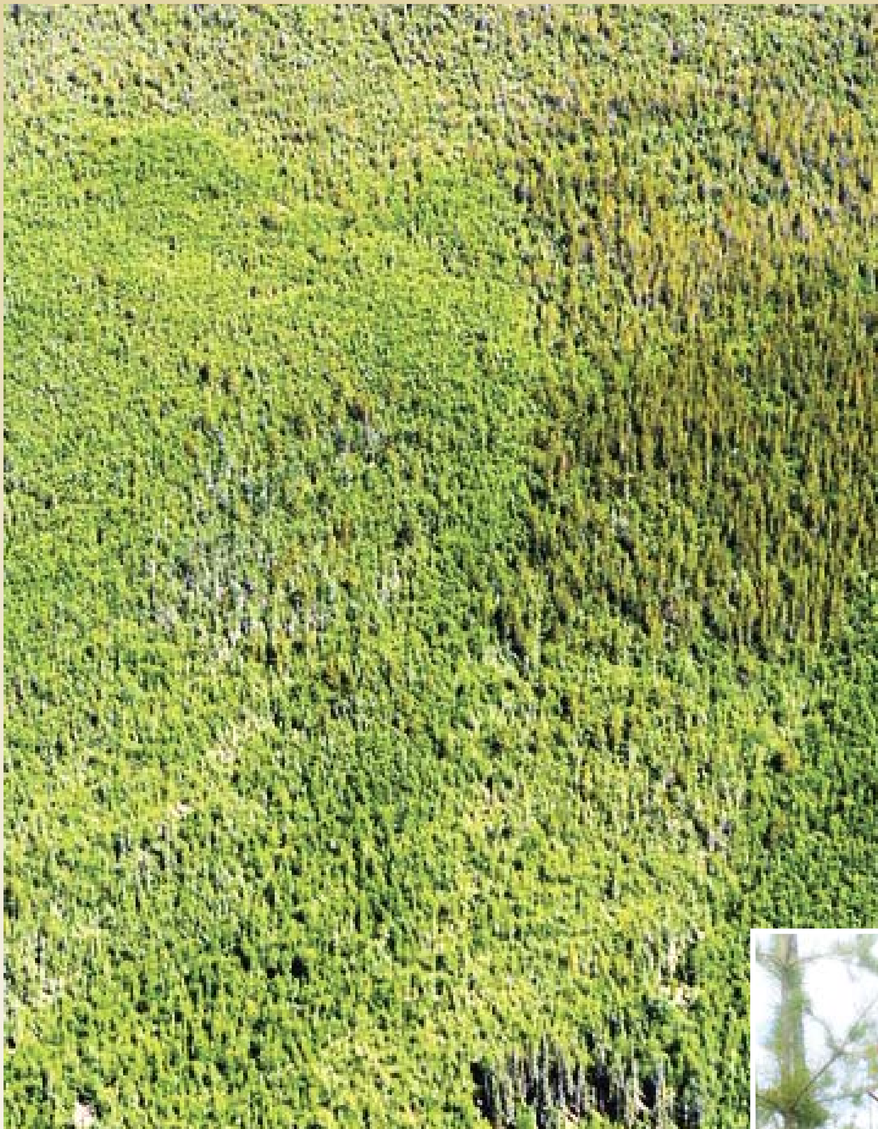


Photo 11. Year-old red needles on needle cast infected tree

Yellow-headed spruce sawfly, *Pikonema alaskensis*

For the third consecutive year, larvae of the yellow-headed spruce sawfly defoliated young ornamental white spruce trees around the perimeter of the parking lot at Shipyards Park and the Takhini Arena in Whitehorse (Photo 12 and Photo 13). No damage was seen anywhere else in Whitehorse. Defoliation was lighter than last year, but sufficient to further stress the young trees still recovering from two previous years of feeding damage. Unlike most other conifers, white spruce has adapted by producing epicormic[2] buds in response to insect feeding (Piene, 1998). These buds flushed later in the growing season and replaced much of the lost foliage.

This insect selects open-grown trees, and for this reason most damage recorded in North America occurs on young planted urban trees rather than in dense forest (Kusch and Cerezke, 1991). Eggs are laid in early June in slits at the base of needles. Usually all eggs of a single adult are laid on a single shoot. When eggs hatch, young larvae start to feed on newly flushed needles. Like most sawflies, the yellow-headed spruce sawfly is a colonial feeder. When the new growth has been consumed, larvae will continue feeding on the older needles until they are ready to pupate in mid-July. Pre-pupal larvae drop to the ground and dig into the duff layer under the tree where they spin their cocoon, and they remain there until the adult emerges the following season to coincide with the swelling of buds in the spring.

Control

Because the trees are small in this situation, the simplest method of population control is to locate clusters of feeding larvae while they are still small. Larvae can be dislodged by shaking branches and catching the falling larvae in a bucket of soapy water (Hansen and Walker). Control can also be readily achieved by the application of insecticidal soap when larvae have just begun to feed (Government of Alberta).

[2] Epicormic buds: buds that lie dormant beneath the bark that under certain conditions may develop into active shoots

Photo 12. Yellow-headed spruce sawfly larvae

Photo 13 . Yellow-headed spruce sawfly damage at Takhini Arena in Whitehorse

Pine engraver beetle, *Ips pini*

One of the stops on the field portion of the Forest Health Training course in June was a stand of trees in the Granger subdivision in Whitehorse. The stand of mixed middle-aged pine and spruce had been thinned as part of the FireSmart program to reduce the fire hazard adjacent to the community (Photo 14).

Many of the felled pine had been attacked by Ips beetles, and when examined in June, the adult beetles had laid significant numbers of eggs (Photos 15 and 16). The Ips population will likely increase in the downed material and there is a risk of future increased attacks to adjacent trees in 2012. The stand will be closely monitored and management action, such as infested tree disposal, will be taken as required.

Photo 14. Middle-aged stand adjacent to Granger subdivision thinned as part of FireSmart program

Photo 15. *Ips pini* parent adults. Note the concave indentationat the hind end characteristic of all Ips species

Photo 16. *Ips pini* parent gallery with eggs

Porcupine, *Erithizon dorsatum*

Suspected porcupine-caused lodgepole pine mortality was mapped at seven separate locations over a total of 26 ha during aerial surveys of Forest Health Zone 2. The patches of mortality ranged in size from approximately 0.8 to 10 ha. All were mapped in young-to-middle-aged pine stands. The damage was seen as red crowns scattered within the stands. Most of the red pine were in four small polygons adjacent to Merrice Creek northwest of Five Finger Rapids. A fifth larger polygon was mapped to the east across the Yukon River, adjacent to McGregor Creek.

Porcupines feed on the nutrient-rich inner bark of all species of coniferous and deciduous trees, but they prefer pine (Photo 17). This is the third consecutive year porcupine feeding had been mapped from the air, and it indicates a recent increase in porcupine populations throughout southern Yukon. This is supported by anecdotal reports of increased porcupine sightings by forest workers and members of the public.

Photo 17. Debarking of pine by porcupines

Abiotic Pests

Dying trembling aspen

Increasing reports of dying trembling aspen trees have been received from around Yukon in recent years. The latest report came in early June from the owners of the LaPrairie Bison Ranch, east of the Kusawa Lake turnoff (Photo 18). Approximately 10 ha of young aspen near the LaPrairie Ranch had failed to leaf-out in the spring. Some trees had produced tufts of small malformed leaves at the end of branches, but most of the trees had died over the winter. When examined in mid-June, there was no evidence of current insect or disease activity in any of the trees. However, in the past 10 years the aspen serpentine leafminer has been active here as it has been in almost all aspen stands throughout southern Yukon.

These stands had regenerated as suckers from the roots of fire-killed trees following the large Takhini fire of 1958. The fire was so intense that all organic materials burned and few nutrients remained in the soil. Ring counts from two trees cut near the ground found both to be around 50 years old. The trees had remained small, averaging only about 10 cm in diameter. The stress induced by marginal growing conditions, coupled with repeated severe droughts and repeated leafminer damage, is thought to have been the chief cause of mortality.

The sudden uniform mortality is likely related to the clonal nature of aspen stands. Aspen clones are all offspring from a single parent and can be thousands of years old and cover more than 40 ha (DeWoody et al, 2008). Individual stems of aspen are referred to as "ramets" rather than trees. The term ramet is from the Latin ramus referring to a branch. In the case of aspen, the stem – as part of a much larger organism – is likened to a branch (Jaeger, 1944). All ramets in an aspen clone are genetically identical and essentially a single organism. As a result, landscape-scale stressors affect them all simultaneously.

Photo 18. Dead and dying aspen near LaPrairie Bison Ranch

Wind desiccation

On April 20, 2011, FMB received a report about discoloured trees on the west-facing slopes of Mount Vanier, just east of Kusawa Lake. The sighting was made from the Kusawa Road about 40 km from the damage, so tree species could not be identified. The presence of recent severe spruce bark beetle-caused white spruce mortality across the valley to the west meant there was a strong possibility that the damage could be due to spruce bark beetle. The concentration in high elevation stands was also suggestive of spruce bark beetle attack patterns.

On May 4, 2011, a crew of three from FMB flew from Whitehorse by helicopter to map the damage from the air and to access the stand from the ground. They mapped defoliation over an area of 96 ha (Photo 19; Map 6). The stands were mainly composed of mature and semi-mature lodgepole pine with a small spruce component. Most of the trees were discoloured with an average of 40-60 per cent of the upper crowns affected (Photo 20 and Photo 21). There was significantly more discoloration on the southwest side of trees. Lower branches that had been covered by snow were not affected.

