Yukon 2004

Introduction

The annual forest health survey of the Yukon was conducted throughout the month of July. The year of 2004 was marked by an unusually early spring and a repeat of warm dry conditions throughout the growing season.

In late winter 2004 the Shakwak Trench and Kluane National Park received a deeper than average snow pack. The snowmelt, rather than sublimating or running off over frozen ground was evidently taken up by the soil, providing enough moisture to compensate for the lack of rain from April on. This was supported by data from temperature probes placed at Quill Creek (south) and near Dezadeash Lake for the Kluane Ecological Monitoring Project (KEMP). At both of those sites the snow departed in the second week of March, and daytime temperatures were unusually high for the remainder of the month. Consequently in almost all forested areas, the growing season was a time of renewed vigour and exceptional growth. By July it was common to see 30 and 40 centimeter-tall leaders on the white spruce trees Between April and mid-July, however, only a few millimeters of rain fell, and by early July the forest floor was tinder dry. Fortunately, lightening strikes in the Kluane Range in early July failed to cause ignition, and, unlike areas to the north, the southwest survived another season without any serious wildfires.

As in previous years most of our time was spent in and around Haines Junction working within the Forest Health Assessment (FHA) plots, examining the health and development of spruce beetle populations and surveying the recent damage. Between July 6th and 16th, 20 of the 27 plots were visited and plot tree status re-assessed. In early July six sets of pheromone traps were hung in stands infested with a spruce budworm between the south end of Kluane Lake and the White River. Two pheromones were used; one of which was attractive to the two-year cycle spruce budworm, *Choristoneura biennis* and the other specific to *C. orae.* The traps were retrieved at the end of the month.

In the third week of July the annual assessment of the forest pest activity was made along the Alaska Highway north of Haines Junction to Beaver Creek and across the Top of The World Highway to Dawson City. Forests along the Dempster Highway, the Mayo Road, the northern portion of the Robert Campbell Highway, as well as the north Klondike Highway were surveyed for pest damage. Aerial surveys were completed in late July to map the fading crowns of trees killed by spruce beetle in 2003. Also in late July, the highway survey extended to the Alaska border along the Haines Road and South Klondike Highway, and was completed with visits to Atlin and road travel between Whitehorse and the B.C border near Irons Creek, east of Watson Lake.

With the exception of spruce beetle, aspen serpentine leafminer, and two-year cycle spruce budworm, pest activity was low throughout the Territory.

Spruce Beetle

The spruce beetle, *Dendroctonus rufipennis*, has infested white spruce stands in the Shakwak Trench and Kluane National Park since the early 1990s. By the turn of the century beetle populations were in decline and, with a return of cool moist conditions in the growing seasons of 2000 and 2001, it appeared that the balance had turned in favour of the trees' capacity to defend against beetle attacks. A collapse of beetle populations seemed imminent. True to the dynamic of this infestation however, the population trend did not follow historical precedents. Instead of overcoming beetle attacks with their renewed vigour, re-hydrated trees that were successfully attacked, provided a much improved environment for beetle brood development, and 2002 saw a healthy resurgence of the population, and greatly increased areas and intensities of attack. The resurgence continued to accelerate in 2003 with fresh attacks causing mortality over an area of 99 630 hectares (ha): light[1], 47 945 ha; moderate, 24 472 ha; severe, 28 083 ha (Map 1). The mortality was mapped from the air in late July, 2004. Since almost the entire population was on a two-year development cycle, this was the same population that in 2002 caused 69 415 ha of mortality. The area of mortality in 2004, therefore, represented an almost 50% increase from 2002 and a 250% increase from last year (Figure 1). Most significant this year were expansions eastward from Dezadeash Lake to Kusawa Lake and the largest continuous area of severe infestation ever mapped in this outbreak (>20 000 ha), from Klukshu, south to Dalton Post, and from there northeast throughout the Fraser Creek drainage.

