Yukon 2005

The annual forest heath survey of the Yukon was completed between July 3rd and 29th of 2005. Following an average winter with a significant period of extreme cold in January, the Yukon experienced an exceptionally early and warm spring through April and early May. Following this the weather cooled for the remainder of May, though until mid June. For areas around Whitehorse this period was also wet, with episodes of torrential rain, while in the southwest it remained relatively cool and dry.

Significant pests recorded during this year's survey included spruce beetle, *Dendroctonus rufipennis*, a pine engraver beetle, *Ips perturbatus*, larch sawfly, *Pristiphora erichsoni* and aspen serpentine leafminer, *Phyllocnistis populiella.*

Since 1994 when the spruce beetle epidemic was first surveyed in the Southwest Yukon, most of the available field time has been spent assessing the condition of the beetle population, monitoring its spread and mapping the recent damage. A particular emphasis this year focused upon determining any trend toward eastward movement of beetle populations within the Dezadeash River Valley. To aid in this, pheromone baits specific to spruce beetle were strategically placed along the Kusuwa Road and along the Alaska Highway from the Kusuwa Lake turnoff at 10 km intervals as far as Haines Junction, and south of Haines Junction as far as the south end of Dezadeash Lake. The traps served to monitor the timing and extent of this year's adult emergence.

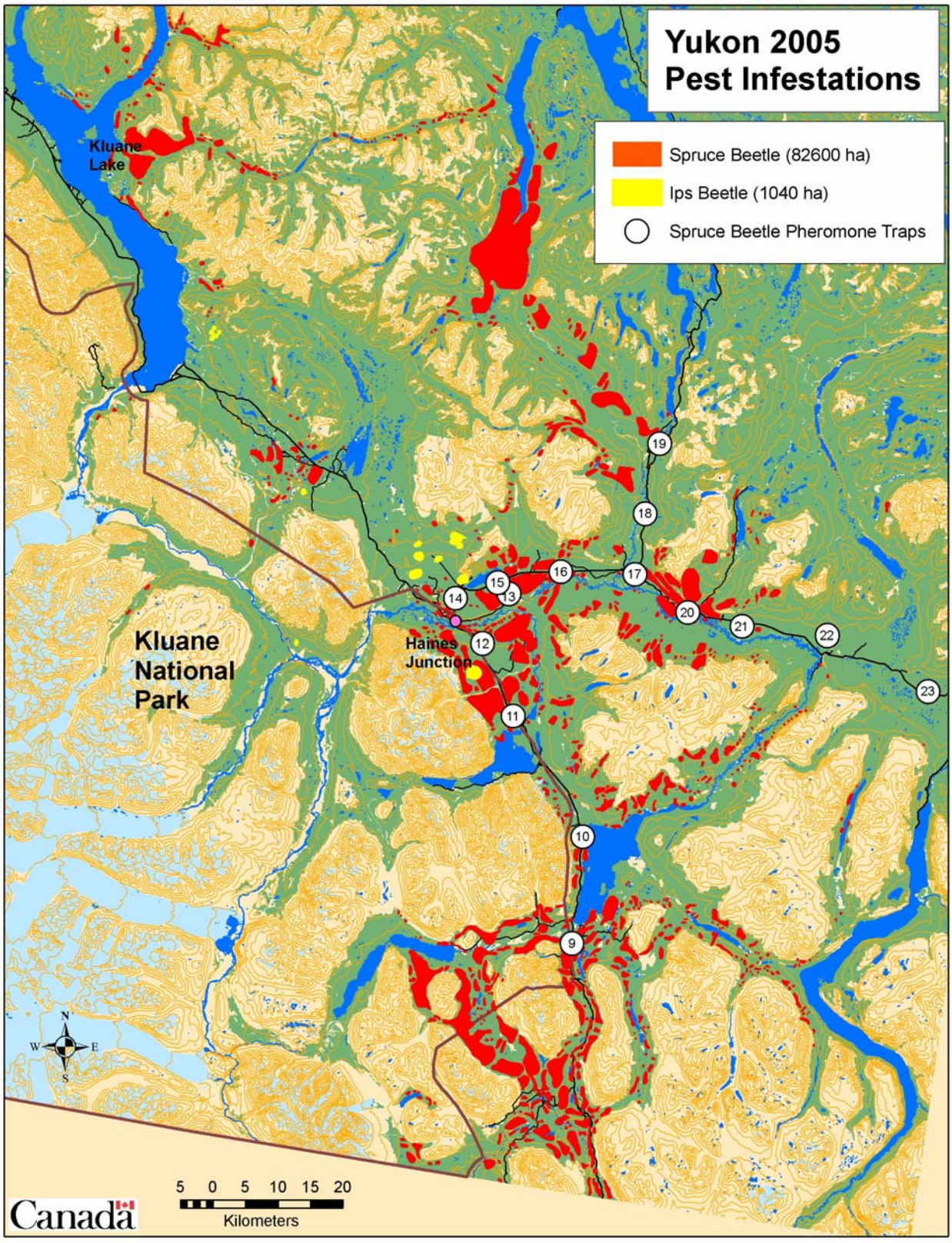
In addition to the annual forest pest assessment of southern Yukon forests, Don White and myself completed a six-day helicopter survey of northern forests between July 14th and 20th. For the first three days, we were based out of Old Crow, where the survey focused on the Porcupine River drainage. For the remaining three days we were based out of Eagle Plains and covered the Peel River drainage. A total of 13 permanent assessment plots were established in white spruce stands along many of the major rivers. The plots served to assess recent pest activity and general forest condition. This year's data will also serve as the baseline against which data from future assessments of the same plots will be compared.