The damage was caused by cold winter winds that funnelled up from the southwest over Kusawa Lake. The extremely dry wind absorbed what little moisture remained in the needles. The moisture could not be replaced from the frozen ground and the needles died. Most of the dead needles had been shed by mid-summer, and by the time spruce bark beetle aerial surveys were completed in late August the damage was barely visible from the air. It is likely, with this moderate and variable degree of damage, that most of the buds at the branch tips survived. The new flush from these buds will help to minimize the long term effects of the damage. Unless they are struck again in the same fashion this winter, they should regain full vigour in a few years.

A second example of wind desiccation was seen near LaPrairie Bison Ranch affecting only the young lodgepole pine. Likely the same wind that caused the damage farther to the south had desiccated the needles on the south sides of the trees. White spruce growing in the same area were unaffected.

Photo 19. Wind-desiccated lodgepole pine on west slope of Mount Vanier

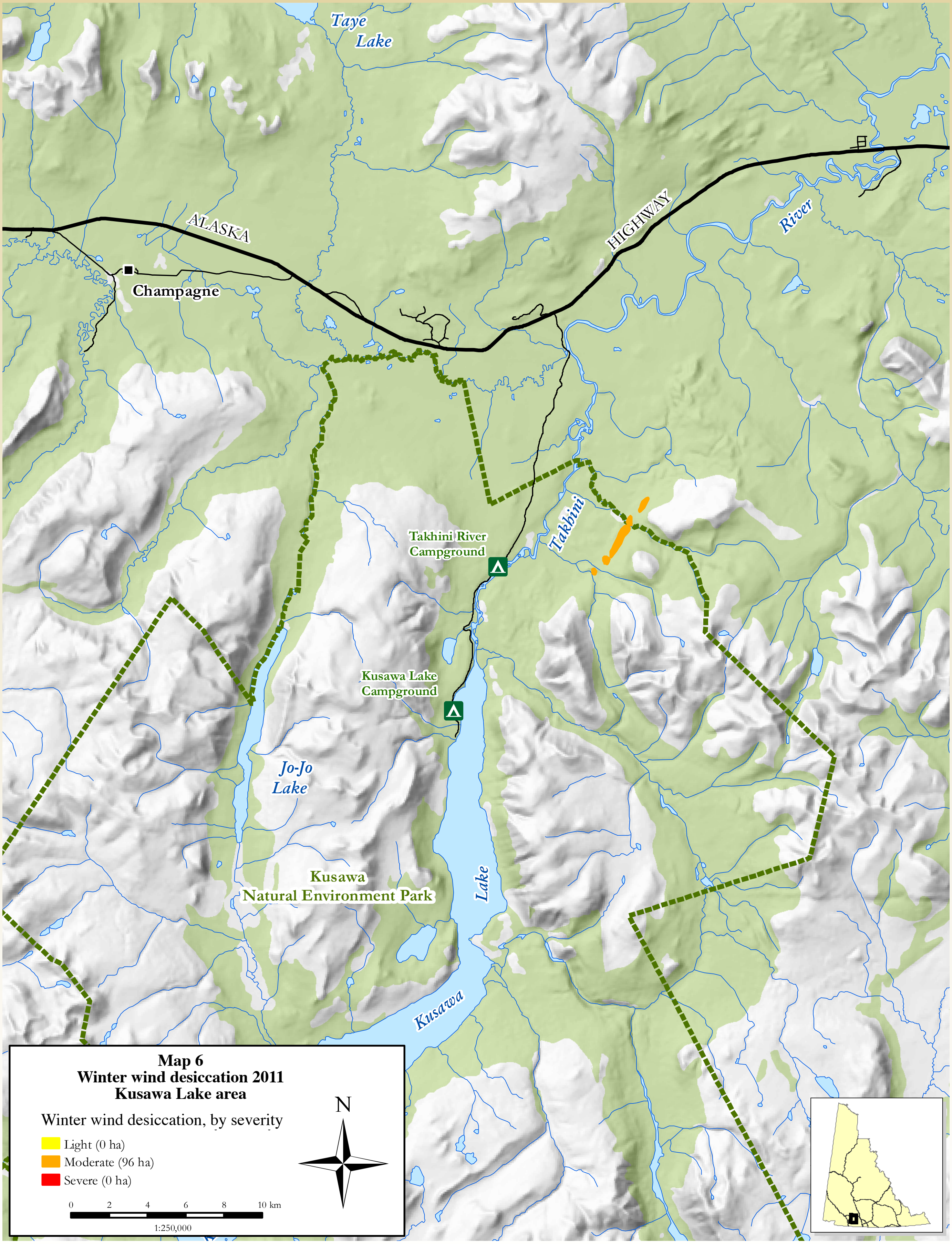

Taye Lake
ALASKA
HIGHWAY
River
Champagne
Takhini
Takhini River Campground
Kusawa Lake Campground
Jo-Jo Lake
Kusawa Natural Environment Park
Lake
Kusawa
Map 6
Winter wind desiccation 2011
Kusawa Lake area
Winter wind desiccation, by severity
Light (0 ha)
Moderate (96 ha)
Severe (0 ha)
0 2 4 6 8 10 km
1:250,000
N

Photo 20. Mount Vanier pine desiccated primarily on south side of trees

Photo 21. Wind-desiccated pine north of Kusawa Lake (note needles discoloured on south side only)

Dead and dying spruce, aspen and lodgepole pine

In early June a resident of the Cowley Creek subdivision, south of Whitehorse, reported tree damage. A visit to the area was subsequently included in the field portion of the Forest Health Training course. The damage affecting spruce on the resident's property was found to also include lodgepole pine and trembling aspen at adjacent roadside locations. One of the dying pines was found to be infested with the lodgepole pine beetle, *Dendroctonus murryanae*, though the attacks were incidental to the primary stress agent.

This appeared to be another example of dieback and mortality that has been observed at numerous locations along the Alaska and Klondike highways since the 1970s. The cause of the damage has been the subject of much speculation. The only undisputed element is the abiotic nature of the damage. There has been no evidence of any insect or disease involvement, which is supported by the fact that all species of tree, whether deciduous or conifer, are affected to varying degrees.

The damage is characterized initially by branch dieback that progresses over a number of years until the trees die. There is no set pattern to the dieback; in some trees the damage progresses from the top downward, and in others the progressive branch dieback occurs throughout the crowns. Suggested possible causes have ranged from salt and dust abatement chemicals to wind desiccation. However, none of these causes explains the widespread and ongoing nature of the damage.

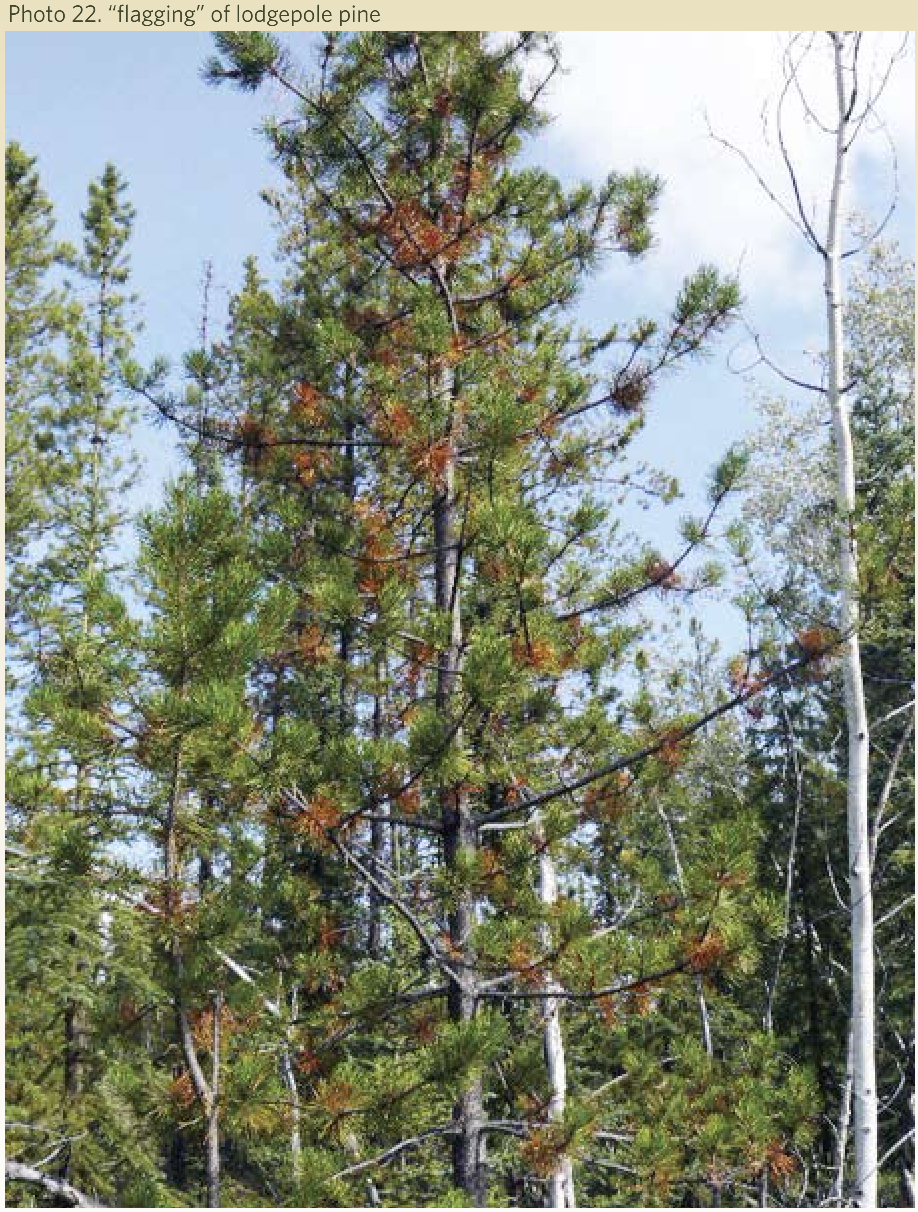
Poplar decline

Though not considered a true pest condition, balsam poplar decline and death is commonly seen in mature stands along major rivers. This year 529 ha of dead and dying poplar was mapped during aerial surveys of Forest Health Zone 2. Most was mapped adjacent to the White River, south of Snag. This little-studied phenomenon is thought to be a result of senescence[3], the slow decline of over-mature stands.