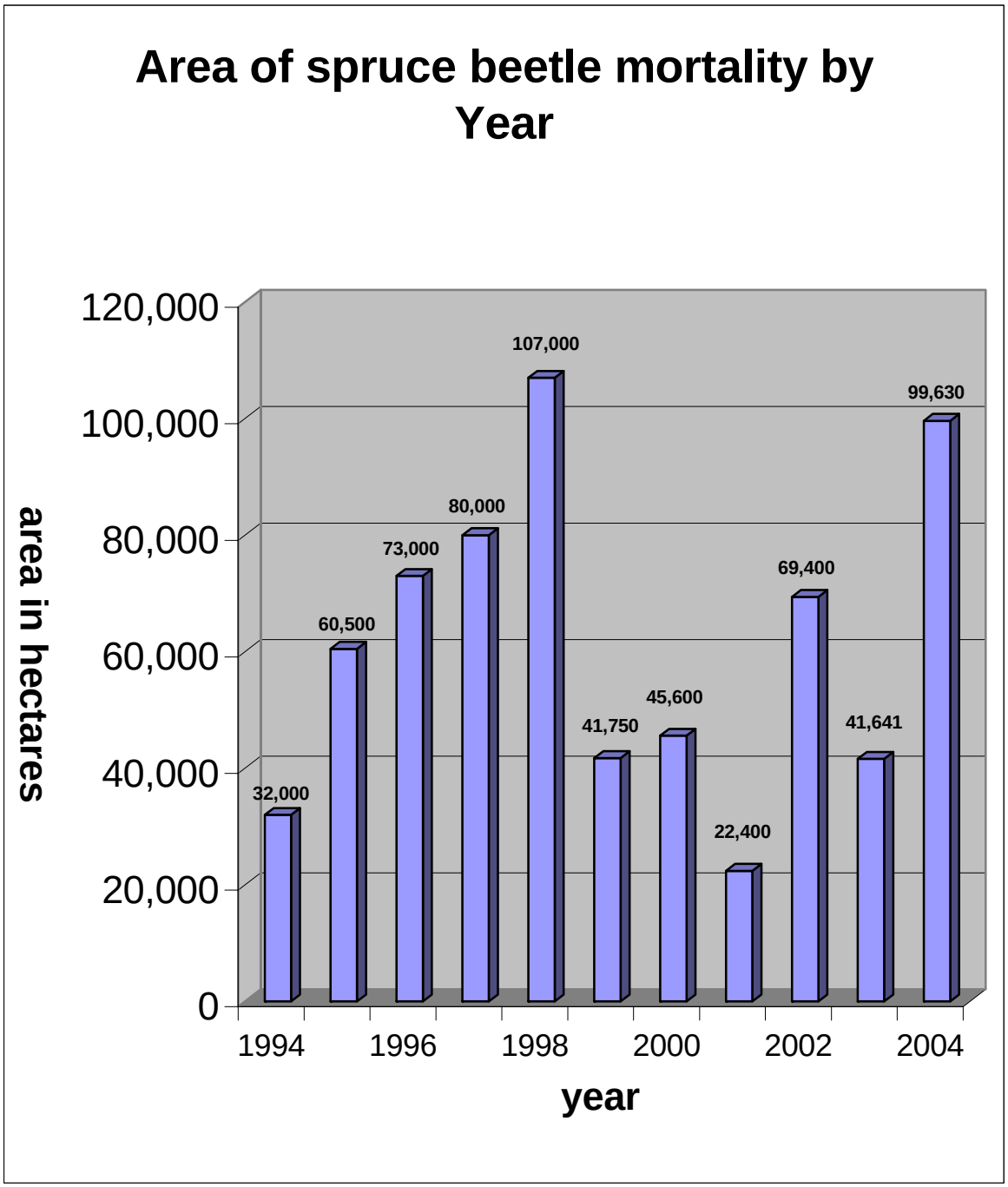
The scene in 2004

The annual aerial survey was conducted in late July using a Cessna 205 fixed-wing aircraft. The purpose of the survey was to map the severity and extent of the previous year's beetle-caused mortality within stands of white spruce as well as any damage symptomatic of other pest activity.