Spruce beetle

For the (estimated) 14th consecutive year spruce beetles killed large numbers of mature and near-mature white spruce in the southwest Yukon, throughout the Shakwak Trench, the Dezadeash River Valley and southern forested areas within Kluane National Park. A two-day aerial survey was completed in mid-July to map red trees killed by attacks in 2004 (Map 1). A total of 82 620 ha of recent kill was mapped, including 27 064 ha of light[1], 17 336 ha of moderate and 8220 ha of severe.

[1] < 10% of stand killed in the previous year = light; 11-30% = moderate and >30% = severe.

Map 1. Areas where recent spruce beetle and Ips mortality were mapped



This was somewhat reduced from the 99 630 ha mapped in 2004. Similar to last year the most extensive and intensive attacks occurred in the southern end of the Trench between Dezadeash Lake and the B.C. border.

The scene from the air in 2005

Following the early beetle flight in 2004, by late July the needles of attacked trees had begun to fade, and by the spring of this year the color change was well advanced; so well advanced in fact that the annual aerial survey was conducted in early rather than late July to map the faded trees before they dropped their needles.

Starting in the northeast, light attacks with some patches of moderate were continuous from the east end of Killermun Pass to the south end of Sekulmun Lake, and from there along both sides of the Lake for about one-third of it's length (Map 1). Toward the north end of Sekulmun Lake beetles have continued to migrate down Isaac Creek, and have now crossed the Lake and killed a small number of trees on the east side. This population along with those moving up from the south will likely continue to migrate north as the climate allows. To the west, infestations continued to intensify along Talbot Arm (of Kluane Lake), especially Raft Creek where large areas of moderate and severe mortality were mapped. Spot attacks were also seen on the east and west side of the Arm north of Raft Creek. South of Raft Creek a slight increase in mortality was mapped on both sides of the Arm, intensifying with the approach of the Gladstone River, the source of these populations. A few small groups of red trees were mapped on Jacquot Island for the first time. Large areas of only light mortality near the mouth of Gladstone were evidence that this long-standing infestation is tapering off, no doubt due to the lack of surviving susceptible host. South of the Gladstone mortality was significantly reduced from last year with only scattered light patches and concentrations along the lakeshore north and south of Long Creek and again at Cultus Creek. No recent mortality was mapped on the west side of Kluane Lake.

Proceeding south in the Shakwak Trench little susceptible host remains, but areas of vigorous immature timber near Sulphur Lake were severely attacked for the second consecutive year. These stands were too young when the first wave of beetles swept though in the mid '90s, but in the ensuing years, thanks to an unusually rich site, these trees, averaging just over 50 years of age, have grown large enough (24 – 30 cm dbh) to be attractive to the beetle. These stands also house the headquarters for red squirrel research in the north and where populations of red squirrels have been observed gnawing through the bark of infested trees and feeding upon the beetle larvae. The squirrels, faced with greatly reduced crops of their staple spruce cones, have tapped a new and rich, if only temporary, source of protein.

Since the beginning, the progression of infestations across landscapes has largely been determined by topography and the prevailing southwest wind. Between them they determined which areas became infested and which areas remained beetle free. Until recently stands to the west and east of Haines Junction were examples of the latter. Infestations here grew more slowly, building upon local breeding populations rather than

the in-migration of remote ones. In the past few years these populations have reached threshold levels and the infestations have blossomed. West and south of Haines Junction the east-facing slopes of the Auriol Range that remained curiously green for so long, are now turning red and grey. Likewise the stands along both sides of the Dezadeash River to the east and, remaining stands on the west side of the Kathleen River to the south have increased in size and intensity. Some of the most intensive attacks occurred on the southeast-facing slopes of Paint Mountain near the east end of Pine Lake, and across Marshall Creek on the south facing slopes of Hard Time Mountain. This is also the western mouth of the Aishihik River valley, another area that has remained infestation-free until recently. Beetle populations that migrated eastward through the pass at the head of Marshall Creek over five years ago have incubated, and slowly increased until they, too, blossomed this year on both sides the West Aishihik River valley, moving to the south as far as Emery Creek and northward on the slopes of the Three Guardsmen, to coalesce with the more long-standing infestations that years ago had migrated through Killermun Pass. Possibly the most significant expansion of existing infestations was seen adjacent to the eastern mouth of the Aishihik River Valley at Wagga Creek, continuing south around the headland and east into Cracker Creek. Some of the patches especially those higher up on the slopes were moderate in intensity. Lower down on the Dezadeash River Valley floor continuous light attacks were mapped on both sides of the Alaska Highway from Canyon to beyond Cracker Creek breaking into smaller polygons that stretched northeast almost as far as Shaneinbow Lake. This was almost unchanged from last year. Farther north, small spot infestations mapped last year just south of Morraine Lake have expanded and moved as far as the north end of the Lake and just north of Klowton Lake. A single isolated patch of light attack covering approximately 100 ha was mapped in the Mendenhall River drainage just north of Taye Lake. This was the first time in ten years that activity had been detected in this area.

On the south side of the Dezadeash River infestations have been building ever since they migrated from the Shakwak Trench north through Granite Pass into the Moose Creek drainage. Since then they have radiated to the east and west, killing increasingly large patches of spruce along the whole north side of the Dezadeash Range. Most significant this year was the continued eastward movement onto the lower slopes of Mount Bratnober.