Lodgepole pine flagging

Despite the increased moisture this summer, lodgepole pine throughout southern Yukon continued to shed their internal needles (Photo 22). What appears at first glance to be a needle disease is a phenomenon known as "flagging," a direct result of drought stress. In such a damp year, flagging is still common and widespread, suggesting that trees may take more than one season to regain full vigour. The needle loss causes little damage to the tree as the newest healthiest needles are retained to sustain photosynthetic activity.

Photo 22. "flagging" of lodgepole pine



[3] Senescence: The change in the biology of an organism as it ages after its maturity.

Minor Pests

Comandra blister rust, *Cronartium comandrae*

This stem disease has been increasing in recent years on young lodgepole pine in southern Yukon. Reports of infection were received from the Marsh Lake Timber Harvest Area and the Sawmill Road, south of Whitehorse. It was also seen for the second consecutive year at km 10 of the Kusawa Road in young roadside pine (Photo 23).

As with most rust diseases, this fungus requires the presence of an alternate host to complete its life cycle. Comandra blister rust alternates on bastard toad flax *(Geocaulon lividum)*. This low growing perennial is common in dry-to-moist open woods throughout southern Yukon. When infected by blister rust, the normally green leaves of toad flax appear yellow-variegated (MacKinnon, Pojar and Coupe, 1992).

The disease produces elongate and often diamond-shaped perennial cankers on the branches and stems of infected trees (Allen, 1996). The cankers grow progressively in length and girth, eventually girdling and killing the trees. Two similar species of rust affect lodgepole pine. The second species, stalactiform blister rust *(Cronartium coleosporiodes)* is more dominant in the south where its alternate host, Indian paintbrush *(Castilleja miniata)* is more commonly found.

Photo 23. Comandra blister rust cankers on young pine

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YUKON FOREST HEALTH REPORT
2011 MOUNTAIN PINE BEETLE SUPPLEMENTARY REPORTS

As part of the ongoing planning for risks to the health of Yukon forests, Government of Yukon forest managers are closely monitoring the mountain pine beetle. Three appendices have been completed (Appendix 1. Mountain Pine Beetle and Yukon Assessment Report; Appendix 2. Mountain Pine Beetle in Rocky Mountain Trench August 2011 and Appendix 3. Summary Mountain Pine Beetle Northern Range Expansion Risk Assessment Project).

As explained in the main body of the Forest Health Report 2011, Government of Yukon completed two surveys to determine the movement of the mountain pine beetle between 2010 and 2011, as well as an assessment of the size and health of the current mountain pine beetle infestation. The surveys were conducted in two stages; Stage 1 was an aerial survey to map recent mortality (Appendix 1) and Stage 2 was a ground-based survey to assess beetle populations (Appendix 2).

The Mountain Pine Beetle Northern Range Expansion Project was funded by the National Forest Pest Strategy 2009-2010 and was completed by the Sustainable Forest Management Laboratory at University of British Columbia. In 2011, the Forest Management Branch and a contractor condensed the large report into a 6 page summary (Appendix 3).

Appendix 1.

Mountain Pine Beetle and Yukon 2011 Assessment Report-July 2011

Appendix 1

July 21, 2011

Mountain Pine Beetle and Yukon 2011 Assessment Report

Background

The current mountain pine beetle epidemic began in 1994 in northern Tweedsmuir Park and over the next 10 years moved quickly east and south, crossing the Rocky Mountains in 2004.

From early on it has been recognized as a product of a moderating climate.

It is now well established in Alberta and is poised to invade the jack pine stands of northeastern Alberta and Saskatchewan.

From a Yukon perspective the question has always been: how far north can it survive and if it does survive, how long before it reaches Yukon?

The situation as it exists today

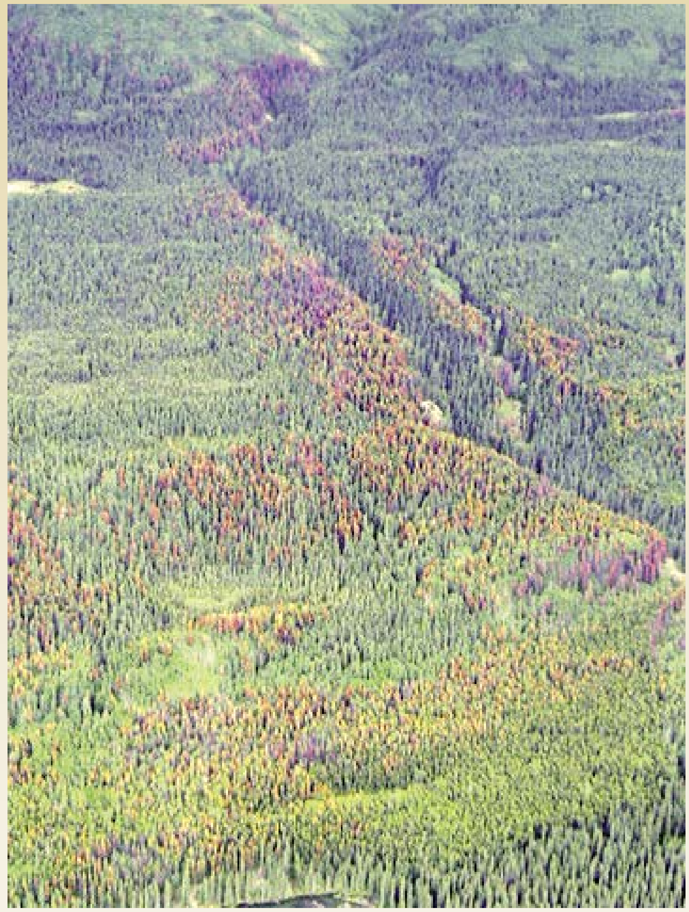
The beetle has moved quickly northward within the Rocky Mountain Trench in the last few years, and, unless we experience an unusually cold winter (sustained maximum daytime temperature of -40° C. for at least one week) this northward movement will continue.

The main body of the infestation (defined as areas of continuous infestation) is approximately 150 km south of the Yukon border; in the same area as was mapped in 2010 (Photo 1).

The main body contained approximately equal numbers of 2009- and 2010-attacked trees. This is encouraging as it indicates that there was no mass northward migration last year.

Photo 1. Main body of infestation 150 km south of Yukon border

Photo 2. Additional picture of main body of infestation 150 km south of Yukon border
Note: "Faders" in fore front are from trees attacked in 2010-"Reds" are trees attacked in 2009

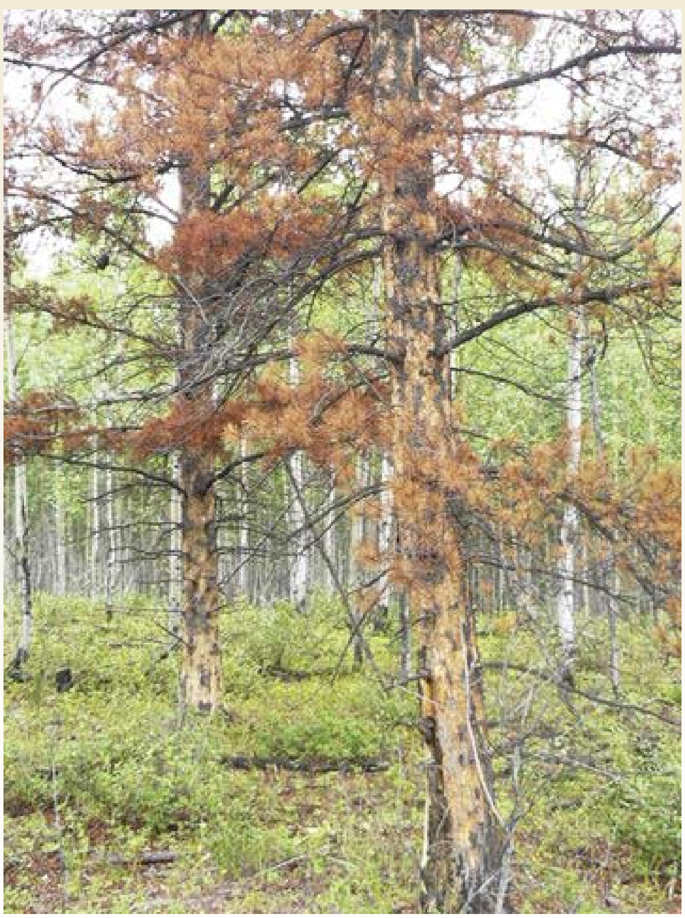


Many smaller infestations were mapped on July 10th of this year north of the main body. These are small concentrations of attack that range in size from hundreds of red trees (those killed in the previous year) just north of the main body, down to 3-5 tree spot infestations that range as far north as 59° 14'; approximately 80 km south of the Yukon border (Photo 2).