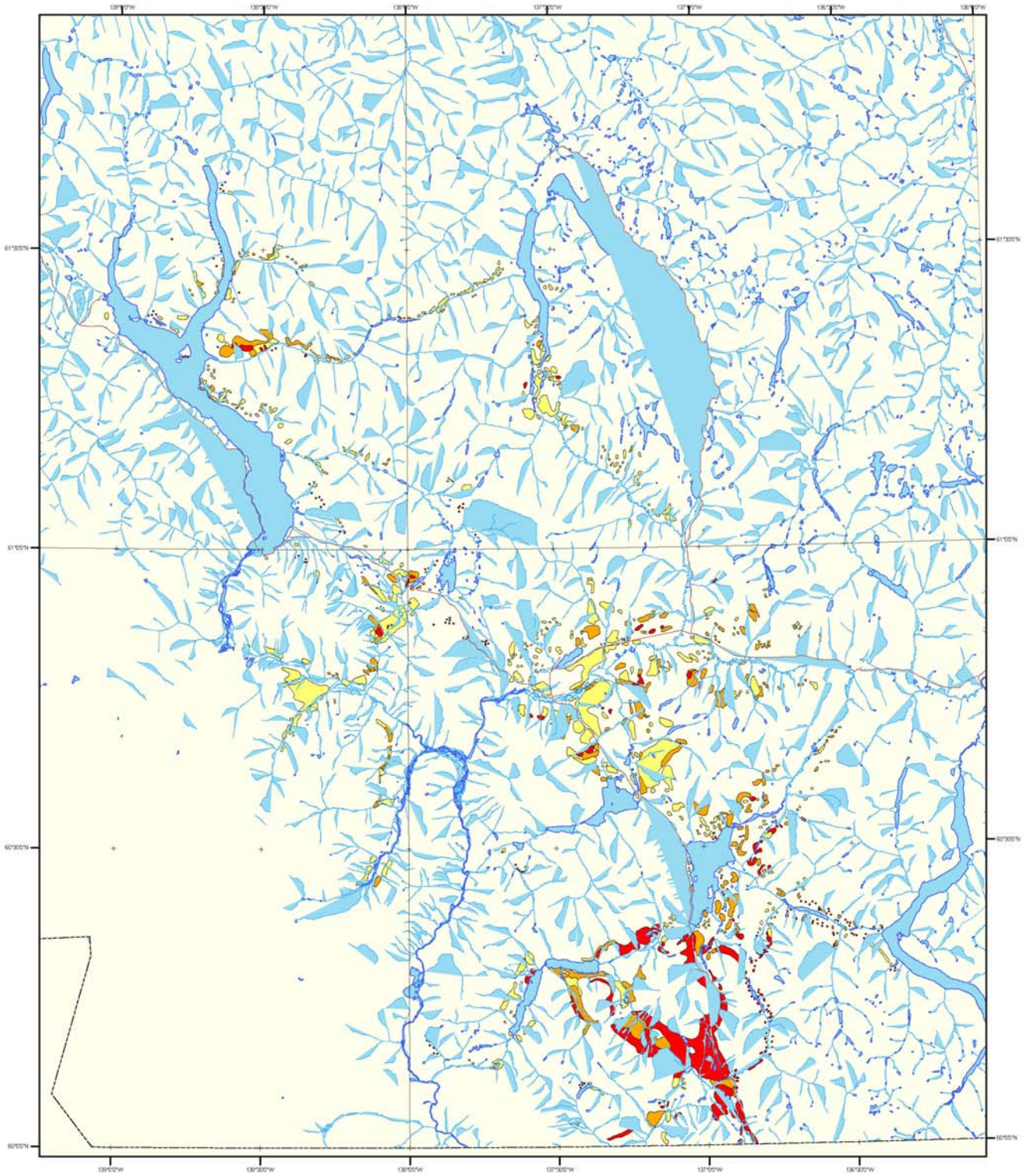
Starting in the northeast, attacks increased along the length of Isaac Creek, from the headwaters east to Sekulmun Lake. Attacks were mapped for the first time on the eastern shore of Sekulmun Lake across from the mouth of Isaac Creek and large areas of light and moderate attacks were mapped along the southwest shore of the Lake. This marks a northward expansion of activity in the West Aishihik River drainage. Farther south, large areas of light and moderate attack were recorded on both sides of Bear Lakes and along the east side of the West Aishihik River. Farther west in the Kluane Lake drainage, numerous attacks occurred once again along the Gladstone River with significantly