In the Shakwak Trench south of Haines Junction, infestations are almost continuous near tree-line along the Auriol Range as far as Kathleen Lake. These infestations broaden down-slope significantly near Quill Creek to meet the Haines Road, and cross the road south of Quill Creek to break into discrete patches across the Valley as far as the Kathleen River. This marks a resurgence of activity in these stands that were attacked initially in the mid 1990s, and, like at Sulphur Lake the beetles may be attacking trees that were not yet susceptible ten years ago. Attacks were scattered at the higher elevations on both side of the Trench between Kathleen Lakes and Dezadeash Lake. Northeast of Dezadeash Lake attacks had intensified, with many patches of severe in the hills north of Six Mile Lake and adjacent to Red Squirrel Creek. From here the polygons were reduced in size and intensity but scattered patches of recent mortality stretched up

Dune Creek and the Dezadeash River to within approximately five kilometers of Champagne.

On the east side of Dezadeash Lake scattered, mostly moderate and severe patches of recent mortality followed the Kluhini River, eastward, continuing on both sides of Frederick Lake and fanning out to the north and south along the west side of Kusuwa Lake. Along Kusuwa Lake the most concentrated attacks were in high elevation stands to the south, running almost continuously as far as Devilhole Creek. This marks a significant intensification from last year. To the north the patches were smaller and more scattered but extended as far as the north end of Jo Jo Lake.

Near the southeast side of Dezadeash Lake the picture was similar to last year with numerous polygons of all severities in the lowlands adjacent to the Lake and around the north and south sides of the "hill" and into Frederick Creek. South of the Lake attacks intensified and, like last year, every susceptible stand from Klukshu Village to the B.C. border was mapped as moderate or severe. Also like last year, patches of mortality of all severities were mapped in the Takanne River drainage, Howard Lake and upper Klukshu River areas. In the upper Tatshenshini drainage mostly light and moderate patches occurred in the higher elevation stands above Pirate Creek, Squaw Creek, the Bridge River and Onion Lake. In the Fraser Creek drainage, attacks were almost continuous from Dalton Post to Mush Lake. Attacks were as extensive but less intensive than last year. Around Mush Lake itself, only the Mush Creek infestation continued at light levels, the rest of the beetle population having died out due to a lack of susceptible host. To the east, attacks in the higher elevation stands north and south of Alder Creek were mostly moderate in intensity and almost continuous as far as the south end of Dezadeash Lake and Klukshu.

The population in 2005

In the absence of effective host resistance or disease, parasitism and predation within the spruce beetle population, climate has been the only effective regulating force. Most of the climatic features that have characterized the last 15 years; the relatively mild winters, the warmer springs and summers and the recurring drought, have all favored the beetle's survival and development. Early 2005 unfolded in what has recently come to be a familiar way, with warmer than average temperatures in the early spring. It was so warm, in fact, that the flush of the aspen leaves in Whitehorse was the earliest in more than 30 years (Don White pers. comm.). These conditions continued until early May, at which time I had an opportunity to spend some time in the Yukon setting out pheromone traps and assessing the overwintering beetles. Due to an early beetle flight (estimated to have been late May) in 2004, and ideal developmental conditions, most of the progeny had entered the winter of 2004/2005 as young adults, and were therefore poised to cycle in a single year instead of the normal two. In early May of 2005 these, now mature adults, were active within their overwintering sites under the bark at the root collar, and appeared ready to fly up to a month earlier than normal. The minimum ambient (i.e. the under-bark) temperature required for beetles to emerge and fly is approximately 15^{o} C. When the weather warms and the minimum temperature is reached, beetles emerge and

commence their mass-attack of susceptible host. This year however, just before the critical temperature was reached, the weather changed, and much cooler conditions prevailed from the second week of May thru mid-June. So, weather conditions that at first appeared conducive to an exceptionally early beetle flight, resulted instead in a relatively late one. The negative affects of the delayed flight on the vigour of the population were further compounded when, even after the weather warmed, temperatures remained marginal for emergence, and site-specific variation meant that on a given day, some areas reached the minimum, while others did not. This resulted in a prolonged and staggered beetle flight and a significantly reduced ability for beetles to mount mass attacks. This was reflected in a greatly reduced level of current attacks in many areas, and, because both the one year cycle from last year and the two-year cycle from the year before matured at the same time, almost the whole population was set to fly this year. We are, therefore, looking at a significant overall population reduction.

Nowhere has the beetle population been more adversely affected than in stands between Dezadeash Lake and Blanchard River where large areas were mapped as severe in both 2003 and 2004. Throughout this area less that 20% of the (smaller) susceptible host remained alive in the spring of 2005, but less than half of these remaining trees were currently attacked and some were strip attacked (attacked but not killed), a situation that occurs only when the beetle population is too small to saturate the tree. Of the very large population that entered the winter last year in this area, it seems that only a remnant survived. To account for such a population drop there were likely stress factors in addition to the unfavorable weather during emergence. In a few examined trees for instance, the mature one-year cycle broods failed to migrate to the root collar, overwintering instead at their pupation sites. Adults are not as winter hardy as larvae and these had all succumbed to the winter cold.

Where assessments were made elsewhere in the infestation, populations did not appear to have suffered as greatly as the southern population.

A particular emphasis this year was placed upon determining the extent of eastward migration of the infestation, to address concerns regarding its containment within the Dezadeash River Valley and Shakwak Trench. This was addressed by three distinct surveys. The first was the annual aerial survey which was extended this year to include the north end of Kusuwa Lake and northeast beyond the Hutshi Lakes.

