AN INVENTORY OF FOREST RESOURCES

NABESNA & CHITINA DISTRICTS
WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE

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ABSTRACT

As a pilot forest resource assessment project, three forest strata and three timber stands were inventoried along the Nabesna Road in Wrangell-St. Elias National Park and Preserve during the 1986 field season. Silvicultural parameters such as gross volume, current annual productivity, density, mortality, regeneration and species composition were determined. Relatively high elevation for an interior Alaskan forest and the widespread presence of discontinuous permafrost are major factors contributing to the very low current annual productivity found throughout the area.

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INTRODUCTION

In Wrangell-St. Elias National Park and Preserve (WRST) there is a continuing demand for the subsistence use of forest resources. Most requests are for green timber to be used as firewood and house logs. The disposal and development of state, native and private lands in or on the borders of the park/preserve is expected to increase the number of residents in the area and thus the demand for forest resources. The Alaska National Interest Lands Conservation Act (ANILCA) permits the cutting and gathering of trees for subsistence purposes if such use is compatible with the purposes for which the park and preserve were established (36 CFR 13.49, RMP, 1984). As mandated, forest management in WRST will therefore "... provide for the continued subsistence harvest of green trees in a manner which does not cause unacceptable environmental impacts or impair the productivity of forested stands" (RMP, 1983). The WRST Natural and Cultural Resource Management Plan (RMP, 1984) identified the Forest Products Management Program (proposal number N-15) as a project requiring immediate attention. An initial inventory of forest resources along the Nabesna Road is reported here.

Existing estimates of forest resources within WRST are based on incomplete forest surveys and extrapolated averages (Final Environmental Statement, WRST, 1973). Although literature about interior Alaskan timber types is available, much of it has an emphasis on commercial logging operations rather than one of sustained yield management or the use of timber for subsistence purposes. Very little has been published about the WRST area or about timber at elevations typical within the park/preserve. In 1975, Karl M. Hegg published a paper for the U. S. Forest Service entitled "Timber Resource Statistics for the Copper River Inventory Unit, Alaska 1968". In the study, he interpreted 7,201 photo points and checked timber at 166 ground locations on over 2 million acres of land. Although relatively close in proximity to WRST, Hegg's study focuses on timber stands that are lower in elevation than WRST timbered lands and evaluates them in terms of their feasibility for commercial use. Thus, the effects of continued timber cutting for subsistence purposes and the levels at which harvest can be sustained, if it can, in forests of this region and elevation is largely unknown. Overharvest could inadvertently be authorized under current management policy without locally specific and accurate estimates of the availability, volume and productivity of forest resources, particularly in areas of high subsistence activity (RMP, 1983).

The Nabesna Road area was chosen as the initial timber inventory area because of its history of and continued use as a source of subsistence house logs and firewood. In addition, ease of access made the Nabesna area the most logistically feasible choice. After an initial investigation of the efficiency and appropriateness of

various timber inventory methodologies, the Bitterlich Variable Probability technique was selected.

The Nabesna forest resources inventory area was separated into three broad vegetation types, or timber strata, after factors such as aerial photography limitations, field season constraints and data analysis requirements were considered. During the initial inventory of timber strata, several discrete timber stands were identified as experiencing the majority of timber harvesting activities and of having high concentrations of house log sized trees. It was deemed beneficial to sample more intensively in these stands in order to provide specific information about annual productivity, gross volume and size class distributions in areas where most timber harvesting has and continues to occur.

Familiarity with forest resources of a region, as well as of specific timber stand conditions is essential in designing a forest resource inventory of that area. Anticipating a future need for timber information in the Chitina District, a one week, non-systematic inventory was conducted along the McCarthy Road near the end of the field season. This preliminary data will assist in planning future forest inventories in the area, as well as provide interim forest resource information as needed for other land use and management issues.

The results and discussion of this inventory are accompanied by guidelines for the issuance of green wood permits and recommendations for subsequent forest resource inventories.

METHODS

Nabesna Inventory

The Nabesna Road inventory area included accessible areas of green timber within a one half mile corridor on either side of the Nabesna Road and along the major trails (Figure 1). The total area surveyed was delineated on 1:60,000 scale CIR aerial photograph overlays. Timbered vegetation within these areas were differentiated into three strata: closed coniferous (approx. 2390 acres), open coniferous (approx. 13,240 acres) and mixed coniferous/deciduous (approx. 440 acres). Those stands with 60% or more canopy cover were classified as closed coniferous, whereas stands with less than 60% canopy cover were classified as open coniferous. Open and closed timber stands with deciduous and coniferous trees were classified as the mixed strata (Viereck, et. al., 1986). Sample plots were randomly selected using a random numbers table and were located with a dot grid on photo overlays (Figure 2). Proportional allocation for stratified random sampling (Freese,1986) was used to determine sample size for each strata. Variance estimates of timber volume obtained from an

initial sampling of at least 19 plots within each strata and an 80% confidence interval were used in the allocation equation.

In addition to collecting general information in the three timber strata, three accessible stands of timber experiencing high levels of current houseog and firewood harvest were sampled separately. Site specific information was obtained at the following locations along the Nabesna Road (Figure 1): Bazulnetas (320 acres), Mile 20 (160 acres) and Lost Creek/Trail Creek (660 acres). Hereafter these locations are referred to as "stands" to distinguish them from the timber strata. Plots within the stands were located on CIR aerial photographs 0.20 mile apart.

The Bitterlich method of variable plot cruising was used in both phases of the inventory (Finlayson; and Dilworth and Bell, 1984). A Bitterlich Spiegel Relaskop with a basal area factor (BAF) of 22.05 was used to determine which trees were to be included in the plot. Species, diameter at breast height (DBH), tree height, crown ratio, crown class and damage class were recorded for each tree. All trees less than four inches DBH, but greater than one inch DBH were classified as saplings. The same information was recorded for saplings, with the exception of age and ten year increment. Information collected on seedlings (trees less than one inch DBH) included species, height, crown ratio, crown class and damage class.

To estimate stand age, a minimum of two dominant and/or co-dominant trees were cored at breast height at each plot. More trees were cored at plots with a large number of trees in order to account for species composition and differing size classes (Pers. comm., F. Larsen). Total age at breast height and the width of the most recent ten year increment were recorded for all trees cored. Bark thickness was also recorded for trees cored in the three timber stands and in the McCarthy inventory.

Percent slope, elevation, aspect, drainage, understory vegetation species and vegetation type (Viereck, 1986) were recorded at each sample site. Vascular plant nomenclature follows Hulten (1968). The list of understory species most frequently found in each strata and stand is ordered with respect to descending frequency of field plot observations. Two photographs were taken of each plot center, the first towards the north and the second towards the south. A sample plot sheet is included in Appendix 21.

McCarthy Inventory

Twenty-five sites along the McCarthy Road corridor were sampled. Data from this inventory is site specific and is not used to estimate volume and productivity for the McCarthy area.

Data Evaluation

Gross volume estimates were determined for each forest type by species using V-Bar (tree volume to basal area ratios) and mean basal area values (Dilworth and Bell, 1984) and the volume equations of Haack (1963) for trees of interior Alaska. Current productivity was estimated according to the method of Hush, et al. (1972) using the current ten year increment to estimate timber volume per acre in ten years. Volume and current annual productivity estimates exclude the volume of the tree bark, which was computed with bark thickness information collected in the three timber stands (i.e. DIB, diameter inside bark). DBH size class distributions and the density of live and dead trees, saplings and seedlings within each forest type were also obtained.

RESULTS

All sample plots are plotted on the 1:63,360 scale topographic maps accompanying this report. The original plot sheets, which include site specific comments and vascular plant species lists, are on file in the WRST Resource Management office. Photographs of each sample plot have been placed in a separate binder. McCarthy inventory stand descriptions, gross volume estimates, tree ages and seedling, sapling and dead tree counts are located in Appendices 14 - 19.

Gross Live Volume

The gross live volume of the closed strata (3129.35 cubic feet per acre) was greater than the gross volume of both the open strata (610.85 cubic feet per acre) and the mixed strata (2255.18 cubic feet per acre), (Table 1).

White spruce (*Picea glauca*) was the major timber constituent of both the closed and open strata, comprising 86.5% of the total open strata gross volume and 95.7% of the total closed strata volume. The remaining gross volume in both strata was contributed by black spruce (*Picea mariana*).

Quaking aspen (*Populus tremuloides*) and white spruce contributed the greatest gross live volume to the mixed strata, 43.3% and 37.3%, respectively. Balsam poplar (*Populus balsamifera*), paper birch (*Betula papyrifera*) and black spruce constituted the remaining volume.

The Batzulnetas, Mile 20, and Lost Creek/Trail Creek timber stands had similar gross live volume values. Mile 20 had the greatest gross volume (5633.66 cubic feet per acre). The estimated gross volume was 3926.31 cubic feet per acre at Batzulnetas and 2927.30 cubic feet per acre at Lost Creek/Trail Creek. The gross live volumes of the three timber stands were most similar to the gross volume

of the closed strata.

Within the Batzulnetas stand, 95.9% of the gross live volume was contributed by white spruce. Black spruce, quaking aspen and black cottonwood constituted the remaining gross volume of this stand. White spruce comprised the entire gross volume at Lost Creek/Trail Creek and at Mile 20.

Volume and Density of Dead Trees

The volume of dead trees was lowest in the open strata (29.95 cubic feet per acre). The dead tree density of the open strata was also relatively low (20.85 trees per acre) but the percentage of gross volume was similar to the other timber stands (4.7%) (Table 2). Dead tree volume in the closed strata was highest with 216.98 cubic feet per acre. Dead tree volumes ranged from 130.22 cubic feet per acre at Mile 20 to 282.65 cubic feet per acre at Batzulnetas. Mile 20 had the lowest density (17.26 dead trees per acre) and the lowest percentage of total volume (2.3%). Batzulnetas had the greatest density of trees (103.31 dead trees per acre) and the greatest percentage of total volume (6.7%).

Current Annual Productivity

Current annual productivity was similar for the closed and mixed strata (20.12 cubic feet per acre and 21.80 cubic feet per acre, respectively) and for Batzulnetas and Mile 20 (27.32 cubic feet per acre and 26.71 cubic feet per acre, respectively), (Table 3). Current annual productivity was reduced in the open strata (3.33 cubic feet per acre) and at Trail Creek/Lost Creek (12.51 cubic feet per acre).

Maximum current annual productivity was attained in the seven inch DBH size class at Batzulnetas, in the nine inch DBH size class in the open and mixed strata and in the eleven inch DBH size class in the closed strata, at Mile 20 and at Lost Creek/Trail Creek. For all strata and stands, current annual productivity decreased with increasing size classes after maximum productivity was realized.

Table 1. Gross volume inside bark by tree species for the timber strata and timber stands measured along the Nabesna Road. Estimates are for live trees.

Timber Type	Total Stand Volume	white spruce	black spruce	quaking aspen	balsam poplar	paper birch	
	GROSS LIVE VOLUME INSIDE BARK (cubic feet per acre)* (% of TOTAL VOLUME)						
Open	610.85	528.23	81.64	------	------	-----	
(86.5)	(13.4)	------	------	-----			
Closed	3129.35	2995.69	136.75	------	------	-----	
(95.7)	(04.3)	------	------	-----			
Mixed	2255.18	840.29	220.33	976.92	167.12	54.52	
		(37.3)	(09.8)	(43.3)	(07.4)	(02.4)	
Batzul-	3926.31	3763.40	44.94	70.31	43.39	-----	netas
(95.9)	(01.1)	(01.8)	(01.1)	-----			
Mile 20	5633.66	5633.66	------	------	------	-----	
(100.00)	------	------	------	-----			
Lost Cr/	2927.30	2927.30	------	------	------	-----Trail Cr	
(100.00)	------	------	------	-----			

* Confidence limits, ranges and percent standard error for V-Bar and basal areas values used to compute these gross live volume values are listed in Appendices 1 through 4. Gross live volume was estimated using the volume equations of Haack (1963).

Size Class Distribution and Density of Live Trees

The lowest live tree density occurred in the open strata (277.31 trees per acre), (Table 4). Density was similar for the closed strata (729.80 trees per acre) and the mixed strata (650.62 trees per acre). Maximum timber density of any strata or stand was at Batzulnetas (810.14 trees per acre). Mile 20 and Lost Creek/Trail Creek had similar densities of trees (516.87 and 435.05 trees per acre respectively). The maximum density for the open, closed and mixed strata was in the five inch DBH size class. Over 50% of all trees measured in each of the three strata were in this size class. Of the trees at Batzulnetas, 88.2 % were in DBH size classes five through nine with 44.9% of the trees in the five inch DBH size class. Trees in DBH size classes seven through eleven comprised 71.5% of the total number of trees at Mile 20 and 60.6% of the trees at Lost Creek/Trail Creek. Density of live trees by species for the three strata and stands is displayed in Appendix 13.

Age Class Distribution

Average tree ages in the closed strata ranged from 111.2 years in the seven inch DBH class to 198.0 years in the fifteen inch DBH class (Table 5). The closed strata had the oldest average strata age (125.4 years) even though the open strata had the oldest average aged trees in DBH size classes seven through fifteen inches. Tree ages in the open strata ranged from an average of 95.4 years for the trees in the five inch DBH class to 357.0
years for trees in the fifteen inch DBH class. Average stand age was youngest in the mixed strata (77.23 years). Tree ages in the mixed strata ranged from 72.7 years for trees in the five inch DBH size class to 130.4 years for trees in the thirteen inch DBH size class.

Table 2. Volume and density of dead trees for the three timber strata and three timber stands measured along the Nabesna Road.

DENSITY AND VOLUME OF DEAD TREES
(percentage of dead trees within the total volume or density of dead and live trees)

	Volume of Dead Trees (cu. ft./acre)*	Density of Dead Trees (trees/acre)
Open	29.95	20.85
	(4.7)	(7.0)
Closed	216.98	23.03
	(6.5)	(3.1)
Mixed	66.25	43.43
	(2.9)	(6.3)
Batzulnetas	282.65	103.31
	(6.7)	(11.3)
Mile 20	130.22	17.26
	(2.3)	(3.2)
Lost Creek/ Trail Creek	189.92	45.72
	(6.1)	(9.5)

* Confidence limits, ranges, and percent standard error for V-Bar and basal area values used to compute the dead tree volume values are listed in Appendices 1 through 4. Volume was estimated using the volume equations of Haack (1963).

Table 3. Current annual productivity inside bark by DBH class for the three timber strata and three timber stands measured along the Nabesna Road. Complete stock tables derived to estimate productivity are displayed in Appendices 7 - 12 (Hush, et. at., 1972). The ten year increment was used to determine current annual productivity.

	CURRENT ANNUAL VOLUME PRODUCTION (cubic feet per acre per year)					
DBH Class* (in.)	Open	Closed	Mixed	Batzul-netas	Mile 20	Lost Creek/ Trail Creek
5	0.49	2.09	2.14	3.27	0.26	0.30
7	0.69	4.19	4.98	6.95	3.20	1.26
9	1.04	3.32	7.09	6.70	5.00	2.96
11	0.66	4.87	4.37	4.23	8.06	3.74
13	0.43	1.76	1.28	3.32	6.06	1.86
15	0.02	1.50	0.95	1.50	2.80	1.62
17	0.00	1.37	0.72	0.60	0.66	0.54
19	0.00	0.78	0.21	0.54	0.67	0.23
21	0.00	0.24	0.06	0.21	0.00	0.00
Total:	3.33	20.12	21.80	27.32	26.71	12.51
Cords**	0.04	0.25	0.27	0.34	0.33	0.16

* DBH Class: Diameter outside bark (DOB) midpoint values of class; (e.g., DBH class 5 includes values from 4.0 inches to 5.9 inches).