[1] Light: up to 10% of stand trees killed the previous year
Moderate: from 11 to 30% of stand trees killed the previous year
Severe: more than 30% stand trees killed the previous year

Figure 1.



increased area and attack severity along the north side of the River near Kluane Lake. Attacks have continued to intensify along Talbot Arm with increased mortality on both sides, from Gladstone River north into Raft Creek. In addition, five small centers of attack were recorded within five kilometers of the north end of the Arm; a significant


Legend
IPS Species - Low (29 ha)
Spruce Beetle - Low (47046 ha)
Spruce Beetle - Moderate (24472 ha)
Spruce Beetle - Severe (28083 ha)
Yukon Spruce Beetle 2004
(Rotation Angle 10 °)
0 4.5 9 18 27 36 45
Kilometers
Produced for:
Pacific Forestry Centre
Canada
FIR GISolutions Inc.

northerly extension of the infestation. South of the Gladstone River attacks continued on the east side of Kluane Lake, from Long Point to Thorsen Bay, at levels similar to the last few years, but there was a significant increase in area and intensity of attacks along Cultus Creek, from Cultus Bay to Big Joe Lake.

From Kluane Lake to Haines Junction little was mapped with the exception of very active centers in the vicinity of Sulphur Lake. These infestations encompass the seasonal research settlement known as Squirrel Camp. This 'island' of infestation is discussed later in the report.

Similar to last year, light scattered attacks were common in stands from Bear Creek to the northwest side of Paint Mountain, through the pass into Marshall Creek, and immediately northeast of Pine Lake. East of here, however, numerous pockets of moderate and severe intensity were mapped on the lower slopes of Hard Time Mountain between Marshall Creek and Canyon. For the first time mortality was also detected in the Aishihik River Valley near Seven Mile Creek, but attacks were much more intense near the Valley mouth, near Wagga Creek and east into the Cracker Creek drainage. This marks a new but long anticipated trend of eastward population movement along both sides of the Dezadeash River Valley. This trend was initiated about five years ago on the south side of the Valley when a population spilled through Granite Pass from the west into stands adjacent to Moose Creek and spread to the east and west. The eastern spread continued and has now reached the north slopes of Mount Bratnober. Within a few years this population will coalesce with one moving north along the Dezadeash River from Dezadeash Lake, which has now reached the west facing slopes of Mount Kelvin. West of Moose Creek numerous pockets of activity reflected a continuation of last years increase. Infestations along the northwestern slopes of the Dezadeash Mountain Range, just east of the confluence of the Dezadeash and Kathleen rivers, remained very active. The main difference from last year was the dramatic increase in activity along the flats adjacent to the Dezadeash River, immediately south and east of Haines Junction. This follows a commonly observed sequence of infestation in this outbreak, whereby beetle populations first invade sub-alpine stands and move down-slope in subsequent years. This is the opposite sequence of infestation common to more southerly spruce beetle populations that, at outbreak levels, characteristically focus their activity within river bottom stands.

Similar to last year, numerous light and moderate patches covered the east and north-facing slopes of the Auriol Range as far south as Kathleen. Large polygons of mostly light damage remained in the Kathleen River Valley where, following many years of infestation, a remnant population has survived by attacking the remaining susceptible host.

