FOREST RESOURCES ON STATE LANDS IN THE KENAI PENINSULA 2012

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I. EXECUTIVE SUMMARY

The inventory of forest resources within the Kenai Peninsula is the first comprehensive stand based inventory to be conducted by the Division of Forestry (DOF) in this area of the state. Funding for the project was made available in part through a reimbursable services agreement with the Alaska Energy Authority (AEA). AEA's interest in the project is to obtain biomass resource information in part to determine the feasibility of supplying woody biomass to peninsula communities. Ionia a small residential treatment facility located on 160 acres is adjacent to Kasilof. It looks to expand its use of biomass through the installation of additional solid wood Garn heating units. Seward seeks to heat several school buildings that are co-located together with biomass. It has not decided what form the biomass will take. Additionally, the community of Homer although not currently proposing a biomass project is not served by natural gas and may benefit from the use of biomass resources. These three communities are analyzed for a potentially operable biomass supply. Information contained within this report will aid AEA and DOF in forest planning activities as well as identifying suitable biomass resources. State lands that are included are classified in the Kenai Area Plan for a broad range of land uses including forestry (Table1). Lands classified for other uses are generally available for forestry because much of the area has been impacted by the spruce bark beetle. Timber harvest on these lands is generally viewed as a way to conduct forest rehabilitation with the intent of establishing new regeneration. The inventory comprises a total of 83,178 acres and summarizes field data collected during the summer of 2011. A total of 46,780 acres of timberland are present on this land. Total volume of these stands is 30,422,585 net cubic feet, 567,642 net tons and 96,755,359 net board feet (Table 2).

Land Classification	Acres	Percent
Agriculture	139	<1
Forestry	560	1
Forestry/Habitat	21,247	26
Forestry/Habitat/Public Recreation	361	<1
General Use	19,126	23
Materials	886	1
Public Facilities-Retain	1,452	2
Reserved Use Habitat	26,928	32
Settlement	12,477	15
Trail	2	<1
	83,178	100

Table 1. State land classification by acreage.

Inventory Area Land Classification	Acres
Timberland	46,780
Dwarf Forests	8,353
Non-Forest	28,045
Total Inventory Area:	83,178
Timberland Area by Timber Type Size Class	
Sawtimber	21,673
Sawtimber/Poletimber Mixed	16,122
Poletimber	4,122
Reproduction	4,863
Total Timberland Area:	46,780
Timberland Area by Timber Type Species Class	
Spruce	27,882
Spruce-Hardwood	8,066
Hemlock	791
Hardwood-Spruce	3,372
Hardwood	3,893
Black Spruce	2,776
Total Timberland Area:	46,780

Total Net Volume		
Cubic Feet (≥ 5”dbh)	Tons (≥ 5”dbh)	Board Feet (≥ 9”dbh)
30,422,585	567,642	96,755,359

Table 2. Inventory volume and acreage summary.

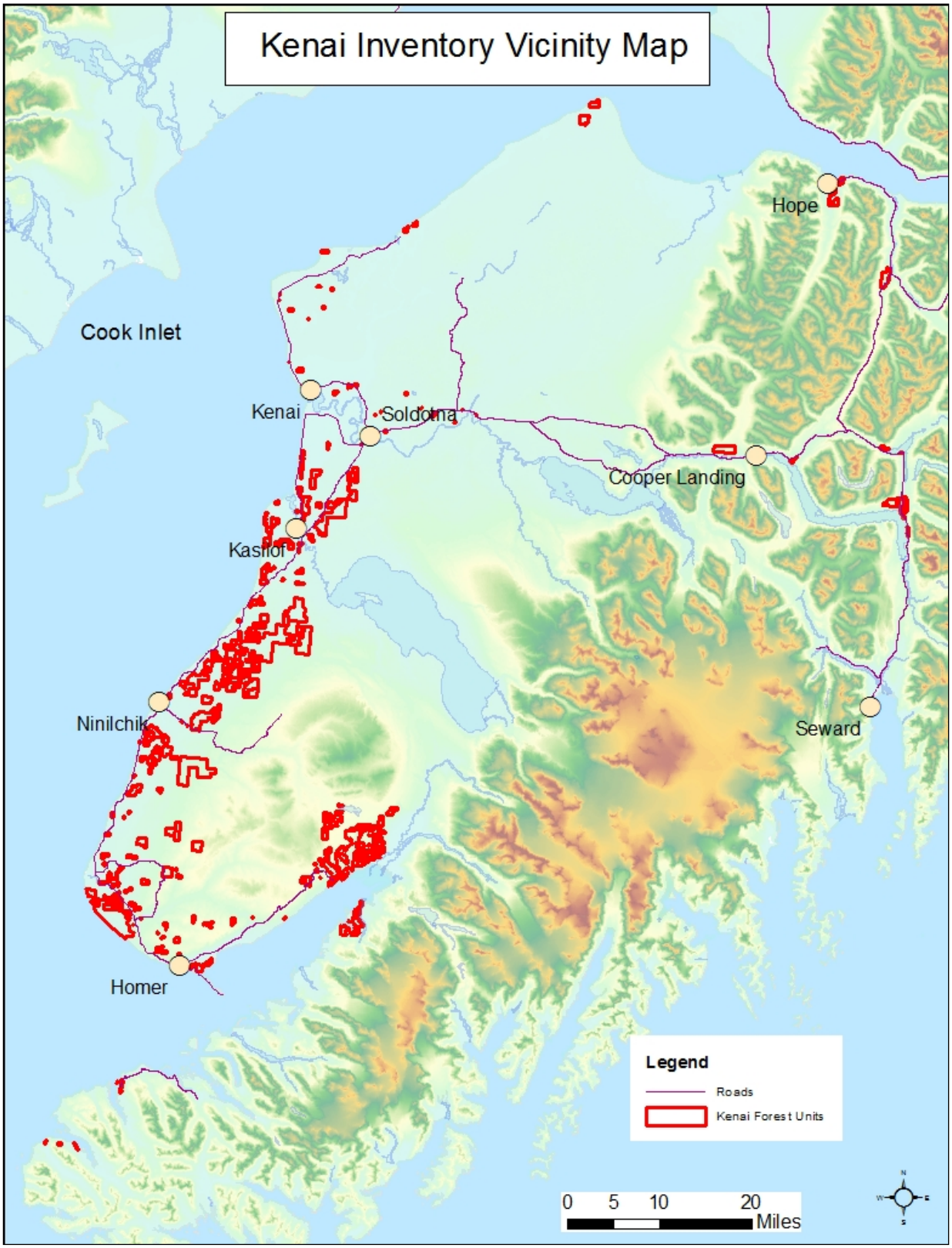


Figure 1. Project area vicinity map.