** A cord of wood equals 80 cubic feet.

Table 4. Size class distribution and density of live trees for the three timber strata and three timber stands measured along the Nabesna Road.

DBH Size Class* (in.)	DENSITY OF LIVE TREES (trees per acre) (percent in size class) Open	Closed	Mixed	Batzul-netas	Mile 20	Lost Creek/ Trail Creek
5	158.21	379.71	346.24	363.56	32.32	107.72
	(57.0)	(52.1)	(53.2)	(44.9)	(06.2)	(24.8)
7	61.84	173.15	149.20	230.17	137.42	91.61
	(22.3)	(23.7)	(22.9)	(28.4)	(26.6)	(21.0)
9	35.34	72.34	102.16	120.57	123.06	88.69
	(12.7)	(09.9)	(15.6)	(14.9)	(23.8)	(20.4)
11	16.00	58.43	34.98	51.48	109.07	83.48
	(05.8)	(08.0)	(05.4)	(06.4)	(21.1)	(19.2)
13	4.98	19.13	10.25	27.88	81.29	38.52
	(01.8)	(02.6)	(01.6)	(03.3)	(15.7)	(08.9)
15	0.75	14.37	4.48	10.48	25.14	16.96
	(00.3)	(02.0)	(00.7)	(01.3)	(04.9)	(03.9)
17	0.00	8.39	2.00	3.50	5.59	6.21
	(00.0)	(01.1)	(00.3)	(00.4)	(01.1)	(01.4)
19	0.00	3.36	1.07	1.86	2.98	1.86
	(00.0)	(00.5)	(00.2)	(00.2)	(00.6)	(0.4)
21	0.19	0.92	0.44	0.64	0.00	0.00
	(00.1)	(00.1)	(00.1)	(00.1)	(00.0)	(0.0)
Total:	277.31	729.80	650.62	810.14	516.87	435.05

* DBH class: Diameter outside bark (DOB) midpoint values of class; (e.g., DBH class 5 includes trees from 4.0 inches to 5.9 inches DBH).

Lost Creek/Trail Creek had the oldest average stand age (186.1 years) of the three timber stands and the three strata. Average tree ages at Trail Creek/Lost Creek ranged from 158.1 years for trees in the nine inch DBH class, to 307.5 years for trees in the seventeen inch DBH class. The average stand age of Batzulnetas indicated that it was the youngest of the three stands (111.2 years). Batzulnetas also had the youngest aged trees in all DBH classes within the three stands. Average tree ages at Batzulnetas ranged from 97.8 years for the five inch DBH class to 201.5 years for the fifteen inch DBH class. The age distribution by diameter size class of the trees at Bazulnetas was similar to the distribution of the closed strata. The average tree age at Mile 20 ranged from 137.7 years for the seven inch DBH class to 291.0 years for the seventeen inch DBH class.

Seedling and Sapling Density

Lost Creek/Trail Creek had the fewest number of seedlings per acre (75.82) of all strata and stands (Table 6). The number of seedlings per acre was more similar for the other strata and stands ranging from 236.38 seedlings per acre at Mile 20 to 539.66 seedlings per acre in the open strata.

The number of saplings per acre was relatively low at both Lost Creek/Trail Creek (26.76) and at Mile 20 (31.22). The range for the remaining strata and stands was 223.00 saplings per acre for the closed strata and Batzulnetas, to 593.18 saplings per acre in the mixed strata. The mixed strata was the only strata or stand with a higher density of saplings then seedlings.

Table 5. Average age by DBH class for the three timber strata and three timber stands measured along the Nabesna Road.

DBH Class* (in.)	AVERAGE AGE (Years) (number of trees cored) Open	Closed	Mixed	Batzul-netas	Mile 20	Lost Creek/ Trail Creek
5	95.4 (23)	127.1 (8)	72.7 (10)	97.8 (4)	-----	170.0 (2)
7	147.4 (20)	111.2 (9)	77.8 (11)	102.3 (9)	137.7 (3)	171.0 (6)
9	146.3 (16)	120.6 (8)	85.2 (13)	126.3 (26)	162.1 (7)	158.1 (12)
11	179.3 (5)	121.4 (8)	76.1 (7)	153.8 (17)	160.1 (16)	198.4 (16)
13	160.0 (2)	157.2 (9)	130.4 (5)	166.4 (13)	225.5 (18)	266.4 (8)
15	327.0 (1)	198.0 (7)	101.0 (2)	201.5 (4)	224.4 (7)	219.5 (4)
17	-----	190.0 (4)	90.7 (3)	196.0 (3)	291.0 (1)	307.5 (2)
19	-----	178.0 (1)	-----	170.0 (2)	162.0 (2)	260.0 (1)
21	-----	151.0 (1)	163.0 (1)	-----	-----	-----
Ave. stand or strata age: (n=)	120.2 (73)	125.4 (56)	77.2 (51)	111.2 (78)	166.5 (54)	186.1 (51)

* DBH Class: Diameter outside bark (DOB) midpoint values of class (e.g., DBH class 5 includes trees from 4.0 to 5.9 inches DBH).

Table 6. Density of seedlings and saplings for the three timber strata and three timber stands measured along the Nabesna Road.

	Seedlings per acre*	Saplings per acre*
Open	539.66	374.64
Closed	245.30	223.00
Mixed	383.56	593.18
Batzulnetas	539.66	223.00
Mile 20	236.38	31.22
Lost Creek/Trail Creek	75.82	26.76

*These values are provided by species in Appendices 5 and 6.

DISCUSSION

The discussion section of the Nabesna Timber Resources Survey is organized such that results and observations of each strata and stand are detailed in separate, comprehensive profiles.

Open Strata

The open coniferous strata encompasses approximately 13,240 acres of timbered land, or roughly 82 % of the Nabesna timber resources study area. Nearly all plots are located in extensive stands of timber hundreds of acres in size. Although a sizable number of all open strata plots have less than 25 % canopy coverage and thus are more accurately classified as coniferous woodlands (Viereck, 1986), all coniferous plots with less than 60 % canopy coverage are collectively treated as the open strata.

Ranging from 2250 to 3500 feet in elevation, open strata plots average 2400 feet in elevation. A gradual mean slope of 3 % was observed. There is no dominant aspect, as open strata plots are not primarily oriented in any one direction. Overall, ground substrate drainage conditions for the open strata were determined to be "somewhat poorly drained" (U.S. Forest Service, PNW Res. Sta. and AK. DNR, 1983; Appendix 20).

Slightly less than half of all open strata plots surveyed are composed entirely of white spruce, while a nearly equal proportion are purely black spruce. A small number of plots have a mixture of white and black spruce trees. Understory plant species most frequently found in the open strata include moss species, alpine blueberry (*Vaccinium uliginosum*), low bush cranberry (*Vaccinium vitis-idaea*), Labrador tea (*Ledum palustre*), willow (*Salix* sp.), crowberry (*Empetrum nigrum*), sedge (*Carex* sp.), dwarf birch (*Betula nana*), lichen species, red bearberry (*Arctastaphalos rubra*), graminoid species, Labrador lousewort (*Pedicularis labradorica*) and arctic lupine (*Lupinus arcticus*). Fifty four plant species were observed in the open strata.

Gross live volume (610.85 cubic feet per acre) and gross current annual productivity (3.33 cubic feet, or 1/25 of a cord of wood per acre per year) are very low in the open strata. A timber stand with less than 800 cubic feet of timber per acre and less than 20 cubic feet per acre per year, such as the Nabesna open strata, is classified as a non-commercial timber stand in Alaska (Hegg, 1967). Other studies assert that among timbered Alaskan vegetation types, the black spruce type has the lowest tree productivity, lowest overstory biomass, lowest forest floor temperatures (low soil temperatures), highest soil moisture content, lowest forest floor decomposition rates

and lowest nutrient cycling rates (Zasada et al., 1977; Van Cleve et al., 1983; Viereck et al., 1983). Ubiquitous throughout the open strata, is a thick, ground-insulating moss organic layer. Van Cleve et al. (1983) reports annual productivity of moss in the black spruce type to be three times that of the annual tree foliage production. Zasada et al. (1977) states that the nutrient content of the forest floor appears high enough to support a more productive ecosystem. However, controls specific to the black spruce vegetation type (eg. reduced decomposer activity caused by low soil temperatures and luxuriant growth of the feather mosses which compete with spruce for nutrients) restrict the portion of the available nutrient pool which can be utilized by spruce. Low annual productivity, presence of a thick moss organic layer and the open nature of timber are indicative of a shallow active permafrost layer in the open strata (Zasada et al., 1977). Because of cold soils and permafrost, trees of taiga forests are shallow rooted. Viereck et al. (1983) reports that in black spruce, there is a mean rooting depth range of 6.3 inches in the poorest sites, to 20.1 inches in the best sites.

Density of live trees in the open strata is very low, with 277.31 trees per acre. Of the total density of live trees, 92.3 % are included in the three smallest DBH size classes (five, seven and nine inch). Estimations of average age within individual DBH size classes range from 95.4 years in the five inch DBH class, to 179.3 years in the eleven inch DBH class. One white spruce surveyed in the fifteen inch size DBH class was determined to be 357 years of age at breast height. Three trees bored in the sapling size class had an average age of 68.3 years. The average estimated age of trees in the open strata is 120.21 years, similar to that of the closed strata.

The estimated density and volume of dead trees in the open strata is 20.85 dead trees per acre and 29.95 cubic feet per acre, respectively. These figures indicate that trees in the open strata generally have a low volume when they die. Of the combined density of both live and dead trees, approximately 7.0 % are dead.

Although regeneration in the open strata is generally abundant (539.66 seedlings per acre and 374.64 saplings per acre), it is more illustrative to analyze regeneration within black and white spruce stands of the open strata separately. Among open strata white spruce plots, 304.1 seedlings per acre and 202.7 saplings per acre were observed (Appendices 5 and 6). In comparison, black spruce plots within the open strata have 658.4 seedlings per acre and 552.2 saplings per acre, more than twice as much regeneration as that within white spruce plots. Most of these black spruce seedlings originated by a prolific form of asexual propagation common in black spruce known as layering. Layered seedlings are produced when low, moss covered tree branches sprout adventitious roots. These seedlings are not as vigorous as seed produced seedlings however, and often occur in poorly distributed clumps (Heinselman, 1957).

As permitted by ANILCA, dead trees scattered in accessible open strata areas are commonly harvested for firewood. Live timber in the majority of the open strata, however, is not harvested for firewood or houselogs, except for occasional trees immediately adjacent to the Nabesna Road. One open strata plot surveyed had evidence of extensive timber harvest, although it was noted that prior to cutting, the stand probably had a closed canopy. In addition, some timber stands in the vicinity of Lost Creek, Trail Creek, and Jack Creek have a relatively large volume of timber despite the presence of an open canopy. Timber harvest was observed in these areas.

Closed Strata

The closed coniferous strata includes approximately 2,390 acres of land, or roughly 15 % of the Nabesna forest resources study area. Stands of trees with closed canopies range in size from one to several clustered acres, to stands like Batzulnetas and Mile 20, which are considerably larger. Ranging from 2300 to 3200 feet, elevation of the closed strata averages 2750 feet. A very gradual average slope of 2 % was observed. The steepest plot slope encountered was 7 %. Aspect averages southwest, although approximately half of all plots surveyed have no discernable aspect or are situated on slightly undulating terrain. Ground substrate drainage conditions range from "somewhat poorly drained" to "moderately well drained" (U.S. Forest Service, PNW Res. Sta. and AK. DNR, 1983; Appendix 20).

The majority of plots surveyed in the closed strata are composed entirely of white spruce, although several contain a small percentage of black spruce. Two plots surveyed consist entirely of black spruce. Timber canopies range from 60 % to nearly 100 % closure. Despite an estimated average canopy closure between 60 % and 70 %, closed strata timber can be considered well stocked (Farr, 1967). Stocking as such, refers to the degree of occupancy of land by trees. The number of trees in the stand is compared with the number of trees required to fully utilize the growth potential of the land (Hegg, 1975). Although fully stocked, typically narrow-crowned, Alaskan white spruce may give a stand the appearance of being understocked.

Understory plant species most commonly found in the closed strata include: moss species, lichen species, low bush cranberry (*Vaccinium vitis-idaea*), crowberry (*Empetrum nigrum*), Labrador tea (*Ledum palustre*), willow (*Salix* sp.), arctic lupine (*Lupinus arcticus*), sweet vetch (*Hedysarum alpinum*), sedge (*Carex* sp.), horsetails (*Equisetum* sp.), alpine blueberry (*Vaccinium uliginosum*), red bearberry (*Arctastaphlos rubra*) and graminoid species.

A thick, ground-insulating moss organic layer is present in the vast majority of plots surveyed in the closed strata. High latitude

forests such as this one, have a significantly greater percentage of total forest biomass represented by the moss organic layer than similar forests farther south (Zasada, 1976). The ground-temperature insulating moss organic layer becomes increasingly thicker with greater stand age, resulting in a decrease of the soil temperature regime. Also reducing soil temperature is the degree to which tree and shrub canopy coverage limits the amount of radiant heat reaching the ground. Soil temperature reduction eventually leads to permafrost development and a subsequent decrease in the depth of the active permafrost layer (Zasada et al., 1977). The active permafrost layer refers to the depth to which the ground thaws in the summer. Soil water content is increased as the moss organic layer interferes with evaporation. In addition, high permafrost levels impede soil water drainage, which further augments the formation of permafrost. Permafrost development ultimately decreases site quality and hence productivity (Zasada et al., 1977). As a result, the later stages of some forest types such as floodplain white spruce and black spruce decline in timber biomass and eventually evolve towards a non-forested bog (Zasada et al., 1977).

The two most important environmental factors that can reverse these general trends are fire and flooding. Fire destroys the timber overstory, releases significant quantities of nutrients, decreases the moss organic layer thickness, increases soil temperatures and increases the thickness of the active permafrost layer. The varying degrees to which these effects are produced is dependant upon the size and the intensity of the fire. Without necessarily destroying the overstory, flooding deposits silt, releases soil nutrients and most importantly, reduces the moss organic layer which depresses soil temperature (Zasada et al., 1977). The most productive stands of white spruce are found along well-drained riverbottoms and good alluvial sites (Huchison, 1967). Flooding, and therefore proximity to a creek which may flood intermittently is an critical factor in maintaining the existence and growth of relatively productive, closed canopy timber stands. Although usually much closer in proximity, most plots surveyed in the closed strata are within one half mile of several major creeks in the area including: Tanada Creek, the Copper River, Caribou Creek, Trail Creek, Lost Creek and Jack Creek. Some plots surveyed have evidence of recent flooding and thus, are apparently experiencing maintenance of relatively high site quality. Sites undisturbed by periodic flooding or fire, however, may currently be undergoing a gradual decline in site quality and thus, productivity.

In Alaska, a commercial timber stand is defined as having greater than 800 cubic feet per acre of net timber volume and greater than 20 cubic feet per acre per year of net productivity (Hegg, 1967). Timber stands with less than 800 cubic feet per acre of net timber volume and less than 20 cubic feet per acre per year of net productivity are considered non-commercial. Timber stands with high volume (greater than 800 cubic feet per acre) but low annual productivity

(less than 20 cubic feet per acre per year of net productivity) constitute a third category, operable non-commercial. Though marginal, high volume, low productivity timber stands are considered to have "some potential value as a commercial wood supply" (Hegg, 1967).