The second means of detecting eastward movement of the population was through the placement spruce beetle-specific pheromone traps in May. These traps served the dual purpose, especially on the fringes of the infestation, of eliminating small populations as they were detected. The third was the systematic assessment of susceptible stands from Haines Junction eastward until no activity could be detected. The results of this third survey are contained in Table 1.

In early May, Lindgren© funnel traps baited with spruce beetle pheromone were set out at 24 locations from the Kusuwa Lake Road west to Haines Junction and south along the Haines Road to near the B.C. border. All traps were monitored weekly from the third

week in May through the third week in June and trapped beetles removed. We have, therefore, a record of weekly emergence from trees adjacent to the traps through that period. Trap locations are displayed on Map 1 and trap results are tabulated in Table 2. Eight traps that were placed one kilometer apart along the Kusuwa Lake Road, through an area of significant recent blowdown caught no beetles, so are not included on the map or in the table.

Table 1. Spruce beetle stand assessments between Haines Junction and Champagne.

			UTM[1]			% of trees			
Plot no.	Location	Zone	Easting	Northing	Healthy[2]	Current	Red	Grey	Partial
1	just -E- of Marshall Cr.	8	377089	6746421	38	20	18	11	14
2	just -E- of Canyon	8	391875	6747447	84	6	2	8	0
3	Cracker Creek	8	401382	6743299	56	10	8	19	8
4	10km -E- Cracker Cr.	8	409871	6743264	96	0	0	4	0
5	Near Champagne	8	419122	6742864	87	0	0	9	4

[1] Universal Trans-Mercator grid system

[2] Healthy - not attacked
Current - attacked by spruce beetles in current year
Red - attacked the previous year
Grey - attacked two or more years previously
Partial - attacked but not killed

Table 2. Spruce beetle pheromone trap locations and weekly trap catches

Trap#	Location	UTM co-ordinates	May24	May31	Jun7	Jun14	Jun21	Jun29
9	south end of Dezadeash Lake	8 387097 6691099	5	8	7	5	2	1
10	north end of Dezadeash Lake	8 386718 6707582	5	19	50	63	0	1
11	Kathleen River	8 373759 6724570	1	0	3	9	4	5
12	approx. 5 km -S- Haines Jct.	8 367784 6735019	1	2	1	27	4	2
13	10 km -E- of Haines Junction	8 370774 6743057	9	0	12	17	16	2
14	Haines Junction Airport road	8 362790 6741339	0	0	0	0	0	0
15	Km 1624 Alaska Highway	8 368887 6744544	0	1	1	9	1	0
16	Km 1614 Alaska Highway	8 359004 6747720	0	0	0	1	0	0
17	Canyon	8 389565 6748439	0	0	0	1	3	0
18	Km 10 Aishihik Lake Road	8 389981 6787898	0	0	0	0	0	0
19	Km 22 Aishihik Lake Road	8 387334 6657427	1	0	1	16	3	0
20	Km 1592 Alaska Highway	8 398291 6743525	0	0	0	1	0	0
21	50 km -E- of Haines Junction	8 406854 6743375	0	0	0	1	0	0
22	Km 1514 Alaska Highway	8 419822 6742854	0	0	2	0	5	2
23	Mendenhall Subdivision	8 436353 6736375	0	0	0	17	0	0
24	Mendenhall Microwave tower rd.	8 441628 6738414	0	0	0	0	0	0

We can see from the trap results that the beetles started emerging in the week before May 24th and continued to emerge slowly over the next six weeks, peaking in the second week of June. The highest counts were from traps at the north end of Dezadeash Lake but even these were very low. A large beetle flight would have left hundreds of beetles in the traps. The trap results reinforced the evidence of a relatively small population emerging

over a protracted flight period, both of which reduced the beetles' ability to mount successful attacks.

Because the main body of the infestation cycled in a single year a population trend can be determined by comparing levels of current attack compared to levels of red trees (2004 attacks). We can see from current attack levels this year in the first three plots that there is a weak trend toward an increasing population. Beyond Cracker Creek there were no new attacks. Many of the grey trees (attacked prior to 2004) were old and some were caused by Ips engraver beetles rather than spruce beetle. These five stands will be monitored on an ongoing basis while the population survives.

Fire Smart

The Fire Smart program in and around Haines Junction has significantly reduced the amount of fuel available to a wildfire should such an event occur in the vicinity. As well as thinning the stands, the program has reduced the equally problematic ground fuel loads, and in the next few years we should witness a greening of the forest floor as herbs and shrubs take advantage of the increased available light. This will further serve to reduce the hazard. The effectiveness of the program will be compromised however, if the populations of spruce beetle active in stands just south and west of town move into the thinned stands and kill the remaining standing spruce. Another consequence of opening stands is often to increase the frequency of blowdown. To monitor these potential outcomes I spent time in four of the project areas doing tree-by-tree assessments. Two of the stands were within the heart of the village residential area, one behind the school and the other adjacent to the water tower. No problems were identified in the first but in the second, spruce beetle and the northern engraver beetle, *Ips perturbatus* had migrated into the east edge from adjacent stands. Seven current attacks were found; six spruce beetle and one Ips. attack Another nine trees were strip-attacked (partial attacks) by spruce beetle. The third assessed stand was adjacent to the Kluane National Park visitors centre. No beetle activity was detected here but many of the cut trembling aspen were infected with the root disease, *Armillaria mellea,* some supporting the characteristic fruiting bodies (photo 1). This suggested that many of the aspen left standing were also infected, and will either die or fall over in the future as the disease progresses. The fourth site was adjacent to the Forest Management Fire Centre just north of the village. Two of the larger spruce were attacked, one by spruce beetle and one by Ips. There were also seven previous attacks that were now grey.