The real story of increased movement and attack intensity mapped in 2004 was told in stands from Dezadeash Lake, south. Until recently significant mortality had been restricted to the mountain slopes immediately to the west of the Lake, but recent expansions have seen the infestation progress to stands on all sides. Numerous small infestation centres were scattered throughout stands on the east side of Dezadeash Lake

above the north and south sides of Six Mile Lake, along the Kluhini River through the pass to Kusawa Lake and down the west side of Kusawa Lake as far as Devilhole Creek. Numerous 100+ ha polygons of moderate and severe attack were also mapped near the southeast end of Dezadeash Lake and around the hill into Fredrick Creek. From here small patches were mapped south to Howard Lake and through the Takhanne River valley to Million Dollar Falls.

From the south end of Dezadeash Lake moderate and severe infestations were continuous on both sides of the Haines Road to the B.C border. The single largest continuous area of severe mortality included this area and the entire valley of Fraser Creek northwest of Dalton Post, and extending into the Mush/Bates lakes area. Infestations in Mush/Bates were about as severe and extensive as in 2003 but new large areas of severe attack were seen east of Mush Lake along both sides of Alder Creek.

Discussion

Once again, the weather was the responsible for a change in momentum of the infestation. The early spring resulted in a very early emergence of overwintering adults and a subsequent early mass attack of healthy white spruce trees. The KEMP weather data from the 'Silver' station near the south shore of Kluane Lake suggests that the beetles could have been flying as early as the second week of May instead of the normal flight period in early June. When field examinations are initiated in the first week of July we normally see adult female beetles still actively establishing vertical brood galleries within the inner bark, and laying numerous clusters of eggs on alternating sides of the gallery wall. This year, in the first week of July the adult galleries were fully extended and most of the eggs had already hatched. First and second instar (i.e. larval stage – out of four) larvae had already started to create their horizontal galleries and the blue stain *Ceratocystis* fungus, carried by the parent adults, had already begun to infect the sapwood. Larval development continued on this pace throughout July, and, by the end of the month, most were in the fourth and final instar, (see Photos1 and 2) and some had already pupated. From examinations of trees throughout the infested area I concluded that approximately 80% of the broods would develop through to the adult stage before the fall and, as a result, complete their life cycle in one year.

The spruce beetle normally requires two years to mature as the weather-dependent larval development period is too short to permit completion in a single season. Some one-year cycling was seen in the mid 1990s during unusually warm dry summers, but then only about 30% of the population was involved. The significance of the one-year cycling lies in its potential to further intensify the infestation. When adults emerge in the late spring of 2005 to search out new hosts, the flight will combine beetles from the 2004-attacked trees as well as the two-year cycle emergence from trees attacked the year before. The beetle population also benefits by the progeny spending only one winter inside the tree instead of the normal two. In a two-year cycle the larval progeny spend their first winter above the snow just beneath the bark, and are therefore susceptible to periods of extreme cold weather. In the fall of the second year the young adults leave the galleries and migrate to the base of the tree where they re-enter and spend the winter under a protective

layer of snow. Most of the one-year cycle young adults are expected to behave in the same way. In addition, woodpecker and insect predation will be reduced as well as losses to disease such as that caused by the fungus *Beavaria bassiana*. It was no coincidence that the period of rapid population growth in the mid 1990s coincided with one-year cycling. The only good news is that last year's over-wintering larvae experienced the intense cold of January and a large proportion of the population (>80%) died, thereby significantly reducing the contribution of the two-year cycle component in next year's flight.

Current Condition of FHA Plot Trees

Plot No.	No. of white spruce	% healthy[1]	% current[2]	% red[3]	% grey[4]	% partial[5]	% dead other causes
1	62	29	5	8	44	13	1
2	35	66	6	0	17	11	0
3	62	36	11	0	53	0	0
4	41	59	15	5	20	2	0
5	73	40	5	0	53	3	0
6	37	24	0	0	73	3	0
9	37	68	0	0	30	0	0
11	73	60	4	0	30	5	0
14	57	68	0	0	7	0	25
15	43	65	2	0	33	0	0
16	48	54	6	2	22	4	12
17	24	46	0	0	54	0	0
18	24	41	14	0	27	18	0
19	57	30	2	0	33	2	12
21	51	31	12	4	45	1	6
23	28	43	0	0	54	0	4
27	30	30	0	0	63	7	0
28	53	19	2	0	69	2	8
29	27	4	41	4	37	11	4
30	31	19	6	0	65	6	3
32	88	8	6	0	68	1	15
average	**45**	**38**	**6**	**1**	**41**	**4**	**4**
% change from 2002		**-11**	**0**	**2**	**11**	**-3**	**2**