Commercial stands surveyed in the Copper River Inventory Unit (roughly extending from Chistochina to McCarthy) averaged 1089 cubic feet of net volume per acre. The average elevation of timber stands surveyed in the study was 1000 feet, 500 feet below the 1500 foot elevational limit of commercial tree growth (Hegg, 1975). The average elevation of the Nabesna closed strata (2750 feet) is nearly three times that of the Copper River Inventory Unit and 1250 feet above the 1500 foot elevational limit of commercial tree growth for interior Alaska. By comparison, the average estimated gross volume of timber in the closed strata (3129.35 cubic feet per acre) is much higher than the Copper River Inventory Unit figure for net volume because volume for timber defect and disease was not deducted in the closed strata. Calculated with gross volume figures, current annual productivity in the closed strata exceeds the 20.00 cubic feet per acre per year net productivity requirement for Alaskan commercial stands by only 0.17 cubic feet per acre per year (the closed stand produces approximately 1/4 of a cord of wood per acre per year). It can be extrapolated that if volume attributed to defect and disease were deducted from gross volume prior to productivity calculations, net volume and therefore current productivity would be lower than that of the Copper River Inventory Unit. Because net volume and productivity figures would also be lower than commercial Alaskan timber stand requirements, the Nabesna closed strata would be categorized as either an operable non-commercial or a non-commercial Alaskan timber stand. When compared with the closed strata, the other strata and stands along the Nabesna Road have relatively similar or smaller gross volume and productivity estimates. It is likely that they too would be categorized as either non-commercial or inoperable non-commercial Alaskan timber stands.

Despite the existence of commercial timber stands within the Copper River Inventory Unit, Hegg (1975) states "the greatest potential for this area seems to be in recreation, hunting, and esthetics, with logging activity likely to be only for local use." The limited range of closed timber stands along the Nabesna Road and the improbability that any of these stands truly qualify as commercial stands, indicates that the Nabesna area is even less suited for timber harvesting activities than lands included in the Copper River Inventory Unit.

Live tree density in the closed strata is relatively high with 729.8 trees per acre. Half of this total density is concentrated in the smallest, or five inch DBH size class. Density within each of the seven through thirteen inch DBH size classes is dramatically smaller than the class preceding it. Although numerically low, the density within the thirteen through twenty-one inch DBH size classes is

relatively large in comparison with the other two strata. Average estimated age of trees within individual DBH size classes ranges from 111.2 to 198.0 years for the seven and the fifteen inch DBH size classes, respectively. Likewise, the average estimated age for all timber in the closed strata is 125.4 years, older than that of the other two strata. Accounting for 216.98 cubic feet per acre in volume and 23.03 dead trees per acre, dead trees in the closed strata are relatively large at the time of mortality. Of the combined density of both live and dead trees, approximately 3.1 % are dead in the closed strata.

Seedling and sapling density in the closed strata is low with 245.3 seedlings per acre, and 223.0 saplings per acre. Although 90.9 % of all seedlings and 70.0 % of all saplings are black spruce, black spruce in the overstory only accounts for 17.2 % of the total tree composition (Appendices 5 and 6). The difference in proportions between the black spruce overstory and regeneration densities may either be caused by low survival rates of black spruce seedlings and saplings or a gradual site quality deterioration trend resulting from a decreasing active permafrost layer. Black spruce seedlings can successfully outcompete white spruce seedlings as a result of a higher tolerance of poor site quality (Heinzelman, 1957).

Evidence of timber harvest was occasionally observed in closed strata plots. Most logging, past and present occurs in the vicinity of the Batzulnetas, Mile 20 and Lost Creek/Trail Creek stands; all are discussed in detail in subsequent parts of this paper.

Mixed Strata

The mixed coniferous/deciduous strata is estimated to include approximately 440 acres of timbered land, or roughly 3 % of the Nabesna forest resources study area. When infrared aerial photographs of the Nabesna Road area are viewed, mixed deciduous/coniferous and pure deciduous timber stands appear to be much more prevalent. This occurs because the infrared signature, or appearance, of common deciduous tree species, is very similar to that of widespread tall shrub species such as willow and alder, and smaller shrub species including dwarf birch, alpine blueberry and Labrador tea. Elevation of the mixed timber strata ranges from 2300 to 3200 feet, but averages 2500 feet in elevation. An average slope of 10 % was observed in the mixed strata. If the four plots with paper birch are considered separately, they average 44 % slope, while all the other mixed plots collectively average 3 % slope. Over one quarter of all plots are either located on flat or slightly undulating terrain. The remainder of the plots have an aspect that is predominantly north to east. Overall ground substrate drainage condition were determined to be "moderately well drained" (U.S. Forest Service PNW Res. Sta. and AK. DNR, 1983; Appendix

20).

The majority of mixed stands are isolated patches within much larger open and closed coniferous stands. Interspersed with coniferous trees, the deciduous element of the mixed strata stands may be in the form of dispersed clumps, stringers of deciduous trees or scattered individual deciduous trees. Tree stands of any size, composed entirely of deciduous species are virtually nonexistent. Farr (1967) reports that in general, there is little competition with spruce by hardwoods above 1500 feet in elevation. Within the mixed strata, one third of all plots have a closed canopy while two thirds have an open canopy. Two thirds of mixed strata plots have white spruce as their principal coniferous tree species. Appearing primarily in conjunction with quaking aspen, the remainder of the plots have black spruce as their principal coniferous species. Two thirds of all plots have quaking aspen as their main deciduous component, while mixed plots with paper birch and balsam poplar as the principal deciduous component account for 19 % and 14 % of mixed strata plots, respectively. All paper birch stands are located near the end of the Nabesna Road.

Understory plant species most commonly found in the mixed strata include: low bush cranberry (Vaccinium vitis-idaea), Labrador tea (Ledum palustre), moss species, willow (Salix sp.), alpine blueberry (Vaccinium uliginosum), crowberry (Empetrum nigrum), graminoid species, lichen species, prickly rose (Rosa acicularis), dwarf birch (Betula nana), twinflower (Linnaea borealis), and northern comandra (Geocaulon lividum). Although a moss organic layer is present to varying degrees of thickness in the mixed strata, it is not as dominant a component of the understory vegetation as within the other two strata. Van Cleve et al. (1983) reports an insignificant moss biomass and moss production on hardwood sites.

Gregory and Haack (1967) assert that quaking aspen and birch characteristically invade burnt-over areas, rapidly forming even-aged stands that develop from seed, suckering of aspen roots or sprouting in birch. Aspen either forms pure stands or grows in conjunction with spruce (Hutchison, 1967). Most individual aspen trees within the mixed strata originate asexually from root suckers, explaining the clumped or circular distribution of trees within aspen stands. Under favorable conditions, stocking of young stands is extremely dense, with early growth comparatively rapid and high mortality due to shade intolerance. When uplands regenerate to a spruce/hardwood mixture, the short lived hardwoods initially outgrow shade tolerant spruce, thus maintaining an overstory position. After eighty to ninety years, pathogen susceptible shade intolerant deciduous trees begin to disintegrate while spruce gradually becomes the dominant tree species (Gregory and Haack, 1967; Farr, 1967).

The average estimated age of trees in the mixed strata (77.23 years at breast height) is the youngest of any strata or stand. Average

age within individual DBH size classes ranges from 72.7 years to 130.4 years, for the five and thirteen inch DBH size classes respectively. Deciduous trees range in age from an average of 56.3 years in the seven inch DBH size class to 82.6 years in the nine inch DBH size class.

Density of live trees in the mixed strata is high, with an estimated 650.62 trees per acre. Of the total density of live trees, 91.9 % are included in the smallest three DBH size classes, the five, seven and nine inch. Virtually no deciduous trees occur in size classes larger than the eleven inch DBH size class. Hutchison (1967) states that because of its short life span, aspen does not normally grow to be larger than ten to fourteen inches DBH and usually averages six to eight inches in DBH. Although occasionally observed, spruce trees in the larger DBH size classes are infrequent.

Total gross volume of live trees in the mixed strata is 2255.18 cubic feet per acre, while gross current productivity is estimated to be 21.8 cubic feet per acre per year (or 1/4 of a cord of wood). While it does not have a large gross volume per acre, the mixed strata has a current annual productivity (mean annual increment) which is relatively high when compared to the amount of volume present per acre in the strata. Zasada et al. (1973) states that the highest mean annual increment reports for Alaska are for hardwood stands. The quantity of organic litter, mostly in the form of dead leaves from deciduous trees, was substantially higher than that of the other two strata. Besides higher rates of productivity, nutrient cycling within mixed stands is also high because of the large annual flux of nutrients created by the annual leaf drop (Zasada et al., 1973). Van Cleve et al. (1983) reports that white spruce, birch, aspen and poplar ecosystems show net accumulated above ground tree biomass to be up to six times greater than forest floor biomass (understory and ground surface vegetation and organic material). This condition reflects rapid decomposition of organic matter in response to warmer soil temperatures and a high quality of organic matter.

Volume and density of dead trees within the mixed strata, 66.25 cubic feet per acre and 43.43 dead trees per acre respectively, indicate that most trees were young with relatively low volume when they died. An estimated 6.3 % of the combined density of dead and live trees in the mixed strata are dead.

Seedling and sapling densities in the mixed strata indicate that they are abundant, with an estimated 383.56 seedlings per acre and 593.19 saplings per acre. Of the total population of seedlings surveyed, 27.9 % are deciduous; all of which are balsam poplar. Deciduous species such as quaking aspen, balsam poplar and paper birch, collectively represent 32.3 % of the total population of saplings. Although no larger than the sapling size class, many of the 14.3 % paper birch saplings observed are clumped adult trees unlikely to grow much larger. In mixed stands with adult black spruce, abundant

black spruce seedlings of layered orgin were observed.

Little evidence of logging activity was observed in the mixed strata. Most mixed strata stands are either too small in size, too isolated, or do not have enough trees of sufficient size to make harvesting worthwhile. Larger, more accessible timber stands with higher concentrations of large trees are considered more desirable. Deciduous trees are not suitable for houselogs although they may be occasionally harvested for firewood use. Quaking aspen trees were cut in some of the larger clearcut areas in the Batzulnetas stand, presumably either for firewood or to facilitate access and removal of other trees. Aspen seedlings produced by suckering following the harvest of adult trees are abundant in these areas. It was observed that many of these suckered aspen seedlings have experienced browsing on their leaders by moose.

Batzulnetas Stand

The Batzulnetas timber stand is located south of the Nabesna Road at mile 9.00 and north of Tanada Creek and the Copper River. Two well-developed, frequently used all terrain vehicle trails (Batzulnetas 101 and Batzulnetas 103 trails; WRST Mechanized Trail Survey, 1985) provide access to much of the timber in the stand. The trails eventually terminate at Tanada Creek, approximately two miles from their trailheads. The Batzulnetas stand is estimated to be 120 acres in size. It has an elevation of 2400 feet, a northwest aspect and a gradual, average slope of 2 %. Overall ground substrate drainage conditions range from "somewhat poorly drained" to "moderately well drained" (U.S. Forest Service PNW Res. Sta. and AK. DNR, 1983; Appendix 20). Exposed mineral soil and bedrock outcroppings are infrequent.

The major tree species in the Batzulnetas stand is white spruce, although it includes occasional interspersions of black spruce and to a lesser degree, stringers of quaking aspen and balsam poplar. Understory plant species most commonly found in the stand include: moss species, willow (Salix sp.) low bush cranberry (Vaccinium vitis-idaea), crowberry (Empetrum nigrum), alpine blueberry (Vaccinium uliginosum), bunchberry (Cornus canadensis), Labrador tea (Ledum palustre), arctic lupine (Lupinus arcticus), graminoid species, horsetails (Equisetum sp.), dwarf birch (Betula nana), red bearberry (Arctastaphalos rubra), and prickly rose (Rosa acicularis). Shrub and herb coverage is generally abundant. The ground substrate underlying most of the stand is covered by a thick, insulating moss organic layer. A thick, moss organic layer and dense timber and shrub canopy coverage indicates a likelihood that at least a discontinuous permafrost layer underlies much of the Batzulnetas timber stand (Zasada et al., 1977).

Although the Batzulnetas stand has a nearly equal proportion of areas with open and closed canopies, the stand is perhaps best compared with the closed strata due to similarities between other silvicultural properties. The Batzulnetas stand has a gross live volume (3921.98 cubic feet per acre) which is most similar to that of the closed strata. Its current annual productivity (27.32 cubic feet or one third of a cord of wood per acre per year) however, is 6.59 cubic feet per acre, or 35.8 % higher then that of the closed strata. In comparison, current annual productivity is relatively high for the amount of gross live volume present per acre in the stand.

Live tree density at Batzulnetas is the highest of any stand or strata (810.14 trees per acre). While the majority of the trees at Batzulnetas are in the smallest DBH size classes, there exists a large number of trees in the middle sized DBH classes relative to the closed strata. The density and volume of dead trees in the Batzulnetas stand are 103.31 trees per acre and 282.65 cubic feet per acre, respectively. This indicates a small average volume and diameter when most trees died. Approximately 4.5 times greater than that of the closed strata, the density of dead trees in Batzulnetas is the highest of any strata or stand. As overcrowded trees compete for light and nutrients in a high density timber stand, a higher mortality rate in the smaller DBH size classes can be expected.

Although the size class distribution with respect to age at Batzulnetas is very similar to that of the closed strata, the average stand age for Batzulnetas (111.18 years) is 14.2 years younger than that of the closed strata. Average age within the DBH size classes ranges from 97.8 years for the five inch DBH size class to 201.5 years for the fifteen inch DBH size class. Also the size classes in which tree density is the lowest, the largest three DBH size classes (15 " - 19 ") decrease in average age from 201.5 years to 170.0 years. Perhaps this occurs as isolated sites with optimum growing conditions allow individual trees to reach a larger than average size in a fewer number of years before eventual senescence and death.

While somewhat inconsistent from plot to plot, seedling and sapling densities per acre (539.66 and 223.00, respectively) indicate ample regeneration in the Batzulnetas stand. There is more than twice the seedling density in Batzulnetas than in the closed strata, whereas sapling density at Batzulnetas and the closed strata are identical. Although black spruce comprises only 6.2 % of the overstory density, black spruce seedlings account for 62.0 % of all seedlings and 34.0 % of all saplings (Appendix 5). Most black spruce seedlings and saplings encountered were of layered origin, were clumped and often exhibited poor form. There is a higher percentage of white spruce in the sapling size class (66.0 %) than in the seedling size class (17.4 %). Once established as a seedling or sapling, white spruce is more likely to survive than black spruce. While deciduous tree species account for 20.7 % of all seedlings, no deciduous saplings

were surveyed.

High density, large current annual productivity and volume, higher than average volume and density of dead trees, young age and high regeneration density indicate that Batzulnetas stand is a nearly mature, relatively productive timber stand in the Nabesna area. Houselog sized white spruce trees within the stand are still relatively abundant despite a history of logging.

The Batzulnetas stand has and continues to experience physical disturbance in the form of logging, vegetation damage from access route formation, and accompanying substrate subsidence. Most tree removal is scattered and patchy, although areas exist within the stand where green timber permittees have created small clearcuts; some being several acres in size. A large scale map displaying these areas, and information pertaining to past green timber permit activity in the park is available in the WRST Resource Management office as well as in Appendix 23.