All of these sites and others will continue to be monitored in future years.

Northern engraver beetle, *Ips perturbatus*

During the annual aerial survey a total of 1040 ha of recent mortality in immature spruce stands was attributed to engraver beetles, a significant increase from the 29 ha recorded last year (Map 1). This included 551 ha of light intensity, 466 ha of moderate and 23 ha of severe. Most of the mortality was in the Shakwak Trench, the most northerly being in five small patches of approximately 10 ha each just north of Inlet Creek, near the southeast end of Kluane Lake. One 20 ha patch of severe intensity was mapped along the

Jarvis River, just south of Sulphur Lake and another of similar size in Kluane National Park near the mouth of the Kaskawulsh River. The majority however occurred in three larger patches near Bear and Marl creeks, just north of Haines Junction, and in one large patch at mid-slope just north of Quill Creek. In addition ground surveys within stands recently infested by spruce beetle south of Dezadeash Lake and east of Haines Junction, indicated that up to 10% of the trees mapped as spruce beetle were either partially or entirely infested with Ips. It is normal in a declining spruce beetle infestation that Ips

Photo 1. Armillaria root disease in recently cut trembling aspen

plays an increasingly larger proportionate role, continuing to attack small trees and larger trees under stress. This can continue for two or three years even after the collapse of the spruce beetle population.

Northern Survey

For a number of years there had been concern voiced by the Vuntut Gwitchin people of Old Crow that their available wood supply was almost exhausted, especially the larger wood for log house construction. There was also concern that, with the moderating climate, forest pest activity may have been increasing and that it was going undetected. The Yukon Government decided, therefore, to mount a one-time helicopter survey of all of the major northern Yukon drainages that supported white spruce. The survey required

six days and 30 hours of helicopter time. During that time we landed and established permanent forest assessment plots at 13 separate locations from Old Crow east, almost to the Northwest Territories border surveying the traditional territories of theVuntut Gwitchin, Tr'ondek Hwech' (Dawson City), and the Tetlit Gwich'in from Ft. McPherson, NWT.

The first three days of the survey were based out of Old Crow and concentrated on the drainage of the Porcupine River including the Bluefish River, Old Crow Creek, Salmon Fork River, Lord Creek, Driftwood Creek, the Bell River, Johnson Creek and the Eagle River (Map 2). The second half, based out of Eagle Plains concentrated on the drainage of the Peel River and included the Whitestone, Miner, Bonne Plume, Wind and Snake rivers (Map 3).

The first impression we had when flying over the rolling land north of the Arctic circle was of the harshness of the landscape. The prevalence of ice lying on or just below the surface often resulted in formations of characteristic checkerboard-like "ice polygons" (Photo 2). Such an environment supports little but willows and stunted trees. Once we became accustomed to this scene it came as a surprise when we encountered the patchwork of healthy and vigorous white spruce stands along many of the creeks and rivers. Most of these stands were less than two hectares in size and were often nestled on the inside of tight bends in the relatively flat watercourses (Photo 3). As such the stands were subject to periodic flooding during times of high run-off. Rather than imperiling these stands however, the slow moving waters were a net benefit, laying down deposits of nutrient-rich silts. Except for the absence of trembling aspen, the stands, including the characteristic understory flora (Table 4), were almost indistinguishable from stands on good sites far to the south. A height–diameter curve (Figure 1) was created using the tree heights and diameters measured in all of the plots. The equation describing the curve was applied, with a volume equation developed by the B.C. Forest Service for northern white spruce to derive a volume per tree. These volumes were summed and by the plot area factor to derive a volume per hectare.

Because we had expected to find smaller trees we decided in advance to record all plot trees above 5 centimeters in diameter, instead of the customary 10 cm. This proved unnecessary. Even with these smaller trees included (115 trees or 19% of the total), the average diameter in all of the plots was 17.6 cm (Table 3), and average height was 19.5 meters.

Much of the forest pest activity encountered during the survey was seen in areas other than the plots. On the first day we were asked to stop at Old Crow resident Steve Frost's cabin which was located on the north side of the Porcupine River about 15 minutes by helicopter west of Old Crow. He had reported possible spruce beetle activity on the property. A single red-topped white spruce was found. This tree had been attacked in 2004 primarily by the northern spruce engraver beetle. There were many adult and larval galleries but the beetles had completed their life cycle and moved on. A single spruce beetle attack was found in the stem consisting of an adult gallery lined with eggs. Also, a single attack by the Allegheny spruce beetle *Dendroctonus punctatus* was found

at the root collar. These beetles represented resident scavenger populations that survive in recently killed trees and those under stress. They pose little or no threat unless northern stands come under stress such as the drought experienced in the southwest corner of the Territory.