1 not attacked by spruce beetle

2 attacked and killed in the current year

3 attacked and killed the previous year

4 attacked and killed two or more years previously

5 attacked in the current year but not killed

One of the more rewarding aspects of the Yukon spruce beetle project has been the opportunity to meet researchers in other, often related fields. The spruce beetle infestation is so large and has been ongoing for so long that it has itself become a major ecological force, influencing the survival of many other species. No population has been more affected by the death of the white spruce overstory than the red squirrel. Squirrels rely on an ongoing supply of spruce seeds as one of their principal winter food sources.

At “Squirrel Camp” a seasonal research facility established near the Boutillier Summit south of Kluane Lake, researcher Jalene LaMontagne has been studying, among other things, the impact of the infestation on squirrel populations. In the past two years their observations have included squirrels chewing through the bark of infested trees and feeding on the spruce beetle larvae. This behaviour had not been documented previously. The squirrels have to some degree compensated for the loss of the high protein seed by replacing it with the high protein beetle larvae. There will be no shortage of food within the trees this winter, as 30% of trees above 5cm in diameter were attacked in 2004 (J. LaMontagne unpub. data) by spruce beetles. This alone was unusual because the spruce beetles had infested this area during the first wave in the mid 1990s and killed all of the scattered 200+ year-old mature spruce. There were no more than 20 of these trees per hectare so the intensity of the infestation was recorded as light at the time. These large trees had apparently been survivors of a wildfire that swept through the area in 1906 (Francis 1996). Despite the nearly 100 years since the fire, the average age of white spruce within the succeeding stand is only about 60 years. The site lies at the base of a slope and has received soil from above. Consequently the soil is relatively deep, and the trees have grown quickly, averaging 28 cm diameter at breast height (dbh). Ten years ago these trees were not attractive to the beetle and the infestation swept though without them being affected. Now the trees are 10 years older and have attracted a high concentration of mass attacks. There were no indications of stress in the stand that would suggest that the beetles were acting as secondary agents. Instead, the beetles, exhibited “epidemic” behaviour, and were attracted by the chemical signals of healthy hosts with thick phloem, offering them a high degree of food and protection from weather – once the tree defenses had been overcome. This “second wave” effect is but one more instance where this infestation has proven unique in both intensity and duration. The high intensity of attacks here are also consistent with intensities seen elsewhere on the fringes of the infestation. Unfortunate for the squirrels, however, their reliable and renewable spruce cone food source has been replaced by one that will provide food for only a few years. One of the purposes of work at Squirrel Camp will then be to document the effects on squirrel populations.

Among the tasks undertaken in 2004 was the reassessment of plot trees within the Forest Health Assessment plots. Twenty-one of the 27 plots were visited; all plots that could be accessed by road. Plots within Kluane National Park that were either boat or helicopter access could not be visited this year. The exception was Plot 30 within the Kaskawulsh River Valley that was reached by mountain bike.

In the past two years the number of healthy trees had dropped an average of 11%, and the number of greys had increased by the same number. Current attacks still averaged 6%. In five of the 21 plots, current attacks were above 10%. Plot 29 in the Cultus Creek drainage was exceptionally active with 41% of trees currently attacked. This is another revitalized population, though in an unlikely stand, where average dbh was only 14 cm.

Photo 1. **Spruce beetle larval development in currently attacked tree on July 14 – mid instar**

Aspen serpentine leafminer, *Phyllocnistis populiella*

Damage to aspen leaves caused by the leafmining larval stage of this insect was widespread and intense throughout most of the southern Yukon with damage similar to that recorded during the last four years. By mid-July most aspen leaves and many balsam poplar were so severely mined that no photosynthetic capacity remained and the trees were silver-grey in colour. Despite the intensity of the damage, which probably causes a significant loss of growth potential, there is, as yet, no evidence to suggest that the infested trees are at risk of mortality from the pest.