Many clearcut and some select cut areas have numerous, recently established quaking aspen, balsam poplar, and white spruce seedlings and saplings. It is well documented that white spruce regeneration is most successful in the presence of scarified ground and exposed mineral soil (Zasada and Gregory 1969). Such favorable germination conditions are often created by logging activities which abrade, or denude the ground substrate of its moss organic layer. The amount of mineral soil exposed by skid trails may not be very extensive in select cuts or small scale logging operations such as those typically occurring in the park/preserve. Furthermore, the depth of the moss organic layer is thick enough in places that it is unlikely that mineral soil will be exposed as a result of timber harvest operations. Once established, vegetative competition with seedlings by shrubs may cause mortality in white spruce seedlings and saplings. Open, unshaded clearcut conditions are also favorable for the establishment of deciduous tree species. Deciduous seedlings either originate from seeds, sprouting or an often prolific production of suckers by remnant quaking aspen trees. Quaking aspen and balsam poplar seedlings and saplings have a faster growth rate than that of white spruce (Gregory and Haack, 1967). As a result, the Batzulnetas stand may eventually have a higher proportion of deciduous trees in the overstory than the present overstory proportion of 1.7 % deciduous trees (Appendix 13). If timber harvest continues in the Batzulnetas stand, the relative density of trees in the seedling, sapling and smaller size classes will increase, a condition characteristic of a forest in an earlier stage of succession.

Current timber permit stipulations (Appendix 22) state that timber removal within the park/preserve must be done on frozen, snow covered ground in order to minimize substrate damage. Although it is unknown whether compliance with regulations occurred, there is evidence of damage to the understory vegetation and the moss organic layer, as

well as ground compaction and subsidence resulting from logging operations which have occurred in recent years. Presumably, harvesting during winters with little or discontinuous snow cover will exacerbate the amount of damage to ground substrate by mechanized vehicles. Numerous well-used trails, as well as "one-time" trails which are clearly visible in the ground substrate, may become permanent evidence of logging within the stand. When harvest of timber is spread throughout the stand, rather than concentrated as in a clearcut, more vehicle trails are created. Often, smaller trees are cut in order to more easily access desirable timber. Trees of all sizes have abrasions on their boles, broken limbs and other damage resulting from mechanized vehicles and log skidding. Most seedlings and saplings run over by logging equipment can be expected to die from structural damages or continue to live, though exhibiting damaged form. Weakened by physical damages resulting from logging activities, trees presently established in the overstory may be more susceptible to disease or environmental damage. Incidents of logging waste were observed in several locations. Several dozen houselog-sized white spruce lacking apparent defect were cut down then abandoned. Clearcut areas, substrate damage and damage to live, uncut trees due to logging activities are conspicuous along the two Batzulnetas Trails (Trails 101 and 103, Mechanized Trail Inventory, 1985).

Considering the relatively good condition of the Batzulnetas trails, the Batzulnetas area is one of the few areas along the Nabesna Road where an easily accessed, short, non-strenuous hike with a destination point (Tanada Creek) can be made. As park visitation increases, more intensive trail and recreation use can be expected in the area. The visual quality of the Batzulnetas area may warrant management concern.

As logging continues in the Batzulnetas stand, the effects will be accumulative. The consequences of continued removal of large houselog sized white spruce is of management concern because of the possibility of overharvest. The potential for overharvest raises questions about managing forest resources pursuant to the intent of the park and enabling legislation. A typical tree of houselog dimensions might have a DBH of fifteen inches, a height of sixty feet and a volume of thirty cubic feet (volume estimation: Haack, 1963). The removal of one such tree per acre would approximately equal the cumulative amount of wood that same acre would normally produce per year in the Batzulnetas stand. A timber permit was issued for the harvest of 200 houselog sized trees from Batzulnetas during the winter of 1983 - 1984. Such a level of harvest cannot be maintained in a timber stand of limited size with a low density of large white spruce and a low current annual productivity level characteristic of higher elevation interior Alaskan forests.

Mile 20 Stand

Encompassing 80 acres, the Mile 20 timber stand is located directly northwest of the intersection of Caribou Creek and the Nabesna Road at mile 18.65. The stand has an elevation of 3000 feet, a south to southwest aspect and an average slope of 3 %. Overall ground substrate drainage conditions were determined to be "well drained" (U.S. Forest Service PNW Res. Sta. and AK DNR, 1983; Appendix 20). The majority of the Mile 20 stand occurs on the alluvial floodplain that borders Caribou Creek. The creek floods parts of the stand periodically; most recently, during the summer of 1985.

The ground substrate and vegetative understory throughout the stand exhibits a wide range of conditions. Some areas have a thick moss organic layer overlaying alluvial outwash and abundant understory shrubs and herbs, while other areas, especially those which have experienced recent flood activity, are virtually devoid of a moss organic layer and have a very sparse shrub and herb understory. Understory plant species most frequently encountered in the Mile 20 stand include: moss species, arctic lupine (Lupinus arcticus), graminoid species, mountain alder (Alnus crispa), crowberry (Empetrum nigrum), sweet vetch (Hedysarum alpinum), one-sided wintergreen (Pyrola secunda), arctic wintergreen (Pyrola grandiflora), single delight (Moneses uniflora), willow (Salix species), lichen species, mountain wormwood (Artemesia Tilesii) and low bush cranberry (Vaccinium vitus-idaea). The majority of the Mile 20 stand is classified as a closed white spruce stand (Viereck et al., 1986). White spruce (Picea glauca) was the only tree species encountered during the survey. Many trees have bases buried by river alluvium deposited during flooding.

Estimated gross live volume at Mile 20 (5633.66 cubic feet per acre) is very large for the Nabesna area, with over one and three quarters times the gross live volume of that of the closed strata. Mean annual increment, or current productivity is also high, estimated at 26.71 cubic feet or one third of a cord of wood per acre per year. Such a high gross live volume and current annual productivity in the Mile 20 stand may be indirectly attributed to the periodic flooding of Caribou Creek. Zasada et al. (1977) reports that removal of the moss organic layer by flooding increases the soil nutrient pool, the soil temperature and the thickness of the active permafrost layer, resulting in the maintenance of relatively high site quality and productivity.

Timber density of the Mile 20 stand is low in comparison with the closed strata. Furthermore, Mile 20 has very low density in its smallest DBH size classes and relatively large densities in its middle DBH size classes, whereas the closed stand has the majority of its density in the smallest DBH size classes and much lower densities in its middle sized DBH classes.

Density and volume of dead trees in the Mile 20 stand is very low in comparison with the other stands and the closed strata. Dead tree volume in the Mile 20 stand was approximately 60% that of total dead tree volume in the closed strata. None of the dead trees surveyed were estimated to have died in the last five years. Average estimated stand age at Mile 20 (166.52 years) was 41.1 years, or approximately one third older than the average stand age of the closed strata. In addition, trees within individual DBH size classes averaged older in all size classes than trees of the closed strata. Estimates of average age within DBH size classes range from 137.7 years in the seven inch DBH size class to 291.0 years in the seventeen inch DBH size class. Although the trees average older than those of the closed strata, they have not begun to experience a high rate of mortality.

Overall, white spruce regeneration at Mile 20 is extremely low as indicated by an overall low density of seedlings, saplings and trees in the smallest DBH size classes. It was observed however, that there were locally abundant patches of seedlings and saplings. The difference in density between seedlings (236.58 per acre) and saplings (31.22 per acre) in the stand indicates a high rate of mortality within the seedling size class. Seedling and sapling success is adversely affected by several site conditions present in the stand, including a lack of exposed mineral soil for seed germination in some areas and a thick moss organic layer which inhibits germination in others (Zasada and Gregory, 1969). Though ultimately providing the mineral soil substrate favorable of germination, periodic flooding of Caribou Creek may physically damage or kill established seedlings and saplings.

A combination of factors, including a large gross live volume, low current annual productivity relative to the amount of gross live volume per acre, a high density distribution in the middle-sized DBH classes, relatively high average stand age, and low seedling and sapling regeneration indicate that Mile 20 is a mature timber stand, approaching overmaturity. As long as Caribou Creek regularly floods the stand area, however, it is likely that the area will remain relatively productive. Presently, there is a comparative abundance of houselog sized white spruce in the stand. Perhaps the Mile 20 stand could be used at least in part, as an alternative timber harvesting area to the Batzulnetas stand.

The Mile 20 stand has experienced considerable timber harvesting, although most tree stumps observed appear to be at least five years old, with many appearing much older. The highest density of stumps occurs adjacent to the Nabesna Road, then decreases as the distance increases from the road. No stumps from recently harvested trees were observed in any of the fifteen timber plots surveyed. The creation of trails and substrate damage caused by logging practices appears to be minimal. In October of 1984, illegal harvesting of timber was documented by park staff adjacent to the Nabesna Road, in the northeast end of the stand. Approximately 16 trees were cut

(Nabesna Road, Mile 20 Unauthorized Timber Harvest file, on file in the WRST resource management office).

Lost Creek/Trail Creek Stand

The timber on either side of and including most of the area between Trail and Lost Creek is considered one extended stand of trees. However, it was deemed most beneficial to intensively sample a smaller portion of the most dense, and therefore the most likely area of the stand to experience timber harvest. Plots were systematically chosen directly adjacent to Lost Creek at mile 31.0 and Trail Creek at mile 29.1 of the Nabesna Road. The two sections are treated as one stand due to their small size and overall similarity. Information pertaining to the larger stand area surrounding and including the Lost Creek/Trail Creek stand, as has been defined here, can be obtained by locating individual open and closed strata plots surveyed within the area.
The Lost Creek/Trail Creek stand is situated between 3100 and 3200 feet in elevation, has a south to southwest aspect and a gradual slope of 4 %. Overall, the ground substrate drainage condition within the stand was determined to be "moderately well drained" (U.S. Forest Service PNW Res. Sta. and AK DNR, 1983; Appendix 20). The timber stand is located on the broad alluvial fans of Lost and Trail Creeks. Primary creek channels and subordinate channels formed during infrequent periods of flooding are evident throughout the stand, especially in the Lost Creek portion. Many tree bases are buried by river alluvium deposited during flooding. Other than recently created stream channels, exposed mineral soil and bedrock outcroppings are generally absent.

The vast majority of the Lost Creek/Trail Creek stand is an open white spruce timber type, although there are isolated areas where canopy coverage is closed. Despite open canopy coverage, Lost Creek/Trail Creek is perhaps best compared with the closed strata because of similar silvicultural properties of the stand. The stand is composed entirely of white spruce (Picea glauca). Understory plant species most commonly found in the stand include: moss species, willow (Salix sp.), arctic lupine (Lupinus arcticus), low bush cranberry (Vaccinium vitis-idaea), red bearberry (Arctastaphalos rubra), crowberry (Empetrum nigrum), Labrador tea (Ledum palustre), sweet vetch (Hedysarum alpinum), arctic wintergreen (Pyrola grandiflora), lichen species, graminoid species and soapberry (Shepherdia canadensis). Except in creek channels, a thick, ground-insulating moss organic layer exists throughout most of the stand. Shrub and herb coverage is generally abundant.

The Lost Creek/Trail Creek stand has a gross live timber volume of 2927.30 cubic feet per acre, similar to that of the gross live volume

of the closed strata. Its current gross annual productivity is 12.47 cubic feet per acre per year, or approximately one sixth of a cord of wood. Considering the large quantity of gross live volume in the stand, current annual productivity per acre is comparatively low.

The density of live trees at Lost Creek/Trail Creek (435.05 trees per acre) is less than two thirds that within the closed strata. Although the DBH size class with the highest density is the five inch size class (107.72 trees per acre), the seven, nine and eleven inch size classes do not exhibit dramatic decreases in density from one size class to the next, as does the closed strata. The Lost Creek/Trail Creek stand maintains more trees per acre in the nine through thirteen inch DBH size classes then the closed strata.

Density of dead timber in the Lost Creek/Trail Creek stand is 3.1 times that of the closed strata, indicating a high rate of mortality. An estimated 9.5 % of the total tree density at Lost Creek/Trail Creek is dead; the highest proportion of any strata or stand. Dead tree volume is similar to that of the closed strata. An estimated 41.8 % of all trees in the stand display serious visible defects. Timber defects commonly exhibited in the stand include: disease, rot, a bole lean greater than 15 %, forked top, dead top, broken top, sweep (a curved bole), crook, bole split or unhealthy foliage. Over half of the total density of defect and disease afflicted trees are in the nine inch and eleven inch DBH size classes. Internal defects like disease and rot are likely to have remained undetected unless each tree was individually bored. Overall, there is a much higher incidence of timber defect and disease in the Lost Creek/Trail Creek stand than in the closed strata. The open nature of the stand can be explained by the relatively small diameters of individual tree canopies relative to their bole diameters.

The DBH size class distribution with respect to average estimated age indicates that trees in the Lost Creek/Trail Creek stand are considerably older within all DBH size classes than those of the closed strata. By the time an average tree graduates from the sapling size class to the five inch DBH size class, it is approximately 170.0 years old. Such a tree is one third older than a same sized tree in the closed strata. Hegg (1975) reports that most white spruce stands mature between 100 and 150 years of age if not damaged or destroyed by fire. The average estimated stand age of Lost Creek/Trail Creek is 186.48 years old; one and a half times as old as that of the closed strata. An Alaskan white spruce stand with such a high average age is considered overmature.

Farr (1967) asserts that white spruce stands remain well-stocked for 180 years or more as mature trees die and form openings. Throughout the stand, although more frequently observed in the Trail Creek section, is an abundance of trees toppled by wind. It is probable that when these trees blew down, they were live, but senescent trees,

vulnerable to windfall. Little reproduction seems to be occurring in these newly open areas because the thick moss organic layer and permafrost inhibits seedling and sapling establishment. Remnant spruce may live for 350 years or more (Farr, 1967). One white spruce surveyed in the twelve inch DBH size class was determined to be 413 years old at breast height. Many spruce were over 300 years old. As a white spruce timber stand progresses from maturity to overmaturity, canopy shading and an increasingly thick moss organic layer will gradually promote a decrease in the thickness of the active permafrost layer. In the absence of flood or fire disturbances which can reverse permafrost formation, decreasing productivity and decreasing site quality will result. Trees in an overmature stand such as at Lost Creek/Trail Creek will continue to die and topple over, eventually resulting in most of the area evolving towards a non-forested bog (Zasada et al., 1977). The limited portion of the stand which continues to flood regularly, however, will probably maintain a higher level of productivity.

Seedling and sapling density in Lost Creek/Trail Creek is very low, with 75.82 seedlings per acre and 26.76 saplings per acre. The low regeneration density may result from a combination of factors, including a lack of exposed mineral soil, a thick germination inhibiting moss organic layer and shallow depth to permafrost (Zazada and Gregory, 1969). All seedlings and saplings surveyed in the stand were white spruce.

When stand characteristics are considered collectively, they indicate that the Lost Creek/Trail Creek stand is overmature. Low current annual productivity, high dead tree density, high average stand age, a high percentage of trees with defects and disease and low regeneration density reinforce this conclusion. Although dispersed, usable houselog sized trees are relatively abundant in the stand.

Presence of logging activity was observed not only in the Lost Creek/Trail Creek stand, but throughout the larger surrounding area. Creekbed alluvia of Lost Creek and Trail Creek provide easy harvesting access to the interior of the stand. Although not widespread, logging access routes are evident, ranging from faint, "one-time" trails to trails with established wheel ruts. Logging intensity seems to decrease as distance from the Nabesna Road increases. Scattered about the Lost Creek portion of the stand are a number of very old, decaying piles of stacked wood, with a volume of approximately two cords per pile. Old stumps are abundant throughout both portions. Continuing log removal is evident within the stand, as stumps from several recently cut trees was observed. Several abandoned felled trees of houselog proportions were noted, although most of them were on private property. The removal of one average houselog sized tree outweighs the cumulative amount of wood the Lost Creek/Trail Creek stand produces on two acres in one year. Because the Trail Creek portion of the stand is on private land, logging activities there are not of direct management concern, unless tree removal extends onto or affects lands

administered by WRST.