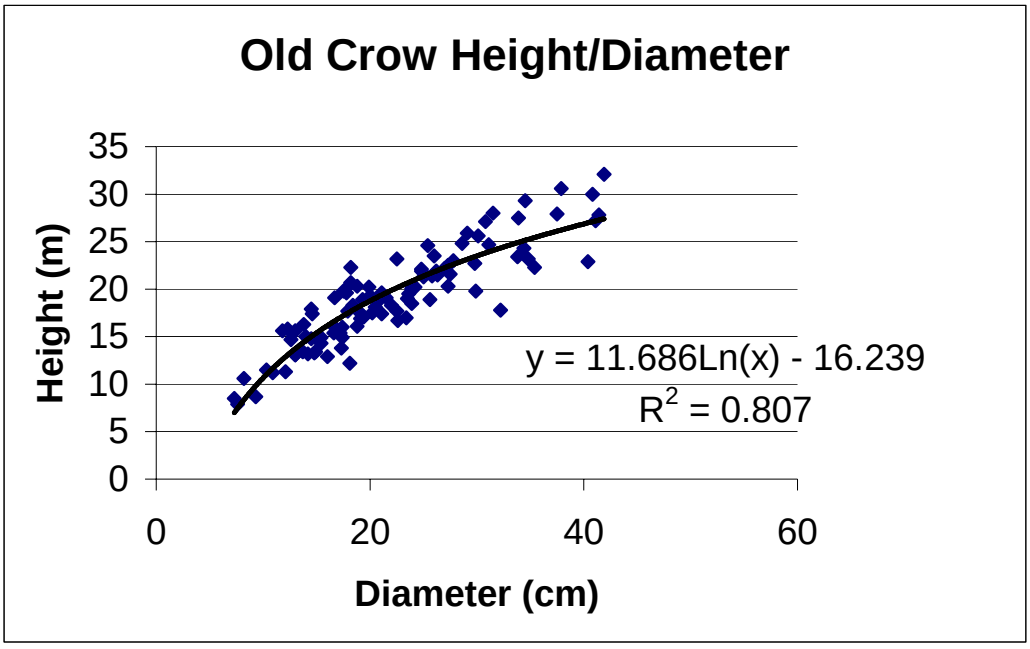
Photo 2. Fields of ice polygons just south of Old Crow

Common around the Old Crow airport feeding on the foliage of willow spp. were larvae of the Mourning cloak butterfly, *Nymphalis antiopa*. Numerous colonies containing up to 100 larvae were seen causing noticeable defoliation.

Our survey focused on white spruce stands that were large enough and with sufficient stocking to maximize our information gathering in the shortest possible time. This meant we focused our attention on the most vigorous stands on the best sites. Unfortunately these were not the best stands for gathering pest information, as many forest pests, particularly the bark beetles, are attracted to stands under stress. The most significant damage was found in Plot 8 along the Miner River where 14 dead-standing eastern larch, *Larix laricina*, occurred in the plot. These had been substantial trees averaging 18.8 cm in diameter and 22.7 m in height. Similar damage was seen in the Lower Bonnet Plume plot and again sawfly larvae were found in the larch regeneration. It appeared in both cases that the trees had been dead for 10 years or more as butt rot was well advanced in all of the trees that were examined.

Photo 2. Typical surveyed stand along the Salmon Fork River

Figure 1. Height/ diameter curve developed from northern white spruce



These were the most northerly populations of sawfly ever recorded in the Yukon. Ten years ago I encountered a severe infestation of this insect in stands in the southeast Yukon near the LaBiche River that resulted in the death of many of the mature larch. It is common when defoliator outbreaks occur that they are recorded simultaneously in many areas. Though the Miner and Bonnet Plume rivers are far removed from the southeast, it may have been the case here.

With the rapid progression of change in the north as a result of moderating temperatures it is clear now that the ecosystems are being subjected to stresses that will almost certainly result in significant ecological changes, especially in areas where the perma-frost is melting. We are already seeing the affects of this with the "drunken forests" as shallow-rooted trees lose their firm support base and fall spontaneously or in relatively light winds. There is also little doubt that the effects of this change will accelerate in the coming years. This first round of northern forest assessment will serve as a baseline for future surveys. It is important that the interval between surveys not be too long as the survival of the community of Old Crow will depend upon current reliable environmental data for long-term planning. Key to this are the continued observations and reports from community members as they practise their traditional lives on the land.

Table 3. Stand data summary from plots established in the Porcupine and Peel River drainages