Prior to the spruce beetle infestation in the southwest, the most damaging insect pest in the Yukon had traditionally been the large aspen tortrix, *Choristoneura conflictana.* Severe infestations often resulted in the death of large numbers of trees. Whether there is a direct cause-and-effect relationship between the rise of leafminer populations and the decline of the tortrix is not known, but there has been a significant decline in the number and intensity of tortrix infestations in the past four years. It is possible that the mining of the leaves had reduced the food available to the tortrix, and their populations have been thus controlled.

Photo 2. Spruce beetle brood development in currently attacked tree on July 28 - late instar larvae and pupae

Fir-spruce budworm, *Choristoneura orae*

Light defoliation by the immature larvae of this insect was reported last year stretching from the southwest end of Kluane Lake, north through Beaver Creek. The larvae were only in their first two (out of six) larval stages, and therefore very small. As a result damage was confined to buds and branch tips. Defoliation was expected to be much more severe in this, the larval maturation year. In the summer of 2003 larvae were collected on branch samples for rearing at the Pacific Forestry Centre. These samples remained in cold storage over the winter. When samples were re-warmed in February 2004 and the tiny budworm larvae re-activated it became quickly apparent that approximately 25% of the population was itself infested with two parasites; the Ichneumonid wasp *Glypta fumiferanae* and the Braconid wasp *Apanteles fumiferanae.* It was no surprise therefore, when the significant levels of defoliation that were initially expected, failed to occur. Only a small patch (approximately 5ha) of light defoliation was seen during aerial surveys near the Burwash Airport. Elsewhere little or no damage was seen.

This was the first time any spruce budworm other than the eastern spruce budworm, *C. fumiferanae*, had been recorded causing defoliation in the Yukon. Initially it was assumed, because it was on a two-year cycle, that it was the two-year cycle budworm, *C. biennis.* *Choristoneura biennis* had been found here in the past in standard three-tree beating samples. However, a later search of the records showed that the fir-spruce budworm had also been found in past samples from the area. It is only with great difficulty through analysis of specific enzymes that the two species can be distinguished in the laboratory, but, fortunately, they are attracted to pheromones of slightly differing molecular structure. Six sets of plastic "Multifer" traps containing the two different formulations were set out in early July and retrieved at the end of the month following the moth flight.

Results of Spruce Budworm PheromoneTrapping

		No. of moths	
Location	**UTM[1]**	**C. f.o.b.[2]**	**C. orae[3]**
Congdon Creek	07 631507 6782173	85	157
9 km -N- of Congdon Creek	07 624826 6787043	15	71
5.6 km -N- of Destruction Bay	07 614334 6797145	121	210
6.5 km -N- of Burwash	07 600866 6805325	4	40
8 km -N- of Duke River Bridge	07 594441 6812380	4	107
4 km -N- of Kluane Village	07 582324 6829700	1	45
	average	38	105

[1] - UTM - Universal Trans-Mercator grid system

[2]C. f.o.b. - aldehyde formulation attractive to *Choristoneura fumiferana, C. occidentalis and C. biennis*

[3]C. orae - acetate formulation attractive only to *C. orae*

The almost 3/1 ratio of moths caught with the *C. orae* bait suggests that the population is, indeed, *C. orae,* and that there was a slight attraction as well to the *C. f .o.b*. bait. This is thought to be more likely than the alternative; that both *C. orae* and *C. biennis* were present (Dr. Vince Nealis pers. comm.).

Acknowledgements

The annual pest survey of Yukon forests as well as the ongoing analysis of damage caused by the spruce beetle is facilitated to a large degree by financial and fiscal support from the Forest Management Branch, Department of Energy, Mines & Resources of YTG. In particular, the support of Don White in Whitehorse as well as John Jennings, John Trotter and Neale Wortley in Haines Junction was greatly appreciated. Weather data was supplied courtesy of Kluane National Park and Reserve ecologist, Dr. David Henry.