II. OBJECTIVES

The objective of this report is to provide reliable inventory data to assist in the management of forest resources on the Kenai Peninsula. Determination of an operable land base, sustainable harvest rate and harvest scheduling all require accurate volume data and geographically referenced spatial locations of individual stands. This data, both in spatial and tabular form can be used to assess the availability of timber and biomass resources and determine economic viability of proposed harvest development activities. The inventory provides the following items useful for development and planning:

- Spatially accurate stand polygons overlaid on geographically rectified photo base.
- Accurate acreage determination of forest cover.
- Statistically valid sampling design that produces a variety of tree and stand attributes.
- Field sampling of tree and stand productivity variables useful for determining sustainable harvest rates.
- Internet Geographic Information System (GIS) mapping access of spatial data with volume and acreage querying capabilities.
- Compatibility with Kenai Peninsula existing land cover classification.

III. METHODS

Forest inventory information was collected through a stratified random sampling design. The project area was divided into subpopulations (timber types) in order to account for variation in species composition, density and size class. Each timber type was then treated as a random sample population. The number of stands sampled within each timber type was based on the variability encountered in previous forest inventory and timber sale projects. A total of 91 individual timber stands were field sampled during the summer of 2011. These field samples comprise 910 individual measurement plots. The black spruce seedling/sapling type was not sampled and this type is considered non timberland dwarf timber. The sample timber types were selected randomly and access to the stands was by foot, or four-wheeler. Field measurements were made in the selected stands to provide estimates of volume, stocking, defect and growth by individual tree species.

A. Base Imagery

A mosaic dataset of Quickbird satellite scenes was utilized as the project's base imagery. These scenes acquired between 2006 and 2011 were utilized for the field sampling phase and provided a means to accurately navigate to individual sample stands. Timber type polygons, ownership boundaries, roads and sample stands were overlaid onto the base imagery. These scenes however were not used to classify the vegetation. Vegetation classification is discussed in the next section below.

B. Vegetation Classification

Vegetation classification was initiated through recommendations made from a multi-party task force established during the Kenai Peninsula spruce bark beetle outbreak. The task force generated numerous consensus policy recommendations, one of which was to produce a GIS database of forest stands and vegetation cover across the peninsula. In the vegetation typing

process, boundaries of individual features (polygons) were determined from the stereo image of 1996 true color and 1997, 1998 and 2001 color infrared 1:30,000 scale aerial photos. All vegetation was identified and timber stands were classified by species, size class and density. A priority was placed on accurately identifying spruce bark beetle killed forest. Vegetation was classified to a minimum mapping unit of 10 acres. The GIS database of forest stands and vegetation cover was clipped to the state ownership and forms the basis of the acreage estimates used in this report.

C. Field Inventory Design

The variable plot radius sampling method was used for field data collection of poletimber and sawtimber size trees. The basal area factor utilized was 20 square feet. In each timber stand sampled, ten plots were spaced uniformly on a traverse located systematically through the stand. The traverse was located in such a manner as to attempt to sample the variation within a stand. To minimize travel time, plots were generally located with a maximum interval of 330 feet. Tally trees were selected or rejected with a relascope prism. On five of the ten plots, species, tree vigor, crown ratio, defect type and estimated defect percentage, were recorded and tree diameter, total tree height, bark thickness, and ten-year growth were measured (measure plots). Tree diameters were measured 4.5 feet above ground, commonly known as "diameter breast height" or dbh. Co-dominate and dominant trees were cored at dbh to determine average age and site index of the sample stand. On the other alternating five plots, only the number of trees by species and size class selected by the relascope were recorded (count plots). Count plots generally serve to lower the sample error by increasing the overall plot numbers, but economize time spent in the field collecting data. Only trees five inches dbh and greater were measured utilizing the variable plot sampling method.

The fixed plot sampling method was used for field data collection of trees less than five inches dbh. At every other plot in the ten plot traverse (measure plots) seedling and sapling size trees were measured. Species and quality were recorded and tree diameter and total tree height were measured. The fixed plot was a circular $1/250^{th}$ acre plot (7.45 foot radius).

D. Data Summary

Upon completion of the field work, sampled stand data were entered into TCruise, a timber inventory software program. The inventory software calculated volume attributes for the individual sampled stands. These stands were then grouped into strata and re-processed in TCruise. The inventory contains eight separate sample strata for which estimates of gross and net volume per acre have been calculated. The strata contain field data from 91 individual timber stands containing 910 plots (Table 4). Field data from some sampled stands were similar enough to each other to allow combining of different stand timber types into like strata. Acreage of un-sampled timber types deemed similar enough was also included in the strata. Characteristics of these timber types were observed during the field work phase of the inventory. Acreage of sampled and un-sampled timber types and the corresponding strata are shown in the appendix. Total inventory volume was calculated by multiplying the average per acre volume figures for each stratum by the number of acres each sample stratum represents. These calculations were performed in a Microsoft Access database and utilize the GIS acreage figures. Output reports written in Access display numerous stand attributes from the associated database tables and queries.