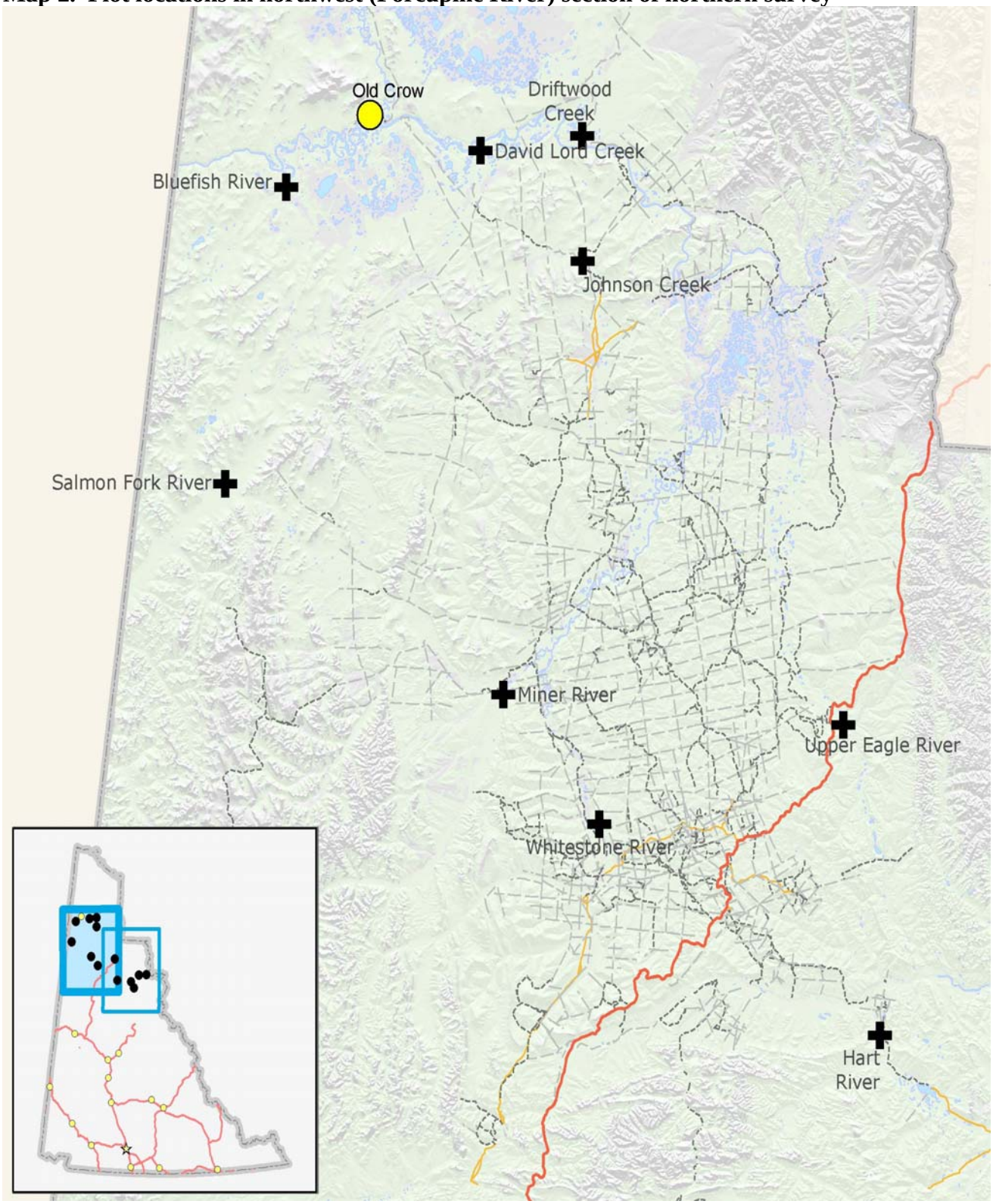
Plot #	Location	Co-ordinates	Tree sp.	avg. dbh[2] (cm)	dbh range	avg. height (m)	number trees/ha	vol./ha[3] (m^3)
1	Bluefish R.	67° 23.975" N 140° 17.942" W	wS[1]	15.0	6 - 26.5	17.9	1385	190.6
2	Salmon Fork R.	66° 45.898" N 140° 28.399" W	wS	24.6	6.6 - 37.9	22.6	1353	310.7
3	Lord Cr.	67° 31.710" N 139° 06.789" W	wS	17.5	7.1 - 35.4	18.4	1633	249.5
4	Driftwood Cr.	67° 35.025" N 138° 29.268" W	wS	16.1	5.5 - 28.2	18.6	1479	263.1
5	Johnson Cr.	67° 19.313" N 138° 25.291" W	wS	12.4	5 - 34.8	17.5	1322	181.2
6	upper Eagle R.	66° 24.240" N 136° 38.378" W	wS	20.3	5.5 - 40.8	23.8	676	242
7	Whitestone R.	66° 09.149" N 138° 02.984" W	wS	19.3	8.3 - 30.8	17.2	1133	299.3
8	Miner R.	66° 24.115" N 138° 40.872" W	wS	16.6	5.5 - 34.4	19.2	708	144.1
9	Wind R.	65° 44.692" N 135° 09.102" W	wS	15.2	5.7 - 31.1	17.3	865	142.8
10	Peel R.	65° 57.579" N 134° 31.713" W	wS	18.6	7.6 - 37.5	20.6	1164	290.5
11	Snake R.	65° 58.291" N 133° 52.956" W	wS	20.4	5.7 - 41.4	20.4	850	295
12	Bonnet Plume R.	65° 33.585" N 134° 54.363" W	wS	14.1	5.2 - 32.2	15.7	2045	275.7
13	Hart R.	65° 45.677" N 136° 19.313" W	wS	18.9	5.3 - 41.9	23.7	943	277.1
		averages		**17.6**		**19.5**		**243.2**

[1] White spruce

[2] diameter at breast height (1.3 m)

[3] A height/diameter curve was developed from the 102 tree heights taken in the 13 plots. The heights and diameters were then applied to the "Whole stem Cubic Metre Volume Equations" for northern white spruce. British Columbia Forest Service 1976.