Photo 3. Spot infestation 80 km south of the Yukon border

On July 10th the crew was able to land at an outfitters camp at Scoop Lake, 100 km south of the Yukon border, where, adjacent to the airstrip were two small infestations containing both 2009 and 2010 attacks.

Photo 4. Red tree at Scoop Lake airstrip; debarked by woodpeckers feeding on overwintering larvae .



By removing bark and examining the beetle galleries it was determined that the beetles (at least at this location) had not survived.

At the time of the assessment it appeared that this year's flight had not yet occurred.

The beetle progeny, when mature, will fly when the temperature under bark reaches 16° C. A mass flight will occur on a day when temperatures exceed 20° C. The current weather has been some what cooler suggesting staggered flights and lower success.

Future assessments

To assess both current attack levels and the health of the population it will be necessary to access stands within the main body of the infestation. This will be done by helicopter in late August.

Plans are currently being finalized to accomplish this task using the Scoop Lake camp as a forward operating base.

In early June of 2012 these same stands will be revisited and "R value" assessments will be made in 2011-attacked trees. The results of this objective assessment will determine if populations are increasing, static or decreasing.

Appendix 2.

Mountain Pine Beetle in Rocky Mountain Trench
August 2011

Appendix 2

August 2011

Mountain Pine Beetle in the Rocky Mountain Trench

Introduction

This report is a follow-up to the initial report submitted in July following an aerial survey of mountain pine beetle in the Muskwa-Kechika conservation area. This special management zone is located within the Rocky Mountain Trench south of the southeastern Yukon border.

The aerial survey identified the existing infestations as a real and imminent threat to the pine forests of southeast Yukon. In the next few years there is the potential for a northward surge of a large population of beetles. These populations can migrate short distances by local beetle flight within stands, but more importantly, they can move much greater distances by wind dispersal. The extent of that threat could be determined only by ground-based assessments to identify the current health of the beetle population.

Because the infestation is currently in B.C., an important aspect to Yukon-based assessments has been to ensure that the B.C. Ministry of Forests, Lands and Natural Resource Operations, was informed of the work being done by Yukon Forest Management Branch. For this reason Ken White forest entomologist from the Smithers regional office was invited to participate in the ground-based assessments.

This report summarizes the findings of an assessment by the three person field crew of 13 separate stands accessed by helicopter between August 22 and 25, 2011.

Report on ground-based assessments

Objectives

1. To identify the breeding success of beetle populations in trees attacked in 2009 and 2010.
2. To determine the levels of current (2011) attack as well as the timing of the beetle flight relative to expected normal mountain pine beetle cycling.
3. To identify stands for subsequent "R" value surveys in June 2012 to evaluate the over-wintering survival of beetle populations within 2011-attacked trees.

Methodology

Identifying areas to be assessed:

The study focused on the portion of the infestation that posed the greatest risk for northern movement to Yukon. After reviewing the maps from the July aerial survey, the infested area was subdivided into three distinct classes depending upon the intensity of the attack. They were as follows:

1. The northern end of the continuous infestation.
   This area is approximately 150 km south of the Yukon border (Photo 1), containing, potentially, the largest population of beetles. These stands represented the greatest risk of future infestations to stands farther north. Note: infestations farther to the south were older with a minor component of residual green pine and therefore less likely to contain current attacks.
2. Areas of discontinuous infestation just north of the main body. These areas consisted of large patches of attack containing both 2009 and 2010 attacked trees (Photo 2). This was the leading edge of mass population movement. These areas also contained a large residual of susceptible trees and represented the area of greatest potential current attack.
3. Spot infestations
   These infestations, at the northern end of the infested area, were between .25 and 2 hectares in size. Attacks were initiated by small populations blown in from the larger infestations farther to the south. They were scattered over a large area between approximately 120 km and 80 km south of the Yukon border (Photo 3). If successful, these small populations could expand the infestation rapidly and be the first to reach Yukon.

Photo 1. The northern end of continuous infestation

Photo 2. Representative stand of discontinuous infestation

Photo 3. Representative of scattered spot infestations at the northern edge of the infestation.

Selecting sites for ground assessments

The areas to be assessed were very remote and accessible only by helicopter. The following were the criteria used in site selection.

- Sites that contained both 2009- and 2010- attacked trees as determined by the degree of tree crown discoloration.
- The availability of mature green pine trees susceptible to current (2011) attack.
- A range of elevations from valley bottom to the slopes on the east and west sides of the Ketchika River valley.
- Individual landing sites were randomized by the chance availability of a helicopter landing area adjacent to an area of infestation. These openings were provided either by a gravel bar beside a river or a marshy meadow higher in the hills.

Photo 4. Site 1 in the area of continuous infestation shows crown discoloration of 2009 and 2010 attacked trees as well as a residual supply of host for further attack (landing site left-centre of photo)

Protocols for carrying out ground assessments

Once in the infested stands the crew separated to maximize the number of trees assessed. Two people made the observations and assessments while the third recorded the information. All observations, recorded by site, are included in Appendix 1.

The following are protocols carried out at each site:

- Removed the bark of 10 to 20 trees attacked in 2009 and 2010 to assess the success of previous broods. Indicators of brood success or failure included the length of vertical parent galleries, the presence or absence of horizontal brood galleries, the degree of woodpeckering (the major predator of mountain pine beetle), and the presence or absence of "exit holes" made by mature progeny when they bored out of the tree.
- Current (2011) attacks were identified on green trees by symptom-indicators such as fresh pitch tubes and/or boring dust (Photo 5).
- The progress of new gallery establishment on current (2011) attack including the length of parent galleries (the length of which indicated the timing of the attack) and the presence or absence of eggs.
- If more than 10 current attacks were found the site was marked for a re-visit in June 2012 for "R" value (over wintering brood survival) determination.
- On representative attacked trees some measurements of age, diameter and height were recorded.

Observations

A total of 13 sites were assessed; three in the northern area of continuous infestation, six in the area of discontinuous infestation and four in northern areas of spot infestation. Only sites 4, 5 and 8 contained significant numbers of initially successful current attacks. These stands will be targeted for "R"-value assessment in 2012. Current attacks in all other sites were either too few to warrant further assessment, or were unsuccessful.

Notes summarizing the field observations at each site are contained in Appendix 2-1. Additional photos from within the stands are contained in Appendix 2-2.

Table 1. Summary of observation by area.

Northern leading edge of the continuous infestation							
Site	Lat	Long	Elev(m)	R-value's for 2012	Current attack 2011	2010 Attack	2009 Attack
1	58°12'52.22"	126°32'26.50"	1013	Not suitable (3 currents)	Few and scattered	Minimum brood survival	Survival moderate
2	58°13'28.72"	126°31'24.59"	824	Not suitable	No current attack	No brood survival	Survival low
3	58°13'25.60"	126°31'21.87"	820	Not suitable (1 current)	Few and scattered	No brood survival	Survival low
Southern edge of discontinuous infestation							
Site	Lat	Long	Elev (m)	R-value's for 2012	Current attack 2011	2010 Attack	2009 Attack
4	58°17'44.19"	126°33'58.69"	967	Suitable (10-20 currents)	Minimal to moderate	No brood survival	Survival low
5	58°21'45.07"	126°39'24.59"	964	Suitable (20 currents)	Moderate - heavy	No brood survival	Survival low
6	58°21'29.20"	126°39'37.41"	924	Not suitable	No current attack	No brood survival	Survival moderate
8	58°24'39.72"	126°44'31.06"	724	Suitable (10-20 currents)	Minimal to moderate	Minimum brood survival	Survival moderate
9	58°31'18.00"	126°58'0.89"	846 m	Not suitable (<10 currents)	Few and scattered	Moderate brood survival	Survival moderate
10	58°31'18.10"	126°58'4.92"	850 m	Not suitable (< 3 currents)	Few and scattered	No brood survival	Survival low- nil
Northern outlying spots							
Site	Lat	Long	Elev (m)	R-value's for 2012	Current attack 2011	2010 Attack	2009 Attack
7	59°0'51.61"	127°39'17.77"	615 m	Not suitable	No current attack	No brood survival	Survival low
11	58°41'52.70"	127°9'54.46"	650 m	Not suitable (< 3 currents)	Few and scattered	Minimum brood survival	Survival low- nil
12	58°52'52.70"	127°14'7.64"	705 m	Not suitable (2 currents)	Few and scattered	No brood survival	Survival low
13	59°0'57.09"	127°24'13.11"	606 m	Not suitable	No current attack	No brood survival	Survival low

Map 1. Location of the 13 assessment sites.