LAND COVER KEY

FOREST SPECIES

A Aspen	BS Black Spruce
B Birch	WS White Spruce
CW Cottonwood	SS Sitka Spruce
HD Hardwood (Aspen, Birch, Cottonwood)	MH Mountain Hemlock

FOREST SIZE / DESCRIPTORS

1 Seedling/Sapling	< 5.0 inches DBH
2 Pole	5.0 inches to 8.9 inches DBH
3 Large (Sawtimber)	≥ 9.0 inches DBH
D Dead	

FOREST DENSITY

C	Closed	(60-100%)	Calls are based
O	Open	(25-59%)	on crown closure
W	Woodland	(10-24%)	percent.

OTHER LAND COVER

HVST	Harvest Area	OS	Other Shrub
GH	Grasses and Herbs	AGRI	Agriculture
GH_CC	Calamagrostis	MSH	Wetland
GH_TDL	Tidal	NF	Non-Forest
GH_OG	Other Grasses	BN	Barren/Snow Ice
ALD	Alder	DEV	Developed Area
WIL	Willow	W	Water

Table 3. Land cover key.

	Volume Strata	Acres	# of Plots	# of Stands
1	Needleleaf: Dead White or Sitka Spruce	21,673	210	21
2	Needleleaf: Live White or Sitka Spruce, Pole	1,346	130	13
3	Needleleaf: Live White or Sitka Spruce, Seedlings and Saplings	4,863	60	6
4	Needleleaf: Black Spruce, Pole Size or Larger	2,776	70	7
5	Needleleaf: Mountain Hemlock	791	70	7
6	Broadleaf: Pole Size or Larger	3,893	160	16
7	Mixed Forest: Broadleaf Dominating	3,372	80	8
8	Mixed Forest: Dead Needleleaf Dominating	8,065	130	13
		46,780	910	91

Table 4. Acreage and number of sampled plots and stands by volume strata.

E. Description of Strata

The eight volume strata are described below. Pictures are shown for selected strata where available. Generally the inventory project area is comprised of spruce dominated stands with lesser amounts of mostly birch hardwoods mixed in. The composition of birch increases moving south to north on the peninsula. The Ninilchik area forms the dividing line between mostly

spruce dominated lands to the south to a more mixed forest to the north. Spruce stands in all regions have a significant amount of beetle kill and much of the sawtimber and larger poletimber are dead. The classified vegetation layer identifies a broadleaf seedling/sapling timber type but upon field checking, these stands are mostly shrub and wetlands. These types instead are grouped in the non-forest shrub stratum.

1. *Stratum 1 Needleleaf: Dead White or Sitka Spruce*

This stratum is found throughout the project area but with heavier concentrations south of Kasilof. Most of the area of Sitka spruce (*Picea sitchensis*) is confined to the vicinity of Homer. Much of the remaining area is white spruce (*Picea glauca*) or Lutz spruce (*Picea x lutzii*). It is the largest in area of all the strata and comprises 46% of the total timberland area. Bark beetle mortality is severe in the stratum and many of the sawtimber and poletimber sized trees are dead. The infestation peaked in the early to mid nineties. The standing dead trees are generally suitable for fuelwood and biomass with little sawtimber potential. The average stratum age is 106 years though the true stand initiation date is likely older based on the dead tree age. The stem count (trees greater than 5" dbh) averages 113 trees per acre but 35% of the trees are dead leaving about 74 live trees per acre. The stratum contains 746 cubic feet per acre and 13 tons per acre but live trees account for only 387 cubic feet per acre and 8 tons per acre. Net yield is quite low when factoring in the standing dead and is 0.04 tons per acre per year (2 cubic feet per acre per year). However gross yield is significantly higher at over 4% and exceeds many strata from other regions of interior and south central state forest lands. This indicates the potential of stand growth on the Kenai Peninsula.

Figure 2. Stratum 1 Needleleaf: Dead White or Sitka Spruce.

2. *Stratum 2 Needleleaf: Live White or Sitka Spruce, Pole*

This stratum is found mostly south of the Ninilchik area. The majority of trees in this stratum are live white spruce poletimber. Defect averages around 9% and the average age is 144 years. The stem count totals 49 trees per acre with scattered dead sawtimber and poletimber size trees

that comprise about 24% of the total. The stratum contains 160 cubic feet per acre and 3 tons per acre. The net annual yield is 0.05 tons per acre per year (3 cubic feet per acre per year).

Figure 3. Stratum 2 Needleleaf: Live White or Sitka Spruce, Pole.

3. Stratum 3 Needleleaf: Live White or Sitka Spruce, Seedlings and Saplings

This stratum is also concentrated south of the Ninilchik area. It occurs mostly on poorly drained sites with a mixture of black spruce seedlings. The black spruce is non-commercial and for the most part is not going to develop into poletimber or sawtimber. There is however limited potential for biomass. Most trees are less than five inches dbh and total 742 per acre for black spruce and 200 per acre for white spruce.

4. Stratum 4 Needleleaf: Black Spruce, Pole Size or Larger

This stratum is found mostly north of the Ninilchik area. The trees in this stratum are dominated by black and white spruce at roughly equal amounts. Defect averages around 4% and the average age is 128 years. The stem count is 45 trees per acre and there is over 2,000 trees per acre of black spruce that are less than 5 inches dbh. For the most part these stands are similar to the un-sampled black spruce seedling/sapling dwarf type but with a somewhat higher poletimber component. The stratum contains 218 cubic feet per acre and 4 tons per acre. It has a net annual yield of 0.06 tons per acre per year (4 cubic feet per acre per year).