Map 2. Plot locations in northwest (Porcupine River) section of northern survey



Map 3. Plot locations in southeast (Peel River) section of northern survey

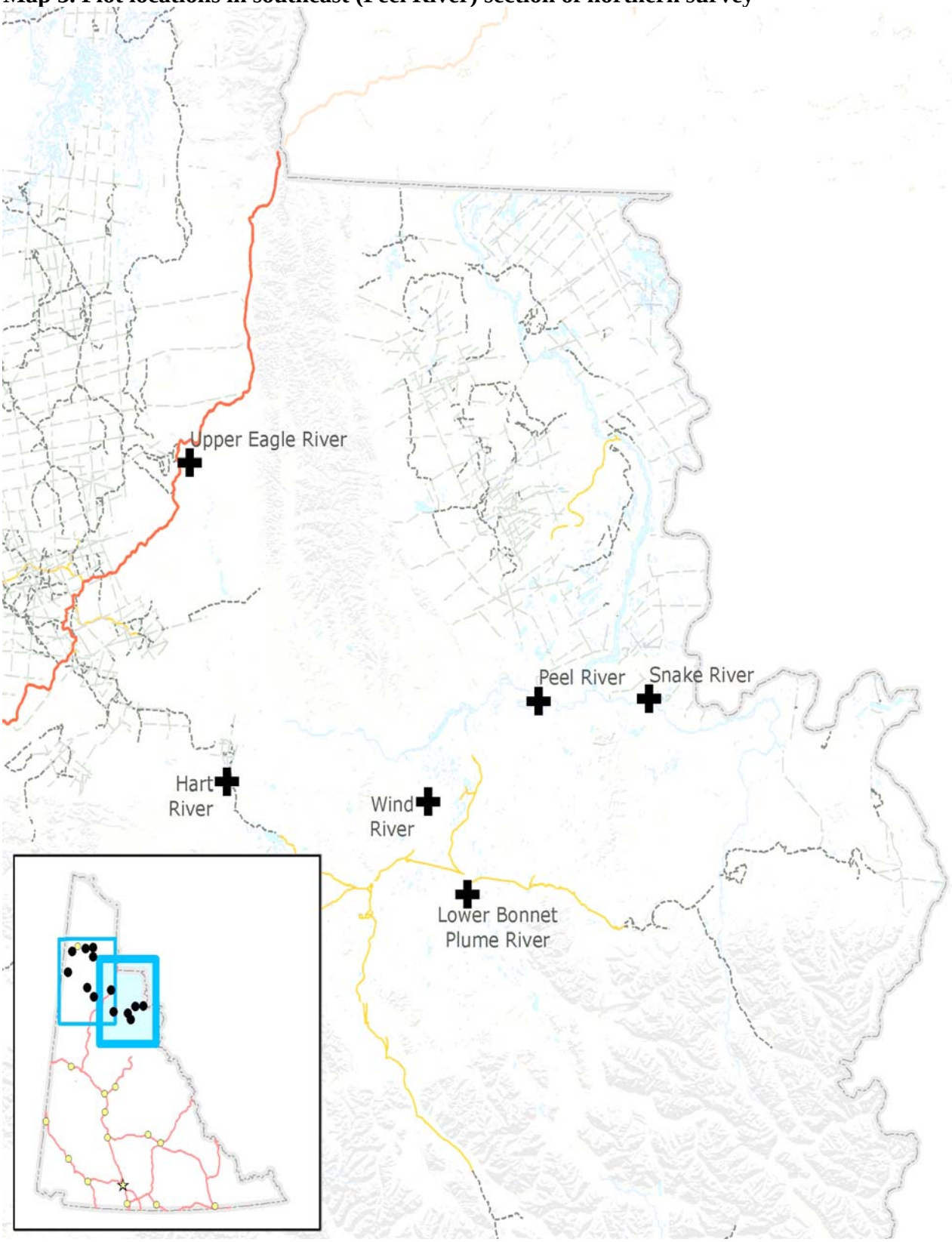


Table 4. Herbs, shrubs and regeneration in 13 northern plots

Plot #	Common herbaceous groundcover (incl mosses, lichens, horsetails etc)	Dwarf shrubs	Major shrubs	Spruce regen (<5 cm dbh) stems/ha	Remarks
1	Equisetum sp., Geocaulon lividum Pyrola secunda	Acrtostaphylos rubra	Salix sp., Juniperus Potentilla fruticosa	634	15 Salix sp. >5 cm dbh
2	Equisetum sp., Acontium delphinii- folium, Monesis uniflora	Empetrum nigrum	Rosa acicularis, Salix sp., Alnus spp.	2315	many Alnus crispa crispa and many smaller A.crispa sinuata
3	Pleurozium schreberi, Peltigera sp Epilobium angustifolium	Linnaea borealis	R. acicularis	910	deep moss covers forest floor
4	P. secunda, P. schreberi Peltigera sp.	Vaccinniun sp.	R. acicularis	190	60% moss cover
5	Lupinus arcticus, P. schreberi P. secunda, M. uniflora		R. acicularis Alnus sp.	952	
6	P. secunda, grass (prob. Poa sp)		R. acicularis Alnus sp., Ribes oxyacanthoides	298	regeneration clumped
7	Pyrola asarifolia, P. secunda, M. uniflora, L. arcticus, Equisetum scirp- oides, Equisetum sp., Cypripedium sp.	A. rubra	R. acicularis Alnus sp.	318	regeneration clumped
8	Mertensia paniculata, P. schreberi	L. secunda	Shepherdia canadensis R. acicularis, Salix sp.	550	14 dead standing Larix laricina killed in mid 1990s by Pristiph- ora erichsonii. Regen clumped
9	P. secunda, G. lividum, P. schreberi Achillea millefolium	L. secunda	S. canadensis, Salix sp Juniperus communis P. fruticosa, R acicularis	943	regeneration well spaced
10	Equisetum sp., P. secunda, P asarifolia P. schreberi, M uniflora		Alnus spp., R. acicularis Cornus stolonifera	64	very dense Equisetum
11	Equisetum sp., P. secunda, P asarifolia P schreberi, M uniflora,		alnus sp. Ribes oxy- acanthoides	0	recently flooded, carpeted with Equisetum
12	Cladina sp., L. arcticus, G. lividum Zygadenus elegans, P. schreberi	Arctostaphylos uva-ursi A. rubra	R. acicularis, S. cana- densis, J. communis	1494	three dead Larix laricina. Prob. from P. erichsonii
13	M. paniculata, Pyrola sp, L. arcticus M. uniflora, Galium boreale	A. rubra, L. secunda	Ribes sp. J. communis R. acaularis	755	