SUMMARY

A preliminary inventory of forest resources was initiated along the Nabesna Road because of concern about the historical and continuing subsistence use of green timber for firewood, and particularly for houselogs. During the 1986 field season, gross volume, current annual gross productivity, density, regeneration, timber age, mortality and species composition of timber in the Nabesna area was determined for three timber strata (open coniferous, closed coniferous and mixed coniferous/deciduous), and three timber stands (Batzulnetas, Mile 20 and Lost Creek/Trail Creek).

Composed of both white and black spruce stands, the open coniferous strata is characterized by very low current annual productivity, low gross timber volume per acre and low density. Although it is the most widespread timber strata along the Nabesna Road, the open strata is generally unsuitable for timber harvest, except dead trees for firewood harvest. The mixed coniferous/deciduous strata is characterized by low gross volume, relatively high current productivity, high density and low average stand age. In the Nabesna area, the mixed strata is very limited in range and is usually not accessible or desirable for timber harvest. For high elevation timbered lands of the Alaskan interior, the closed coniferous strata, although limited in size has relatively high current annual productivity, high volume, and a high density of trees in the larger DBH size classes. The majority of stands which contain harvestable houselog sized trees in the closed strata are located in the three timber stands described below. The Batzulnetas stand is a mature stand with relatively high current annual productivity, gross volume, density and abundant houselog sized trees, although is has a high density of trees in the smaller DBH size classes. Because timber harvest has and continues to far exceed productivity at Batzulnetas, there exists the possibility of overharvest and its resulting impacts. In addition, unacceptable environmental impacts (eg. trail creation, subsidence, vegetation and ground substrate damage) have resulted from past harvesting activities. The Mile 20 stand is a mature white spruce stand with high gross volume, low current annual productivity relative to its to volume, high average stand age and low regeneration density. The Lost Creek/Trail Creek stand is an overmature white spruce stand with low current annual productivity, high average stand age, a high percentage of trees with defect and disease and low regeneration potential. Because neither the Lost Creek/Trail Creek or Mile 20 stands are currently experiencing substantial amounts of timber harvest, they could possibly be used as timber harvesting alternatives to the Batzulnetas stand.

Overall, current annual productivity of timber was determined to be low among all Nabesna strata and stands due to a combination of factors,

including high latitude, high elevation for an Alaskan forest and widespread presence of permafrost. These stands of timber thus qualify as either non-commercial or commercial inoperative Alaskan timber stands. Although current annual productivity is very low and stands of timber which contain harvestable numbers of houselog sized trees are limited in number and size, the park/preserve continues to receive requests for subsistence houselog permits in the Nabesna area. Excluding the Chisana area, Appendix 23 tallies timber permits received by the park/preserve for the Nabesna district from 1982 to 1986.

RECOMMENDATIONS

This pilot study contributed to the development of sound forest resource management policies in four ways. First, it greatly increases our knowledge of the distribution, condition and productivity of the forest resources along the Nabesna Road and provides a cursory assessment of the forest resources along the Chitina Road corridor. Second, it provided the opportunity to research and review different sampling methods and determine which is best suited for use in higher elevation, interior Alaskan forests. Third, the development of survey methods and their implementation in the field provides a workload and funding yardstick to estimate personnel, funding and logistical support needs for future field efforts. And fourth, the results can be used for discussion with resource management professionals, scientists from the timber industry and park management to develop long term management strategies that will protect forest resources, while allowing for subsistence use.

The recommendations are divided into four sections. The first section discusses the issuance of green wood harvest permits, including permittee eligibility, frequency of permit issuance, maximum number of logs per permit, and operational responsibilities and considerations for permit management. The second, identifies additional permit stipulations. The third, discusses monitoring needs for harvested areas. And the final section identifies and discusses several timber harvest strategies and the implications of their use.

Although not all of these recommendations stem directly from the results of this project, virtually all result from experience gained while completing fieldwork, literature reviews and in discussions with forestry professionals. This also includes field observations of the adverse environmental effects of activities associated with past timber harvesting permits.

Issuance of Green Wood Harvest Permits

The intent of the following recommendations is to insure that individuals identified as subsistence users by ANILCA are provided the opportunity to use forest resources within the park and preserve but only with the condition that natural and cultural resources are protected. The recommendations also clearly identify responsibilities for the management of green wood permits. A copy of the current green wood harvest permit is included in Appendix 22.

The permit system in effect is an acceptable management approach under current use levels. However, if permit requests increase, it may become too labor intensive and demanding of the district ranger's time. If this scenario develops, other allocation systems must be employed or permit requests may have to be restricted to a level that can be managed. Regardless of what allocation system is used, protection of forest resources in the park/preserve is a long term goal.

1. Restrict forest resource harvesting eligibility to residents living within park/preserve boundaries.

Since the establishment of the park/preserve, very few requests for green wood permits have been received from individuals outside park/preserve boundaries. Therefore, a pattern of use of forest resources within the park/preserve has not been established by individuals residing outside its boundaries. Residents within park/preserve boundaries, however, have established customary and traditional subsistence use of park/preserve forest resources.

For example, Slana is a community with a population of several hundred people which resulted from a recent BLM land disposal and is located adjacent to, but not within the northern park/preserve boundary. The resulting dramatic population increase of Slana could potentially pose a threat to the forest resources along the Nabesna Road if residents were issued houselog harvesting permits. Other communities within the park/preserve have continued to grow and the number of homesteads have increased steadily through private property development, subdivision and the disposal of state lands. Since this study indicates low productivity in forest resources used for subsistence, harvest pressure must remain low to sustain a yield, such that the viability of resource is maintained. Other sources of forest resources are available to individuals residing outside park/preserve boundaries. Restricting green wood permit eligibility to individuals residing within park/preserve boundaries will reduce harvesting pressure on forest resources and better provide for long term subsistence forest resource use opportunities.

2. Only issue green wood permits to park/preserve residents that do not have other forest resources available.

If a resident owns sufficient forested acreage to supply their resource needs or if ownership was obtained through a disposal that provides areas for harvest of forest resources then the resident is ineligible for a green wood permit within the park/preserve. Aerial photographs, productivity values and forest characteristics of similar parcels will be used to determine if private property can supply the owner's resource needs.

3. Establish maximum harvest levels relative to preharvest stand basal areas and densities such that ecosystem viability, visual quality and the park's mandated resource responsibilities are reflected.

This provides district rangers or designated WRST representatives guidelines as to an acceptable basal area or density of trees per acre to remain in a stand after timber harvest. Timber density and basal area are indicators of stand volume and canopy cover and if carefully regulated, may serve to control and preserve the long term viability of, the structure of, and natural conditions present in the stand. In addition, canopy cover is a function of tree density and is a critical factor regarding the visual impacts of harvested areas. Canopy cover may also affect the depth of the active permafrost layer and the vegetation communities that occupy the site.

Foresters from the Institute of Northern Forestry at Fairbanks indicated that the removal of between 1/4 and 1/3 of the basal area present in many portions of timber stands such as Batzulnetas or Chisana, could be done without negatively altering the structure or viability of the stand. Once the maximum allowable density or basal area has been removed, the area would be closed to further harvesting. This closure would remain in effect until the pre-harvest density or basal area of trees was again matched and the ecosystem was determined to be able to tolerate additional harvesting. The closure criteria would be applied immediately to areas in which harvesting has already removed the allowable portion of the natural basal area or density.

Several management strategies being considered for implementation in the park/preserve are described in the management concerns section that follows (page 45).

4. Require the permittee to submit a blueprint or floor plan of the structure to be constructed if more than 20 houselogs are requested. The maximum number of houselogs a permittee can harvest is 120 houselogs.

A houseplan or blueprint would allow the number of logs required for construction to be estimated and compared against the number of logs requested. The number of logs permitted for harvest will be the number estimated for construction plus a percentage that reflects the estimated incidence of gross internal timber defect in the general

area. Example: If a stand has an estimated 20% incident of butt rot, the harvest quota will be increased by 20%.

Following an analysis of cabin size based on over 200 cabins inventoried within the park, it has been determined that 100 houselogs are adequate to build a structure that meets subsistence needs. An additional 20 trees were included to account for the general incidence of rot and some unavoidable harvest related damage. The number of additional trees included because of rot, defect or damage may be adjusted depending upon data available for the stand.

If the structure the permittee intends to build requires more than 120 logs, the permittee must obtain the additional logs from sources other than public lands within the park/preserve.

5. Restrict the frequency that individuals can obtain green wood harvest permits and only allow one permittee per family unit.

Limit an family unit to one houselog permit every thirty years unless a cabin is damaged by fire, another type of disaster, or an increase in a family warrants an addition to a family's existing cabin. A properly constructed and maintained log cabin should last at least fifty years as evidenced by the condition of many cabins located throughout the park.

Only one person per household or family may obtain a permit. This eliminates multiple permits which would allow the harvest of over 120 trees per family within a thirty year period.

6. Forest products obtained from park/preserve lands cannot be used for commercial purposes.

This provision insures that the permittee is aware that regulations prohibit the use of forest products for personal profit through sale, for barter or for structures used for commercial purposes.

7. District rangers or designated NPS personnel will issue all green wood permits.

District rangers are familiar with the resources of their districts, use patterns, and individuals that reside within their districts. This requirement provides continuity of contact with local residents and actively involves district rangers in resource management within their districts. A district ranger and permittee will select the area and mark trees to be harvested, identify access routes, determine start and termination dates of permit, determine slash disposal methods, and review permit stipulations. This insures that permittees are familiar with permit stipulations, location and layout of harvesting areas, timber harvest practices and resource protection goals. To assist the district ranger, forest

resource maps delineating potential harvesting sites as well as harvested areas that are currently closed will be prepared for each district. The regular review and updating of forest resource areas on this map provides a management opportunity for the district ranger to monitor forest resources and regulate harvesting permits and activities.

Ninety percent of the permittee's houselogs should be marked initially. Near the end of, or after the timber is harvested, a WRST representative would then return to the harvest site with the permittee to mark the remaining ten percent of the trees. The number of trees that are severely damaged or knocked over by careless harvesting techniques would then be deducted from the final ten percent of the permitted harvest quota. This provision will encourage the permittee to display a sensitivity for other park resources by employing appropriate precautions and practices during the falling and transporting phases of the harvesting operation.

By utilizing existing access routes and by concentrating and planning harvest locations, substrate deterioration, trail creation and other damage due to timber harvesting can be minimized. Selecting and identifying access routes is especially important if harvest sites are not near established routes. Once a harvest area has been accessed, considerable movement of vehicles and machinery within a stand is required to cut and remove over one hundred houselog sized trees. Because it is difficult and impractical to regulate all of the movement required to harvest, permittees should be advised to minimize unnecessary movement of vehicles and machinery within the stand either by a WRST representative or in writing.

During the field review of potential harvesting sites, the area that best suits the needs of the permittee that has the least impact to park resources will be selected. This inspection will insure that no endangered species or cultural resources will be affected by the proposed harvest activities. If any doubt exists over the presence of endangered species, critical wildlife habitat or cultural resources, the resource management specialist or appropriate regional staff representative will be contacted. If significant areas or resources are identified, they will be described in a narrative report accompanied by a marked map and given to the resource management specialist. This information would be transferred to the working district office maps and to the permanent maps maintained by resource management at park headquarters. Depending on the situation, the area would then be closed to further harvest, or left open until the allowable amount of basal area was removed.

A copy of all permits, including maps and stipulations, will be forwarded by district rangers to the resource management office for compilation of parkwide timber harvest. If requested, resource management personnel will assist with the issuance of green wood permits.

8. Dates of timber harvest and removal will be identified on the harvest permit.

Typically timber harvest and timber removal activities occur throughout the winter months. It is critical that all timber removal activities are completed well in advance of breakup, to minimize damage of the surface vegetation and protect the ground substrate from compaction and possible thermokarstic subsidence. Removal of timber should cease no later than one month before the average date of breakup. Extension or reduction of the termination date may be dictated by climatic and environmental conditions.

If the allocated number of trees have not been cut and removed by the expiration date, the permit becomes invalid and no more trees may be cut or removed unless an extension is granted or another permit is obtained. Trees that are marked but uncut or trees felled and not removed from park/preserve lands are forfeited. Extensions should be granted only under extenuating circumstances and only if negative environmental impacts will not occur.

9. Require subsequent permittees to use marked or cut trees forfeited by earlier permittees.

Apply marked and cut forfeited trees against subsequent permit quotas for similar forest resources.

10. Indicate on the permit the number of trees to be harvested by species.

This aids in monitoring the use of and harvesting impacts on tree species, particularly birch and other hardwoods, which may not be widespread or abundant in certain areas in the park/preserve.

11. Require the permittee to identify all individuals who will be assisting or acting with or for the permittee.

This insures that all parties involved are responsible for permit compliance if they are acting with, or for the permittee. It also assists with the monitoring of authorized activities for an individual permit or multiple permits in an area and in identifying illegal timber harvest.

12. Photograph the stand from ground level and the air both before and after harvest activities.

Photographs will provide a baseline for comparison of conditions before and after harvesting has occurred. They will also provide a baseline for comparisons through time and may be useful in documenting whether the permittee has complied with permit stipulations.

13. Encourage permittees to use dead, defective, windfall, or smaller trees for firewood.

This would help insure that there will be healthy trees with good form in the smaller DBH size classes which will eventually grow into the larger DBH size classes.

14. Require permittee to post a bond if heavy equipment is used to remove houselogs.

Bonding will provide some financial insurance that green wood permit stipulations are obeyed as well as provide a fiscal base for rehabilitation work, if necessary. Heavy equipment is defined as a tracked vehicle or a vehicle with a GVW greater than 1000 pounds.

15. Include with the permit a list of concerns and suggestions related to forest practices and environmental conditions.

Provide a brief written discussion describing the limited availability of forest resources in the interior of Alaska, the low productivity of interior Alaskan forests and the concept of sustained yield. Because the expertise and knowledge of permittees varies greatly, a description of effective logging practices may help insure permit compliance as well as minimize environmental damage and personal injury.

16. District rangers need to maintain an open working relationship with local representatives of the Alaska Department of Transportation so forest resources can be allocated from areas along road corridors when vegetation is to be cleared for road maintenance activities.

Although the State of Alaska maintains a right-of-way for road maintenance within the park/preserve, the National Park Service retains ownership of resources within the right-of-way. If road maintenance dictates that vegetation within the right-of-way be removed, the district ranger can permit local residents to remove forest resources prior to road work. This removal could occur during any season, with specific stipulations identified by the district ranger.

17. District rangers or designated NPS employees will monitor all green wood harvest permits for compliance.

Monitoring green wood harvesting is critical to insure that permit stipulations are complied with for resource protection. This is especially important with respect to the number of trees harvested, species harvested, harvest location, access routes used, depth of

snow cover, time period of activities, and clean up of area. Resource management personnel will be available to assist with monitoring activities upon request.

18. Resource management personnel will provide program oversight and assistance when requested.

A natural resource specialist will monitor the parkwide forest resource management program including compiling harvest statistics, archiving of permits and stipulations, identifying areas available for harvest and areas closed to harvest, conducting long term monitoring of harvest sites, and maintaining a current knowledge of forest resource sampling and harvesting methods in northern latitudes. As mentioned previously, resource management personnel will be available to assist district personnel with any phase of the forest resource management program.

Additional Permit Stipulations

Since the establishment of the green wood harvest permit system, harvest related stipulations have evolved continually. Throughout the course of the study, changes needed in the permit stipulation were discussed. Additional stipulations and revised stipulations follow.

1. The permittee will provide descriptions of all vehicles to be used during timber harvesting activities, including vehicle make, color, year, and license or serial number.

Vehicle identification assists with permit monitoring and in insuring that appropriate vehicles are used.