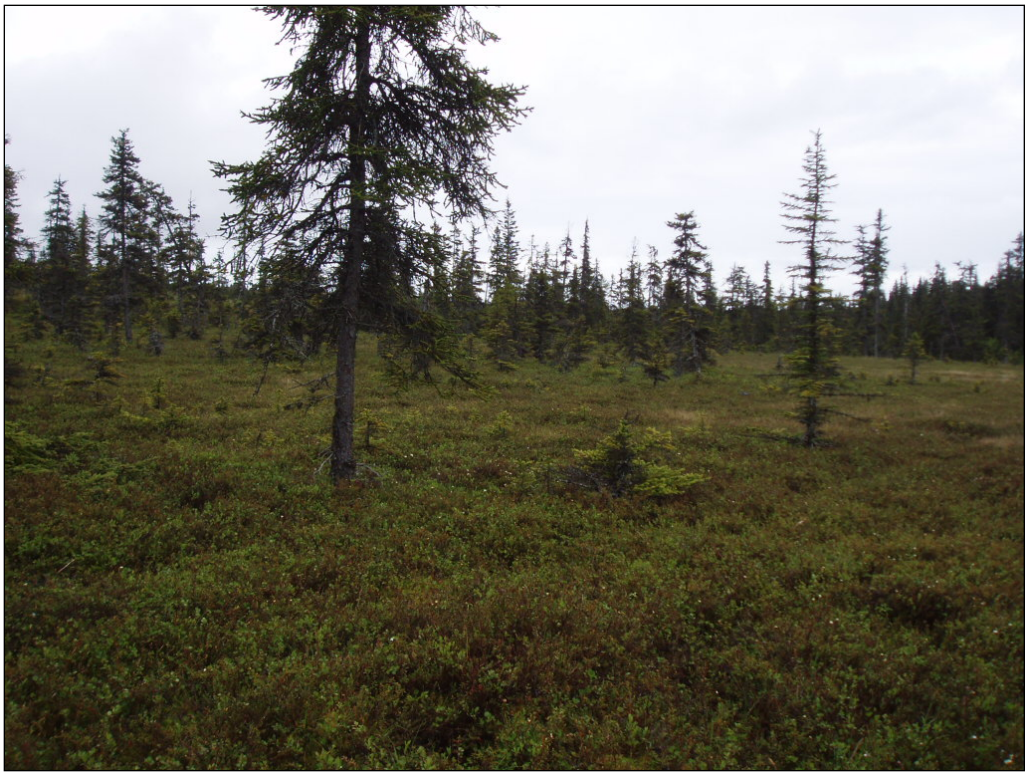


Figure 4. Stratum 3 Needleleaf: Live White or Sitka Spruce, Seedlings and Saplings.

5. *Stratum 5 Needleleaf: Mountain Hemlock*

This stratum is confined to the Cooper Landing area and along the Seward Highway. It contains the highest volume per acre in the inventory and is the oldest. Hemlock dominates the stratum with roughly 16% of the stocking comprised of spruce. Defect averages around 5% and rot indicators do not point to an excessive amount of hidden defect. The average age is 209 years. The stem count is 374 trees per acre. The stratum contains 3,029 cubic feet per acre, 60 tons per acre and 9,490 board feet per acre. It has a net annual yield of 0.93 tons per acre per year (46 cubic feet per acre per year).

6. *Stratum 6 Broadleaf: Pole Size or Larger*

This stratum is concentrated between Ninilchik and Clam Gulch. Birch and white spruce comprise near equal portions of the stocking with small amounts of black spruce, cottonwood and aspen. Defect is relatively high in the birch with most trees suitable for only fuelwood or biomass. The average age is 106 years. The stem count is 85 trees per acre. The stratum contains 493 cubic feet per acre. It contains 10 tons per acre and has a net annual yield of 0.32 tons per acre per year (15 cubic feet per acre per year).

Figure 5. Stratum 5 Needleleaf: Mountain Hemlock.

Figure 6. Stratum 6 Broadleaf: Pole Size or Larger.

7. Stratum 7 Mixed Forest: Broadleaf Dominating

This stratum is found in the Kasilof area along with some additional stands located near the Seward Highway in the Crown Point area. A variety of species is present with birch being the dominate hardwood. Birch has high defect and averages 26%. Average age is 113 years. The stem count is 156 trees per acre. The stratum contains 1,047 cubic feet per acre and 20 tons per acre. It has a net annual yield of 0.49 tons per acre per year (23 cubic feet per acre per year).

Figure 7. Stratum 7 Mixed Forest: Broadleaf Dominating.

8. Stratum 8 Mixed Forest: Dead Needleleaf Dominating

This stratum is found throughout the project area. The species mix is dominated by white spruce of which about one-half of the stems are dead. Birch is the dominate hardwood species. Average age is 114 years. The stem count is 156 trees per acre. The stratum contains 626 cubic feet per acre and 12 tons per acre. It has a net annual yield of 0.08 tons per acre per year (4 cubic feet per acre per year).

IV. RESULTS

A. Forest Volume Definitions

Estimates of timber volume on forested lands have been calculated with three different measurements; cubic foot volume, board foot volume and green tons. The cubic foot measurement includes all timber greater than or equal to five inches dbh and is divided among the live and dead poletimber and sawtimber components of the forest. The board foot measurement is commonly used to determine the amount of lumber that can be sawn from a log. Because the measurement is based on actual boards that can be sawn from a log, it disregards all

material wasted in the process such as slabs and sawdust. The board foot measurement only includes timber equal to or greater than 9 inches dbh.

Volume calculations for both cubic and board foot measurements are based on volume equations produced for Interior and South Central Alaska; U.S. Forest Service research notes NOR-5, NOR-6, PNW-59, National Volume Estimator Library (NVEL) and the University of Alaska Forest Growth and Yield Program. The NVEL volume equations are available on the internet as a Microsoft Excel add-in function. Board foot volume is reported in Scribner Decimal C scale and is based on 16-foot log segments (short log scale). For spruce and hemlock it is reported to a 6-inch top (PNW-59, NVEL) and for hardwoods to an 8-inch top (NOR-5). Cubic volume is reported in Smalian's rule and for spruce, hemlock and hardwoods includes volume to a 4-inch top (NOR-6, U of A, NVEL). Both live and dead volume is reported. Dead volume includes recently dead trees estimated to have died within the last 16 years.