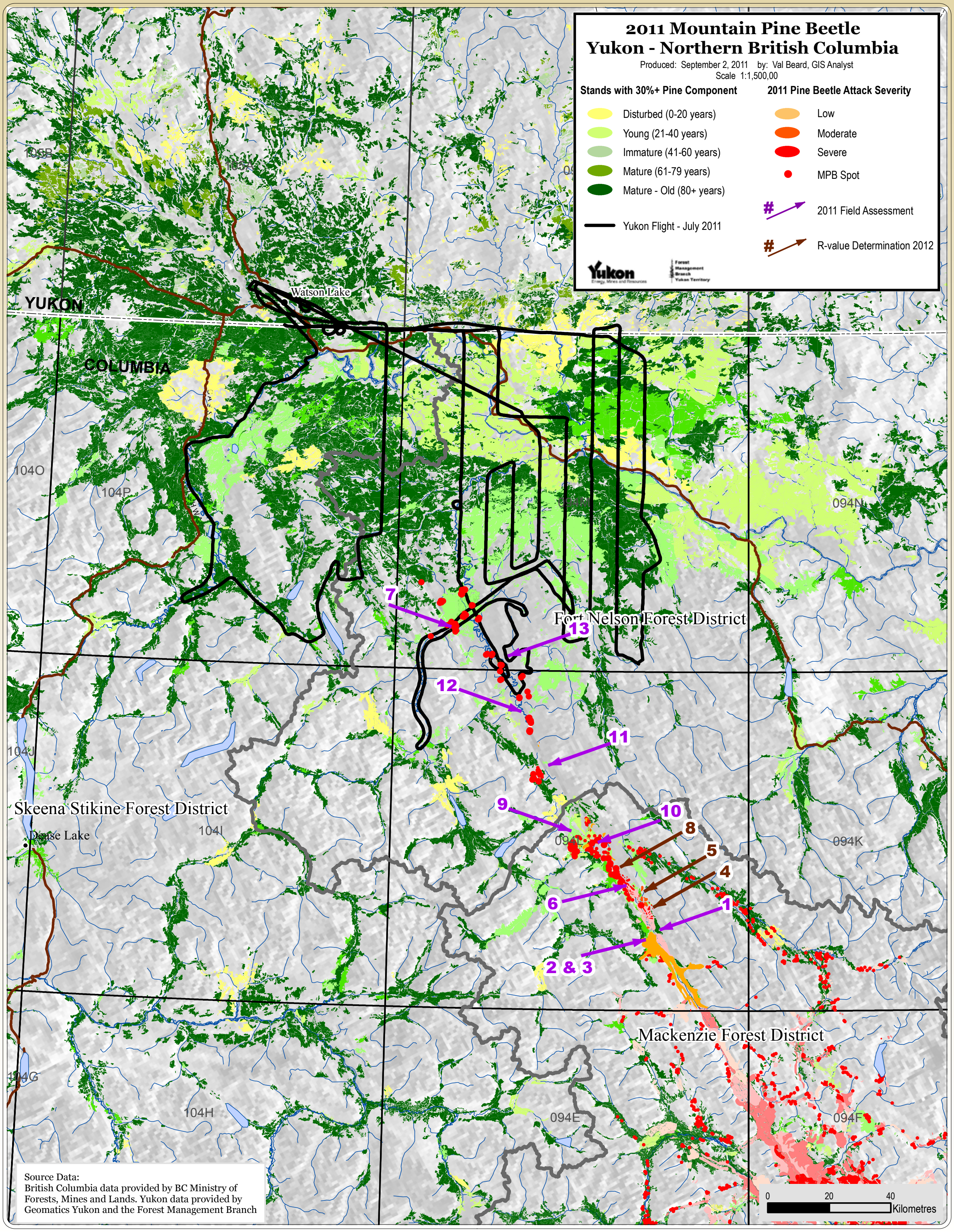


Photo 5. Fresh boring dust at the base of current attack

Summary of Key observations from Ground assessment:

- It became evident early in the stand assessments that a reasonable brood success in 2009 led to equal or slightly diminished attack intensity in 2010 in the southernmost stands. However, brood success in 2010-attacked trees was very low in the all areas assessed. This was likely due to a period of extreme cold (as cold as -48°C according to the outfitter at Scoop Lake) in January 2011. Though parent galleries in the 2010-attacked tree were of a normal length (30-50 cm) and eggs were laid, either the eggs did not hatch or larvae died at an early stage of development (Photo 6). This led to greatly reduced levels of current (2011) attack.
- Heavy woodpeckering (Photo 7) was seen only on the 2009-attacked trees. This would have significantly reduced the broods in these trees and subsequently reduced the levels of 2010 attack. The fact that no woodpecker feeding was observed in the 2010-attacked trees suggested that broods in these trees did not survive into the late winter when most of the woodpecker feeding occurs.
- Significant current attacks were found in only three of the 13 assessed stands. These were all found in the discontinuous areas of infestation just north of the main body of the infestation (Table 1). Three current attacks were also found at site 1. Scattered light current attacks were also seen in some of the spot infestations to the north but most of these were pitched out by the trees (Photo 8).
- In the scattered small patches of mortality farther north, only a few trees were lightly attacked in 2011, and almost all were unsuccessful.
- All current attacks had occurred within the past few weeks. Gallery development and egg laying was weeks behind what is considered optimal for mountain pine beetle survival.

One of the most effective barriers to the northern spread of the infestation is a large area of immature forest resulting from repeated wildfires. The area stretched approximately 30 km from the northern edge of the discontinuous infestation to just south of Scoop Lake. This area likely absorbed a large portion of the wind dispersed population in 2010. The absence of red trees in this area indicated that attacks, if any, were unsuccessful.

Photo 6. Fully extended parent galleries in 2010-attacked tree with no success of broods

Photo 7. Heavy woodpecker feeding on 2009-attacked tree

Photo 8. Light current attack pitched out by the tree.

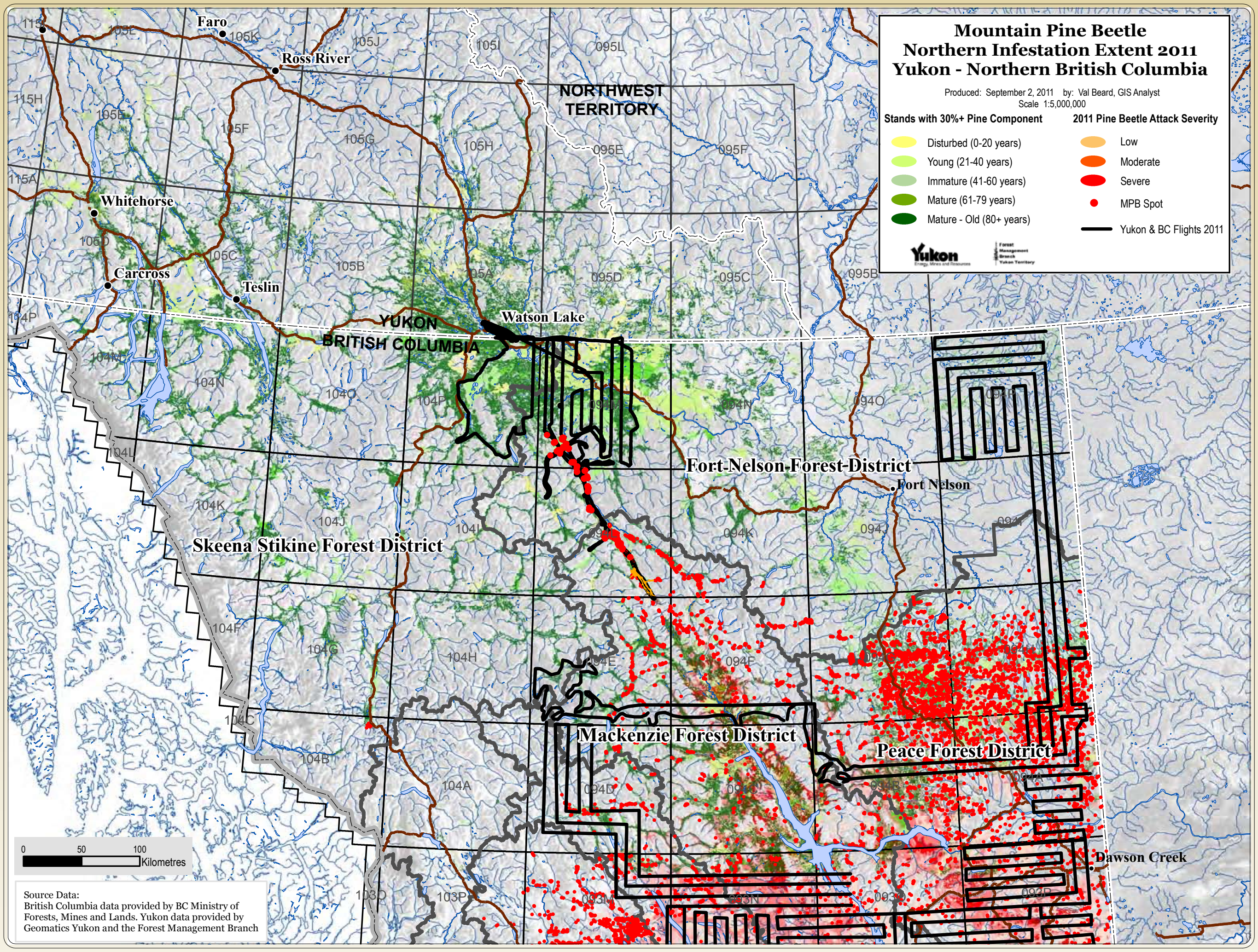
Conclusions

- The late emergence of the adults from the 2010-attacked trees resulted in retarded gallery development in the current attacks.
- During the time that the crew was in the area, daytime maximum temperatures dropped significantly. If these cool temperatures are sustained the broods in these trees could pass the winter in the egg stage rather than the normal early larval stage.
- Another possible scenario is that parent females will stop egg laying and spend the winter in the unfinished galleries. They would then complete gallery development and egg laying in the spring of 2012.
- Eggs and adults are less resistant to winter cold than larvae so the chance of overwintering mortality is increased. In addition, even if the eggs and/or adults survive the winter, normal cycling will be retarded. Historically, these "off-cycle" broods have met with little success.
- The winter of 2010/2011 took a heavy toll on the population. If the winter of 2011/2012 is as severe as the one previously, survival will again be poor and the population could collapse. If, on the other hand, we experience a mild winter, populations could rebound quickly and we could witness a renewed northern surge.
- "R" value assessments of these populations in June of 2012 will determine the success or failure of this population.