2. Trees greater than 10 inches or 25 centimeters DBH are not to be harvested for firewood.

The number of trees suitable for houselogs is limited in the Nabesna area and probably throughout the park/preserve. Requests for houselogs are anticipated to increase. Restricting the size of trees permitted for firewood harvest protects houselog sized trees from unnecessary harvest. An exception to this restriction are trees greater than 10 inches DBH which are unsuitable as houselogs because of structural defects and rot.

3. Trees will not be harvested within 100 feet of roads, major access routes and stream courses, including seasonal drainages that may be dry or frozen during the winter.

This provision establishes a buffer zone to mitigate the visual impacts of timber harvest. District rangers will determine which routes require a buffer zone and if 100 feet is the most effective and reasonable buffer zone width.

4. Timber harvest activities are not allowed in areas with slopes greater than 30 percent.

Erosion, substrate damage and damage to existing vegetation increase as substrate slope increases. Vehicle and equipment operation safety is also compromised on steeper slopes.

5. Girdling of trees is not permitted.

This practice has occurred within the park/preserve as a method of creating standing dead wood, which does not require a permit for harvest. Tree girdling is not acceptable and will not be permitted.

6. Trees damaged or destroyed while gaining access to timber harvest areas or during felling and tree removal operations will be subtracted from the harvest quota.

The intent of this provision is to minimize the mortality and damage of unmarked trees and vegetation remaining in the stand, and to encourage care during felling and removal operations. Trees damaged by logging operations may be rendered unsuitable for houselog construction and could become susceptible to forest pathogens and infestations.

A. Occasionally, high tree densities within a stand may result in the unavoidable loss of trees during felling and/or access. The district ranger may then increase the harvest quota to account for this situation.

B. If an unmarked tree is unnecessarily knocked down or severely damaged by the permittee during the harvesting of marked timber, that tree then becomes part of the permittee's quota and another tree that was marked and intended for harvest would be excluded from the harvest quota.

7. Limbs on harvested trees must be removed before they are skidded out of the stand.

This provision would help minimize damage caused by the abrasion of limbs on the ground substrate and to vegetation during skidding and removal operations.

8. A minimum depth of one foot of snow cover is required for the use of heavy equipment; and adequate snow cover, as defined in Title XI, is required for the use of snow machines and light weight ATV's.

The park staff has documented the occurrence of ground substrate compaction, subsidence, and scarification resulting from harvest activities with the existing snow depth requirement of six inches.

Deeper snow depth requirements for heavy equipment would presumably increase the protection of surface vegetation and ground substrate from damage and deterioration incurred during timber harvest activities. Although these provisions may increase protection, it is possible that regardless of snow depth, some disturbance may occur, especially with high impact activities such as log skidding. Monitoring snow depth and damage caused to the substrate resulting from timber harvest activities, will assist with the fine tuning of snow depth requirements and the identification of impacts associated with various depths. Conversely, this increase in the required minimum depth of snow cover may prove to be too prohibitive, as the annual amount of snowfall in interior Alaska is often inconsistent and unpredictable.

9. Heavy equipment used for the removal of firewood is prohibited.

Only allow the use of snow machines or light weight rubber-tired ATV's for the removal of firewood. Heavy equipment is not necessary for the removal of smaller trees. An exception would be to allow heavy equipment use on trails that have been identified and designated for such access. Heavy equipment could not be used off the established trail however, thus requiring the use of smaller equipment to transport the wood to the established trail.

10. Slash will be lopped and scattered, with pieces not greater than four feet in length. Slash will not be deposited in running or standing water. Stumps will be flush cut with the ground surface.

Proper disposal of slash mitigates certain undesirable effects of timber harvest. These conditions may include the negative visual impacts of logging debris piles and tree stumps, increased fire hazard due to accumulation of downed woody fuels, the creation of stand conditions which would encourage the proliferation of forest pathogens, and the effect of slash on tree regeneration.

11. All flagging, equipment and refuse must be removed from the stand previous to permit expiration.

Inventory and Monitoring Needs

The current permit system was developed to assist the district rangers with managing forest resources within their districts. Monitoring of permit compliance and assessment of changes in the condition of the forest resources is a critical component of the management system. The following recommendations will assist with the monitoring task.

1. Establish permanent forest resource monitoring plots and photopoints in representative forest stands that have been or could be selected for timber harvest.

Permanent forest resource monitoring sites and photopoints provide a mechanism to identify and determine if and to what extent changes are occurring in harvested areas, areas suitable for harvesting, and in forest stands established as control sites. Parameters to be monitored include stand density, mortality, size class distribution, species composition, species regeneration and substrate condition. District staff, resource management personnel or an interdisciplinary team will perform intermittent field checks. Methods applied during the pilot project will be used to maintain a continuity of methods and allow the accumulation of a long-term database. The use of aerial photographs taken before and after harvest activities could also provide a baseline for comparisons through time.

2. Establish permanent monitoring plots to assess the relationship between timber harvest activities and tree regeneration.

The extent to which an area will regenerate after timber harvest depends largely upon conditions present in the stand before harvest. These factors include the depth to permafrost, the thickness of the moss organic layer, the presence of a viable seed source, and a suitable seedbed. Some additional measure of regeneration success may be related to the extent to which logging activities expose mineral soil, scarify the ground, and decrease the thickness of the moss organic layer. Since current management practices restrict the removal of harvested timber to times when adequate snow cover is present, scarification sufficient to significantly increase the number of established seedlings after harvest is not likely to occur. In addition, ground scarification resulting from harvesting activities done without adequate snow cover may produce unacceptable visual impacts.

Long term monitoring plots should be established in harvested timber stands to collect information about the relationship between seedling establishment and harvesting activities. These monitoring plots should address seedling success in a variety of sites which have experienced timber harvest over the past few years. Physical and biological site parameters such as soil classification, moss organic layer depth, depth to permafrost, seedbed condition, tree species, seed source distance, and weather conditions at the time of and subsequent to seedling establishment could be measured.

3. Obtain computer software to assist with sample size determination, statistical analysis, timber volume calculation, productivity and other relevant silvicultural parameters.

Results for this study were laboriously calculated using a hand held calculator. Computer software for statistical analysis and specific calculations such as timber volume and annual productivity, would

greatly increase the speed of obtaining results and enhance the ability to evaluate numerous factors.

4.Continue to obtain high resolution aerial photographs.

Expanding aerial photography coverage in all forest resource use areas is essential for many management activities, including mapping timber harvest compartment boundaries set up in stands, identifying and stratifying forest types and harvest areas, and recording and relocating sample point locations. This level of photography also provides a baseline for assessing changes through time, particularly the overall visual impacts of timber harvest and access routes.

Infrared aerial photograph transparencies with a 1:16,000 scale are available for the McCarthy Road. Photographic coverage of the Nabesna Road is incomplete due to inclement weather during the 1986 photography effort. Contract or cooperatively arrange for use of USDA or NPS aircraft, if available in the Copper Valley Basin, to obtain infrared transparencies of the remainder of the Nabesna Road at the 1:16,000 scale. Contact prints of existing transparencies have been obtained. For mapping purposes, a 1:6,000 scale is preferable for high use timber stands. Estimated cost: $5,000.00

5.Continue to procure basic forest management equipment for each district.

The procurement of basal area prisms, diameter tapes, clinometers, tree marker guns, DBH tapes, increment borers and flagging for each district will allow district personnel to do forest inventory work without relying on resource management personnel to provide equipment. Estimated cost: $200.00 per district.

Management Strategies:

Before the passage of ANILCA and the designation of the new Alaskan park units, the National Park Service had little experience in managing timber and timber harvest. Management policies which provide direction and guidelines for the subsistence harvest of green wood on a sustained yield basis in sub-arctic environments had been considered somewhat, but not yet developed. Due to the complications inherent in managing a program such as this, assistance from outside sources was sought. Silvicultural and sub-arctic forest ecology literature was collected and reviewed to identify management strategies compatible with park/preserve mandates and subarctic forest ecosystems. Then, contacts were made with NPS specialists and foresters from other resource management agencies to discuss various management strategies and their effects.

In considering the results of this study, experience gained during

fieldwork, literature reviewed, and discussions with forestry professionals, it became apparent that the main factors limiting the supply of forest products in the park/preserve are low productivity rates, the small number and scattered distribution of houselog sized trees within any given stand, and the smaller number of houselog sized trees that are physically suitable for log house construction. Park mandates and these conditions, which do vary between stands somewhat, will limit the range of management and harvest strategies suitable for regulating green houselog harvest. Further, the differences between stands indicate that a combination of management strategies will need to be employed for the long term protection of forest ecosystems while at the time satisfying subsistence houselog needs. Such a combination would allow forest management and harvesting activities to be tailored to specific stand conditions and permittee needs, while maintaining resource and forest ecosystem values.

The first step in minimizing the adverse impacts associated with timber harvesting will be to conduct performance evaluations on harvesting strategies and related activities. Secondly, the recommended green wood permit stipulations should be employed and subsequently reviewed in a process that would further refine these stipulations and hopefully reduce the negative impacts associated with green wood houselog harvest. These two steps are essential in the implementation of a forest management policy for the park. In addition, harvesting strategies should be adjusted as new information becomes available. Until timber harvesting in sub-arctic forest ecosystems is better understood, employing these management steps will insure a continuing effort of assessing and managing for the short and long term impacts of access, timber harvesting, visual effects, permit compliance and trade-offs between multiple and continuing resource utilization.

Several management strategies deemed to be compatible with sub-arctic forest environments and with park mandates are discussed below.

1. Determine the maximum harvest level which is to be used in conjunction with the management strategy determined to be best suited for a given stand of timber.

In a given portion of the timber stand, the level of harvest, i.e. the percentage of trees harvested, is to be selected in conjunction with the strategy implemented to manage tree harvest i.e., the select cut, dispersed cut or woodlot. The harvest level chosen to accompany a management strategy can range from no harvest, or stand closure, to a complete removal of trees, or clearcutting. Clearcutting and near total timber removal, however, would unacceptably result in major disturbances to the functioning of the local forest ecosystem and would impair the visual quality of the areas affected. Factors to consider in the determination of an acceptable harvest level are stand size, previous timber harvest levels, stand volume, site potential, annual productivity, species composition, size class distribution, the successional stage of the stand and accessibility. Basal area

and tree density of a stand are parameters by which present and future harvest levels can be gauged. If demand for green wood houselogs exceeds the designated maximum harvest level, a first come first serve system or a permit drawing system could be used to select permittees.

In addressing the harvest level issue, foresters from the Institute of Northern Forestry at Fairbanks indicated that the removal of between 1/4 and 1/3 of the basal area present in many portions of timber stands such as Batzulnetas or Chisana, could be done without adversely affecting the structure or the viability of the stand. Once 1/4 to 1/3 of the basal area is removed, the cut portion of the stand would be closed to future timber harvest until basal area determinations again approximate their pre-harvest level. This harvesting criteria would not apply where past harvesting has already removed the maximum allowable density or basal area of trees in a timbered stand. Such areas would be identified and closed to future harvest because they have already had more than 1/3 to 1/4 of their basal area removed. Implementing this management program could be technically and administratively accomplished in a variety of ways by district and resource management personnel.

2. Use temporary or permanent closures of a portion of or an entire timber stand to prevent overharvest and other unacceptable adverse effects.

This requires a vigorous monitoring program to obtain the biological information needed to predicate and defend the closure of parts of or an entire timber stand. The fact that current annual productivity is minimal in most park/preserve timber stands and that the number of houselog sized trees is limited, cannot be disputed. Management practices must realistically reflect this situation and long term protective management programs must be implemented despite the expectation of an increased demand for forest products. Resource management personnel must maintain inventory and harvest data records and labelled map and aerial photographs that identify forested areas with current levels of harvest as well as closures. Since closures may exist for decades, accurate and consistent record keeping is imperative. Stand areas closed to timber harvest would be allowed to grow until basal areas once again approximated their pre-harvest level, at which time the stand could be opened again for timber harvest. It is possible that because of past harvesting activities, portions of some stands should be classified as closed to any additional timber harvesting. These harvested portions will need basal area assessments followed by boundary surveys which will be marked in the field and delineated on permanent maps.

3. Use a dispersed, cumulative houselog harvesting technique.

Timbered areas managed by a system of dispersed harvesting would have green wood houselog harvest allocated by a series of overlapping

permits in which the total allowable amount of houselogs would be gradually removed through time. Each time timber is harvested from an area, the amount of basal area removed is deducted from the area's specified allowable harvest amount until the designated harvest percentage is attained and the area is permanently closed to further harvest. The intent of this harvesting technique is to disperse the disturbance over time and throughout the harvesting area, minimizing the visual impact of a thinned forest stand as well as related resource damage. It is unknown however, if greater degradation would occur to harvest routes as they would be accessed an increased number of times. With dispersed harvesting, the permittee would have greater latitude in selecting individual trees, because the acreage from which to select houselogs would not be limited to a small area.

This harvesting method could require a larger time and effort commitment by park staff returning to harvest areas several times to implement and review harvest permits and activities than would be expected with select cutting or woodlot harvesting strategies. In addition, there may be increased cost and effort to the permittee to harvest dispersed timber by transporting harvest equipment to several different sites. In many cases however, dispersed timber harvesting may be preferable because of the specific needs of the permittee.

4. Lay out woodlots in timbered stands suitable for a woodlot harvesting strategy.

Woodlots are designated management units within or covering forest stands where the unit boundaries and harvest amount have been determined in advance through an initial intensive planning effort. Individual woodlots are determined using existing stand data and are linked together through a common access system. A woodlot system would reduce the long-term time investment of park personnel in managing harvesting with the greatest time investment in the initial planning and layout of the woodlot. A trained forestry crew would locate woodlots by permanently marking field boundaries and then delineating these areas on aerial photos and maps. Mapped locations would be a reference for permitees and park staff in relocating harvesting areas and conducting monitoring reviews. The premarking of harvest areas would approximate how many houselog permits might be supported by any one stand and allow managers to cooperate with subsistence users in managing limited houselog forests. Disadvantages of the system would include the large initial time commitment to initiate the system and in keeping the separate harvest areas marked for long periods of time while also being unobtrusive.

5.Manage timber harvest through selective cuts.

Selective harvesting is similar to dispersed harvesting except that the entire quantity of allowable harvest would be removed from an area at one time rather than over time with subsequent permits. After

the allowable amount of trees is removed from a portion of the stand, that portion will be closed to future timber harvest. It would be easier to track closed harvested acreages in stands managed with a selective harvesting strategy than the dispersed harvesting strategy because all of the timber would be harvested at once. The selective harvesting strategy would concentrate the disturbance to the surrounding habitat and to access trails. These harvesting activities would initially be more severe during the harvesting period as opposed to several cuttings over a period of time as with a dispersed timber harvest. It is unclear whether harvest related disturbance in a given area would be more permanent or severe if it occurs all at once or over time with successive permits. A disadvantage of the system would be that in most stands, a small percentage of the standing basal area is suitable for houselog use due to high incidence of defect and rot, i.e., much less than 1/4 of the basal area would be suitable for houselog use.

APPENDICES

Appendix 1: V-Bars (tree volume to basal area ratios), confidence intervals (CI), percent standard error (% SE) and gross live volume per acre of three strata. Timber volume (cu.ft./acre) is computed from mean V-Bar and basal area values (Appendix 2).