Volume Formula Name	Volume Unit	Species	Formula
U of A	Cubic Foot 4-inch Top	White, Black and Sitka Spruce	(-0.8937)+0.9963*(0.00217*dbh^1.85171* ht^1.06907)+0.0488*dbh-0.00316*ht
NVEL A01DEMW000	Cubic Foot 4-inch Top	Mountain Hemlock	Region 10 Chugach National Forest http://www.fs.fed.us/fmsc/measure/index.shtml
NOR-6	Cubic 4-inch Top	Birch	(-2.5767)+0.9524*(dbh)-0.10446*(dbh)^2-0.03303*(ht)+0.00282*(dbh)^2*(ht)
NOR-6	Cubic 4-inch Top	Aspen	(-0.5553)-0.02216*dbh^2+0.00246*dbh^2*ht
NOR-6	Cubic 4-inch Top	Balsam Poplar	(-3.2187)+0.8281*(dbh)-0.05908*(dbh)^2-0.01985*(ht)+0.00199*(dbh)^2*(ht)
PNW-59	Board Foot Scribner 6-inch Top	White, Black and Sitka Spruce	39.71+4.2659*dbh-0.55865*dbh^2-1.1184*ht+0.016113*dbh^2*ht-437.92/dbh^2
NOR-5	Board Foot Scribner 8-inch Top	Birch and Aspen	(-27.263)+0.00995*dbh^2*ht
NOR-5	Board Foot Scribner 8-inch Top	Balsam Poplar	(-46.7415)+0.00956*dbh^2*ht
NVEL A01DEMW000	Board Foot Scribner 6-inch Top	Mountain Hemlock	Region 10 Chugach National Forest http://www.fs.fed.us/fmsc/measure/index.shtml

Table 5. Volume formulas by species for poletimber and sawtimber size classes.

Computation of green tons is derived from researched local values found in the Matanuska-Susitna area and utilized in the Mat-Su borough forest inventory report (Sanders 2006. *Matanuska-Susitna Borough: Forest Inventory Report.*). Hemlock values are from the

Engineering Toolbox (http://www.engineeringtoolbox.com/weigt-wood-d_821.html). The inventory cubic foot values are converted to green tons using these ratios (*table 6*).

Species	Pounds per Cubic Foot
White/Sitka Spruce	33
Black Spruce	45
Mountain Hemlock	41
Birch	55
Aspen	50
Cottonwood	50

Table 6. Weight by species for poletimber and sawtimber size classes.

B. Inventory Volume by Species

Inventory volume is reported below in Table 7 by tree species across all strata. When the entire volume by species is summed and divided by the timberland area of 46,780 acres there is an average volume of 650 net cubic feet per acre. Similarly, overall there is an average of 12 net tons per acre and 2,068 net board feet per acre. The values for cubic feet and tons are reported for trees equal to or greater than five inches dbh. Board foot values are reported for trees equal to or greater than nine inches dbh.

	Net CF/Ac.			Net Tons/Ac.			Net BF/Ac.		
Species	Live	Dead	Total	Live	Dead	Total	Live	Dead	Total
Aspen	19	1	20	<1	<1	<1	35	2	36
Birch	83	0	83	2	0	2	300	2	302
Black Spruce	9	3	12	<1	<1	<1	0	0	0
Cottonwood	4	0	4	<1	0	<1	10	0	10
Hemlock	53	1	54	1	<1	1	173	2	176
Sitka Spruce	31	40	70	1	1	1	125	176	300
White Spruce	211	196	407	3	3	7	526	718	1,244
Totals	409	241	650	8	4	12	1,169	899	2,068

Table 7. Volume per acre live and dead across all strata.

Table 8 reports inventory volume by species and size class across all strata. The sawtimber size class comprises 70% of the total net cubic volume or about 21,200,000 CF. The poletimber size class comprises 30% of the total net cubic volume or about 9,200,000 CF. Dead trees of both size classes comprise about 11,300,000 CF or a significant 37% of the total net cubic volume. The percentage is even higher for the sawtimber board foot volume where dead trees represent over 43% of the total net board foot volume.

		Gross Cubic Ft.	Net Cubic Ft.	Gross Tons	Net Tons	Gross Board Ft.	Net Board Ft.
Saw Live							
	Aspen	804,649	610,586	20,116	15,265	2,142,430	1,632,509
	Birch	4,137,385	3,147,667	113,778	86,561	18,946,542	14,040,185
	Cottonwood	85,928	78,050	2,148	1,951	533,500	462,744
	Hemlock	1,877,494	1,771,708	38,489	36,320	8,582,213	8,107,661
	Sitka Spruce	1,265,953	1,265,958	20,888	20,888	5,837,818	5,837,831
	White Spruce	5,491,290	5,353,679	90,606	88,336	25,446,509	24,602,404
	Total	13,662,699	12,227,648	286,025	249,321	61,489,012	54,683,334
Saw Dead							
	Aspen	22,622	23,474	566	587	67,844	70,349
	Birch	213,803	14,374	5,880	395	989,620	91,634
	Hemlock	24,189	23,431	496	480	105,780	102,727
	Sitka Spruce	1,791,401	1,780,875	29,558	29,384	8,243,458	8,212,378
	White Spruce	8,420,031	7,162,855	138,931	118,187	39,647,525	33,594,939
	Total	10,472,046	9,005,009	175,431	149,033	49,054,227	42,072,027
Pole Live							
	Aspen	291,107	278,480	7,278	6,962		
	Birch	825,845	733,941	22,711	20,183		
	Black Spruce	433,947	417,686	9,764	9,398		
	Cottonwood	90,075	88,089	2,252	2,202		
	Hemlock	709,343	693,645	14,542	14,220		
	Sitka Spruce	166,510	165,993	2,747	2,739		
	White Spruce	4,582,133	4,536,959	75,605	74,860		
	Total	7,098,960	6,914,793	134,899	130,564		
Pole Dead							
	Birch	83,860	8,506	2,306	234		
	Black Spruce	161,191	161,191	3,627	3,627		
	Hemlock	31,915	30,746	654	630		
	Sitka Spruce	78,599	78,624	1,297	1,297		
	White Spruce	2,044,394	1,996,070	33,733	32,935		
	Total	2,399,959	2,275,137	41,617	38,723		
	Grand Total						
		33,633,663	30,422,585	637,970	567,642	110,543,239	96,755,359

Table 8. Volume summary by size class and species across all strata.