All evidence from dispersal patterns and the crew's experience indicate that the prevailing wind is moving the population in a northwesterly direction and that beetles will potentially enter Yukon near Watson Lake. This is the pivotal year that will determine either success or failure of the beetle population. In the areas of continuous infestation the beetle has now largely exhausted its supply of susceptible host and, in the host that remained, current attacks were very low. It is important, therefore, to keep in mind that this is a one-time only surge. There is no longer a large feeder population moving up from the south. If the population in the 2011-attacked trees in areas of discontinuous attack is unsuccessful then there will be little or no imminent threat to Yukon resources. Another important mitigating factor is the climate. The farther beetle populations move northward the harsher will be the climatic conditions with which they will have to contend.

There is an additional threat to Yukon pine posed by mountain pine beetle infestations moving northwestward from the Fort St. John Forest District into the Fort Nelson Forest District. Early indications are (from communication with Cathy Bleiker, a mountain pine beetle specialist with the Canadian Forest Service) that the population at the leading edge of this infestation front is healthy and vigorous. The results of 2010 mountain pine beetle mapping in northeastern British Columbia are illustrated in Map 2. The 2011 results for the aerial surveys in the same areas have not been completed at this time.

Map 2. Results of aerial surveys to map recent mountain pine beetle mortality in northeastern British Columbia in 2010 as well as 2011 surveys in Ketchika River valley southeast of Watson Lake



Appendix 2-1

Aug 22-24, 2011

Notes from Mountain Pine Beetle Assessment, Ketchika River valley, northern British Columbia

Data Collection By:
Rob Legare Yukon Forest Management Branch
Ken White Forest Entomologist Skeena Region, MFLNRO
Rod Garbutt RG Forest Pest Solutions,
Forest Health Consultant

Purpose:
To determine the northern movement of MPB toward Yukon

Site #1 GPS WP 43
Leading edge of the continuous infestation
Elevation: 1015 m
Stand composition: Pine leading with some spruce
Heli spot GPS WP 42
Elevation: 1005 m

2009 attack:
Appears to have been initially very successful evidenced by woodpeckering
Full gallery development with pupal chambers and numerous exit holes
Sample tree(s):
- 60 yrs
- 22 cm d.b.h

2010 attack:
High density of attack
However brood production minimal at best.
Larvae development 2nd instar at best
Estimate only about 10% of eggs hatched
Sample tree(s):
- 60 yrs
- 23.5, 22.5 cm d.b.h
- 16 m ht

2011 attack:
3 current attack trees were found in smaller residuals
Attack very recent, suspect within the last week
Parent galleries < 15 cm with a few eggs.
12-15 d.b.h trees are only trees that remain unattacked
Sample tree(s):
Not recorded

General comments on site
Found a 25 d.b.h unattacked tree emphasizing small emergent population

Site #2 GPS WP 44
Leading edge of the continuous infestation
Elevation: 825 m
Stand composition: White Spruce 70% Pine 30%
Heli spot GPS WP 46

2009 attack:
Numerous exit holes.
Survival was low to moderate, certainly enough to continue population
Sample tree(s):
- 19.1 cm d.b.h

2010 attack:
Most adult galleries with no larval development
What larval development occurred reached
2nd instar at best
No successful brood
Fresh *Ips pini* attacks in some trees
MPB attack not that severe so there was room and food available for ips
Evidence parasitic Beauveria fungus killed many larvae
Sample tree(s):
- 17.1 cm d.b.h

2011 attack:
No current attack

General comments on site
Old dead pine not killed by MPB
Good sized un-attacked pine found in area

Site #3 GPS WP 44 (200 m from Site 2)
Leading edge of the continuous infestation
Elevation: 840 m
Stand composition: Pine 40% Aspen 30% White Spruce 30%
Heli spot (same as Site 2)

2009 attack:
Some exit holes.
Survival would have been low to moderate, certainly enough to continue population
Sample tree(s):
Not recorded

2010 attack:

Good larval development initially up to 2nd and 3rd instar then completely died out
No evidence of woodpeckering
Evidence of Beauveria fungus.
Sample tree(s):
- 22.7 cm d.b.h
- 20 m ht

2011 attack:
Found one light current attack but likely pitched out by host
No evidence of successful attack
Sample tree(s):
- 65 yrs
- 23.9 cm d.b.h
- 19.1 m ht

General comments on site
Good sized pine found in area
Good productive site
Fair population pressure in 2009 and 2010
Appeared that stand was first attacked in 2008

Site #4 GPS WP 48
Southern edge of discontinuous infestation
Elevation: 957 m
Stand composition: Pine 60% Aspen 20% White Spruce 20%
Relatively large trees
Heli spot GPS WP 48

2009 attack:
Some exit holes seen
Survival would have been low to moderate;
enough to continue population
Sample tree(s):

- 31.9 cm d.b.h

2010 attack:
No larvae development in most trees examined
Larval development in some trees died out in early instar stage
A few trees with good larvae development evidenced by woodpeckering
Some emergence and a few unemerged beetles still in trees
Successful strip attack on a 30 cm^2 area of single tree; some exit holes
Emergence within last week with some yet to emerge
Sample tree(s):

- 31 cm d.b.h with some exit holes
- 21 cm d.b.h tree attacked; no emergence
- 29 cm d.b.h with some larval development but no pupae
- 30.4 cm d.b.h with pre-flight beetles
- 104 yr old trees

2011 attack:

Current attacks light to moderate in intensity
Parent galleries started beetle within the week or two
10-20 current attacks seen
Site marked for 2012 "R"-value determination
Sample tree(s):

- 20.5. cm d.b.h dead beetle within pitch tube
- 25 cm d.b.h average current attack tree
- 104 yr old trees

General comments on site
Many trees with fire scars
Non-attacked trees

- 22.0. cm d.b.h, 21.2 cm d.b.h, 24.2 cm d.b.h
- 19.7 cm d.b.h, 36 yrs
- 19.2 cm d.b.h, 48 yrs

Site #5 GPS WP 58
Southern edge of discontinuous infestation
Elevation: 978 m
Stand composition: 100% pine
Heli spot GPS WP 59

2011 attack:
10 cm parent gallery with some eggs
Attacked within last few weeks
Site has a many occurences
Marked for "R"-value determination in 2012
Also some reattacked 2010 trees
Some small pitch tubes but lots of boring dust
Sample tree(s):

- 22.7 cm d.b.h, 17 cm d.b.h, 21.4 cm d.b.h
- 18.8 cm d.b.h, 20.4 cm d.b.h, 22.2 cm d.b.h 20.3 cm d.b.h
- 54 yrs, 56 yrs

General comments on site
Notes for 2009 and 2010 trees but similar to others
i.e. successful 2009 attacks but unsuccessful in 2010

Site #6 GPS WP 61
Southern edge of discontinuous infestation.
Elevation: 925 m
Stand composition: 100% pine
Heli spot GPS WP 61

2010 attack:
Trees had full parent galleries
Good larval development up to 2nd and 3rd instar but no evidence of pupation
Sample tree(s):
Not recorded

2011 attack:
No current attacks seen
Sample tree(s):
Not recorded

Site #7 GPS WP 66
Northern outlying spot
Elevation: 616 m
Stand composition: Open Pure Pine 100%
Fairly large trees, dry site

2009 attack:
Some brood success
Some Ips pini attacks
Good development evidenced by woodpeckering
Sample tree(s):

- 31 cm d.b.h, 26 cm d.b.h

2010 attack:
Strip attack not successful
A lot of short parent galleries; no broods
Some full length parent galleries no broods here either
Other trees show good larval development evidenced by woodpeckering
No exit holes seen
Sample tree(s):

- 35.5. cm d.b.h
- 107 yr old trees

2011 attack:
No current attack

General comments on site
Most trees with fire scars

Site #8 GPS WP68
Southern edge of discontinuous infestation
Elevation: 717 m
Stand composition: 100% pine
Heli spot GPS WP 67
Elevation: 1005 m

2009 attack:
Appears to have been successful evidenced by woodpeckering feeding
Full gallery development with pupal chambers and numerous exit holes
Sample tree(s):
Not recorded

2010 attack:
Good larvae development up to 2nd and 3rd instar
No evidence of emergence
Sample tree(s):

- 42 yrs   42 yrs
- 23.3 cm d.b.h   2.0 cm d.b.h
- 17.6 m ht   16.8 m ht

2011 attack:
Many current attacks
Both male and female in 10 cm parent galleries with some eggs
Appears to be coming in that week (week starting Aug 22nd) or last week
Current attack likely from a migrating population rather then local one
Marked for 2012 "R"-value determination
Sample tree(s):
Not recorded

Site #9 GPS WP 70
Southern edge of discontinuous infestation
Elevation: 790 m
Stand composition: Pine leading with some spruce
Heli spot GPS WP 69
Elevation: 790 m

2009 attack:
Appears to have been very successful evidenced by woodpeckering feeding
Full gallery development with pupal chambers and numerous exit holes
Sample tree(s):

- 70 yrs
- 22 cm d.b.h
- 18.0 m

2010 attack:

Brood production; some success; some exit holes seen
Sample tree(s):

- 73 yrs
- 21.5 cm d.b.h
- 17.9 m ht

2011 attack:
Very light and scattered attack or re attack of 2010 partials
Most attacks pitched out
Sample tree(s):