	Mean V-Bar (sq. ft./tree)		
	open	closed	mixed
Ave. live V-Bar	(148)*	(202)	(160)
x + 80% CI	8.97 + 0.57	14.05 + 0.58	-----
% SE	4.93	3.21	
cu.ft./acre	610.05	3129.35	(2255.18)
white spruce	(111)	(184)	(45)
x + 80% CI	10.36 + 0.63	14.76 + 0.59	17.78 + 1.33
% SE	4.73	3.09	5.77
cu.ft./acre	528.23	2995.69	840.29
black spruce	(37)	(17)	(26)
x + 80% CI	4.80 + 0.78	6.89 + 1.14	8.07 + 1.56
% SE	12.44	12.39	14.60
cu.ft./acre	81.64	136.75	220.33
quaking aspen			(66)
x + 80% CI	-----	-----	14.10 + 1.13
% SE			6.21
cu.ft./acre			976.92
balsam poplar			(11)
x + 80% CI	-----	-----	14.12 + 2.58
% SE			13.32
cu.ft./acre			163.12
paper birch			(12)
x + 80% CI	-----	-----	4.33 + 1.73
% SE			29.32
cu.ft./acre			54.52
dead	(9)	(14)	(7)
x + 80% CI	7.24 + 2.56	14.06 + 1.96	9.01 + 3.27
% SE	25.30	10.32	25.21
cu.ft./acre	29.95	216.98	66.25

* (number of trees)

Appendix 2: V-Bars (tree volume to basal area ratios), confidence intervals (CI), percent standard error (% SE) and gross live volume per acre of three stands. Timber volume (cu.ft./acre) is computed from mean V-Bar and basal area values (Appendix 2).

	Mean V-Bar (sq. ft./tree)		
	Batzulnetas	Mile 20	Lost/Trail Creek
Ave. live V-Bar	(242)*	(195)	(163)
x + 80% CI	17.66 + 0.59	19.65 + 0.41	14.66 + 0.49
% SE	2.45	1.62	2.62
cu.ft./acre	3926.31	5633.66	2927.30
white spruce	(228)	(195)	(163)
x + 80% CI	17.97 + 0.58	19.65 + 0.41	14.66 + 0.49
% SE	2.53	1.62	2.53
cu.ft./acre	3763.40	5633.66	2927.30
black spruce	(7)		
x + 80% CI	6.99 + 1.13	-----	-----
% SE	11.19		
cu.ft./acre	44.94		
quaking aspen	(4)		
x + 80% CI	19.13 + 4.50	-----	-----
% SE	14.35		
cu.ft./acre	70.31		
balsam poplar	(3)		
x + 80% CI	15.72 + 7.23	-----	-----
% SE	24.39		
cu.ft./acre	43.39		
dead	(25)	(5)	(12)
x + 80% CI	12.31 + 1.72	17.72 + 6.31	12.92 + 1.59
% SE	10.63	23.23	9.03
cu.ft./acre	282.65	130.22	198.92

* (number of trees)

Appendix 3. Basal areas, confidence intervals (CI), ranges and percent standard error (% SE) of three strata.*

	BASAL AREA (square feet per acre)		
	open (n = 48)	closed (n = 20)	mixed (n = 21)
Total Live Basal Area			
x + 80% CI	67.99 + 12.13	222.71 + 32.71	182.62
range	0 - 374.85	88.20 - 551.25	22.05 - 374.85
% SE	13.72	11.06	
white spruce			
x + 80% CI	50.99 + 13.25	202.86 + 39.14	47.25 + 17.61
range	0 - 551.25	0 - 551.25	0 - 198.45
% SE	19.99	14.53	28.13
black spruce			
x + 80% CI	17.00 + 4.85	19.85 + 14.24	27.30 + 12.16
range	0 - 110.25	0 - 176.40	0 - 154.35
% SE	21.93	54.01	33.86
quaking aspen			
x + 80% CI			69.30 + 21.65
range	-----	-----	0 - 286.65
% SE			16.34
balsam poplar			
x + 80% CI			11.55 + 7.97
range	-----	-----	0 - 88.20
% SE			52.06
paper birch			
x + 80% CI			12.60 + 16.70
range	-----	-----	0 - 264.60
% SE			100.00
Total Dead Basal Area			
x + 80% CI	4.13 + 2.23	15.44 + 6.74	7.35 + 3.68
range	0 - 44.10	0 - 66.15	0 - 44.10
% SE	37.77	32.94	37.80

* n = number of sample sites.

Appendix 4. Basal areas, confidence intervals (CI), ranges and percent standard error (% SE) of three stands.*

	BASAL AREA (square feet per acre)		
	Batzulnetas (n = 24)	Mile 20 (n = 15)	Lost/Trail Creek (n = 18)
Total Live Basal Area			
x + 80% CI	222.34 + 25.71	286.65 + 31.69	199.68 + 19.94
range	88.20 - 551.25	176.40 - 485.10	66.15 - 308.70
% SE	8.99	8.22	7.49
white spruce			
x + 80% CI	209.48 + 27.52	286.65 + 31.69	199.68 + 19.94
range	88.20 - 551.25	176.40 - 485.10	66.15 - 308.70
% SE	9.96	8.22	7.49
black spruce			
x + 80% CI	6.43 + 5.395		
range	0 - 88.20	-----	-----
% SE	63.54		
quaking aspen			
x + 80% CI	3.68 + 0.70		
range	0 - 66.15	-----	-----
% SE	78.02		
balsam poplar			
x + 80% CI	2.76 + 2.01		
range	0 - 22.05	-----	-----
% SE	55.17		
paper birch			
x + 80% CI			
range	-----	-----	-----
% SE			
Total Dead Basal Area			
x + 80% CI	22.97 + 9.50	7.35 + 6.25	14.70 + 8.89
range	0 - 110.25	0 - 66.15	0 - 88.20
% SE	31.37	63.25	45.37

* n = number of sample sites.

Appendix 5. Mean density of seedlings by species for the three strata and three stands measured along the Nabesna Road.

	MEAN NUMBER OF SEEDLINGS PER ACRE					
Timber Type	Total	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
Open	539.66	139.38	399.54	-----	-----	-----
Closed	245.30	22.30	223.00	-----	-----	-----
Mixed	383.56	191.78	84.74	-----	-----	-----
Batzulnetas	539.66	93.66	334.50	17.84	93.66	539.66
Mile 20	236.38	236.38	-----	-----	-----	-----
Lost Creek/ Trail Creek	75.82	75.82	-----	-----	-----	-----

Appendix 6. Mean density of saplings by species for the three timber strata and three timber stands measured along the Nabesna Road.

	MEAN NUMBER OF SAPLINGS PER ACRE					
Timber Type	Total	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
Open	374.64	93.66	280.88	-----	-----	-----
Closed	223.00	66.90	156.10	-----	-----	-----
Mixed	593.18	231.92	169.48	84.74	22.30	84.74
Batzulnetas	223.00	147.18	75.82	-----	-----	-----
Mile 20	31.22	31.22	-----	-----	-----	-----
Lost Creek/ Trail Creek	26.76	26.76	-----	-----	-----	-----

Appendix 7. Stock table derived to estimate the current annual timber productivity (mean annual increment) of the open strata.

DBH Class (ins)	Ave. Age (yrs)	Present Stand Table (live trees/ acre)	Present Vol./tree DIB (cu. ft.)	Present Stock Table (cu. ft./ acre)	Current Ann. Vol. Prod. (cu. ft./ acre)
5	95.4	158.21	0.30	47.46	0.49
7	147.4	61.84	1.65	102.22	0.69
9	146.3	35.34	4.32	152.81	1.04
11	179.3	16.00	7.44	119.06	0.66
13	160.0	4.98	13.68	68.15	0.43
15	327.0	0.75	9.57	7.18	0.02
Total		277.31		504.35	3.33

Appendix 8. Stock table derived to estimate the current annual timber productivity (mean annual increment) of the closed strata.

DBH Class (ins)	Ave. Age (yrs)	Present Stand Table (live trees acre)	Present Vol./tree DIB (cu. ft.)	Present Stock Table (cu. ft./ acre)	Current Ann. Vol.Prod. (cu. ft./ acre)
5	27.1	379.71	0.70	265.80	2.09
7	111.2	173.15	2.69	465.77	4.18
9	120.6	72.34	5.54	400.76	3.32
11	121.4	58.43	10.12	591.31	4.87
13	157.2	19.13	14.48	277.00	1.76
15	198.0	14.37	20.73	297.89	1.50
17	190.0	8.39	31.12	61.10	1.37
19	178.0	3.36	41.15	138.26	0.78
21	151.0	0.92	39.71	36.53	0.24
Total		729.80		2734.42	20.12

Appendix 9. Stock table derived to estimate the current annual timber productivity (mean annual increment) of the mixed strata.

DBH Class (ins)	Ave. Age (yrs)	Present Stand Table (live trees/ acre)	Present Vol./tree DIB (cu. ft.)	Present Stock Table (cu. ft./ acre)	Current Ann. Vol. Prod. (cu. ft./ acre)
5	72.7	346.24	0.90	156.45	2.14
7	70.7	149.20	4.89	352.12	4.98
9	84.6	102.16	11.56	599.95	7.09
11	78.6	34.98	19.98	343.53	4.37
13	130.4	10.25	16.23	166.37	1.28
15	101.0	4.28	47.20	95.85	0.95
17	90.7	2.00	32.73	65.47	0.72
19		1.07	85.51	26.19	0.21
21	163.0	0.44	22.63	9.96	0.06
Total		650.62		1850.60	21.80

Appendix 10. Stock table derived to estimate the current annual timber productivity (mean annual increment) of the Batzulnetas stand.

DBH Class (ins)	Ave. Age (yrs)	Present Stand Table (live trees/ acre)	Present Vol./tree DIB (cu. ft.)	Present Stock Table (cu. ft./ acre)	Current Ann. Vol. Prod. (cu. ft./ acre)
5	97.8	363.56	0.88	319.93	3.27
7	102.3	230.17	3.08	708.92	6.95
9	126.3	120.57	7.00	843.99	6.70
11	153.8	51.48	12.58	647.62	4.23
13	166.4	27.88	19.82	552.58	3.32
15	201.5	10.48	28.92	303.08	1.50
17	196.0	3.50	33.50	117.25	0.60
19	170.0	1.86	49.01	91.16	0.54
21		0.64	56.03	35.86	0.21
Total		810.14		3620.39	27.32

Appendix 11. Stock table derived to estimate the current annual timber productivity (mean annual increment) of the Mile 20 stand.

DBH Class (ins)	Ave. Age (yrs)	Present Stand Table (live trees/ acre)	Present Vol./tree DIB (cu. ft.)	Present Stock Table (cu. ft./ acre)	Current Ann. Vol. Prod. (cu. ft./ acre)
5		32.32	0.95	30.70	0.26
7	137.7	137.42	3.21	441.12	3.20
9	162.1	123.06	6.59	810.97	5.00
11	160.1	109.07	11.83	1290.30	8.06
13	225.5	81.29	16.81	1366.48	6.06
15	224.4	25.14	25.01	628.75	2.80
17	291.0	5.59	34.52	192.97	0.66
19	162.0	2.98	36.43	108.56	0.67
Total		516.87		4869.85	26.71

Appendix 12. Stock table derived to estimate the current annual timber productivity (mean annual increment) of the Lost Creek/Trail Creek stand.

DBH Class (ins)	Ave. Age (yrs)	Present Stand Table (live trees/ acre)	Present Vol./tree DIB (cu. ft.)	Present Stock Table (cu. ft./ acre)	Current Ann. Vol. Prod. (cu. ft./ acre)
5	170.0	107.72	0.48	51.71	0.30
7	171.0	91.61	2.36	216.20	1.26
9	158.1	88.69	5.27	467.40	2.96
11	198.4	83.48	8.89	742.14	3.74
13	266.4	38.52	12.88	496.14	1.86
15	219.5	16.96	20.94	355.14	1.62
17	307.5	6.21	26.76	166.18	0.54
19	260.0	1.86	31.47	58.53	0.23
Total		435.05		2553.44	12.51

Appendix 13. Density of live trees by species for the three strata and stands measured along the Nabesna Road.

Open Strata	DENSITY OF LIVE TREES BY SPECIES (trees per acre)				
DBH Class* (inches)	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
5	63.96	94.25			
7	46.38	15.46			
9	34.30	1.04			
11	15.30	0.70			
13	4.98				
15	0.75				
17					
19					
21	0.19				
Total	165.86	111.45			
(%)	(59.8)	(40.2)			

* DBH class: diameter outside bark (DOB) midpoint values: (e.g., DBH class 5 includes trees from 4.0 inches to 5.9 inches DBH).

cont'd.
Appendix 13. Density of live trees by species for the three strata and stands measured along the Nabesna Road.

Closed Strata	DENSITY OF LIVE TREES BY SPECIES (trees per acre)				
DBH Class* (inches)	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
5	274.68	105.03			
7	152.54	20.61			
9	72.34				
11	58.43				
13	19.13				
15	14.37				
17	8.39				
19	3.36				
21	0.92				
Total	604.16	125.64			
(%)	(82.8)	(17.2)			

cont'd.
Appendix 13. Density of live trees by species for the three strata and stands measured along the Nabesna Road.

Mixed Strata	DENSITY OF LIVE TREES BY SPECIES (trees per acre)				
DBH Class* (inches)	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
5	53.86	115.41	115.41	23.08	38.47
7	27.48	11.78	82.45	19.63	7.85
9	23.76	14.25	49.89	7.13	7.13
11	11.13	3.18	15.90		4.47
13	9.11	1.14			
15	3.42		0.86		
17	2.00				
19	0.53		0.53		
21	0.44				
Total	131.73	145.76	265.04	49.84	58.22
(%)	(20.2)	(22.4)	(40.7)	(07.7)	(08.9)

cont'd
Appendix 13. Density of live trees by species for the three strata and stands measured along the Nabesna Road.

DENSITY OF LIVE TREES BY SPECIES
Batzulnetas (trees per acre)

DBH Class* (inches)	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
5	316.43	47.13			
7	219.84	3.46	3.44	3.44	
9	120.57				
11	45.92		2.78	2.78	
13	26.88		1.00		
15	10.48				
17	3.50				
19	1.86				
21	0.64				
Total	746.11	50.59	7.22	6.22	
(%)	(92.1)	(06.2)	(00.9)	(00.8)	

cont'd
Appendix 13. Density of live trees by species for the three strata and stands measured along the Nabesna Road.

Mile 20	DENSITY OF LIVE TREES BY SPECIES (trees per acre)				
DBH Class* (inches)	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
5	32.32				
7	137.42				
9	123.06				
11	109.07				
13	81.29				
15	25.14				
17	5.59				
19	2.98				
21					
Total	516.87				
(%)	(100.0)				

cont'd.
Appendix 13. Density of live trees by species for the three strata and stands measured along the Nabesna Road.

DENSITY OF LIVE TREES BY SPECIES

Lost Creek/Trail Creek (trees per acre)

DBH Class* (inches)	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
5	107.72				
7	91.61				
9	88.69				
11	83.48				
13	38.52				
15	16.96				
17	6.21				
19	1.86				
21					
Total	435.05				
(%)	(100.0)				

Appendix 14. McCarthy inventory sample site descriptions.

SITE #1
Location: 55.9 miles east of Chitina, 1.0 mile west of Swift Creek, north of the road*. T 5S, R 13E, S 28; SE 1/4, NE 1/4.

Elevation: 1700 feet Slope: 25% Aspect: north

Timber Type: Open white spruce/black spruce

Drainage: Moderately well drained soil.

SITE #2
Location: 30.0 miles east of Chitina, north of the road. T 5S, R 9E, S 13; SW 1/4, NW 1/4.

Elevation: 1500 feet. Slope: 7% Aspect: south

Timber Type: Closed white spruce/black spruce

Drainage: Moderately well drained soil.

SITE #3
Location: 31.5 miles east of Chitina, south of the road. T 5S, R 10E, S 30; NW 1/4, NW 1/4.

Elevation: 1400 feet Slope: 6% Aspect: southwest

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

SITE #4
Location: 33.2 miles east of Chitina, 7.9 miles west of Ruth Lake, north of the road. T 5S, R 10E, S 32; NE 1/4, NW 1/4.