C. Defect Estimates by Species

Defect renders portions of individual trees unusable or of very limited use as forest products due to physical damage such as forked stems, sweep and crook. Table 9 ranks the most common

defect types by species. Crook and sweep are the most common defect types for white spruce followed by broken tops. Broken tops are mostly found in the beetle killed trees. For birch the most common defect types are form related (forked top, crook) followed by rot indicators of scars and conks. Birch has the most amount of defect at almost 26% (*Table 10*).

	Defect Type						
Species	Broken Top	Conks	Crook	Forked Top	Frost Cracks	Scars	Sweep
Aspen	5	3	2	1	-	3	4
Birch	7	4	2	1	5	3	6
Black Spruce	3	-	1	2	-	-	3
Cottonwood	-	-	1	1	-	-	-
Hemlock	4	4	2	3	-	-	1
Sitka Spruce	1	-	-	1	-	-	-
White Spruce	2	4	1	2	3	3	1

Table 9. Defect type ranking by species.

Species	Gross Cubic Feet/Ac	Net Cubic Feet/Acre	Percent Defect
Aspen	24	20	18.4
Birch	112	83	25.8
Black Spruce	13	12	2.7
Cottonwood	4	4	5.6
Hemlock	56	54	4.7
Sitka Spruce	71	70	0.3
White Spruce	439	407	7.2
Total	719	650	9.5

Table 10. Cubic foot defect estimates by species across all strata.

D. Inventory Volume by Strata

Timber inventory results by stratum and species are shown in Figure 8 and Table 11. Detailed results by stratum are contained in the appendix.

Figure 8. Percent of total cubic foot net volume by strata.

	Net CUFT Per Acre	Total Net CUNITS	Net Tons Per Ac.	Total Net Tons	Net BDFT Per Acre	Total Net MBF
Stratum 1 Needleleaf: Dead White or Sitka Spruce = 21,673 Acres						
Aspen	16	3,384	0	8,460	36	774
Birch	51	11,043	1	30,369	224	4,853
Black Spruce	6	1,388	0	3,123		
Cottonwood	2	394	0	984		
Sitka Spruce	135	29,199	2	48,178	589	12,762
White Spruce	537	116,292	9	191,882	1,704	36,926
Totals	747	161,700	12	282,996	2,553	55,315
Stratum 2 Needleleaf: Live White or Sitka Spruce, Pole = 1,346 Acres						
Birch	12	158	0	435	36	48
Black Spruce	6	78	0	176		
White Spruce	142	1,911	2	3,152	382	515
Totals	160	2,147	2	3,763	418	563
Stratum 3 Needleleaf: Live White or Sitka Spruce, Seedlings and Saplings = 4,863 Acres						
Black Spruce	5	263	0	592		
White Spruce	105	5,099	2	8,414	406	1,977
Totals	110	5,362	2	9,006	406	1,977
Stratum 4 Needleleaf: Black Spruce, Pole Size or Larger = 2,776 Acres						
Birch	39	1,082	1	2,975	5	14
Black Spruce	40	1,114	1	2,507		
White Spruce	139	3,864	2	6,376	289	801
Totals	218	6,060	4	11,858	294	815
Stratum 5 Needleleaf: Mountain Hemlock = 791 Acres						
Aspen	6	49	0	123	21	16
Birch	30	237	1	652	61	48
Hemlock	2,659	21,044	55	43,140	8,478	6,710
Sitka Spruce	79	628	1	1,035	295	234
White Spruce	255	2,016	4	3,327	635	502
Totals	3,029	23,974	61	48,277	9,490	7,510
Stratum 6 Broadleaf: Pole Size or Larger = 3,893 Acres						
Aspen	19	740	0	1,850	81	314
Birch	138	5,361	4	14,743	528	2,054
Black Spruce	22	846	0	1,904		
Cottonwood	20	782	1	1,954	34	132
White Spruce	294	11,446	5	18,887	923	3,595
Totals	493	19,175	10	39,338	1,566	6,095
Stratum 7 Mixed Forest: Broadleaf Dominating = 3,372 Acres						
Aspen	122	4,127	3	10,319	119	403
Birch	220	7,432	6	20,437	646	2,177
Black Spruce	10	345	0	775		
Cottonwood	7	229	0	574	54	182
Hemlock	123	4,152	3	8,511	445	1,501
Sitka Spruce	92	3,088	2	5,096	313	1,054
White Spruce	472	15,915	8	26,261	1,616	5,449
Totals	1,046	35,288	22	71,973	3,193	10,766
Stratum 8 Mixed Forest: Dead Needleleaf Dominating = 8,066 Acres						
Aspen	10	825	0	2,062	24	196
Birch	170	13,732	5	37,762	612	4,936
Black Spruce	22	1,754	0	3,947		
Cottonwood	3	257	0	641	18	148
White Spruce	421	33,951	7	56,020	1,046	8,433
Totals	626	50,519	12	100,432	1,700	13,713
Grand Total		304,225		567,643		96,754

Table 11. Volume summary by timber type species class.

E. Inventory Volume of Sapling Size Trees

Inventory volume results are calculated for the sapling component and determine the green tonnage of this material that may be available as a biomass resource. These values represent the total above ground portion of the tree including branches and needles and use equations developed by the State of Alaska Division of Forestry for the Tok area. Due to inaccuracies in projecting weight of very small trees, the equations were only applied to trees with diameters between two and 4.9 inches dbh.

As can be seen in Table 13, most strata have a rather insignificant amount of additional tonnage in the sapling size class. Stratum 4, the black spruce pole stratum, has a significant number of sapling sized trees and has the most volume at over 7 tons per acre.

Species	Sapling Aboveground Green Weight in Pounds
Spruce, Hemlock	-51.272*dbh+11.28*dbh^2+3.752*Ht
Birch, Aspen, Cottonwood	-52.125*dbh+11.408*dbh^2+3.433*Ht

Table 12. Inventory sapling species and weight regression equations.