- 65 yrs current attack pitched out

General comments on site
Some evidence of 2008 attack

Site #10 GPS WP 72
Northern outlying spot
Elevation: 850 m
Stand composition: Pine 100% some scattered spruce understory
Heli spot GPS WP 71
Elevation: 714 m

2009 attack:
Appears not as successful as other sites
Some trees with only early instar development
Few exit holes
Note some woodpeckering associated with this attack but not as extensive as in the other sites
Sample tree(s):
Not recorded

2010 attack:
Limited brood development
Sample tree(s):
- 137 yrs
- 22.4 cm d.b.h
- 14.2 m ht

2011 attack:
Light and scattered attack or re attacked 2010 strip attacks
Attacked within last two weeks
Sample tree(s):
- 127 yr
- 18.1 cm d.b.h
- 15.8 m ht

General comments on site
Extensive fire history

Site #11 GPS WP 74
Northern outlying spot
Elevation: 650 m
Stand composition: Pure pine with 100% pine understory
Dry site
Heli spot GPS WP 74 (same as site WP)
Elevation: 650 m

2009 attack:
Lots of brood production but limited survival
Some exit holes
Woodpeckering not prevalent
Sample tree(s):
Not recorded

2010 attack:
Early brood production but very limited survival
Sample tree(s):
- 107yrs — 76 yrs
- 21.0 cm d.b.h — 24.4 cm d.b.h
- 10.8 m ht broken top — 14.2 m ht

2011 attack:
Light and scattered attack or re-attacked 2010 partials
Re-attacks were pitched out
Small 5-10 cm parent galleries; attacked within 2 week
Lots of green trees available – indicating low surviving population
Sample tree(s):
Not recorded

General comments on site
Extensive fire history

Site #12 GPS WP 76
Northern outlying spot
Elevation: 705 m
Stand composition: 100% pine
Heli spot GPS WP 75
Elevation: 683 m

2009 attack:
Some good brood production evidenced by woodpeckering
Few exit holes
In some trees brood development 2nd and 3rd instar then collapsed
Sample tree(s):
- 97 yrs on 2nd 3rd instar at best tree
- 17.3 m
- 22 cm d.b.h

2010 attack:
No brood development past 2nd instar
Ips pini associated with mpb attack
Sample tree(s):
Not recorded

2011 attack:
Light and very scattered mostly re-attacks of 2010 partials
Sample tree(s):
Not recorded

General comments on site
Small residual stand left over from previous fire
Extensive fire history

Site #13 GPS WP 78
Northern outlying spots
Scoop Lake airstrip
Stand composition: Pine leading with some spruce
Heli spot GPS WP 42
Elevation: 1005 m

2009 attack:
Larval development up to 2nd and 3rd instar
Woodpeckers consumed most of the broods
Sample tree(s):

- 40 yrs heavy woodpeckering 2nd or 3rd instar at best

2010 attack:
Early larval development then collapse
Sample tree(s):

- 33 yrs
- 18.5 cm d.b.h
- 14 m ht

2011 attack:
No current attacks

General comments on site
Population at site has completely collapsed checked both sides of airstrip

Appendix 2-2

Additional photos from within areas of discontinuous mountain pine attack.

Photo 9. Site 1. Current attack note the small parent gallery <10 cm in length indication of late attack

Photo 10. Site 4. Fire-scarred tree attacked by beetles in 2010

Photo 11. Site 4. Currently-attacked tree flagged for 2012 "R"-value assessment

Photo 12. Site 5. Showing stand to be assessed as well as adjacent helicopter landing site

Photo 13. Site 5. Ageing a currently-attacked tree: DBH 33.7 cm; Age 154 yrs

Photo 14. Site 9. Exit holes signifying some brood success on a small portion of a 2010-attacked tree

Appendix 3.

Mountain Pine Beetle
Northern Range Expansion Risk Assessment Project

Appendix 3

Summary: Mountain Pine Beetle Northern Range Expansion Risk Assessment Project

As part of ongoing planning for short and long-term risks to the health of Yukon forests, Yukon government forest managers are closely monitoring mountain pine beetle infestations in other jurisdictions. Thanks to funding from the National Forest Pest Strategy (2008), Yukon government commissioned a risk assessment to evaluate the susceptibility of Yukon forests to attacks by mountain pine beetle (MPB) *(Dendroctonus ponderosae)*. The report addressed two questions related to the evaluation of mountain pine beetle risk to Yukon forests:

1. What are the chances that the current pine inventory becomes susceptible to a MPB attack?
2. What is the likelihood that this current pine inventory increases?

Researchers modeled projected climate and stand structure information to simulate future susceptibility under low, medium and high climate change scenarios. They simulated climate conditions for three 30-year periods to 2020, 2050 and 2080. Results showed that the area experiencing climatic conditions suitable for MPB will increase in northwestern Canada, and the Yukon pine inventory will become susceptible to attack.

Modeling Susceptibility to MPB Attack

As climate changes, the range of lodgepole pine in Yukon and Northwest Territories may extend and could become more climatically suitable to the MPB. To conduct this risk assessment, researchers needed to be able to predict how susceptible Yukon ecosystems are to the MPB in connection with potential changes in climate. They reviewed common risk models; some models focus on stand characteristics, others focus on climate, and some use mixed approaches that consider climate, stand and landscape characteristics and details of the beetles' biology.

Suitable weather conditions may trigger an epidemic, but only if stand conditions are favorable to the MPB. This might be the reason why mixed models are more successful at predicting susceptibility. Models with simple explanatory variables seem successful at identifying high risk stands even if often overestimating susceptibility. A simple model that includes both projected climate and stand structure information is suitable for evaluating the susceptibility of Yukon pine to MPB attack under future climatic conditions.

Predicting Changes in Climate

Estimating future climate and climate change impacts is challenging. Researchers must take into account natural variability and the effects of human activities. They need to use models that have been run for existing scenarios, usually based on low, medium and high levels of climate change. To project climate conditions for future periods, researchers used three popular Global Circulation Models (GCM) scenarios for this assessment:

1. CGCM3-B1 ("low warming") – This Canadian model assumes a convergent world with low population growth and rapid economic changes towards a service and information economy, with reductions in materials intensity and more clean and resource-efficient technologies. This scenario for 2050-2080 projects a 2°C increase in global mean annual temperature, consistent with the target proposed by the 2009 Copenhagen Accord.
2. CGCM3-A2 ("medium warming") – This Canadian model describes a very heterogeneous world with high population growth and regionally oriented economic development.
3. HADCM3-A2 ("high warming") – This British model predicts more drastic changes.

Susceptibility of Yukon Pine

Risk models, which assess the likelihood of a MPB infestation, have shown that infestations are highly sensitive to climatic conditions as well as to long spells of extreme weather, natural disturbance patterns and elevation gradients. Also, while suitable climatic conditions can trigger an attack, an epidemic will not occur without a pine host.

Choice of MPB Susceptibility Model

The aim is to project the climatic conditions through time and to use this information to generate MPB climate susceptibility index projections for Yukon. Given the long-term and large spatial scope of such an inquiry, researchers needed a MPB risk model with low data requirements and a small number of computations.

Stand structure component

The MPB Modeling Group in Alberta (Alberta Sustainable Resource Development/Forest Health Section) generated the stand susceptibility index (SSI) based on the Yukon inventory and a series of permanent sample plots and assigned a value to each polygon where pine was present.

Results

Researchers produced maps for the three climate scenarios using climate change normals for the periods 1990-2020, 2020-2050 and 2050-2080. Under all scenarios, from low to high climate change, the stand susceptibility increased towards the end of 2080. This increase was noticeable in Southeast Yukon where susceptibility is currently the highest. Results showed that the area of climatic suitability will increase northwestwards in Yukon and the pine inventory will be susceptible to a MPB attack.

Stand susceptibility histograms showed that the high warming scenario had the most dramatic increase. Even the lowest estimates of climate change led to an increase in susceptibility of the pine inventory in Yukon. This increase was particularly noticeable in Southeast Yukon. Results also show the area of climatic suitability may increase northwestwards with time. MPB is likely to become a significant concern for Yukon forest managers after 2020.

High Warming Scenario

Figure 1. Stand susceptibility index for the Yukon pine inventory under the high warming climate scenario. These maps only show forested areas where pine is present. Increased susceptibility is indicated by an increasing number of 'yellow' and 'red' stands.