Elevation: 1500 feet Slope: 8% Aspect: south

Timber Type: Open black spruce

Drainage: Moderately well drained soil.

* road = Chitina-McCarthy Road

SITE #5
Location: 33.2 miles east of Chitina, 7.9 miles west of Ruth Lake, south side of road. T 5S, R 10E, S 32; NE 1/4, NW 1/4.

Elevation: 1500 feet Slope: 8% Aspect: southwest

Timber Type: Open white spruce/black spruce

Drainage: Moderately well drained soil.

SITE #6
Location: 37.8 miles east of Chitina, 3.4 miles west of Ruth Lake, south side of road. T 6S, R 10E, S 12; SE 1/4 NW 1/4

Elevation: 1400 feet Slope: 5% Aspect: north

Timber Type: Closed white spruce/black spruce

Drainage: Moderately well drained soil.

SITE #7
Location: 27.9 miles east of Chitina, north side of road. T 5S, R 9E, S11; NE 1/4, SW 1/4.

Elevation: 1500 feet Slope: 5% Aspect: south

Timber Type: Closed aspen

Drainage: Moderately well drained soil.

SITE #8
Location: 33.4 miles east of Chitina, 4.1 miles east of Gilahina River, south side of road. T 5S, R 10E, S 32; SE 1/4, NW 1/4.

Elevation: 1500 feet Slope: 4% Aspect: south

Timber Type: closed white spruce

Drainage: Moderately well drained soil.

SITE #9
Location: 38.4 miles east of Chitina, 5.0 miles east of Gilahina River, north side of road. T 6S, R 10E, S12; SW 1/4, NE 1/4.

Elevation: 1500 feet. Slope: 6% Aspect: south

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

SITE #10
Location: 42.4 miles east of Chitina, 16.4 miles west of Lakina River, north of road. T 6S, R 11E, S 10; NE 1/4, NE 1/4.

Elevation: 1400 feet Slope: 6% Aspect: north

Timber Type: Open black spruce.

Drainage: Somewhat poorly drained soil.

SITE #11
Location: 43.0 miles east of Chitina, 1.4 miles west of Lakina River, north side of road. T 6S, R 11E, S 2; SE 1/4, SW 1/4.

Elevation: 1450 feet Slope: 6% Aspect: south

Timber Type: Closed white spruce/aspen

Drainage: Moderately well drained soil.

SITE #12
Location: 42.9 miles east of Chitina, 1.5 miles west of Lakina River, north side of road. T 6S, R 11E, S 2; SE 1/4, SW 1/4

Elevation: 1450 feet Slope: 4% Aspect: north

Timber Type: Closed white spruce/paper birch

Drainage: Well drained soil.

SITE #13
Location: 48.7 miles east of Chitina, 2.8 miles east of the east end of Long Lake, north side of road. T 6S, R 12E, S 5; NE 1/4, NE 1/4.

Elevation: 1600 feet Slope: 15% Aspect: south

Timber Type: Closed aspen

Drainage: Well drained soil.

SITE #14
Location: 54.3 miles east of Chitina, 2.7 miles west of Swift Creek, south side of road. T 5S, R 13E, S 32; NE 1/4, NW 1/4.

Elevation: 1600 feet Slope: 6% Aspect: south

Timber Type: Open white spruce/ black spruce

Drainage: Somewhat poorly drained soil.

SITE #15
Location: 53.8 miles east of Chitina, 3.2 miles west of Swift Creek, north side of road. T 5S, R 13E, S 30; SE 1/4, SW 1/4.

Elevation: 1700 feet Slope: 10% Aspect: south

Timber Type: Open white spruce

Drainage: Moderately well drained soil.

SITE #16
Location: 60.7 miles east of Chitina, 6.3 miles west of Swift Creek, north side of road. T 6S, R 12E, S 3; NE 1/4, NE 1/4.

Elevation: 1650 feet Slope: 20% Aspect: south

Timber Type: Open white spruce/black spruce

Drainage: Moderately well drained soil.

SITE #17
Location: 59.1 miles east of Chitina, 7.9 miles west of Swift Creek, north side of road. T 6S, R 12E, S 4; NE 1/4, NW 1/4.

Elevation: 1600 feet Slope: 14% Aspect: south

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

SITE #18
Location: 44.3 miles east of Chitina, south side of road. T 6S, R 11E, S 1; SE 1/4, SE 1/4.

Elevation: 1400 feet Slope: 0% Aspect: none

Timber Type: Closed white spruce/black cottonwood

Drainage: Somewhat poorly drained soil.

SITE #19
Location: 51.4 miles east of Chitina, north side of road. T 5S, R 12E, S 35; NE 1/4, SW 1/4.

Elevation: 1650 feet Slope: 4% Aspect: south

Timber Type: Open white spruce

Drainage: Moderately well drained soil.

SITE #20
Location: 3.1 miles east of Chitina, north side of road. T 4S, R 6E, S 8; SW 1/4, NW 1/4.

Elevation: 600 feet Slope: 7% Aspect: north

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

SITE #21
Location: 4.8 miles east of Chitina, south side of road. T 4S, R 6E, S 17; SE 1/4, NE 1/4.

Elevation: 800 feet Slope: 35% Aspect: south

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

SITE #22
Location: 7.1 miles east of Chitina, south side of road. T 4S, R 6E, S 15; SW 1/4, NE 1/4.

Elevation: 1100 feet Slope: 10% Aspect: south

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

SITE #23
Location: 14.5 miles east of Chitina, north side of road. T 4S, R 7E, S 16; NW 1/4, SE 1/4.

Elevation: 1200 feet Slope: 3% Aspect: south

Timber Type: Open white spruce/black spruce

Drainage: Somewhat poorly drained soil.

SITE #24
Location: 17.7 miles east of Chitina, south side of road. T 4S, R 8E, S 30; NE 1/4, NW 1/4.

Elevation: 1300 feet Slope: 25% Aspect: south

Timber Type: Open white spruce/black spruce

Drainage: Well drained soil.

SITE #25

Location: 8.8 miles east of Chitina, north side of road. T 4S, 6 E, S 13; SW 1/4, NW 1/4.

Elevation: 1200 feet Slope: 17% Aspect: south

Timber Type: Closed white spruce

Drainage: Moderately well drained soil.

Appendix 15. Gross volume inside bark by sample site and species for the McCarthy timber inventory.

Site #	Total Site Volume	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
	GROSS VOLUME INSIDE BARK (cubic feet per acre) (number of trees)					
1	1271.70	1231.15 (7)	40.55 (2)			
2	1126.95	24.60 (1)	1102.35 (12)			
4	26.58		26.58 (1)			
5	568.99	62.55 (6)	6.44 (1)			
6	2383.85	2373.71 (10)	10.14 (1)			
7	4929.80			4929.80 (14)		
8	1840.12	1840.12 (11)				
9	1567.44	1567.44 (9)				
10	161.33	161.33 (5)				
11	5367.03	5.95 (1)		5361.08 (13)		
12	3131.06	3033.59 (10)				97.47 (2)
13	1657.41			1657.41 (8)		
14	35.18	31.21 (2)	3.97 (1)			
15	402.01	402.01 (5)				

cont.

Appendix 15. Gross volume inside bark by sample site and species for the McCarthy timber inventory.

	GROSS VOLUME INSIDE BARK (cubic feet per acre) (number of trees)					
Site #	Total Site Volume	white spruce	black spruce	quaking aspen	balsam poplar	paper birch
16	1201.53	1201.53 (7)				
17	2890.37	2890.37 (11)				
18	7997.48	7503.72 (18)			493.76 (4)	
19	882.31	882.31 (6)				
20	2973.81	2973.81 (12)				
21	1506.48	1506.48 (8)				
22	3641.89	3641.89 (15)				
23	1410.65	1399.54 (5)	11.11 (1)			
24	83.92	79.34 (2)	4.58 (1)			
25	2892.09	2892.09 (10)				

Appendix 16. Average ages of trees cored at breast height by sample site and species for the McCarthy timber inventory.

	AVERAGE AGE (years) (number of trees cored)		
Site #	white spruce	black spruce	quaking aspen
1	157.33 (3)		
2		143.00 (3)	
3	46.75 (4)		
4		58.00 (1)	
5	53.00 (3)		
6		110.75 (4)	
7			53.33 (3)
8	196.33 (3)		
9	43.25 (4)		
10		80.00 (2)	
11	34.00 (1)		57.67 (3)
12	93.00 (3)		
13			78.00 (2)
14	42.00 (1)	29.00 (1)	

cont.

Appendix 16. Average ages of trees cored at breast height by sample site and species for the McCarthy timber inventory.

	AVERAGE AGE (years) (# of trees cored)		
Site #	white spruce	black spruce	quaking aspen
15	48.50 (2)		
16	84.00 (3)		
17	89.25 (4)		
18	104.00 (5)		
19	72.67 (3)		
20	177.33 (3)		
21	147.33 (3)		
22	88.80 (5)		
23	39.50 (2)	43.00 (1)	
24	156.00 (1)	75.00 (1)	
25	78.00 (4)		

Appendix 17. Average DBH and height of saplings by sample site and species for the McCarthy timber inventory.

	AVERAGE DBH (inches) / AVERAGE HEIGHT (feet) (number of saplings)		
Site #	white spruce	black spruce	quaking aspen
4		2.17 / 16 (1)	
10		3.30 / 22 (4)	
11	3.03 / 29 (1)		3.82 / 50 (1)
12	2.87 / 18 (1)		
14	3.39 / 21 (1)		
16	3.19 / 21 (1)		
23	3.74 / 17 (1)		

Appendix 18. Average seedling height by species and sample site for the McCarthy timber inventory.

	SEEDLING HEIGHT (feet) (n = 1)		
Site #	white spruce	quaking aspen	balsam poplar
6	10		
7		2	7
11	14		
17	14		

Appendix 19. Number of trees dead by species and sample site for the McCarthy timber inventory.

	NUMBER OF DEAD TREES		
Site #	white spruce	black spruce	quaking aspen
2		1	
13			1
18	1		
21	3		

Appendix 20. Site drainage scale used in timber inventory (USDA, Forest Service and DNR, 1983).

1 Very poorly drained. Water table remains at or near the surface (above 45 cm or 18 in.) most of the year. Soils have a mucky or peaty surface horizon.

2 Poorly drained. Soil is wet much of the time, with water table seasonally near the surface for prolonged intervals. The water table is 45-90 cm (18-36 in.) and soils usually lack a mucky or peaty surface horizon.

3 Somewhat poorly drained. Soil is wet for significant periods, but not continuously, because of a slowly permeable layer or high water table (90-150 cm. or 36-60 in.). The soil has a very thick, dark A horizon due to the abundant growth of coarse grasses.

4 Moderately well drained. Soil is wet for a small but significant part of the year. The soil has a thick dark A horizon and indistinct mottling in the B horizon.

5 Well drained site. Water leaves the soil readily but not rapidly. The soil is intermediate in texture and lacks mottles.

6 Somewhat excessively drained site. Water leaves the soil rapidly. Soils may be shallow and are sandy and very porous.

7 Excessively drained site. Water leaves the soil very rapidly. Soils are very porous.

Appendix 21.

TIMBER INVENTORY DATA SHEET

Point No.:_____ Rank:_____-_____-_____

T:_____R:_____S:_____;_____1/4,_____1/4

Map:_____-___ Aerial Photo #:_____ Date:_____
Observers:_____ BAF:_____

Elevation:_____ Slope:_____ Aspect:_____
Drainage:_____ Veg Type:_____ Photo #'s_____

Tree spp.	Tree Hist	DBH in.	Ht. ft.	Crown Ratio	Crown Class	10 Yr & brk inc	Tree Age	Damage Class	Use Class

Comments:

Understory Species:

WRST Photo #'s:

Wildlife:

Appendix 22. Current timber permit stipulations (October, 1987), as delineated in the WRST Resource Management Plan (1984).

ADDENDUM TO HOUSE L0G HARVESTING PERMIT

Permit Number: _____

Beginning Date: _____

Expiration Date _____

Permittee: _____

Address: _____

Phone Number: _____

Individuals Assisting Permittee: _____

_____

Tree Location: _____

Logs Will Be Hauled To: _____

_____

Method of Tree Removal: _____

_____

Logs Will Be Used to Build: _____

_____

Building Location: _____

_____

Structure Plan Attached: YES NO

Tree Marking Paint Color and Symbol: _____

Species	Number of Trees
_____	_____
_____	_____

TOTAL TREE NUMBER: _____

PERMIT STIPULATIONS

1.This permit authorizes the removal of the above listed trees from public lands only for personal subsistence use only.

2. Only trees marked with _____ can be cut.

3. Ownership of any uncut marked trees or any felled trees not removed from public lands before expiration of the permit reverts to public domain.

4.No new roads or trails will be constructed.

5.Stumps will be flush cut to ground level where possible, if not stumps will be left no higher than snow level.

6.Slash will be lopped and scattered with pieces not greater than six feet in length. In no case will slash be left where it may accumulate in any body of water.

7. Trees must be limbed before they are skidded.

8. Any trees damaged during cutting or transporting operations will be felled and will count as part of the total number of trees authorized by the permit.

9.Tree skidding is permitted only when the ground is frozen and covered with a protective layer (minimum 12") of snow and ambient temperatures are below 32 degrees Fahrenheit.

10.No trees may be harvested from slopes steeper than 30% (i.e. 30 foot change in elevation over a 100 foot horizontal distance).

11. No trees may be harvested within 200 feet of any stream.

12. The permittee is responsible for securing permission to cross private property.

13. If during any operation under this permit the permittee discovers any cultural resources (i.e. stone chips, house pits, or abandoned cabins) or paleontological remains (bones, shells, fossils, etc.) he shall immediately notify the Superintendent and avoid the area until authorized to proceed, in writing by the Superintendent. The disturbance, destruction, or taking of any cultural, archeological, historical, paleontological, or similar objects or sites from public lands is prohibited by federal law. The requirement to notify and avoid until authorized to proceed is placed upon the permittee for his protection as well as protection of the resource.

14. All refuse, equipment, and personal property shall be removed from the harvest area by the expiration date of the permit.

15. Permits for others to cut wood in the same area may be issued by the Superintendent. The issuance of a permit does not give an individual exclusive rights in a given area.

I HAVE READ, UNDERSTAND, AND AGREE TO COMPLY WITH THE ABOVE CONDITIONS.

_____	_____
Permittee	Date
_____	_____
NPS Representative	Date

1) Permits are issued for live trees over three inches in diameter at breast height (DBH) for use as firewood or house logs.

2) The area of timber removal must be designated by a WRST representative.

3) The number of trees to be cut must be indicated on the permit.

4) The remaining density of trees must be indicated on the permit.

5) The necessary ground conditions for removal (frozen or snow covered) must be stated.

6) No permits are required for the cutting or collecting of dead or downed wood or live trees less than three inches DBH.

The following conditions accompany the permit:

1) Trash and fuel containers must be packed out.

2) Only existing trails or dry stream beds may be used, to reduce impact.

3) No new trail or routes may be created.

4) The discharge of oil or fuel is not permitted.

5) No fuel may be cached.

6) All State and Federal laws apply.

7) Timber harvest must occur at least 100 feet from live water.

Appendix 23.

NABESNA TIMBER PERMITS*

Harvest period (winter)	Firewood (cords**)	Houselogs
86 - 87	3	225
85 - 86	39	-
84 - 85	28	200
83 - 84	10	100
82 - 83	16	250
Total	96	775
Yearly Ave.	19.2	155
Total No. of Permits Issued	15	4

* The amount of unpermitted timber cut during this period is unknown. Timber cut from the Chisana area is included.

** A cord is computed as 128 square feet of timber.

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