	Trees/Acre	Tons/Acre
Stratum 1 Needleleaf: Dead White or Sitka Spruce		
Black Spruce	38	0.5
Cottonwood	12	
Sitka Spruce	5	
White Spruce	64	1.0
Total Trees Per Acre	119	1.5
Stratum 2 Needleleaf: Live White or Sitka Spruce, Pole		
Black Spruce	27	0.2
White Spruce	31	0.1
Total Trees Per Acre	58	0.2
Stratum 3 Needleleaf: Live White or Sitka Spruce, Seedlings and Saplings		
Black Spruce	58	0.3
White Spruce	33	0.7
Total Trees Per Acre	91	1.0
Stratum 4 Needleleaf: Black Spruce, Pole Size or Larger		
Black Spruce	479	7.0
White Spruce	29	0.1
Total Trees Per Acre	508	7.2
Stratum 5 Needleleaf: Mountain Hemlock		
Birch	7	0.1
Hemlock	121	1.3
White Spruce	7	
Total Trees Per Acre	135	1.4
Stratum 6 Broadleaf: Pole Size or Larger		
Birch	9	0.3
Black Spruce	13	0.2
Cottonwood	3	0.1
White Spruce	59	0.8
Total Trees Per Acre	84	1.3
Stratum 7 Mixed Forest: Broadleaf Dominating		
Birch	50	3.0
Black Spruce	19	0.1
Hemlock	13	0.2
Sitka Spruce	19	
White Spruce	25	0.7
Stratum 8 Mixed Forest: Dead Needleleaf Dominating		
Black Spruce		
White Spruce	15	0.1
Total Trees Per Acre	85	0.9

Table 13. Number of trees 2-4.9” and tons per acre of saplings by strata.

F. Sampling Error by Volume

Sample error was calculated for the live gross cubic foot estimate by strata and size class (*Table 14*). The sample error percent is given within one standard deviation of the mean. This means that there is a 68% chance (one standard deviation) that the volume of the individual live size class components are within plus or minus the error percentage indicated. High variability and low numbers of pole and saw size trees resulted in high errors for strata 2, 3, and 4. Overall the combined error across strata was a more reasonable 4.3%.

		Live Poletimber		Live Sawtimber		Combined	
Stratum	Number of Plots	Gross CF/Ac	% Sampling Error	Gross CF/Ac	% Sampling Error	Gross CF/Ac	% Sampling Error
1	210	151	10.3	255	12.0	406	8.5
2	130	55	17.6	79	31.9	134	20.1
3	60	30	45.6	46	75.3	76	49.0
4	70	62	31.2	127	30.6	189	23.0
5	70	869	13.2	2,184	9.0	3,053	7.5
6	160	109	18.0	304	10.4	413	9.0
7	80	287	14.5	729	11.5	1,016	9.2
8	130	167	13.2	260	18.1	427	12.2
Total	910	161	6.8	368	5.4	529	4.3

Table 14. Gross live cubic foot percent sampling error.

A. Log Grade

Log grade estimates were made during field sampling. Log grade was only tallied for the live sawtimber sized trees (≥ 9 inches dbh). A grade was given for each of the first two 16-foot log segments. Log grades use Puget Sound grading rules, which contain specifications for various species. White spruce, Sitka spruce, Mountain hemlock and Black spruce were applied to the Puget Sound Sitka spruce rules. Aspen and birch were applied to red alder rules. The summary for white spruce trees in strata 1 and 8 and hemlock trees in stratum 5 is shown in Table 15. Log grade results were not computed by volume but do provide grade estimates in straight percentage terms of trees measured in the field. This gives a reference point for the grade distribution in each stratum. In stratum 1 the first white spruce 16-foot log was coded a number 3 (> 10-inch top, 50 bf minimum) in only 5% of the measurements. Over 80% of the measurements however, coded the first log segment as a number 4 log grade. In stratum 5 hemlock accounted for the most number 3 log grades and the first hemlock 16-foot log was coded a number 3 in 17% of the measurements. The Puget Sound grading rules and detailed results by species across all strata are shown in the appendix.

Strata	Species	First 16-Foot Log Grade	Second 16-Foot Log Grade	Percent of Measurements
1	White Spruce	3	4	5 %
1	White Spruce	4	4	50 %
1	White Spruce	4	Utility	24 %
1	White Spruce	Utility	Cull	7 %
1	White Spruce	4	Cull	10 %
1	White Spruce	Cull	Cull	5 %
5	Mountain Hemlock	2	2	1 %
5	Mountain Hemlock	2	3	2 %
5	Mountain Hemlock	3	3	1 %
5	Mountain Hemlock	3	4	14 %
5	Mountain Hemlock	3	Utility	2 %
5	Mountain Hemlock	4	4	24 %
5	Mountain Hemlock	4	Utility	19 %
5	Mountain Hemlock	4	Cull	8%
5	Mountain Hemlock	Utility	4	1 %
5	Mountain Hemlock	Utility	Utility	18 %
5	Mountain Hemlock	Utility	Cull	9 %
5	Mountain Hemlock	Cull	Cull	2 %
8	White Spruce	3	5	6 %
8	White Spruce	4	Cull	45 %
8	White Spruce	4	4	6 %
8	White Spruce	4	5	28 %
8	White Spruce	5	Cull	11 %
8	White Spruce	Cull	Cull	6 %

Table 15. Log grade for strata 1, 5 and 8.

V. FOREST PRODUCTIVITY

A. Site Index

Tree height has been found as the most reliable indicator of site productivity. In essence, the taller the tree the more productive is the growing site. When height is combined with tree age, the measurements can be reported as a site index number. This number gives the height in feet of a particular stand at a reference base age. Site index of spruce and hemlock uses a base age of 100 years whereas site index of hardwoods uses a base age of 50 years. Site index reflects the combined effect of all environmental factors and is therefore a good index of stand productivity. Site index calculations for white spruce are based on site index equations produced for Interior Alaska: U.S. Forest Service research paper PNW-53. The white spruce PNW-53 values were also applied to Sitka spruce and Mountain hemlock. Site index calculations for birch and aspen are based on site index equations produced for Interior Alaska; U.S. Forest Service research paper NOR-2. The aspen NOR-2 values were also applied to the Cottonwood measurements. In Tables 17 and 18 the white spruce and birch average sample stand site indices were prorated by the strata acreage to give an estimated distribution of sites across the project area.