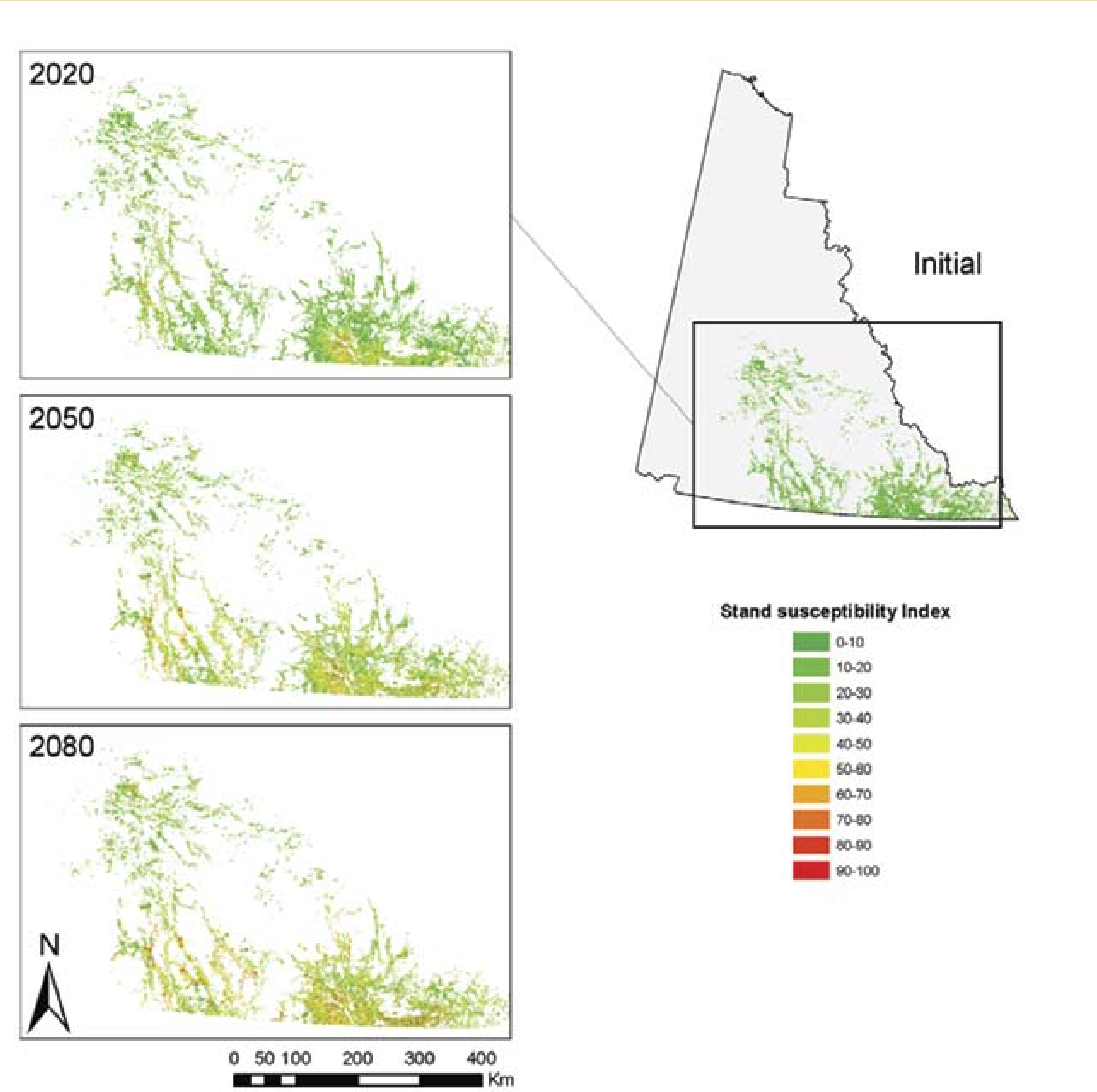
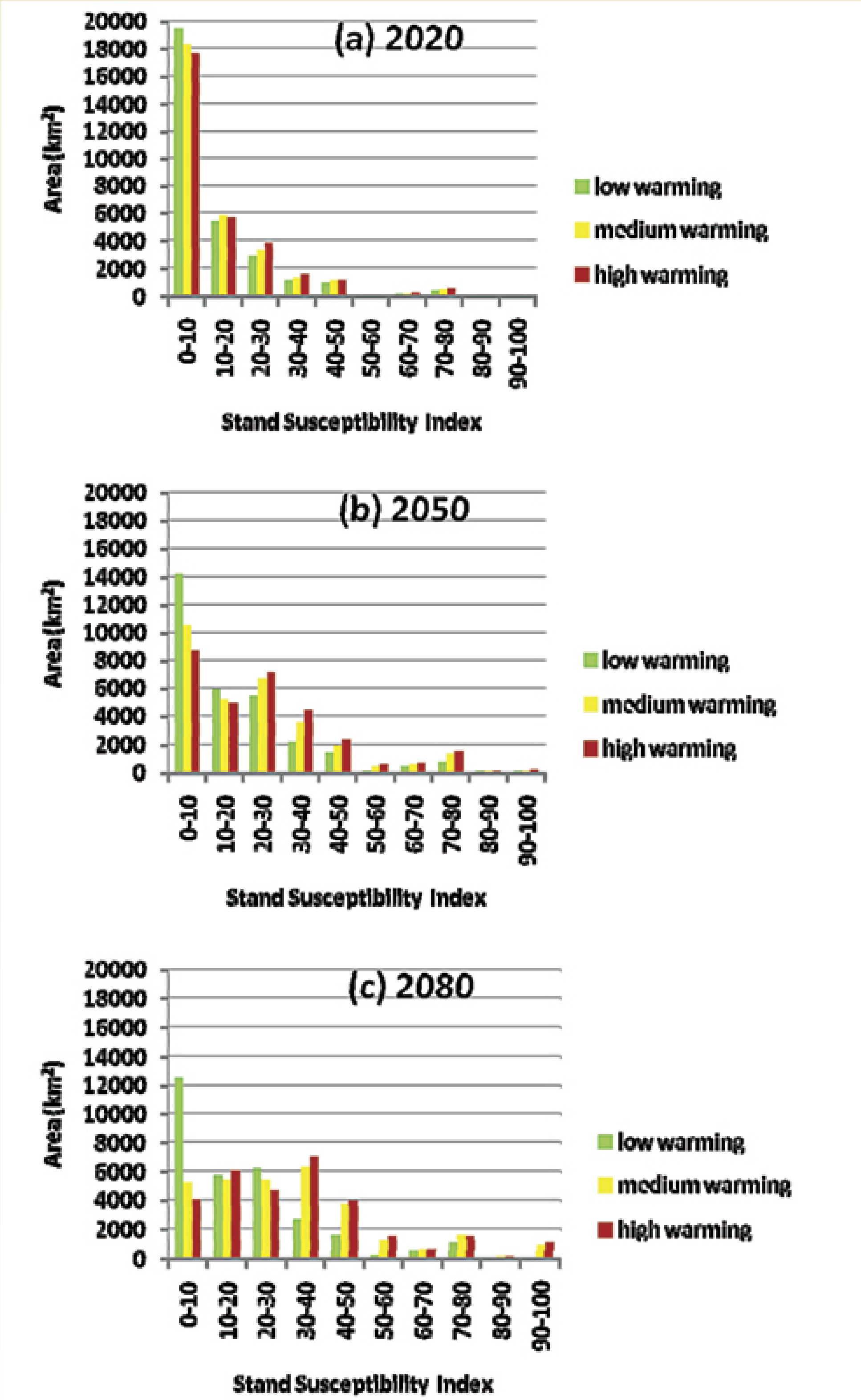


Figure 2. Histograms of stand susceptibility for the Yukon pine inventory across climate change scenarios.



Range Predictions for Pine

Projecting suitable climate conditions for a species range is important in assessing the potential impacts of climate change and developing adaptation strategies in forestry and natural resource management. Bioclimatic envelope modeling is a key approach in projecting suitable climate range for ecosystem classification units and for individual tree species. The most frequent method used in British Columbia to model distribution changes is the biogeoclimatic classification (BEC) system. BEC predicts potential vegetation based on climate, soil and vegetation characteristics. As Yukon does not have a similar ecosystem classification system, researchers extrapolated from BEC to project suitable climate conditions for lodgepole pine.

Climate data

For this assessment, researchers used the ClimateBC program to generate the 44 climate variables used by the Random Forest machine-learning classifier. They drew initial climate data from Yukon meteorological records and also incorporated data from a digital elevation model.

Projections

Though Yukon climate variables were used independently to run the Random Forest model, the extrapolation is not perfect as the model predicts forest types extending as far north as the Arctic Ocean. The model will be most accurate closer to B.C. and accuracy will decrease northwards. Interpretation of results for areas north of 65°N should be done with care. The reliability of the model and associated predictions will increase over time.

The results suggest that Yukon has more areas with climate suitable for lodgepole pine than are currently occupied by lodgepole pine. The northward extrapolation might be biased towards the BEC variant that is most closely related to lodgepole pine frequency in Yukon (5.8%).

All three scenarios projected a similar pattern of expansion, though the medium warming scenario shows slightly more vigorous expansion. The results suggest that future climate conditions will favour lodgepole pine range expansion from northern B.C. to Yukon, which may serve as a connector for MPB to spread into Yukon. One limiting factor to the northward spread of MPB is the absence of pine in current and newly expanded range.

General Conclusions

The risk assessment showed that the area of climatic suitability for lodgepole pine is likely to increase northwestwards in Yukon, and the pine inventory will be susceptible to a MPB attack. This increase was particularly noticeable in the southeastern corner of the territory where susceptibility is already the highest.

Corroborating a previous study in B.C., the results suggested that future climate conditions will favour lodgepole pine range expansion northwestwards from northern B.C. into Yukon. Expansion of pine into this new range may provide a corridor for MPB to spread into Yukon. However, unless lodgepole pine becomes established in this new range, through planting and/or natural dispersal, the expansion of the range of lodgepole pine is unlikely to serve as a MPB connector in the short term.

The study confirmed that MPB may become a concern for Yukon forest managers beyond the 2020s. Although there is little cause for concern in the short term, there is opportunity to monitor closely and plan for MPB attack.

About the project: *Mountain Pine Beetle Northern Range Expansion Risk Assessment Project* was produced for Yukon government and funded by the National Forest Pest Strategy 2009-2010. Researchers at the Sustainable Forest Management Laboratory at the University of British Columbia completed a 54-page report in March 2010.

Disclaimer: This report was based on the most up-to-date information at the time. Since the completion of the main report in 2010 and this summary report in 2011, more mountain pine beetle monitoring has been conducted.

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