Stratum	White Spruce	Sitka Spruce	Site Index Hemlock	Birch	Cottonwood
1	54	84		53	
2	36			34	
3	40				
4	57				
5	48		43	43	
6	63			37	52
7	61	68	46	38	38
8	52			43	
Average	53	77	43	39	47

Table 16. Site index by strata and species,

	Site Index 20-30	30-40	40-50	50-60	60-70	70-80	80-90
Stratum	Acres						
1	1,204	2,408	2,408	7,224	7,224	1,204	
2	367	489	367	122			
3	1,216	1,216		1,216	1,216		
4			1,110		555	1,110	
5		264	264	264			
6	389	389	389	389	1,168	389	779
7				2,248	562	562	
8		1,613	4,033		807	1,613	
Percent	9%	16%	21%	21%	19%	10%	3%

Table 17. White spruce site index (acres) by strata.

	Site Index 20-30	30-40	40-50	50-60	60-70	70-80	80-90
Stratum	Acres						
1				21,673			
2		1,346					
3							
4							
5			791				
6	1,168	1,557	779	389			
7		3,372					
8		1,613	6,453				
Percent	3%	20%	20%	56%	0%	0%	0%

Table 18. Birch site index (acres) by strata.

B. Timberland Area Age Class

Forest productivity can also be examined in terms of overall age class distribution. Typically as trees become older productivity declines. Hardwoods generally begin to decline after year 80 or 90 when rot becomes more frequent. White spruce is longer lived, but generally starts to decline

after year 180. At this age white spruce becomes more susceptible to rot and insect damage. Mountain Hemlock is longer lived and can reach ages in excess of 300 years. *Table 19* shows age class distribution in acres and percent of the total acreage. Roughly 45% of the timberland acreage is between 100 and 150 years of age and less than one quarter of the acreage is between 60 and 90 years of age which is optimum for birch quality. The decline of birch quality is evident in many of the stands and is reflected in the age class distribution where 73% of the stand acreage is in age classes that are over mature for birch. Stand age in stratum one is likely older than the reported age of 103 in Table 20 but most of the larger and older size classes are dead. This age mostly reflects the residual pole and small sawtimber component in these stands.

Stand Age Class	Average Age	Acres	Percent of Total
40 - 50	48	514	1%
50 - 60	54	1,542	3%
60 - 70	64	4,113	9%
70 - 80	75	2,570	5%
80 - 90	86	4,113	9%
90 - 100	94	3,598	8%
100 - 110	105	5,655	12%
110 - 120	115	6,169	13%
120 - 130	123	2,056	4%
130 - 140	136	3,084	7%
140 - 150	144	4,113	9%
150 - 160	158	514	1%
160 - 170	166	3,084	7%
170 - 180	173	2,056	4%
190 - 200	198	514	1%
210 - 220	219	514	1%
230 - 240	232	1,028	2%
240 - 250	240	514	1%
250 - 260	252	514	1%
290 - 300	291	514	1%
Weighted Average	120	46,780	100%

Table 19. Percent of area by age class.

Stratum	Description	Average Age
1	Needleleaf: Dead White or Sitka Spruce	103
2	Needleleaf: Live White or Sitka Spruce, Pole	141
3	Needleleaf: Live White or Sitka Spruce, Seedlings and Saplings	112
4	Needleleaf: Black Spruce, Pole Size or Larger	125
5	Needleleaf: Mountain Hemlock	206
6	Broadleaf: Pole Size or Larger	103
7	Mixed Forest: Broadleaf Dominating	110
8	Mixed Forest: Dead Needleleaf Dominating	111

Table 20. Average age by strata.

C. Regeneration

Another measure of productivity is whether individual timber stands are being replaced by regeneration. The spruce bark beetle has killed much of the larger trees on the peninsula and understory regeneration is critical in restoring the historical stocking in these stands. Regeneration of desirable and acceptable crop trees was generally adequate across the strata but the stocking is likely below levels needed for rapid restoration of white spruce stands (van Hees.2005. *Spruce Reproduction Dynamics on Alaska's Kenai Peninsula*). In some cases the distribution of regeneration is poor and is evident in the mixed strata were grass competition is significant. Table 21 gives numbers of trees per acre less than 5 inches by species and stratum. Trees are of desirable and acceptable quality as determined in the field sample. Undesirable trees not expected to become future crop trees are not included in the table.

	Number of Trees Per Acre < 5" dbh							
Strata #	Mountain Hemlock	Sitka Spruce	White Spruce	Black Spruce	Birch	Aspen	Cottonwood	Total
1		7	274	40	60		43	424
2			127	212	8			346
3			200	742				942
4			93	2,086				2,179
5	2,371	14	29			7		2,421
6			119	13	206	6	9	353
7	50		138	19	50			256
8			188	146	4			338

Table 21. Number of trees per acre less than 5 inches dbh by species and strata.

D. Growth and Mortality Estimates

Growth estimates have been determined through projections made with the timber cruise software TCruise (Table 22). The software projects growth by utilizing 10 year diameter growth increment and bark thickness measurements collected in the field. By collecting both of these variables, the software is able to discount changes in bark thickness that would affect the accurate determination of diameter growth. The software calculates a diameter-height regression (displayed in the appendix) and then applies the projected heights to the new grown diameters. These diameter and height pairs are then processed through the volume tables to calculate gross growth. A growth projection interval of 10 years (2011-2021) is used and then the increased volume growth is divided by 10 to calculate an annual growth rate. This volume figure was then divided by the growing stock base (live tree volume) to calculate a percentage growth rate (gross growth). Diameter-height relationships, diameter growth and calculated bark thickness ratios (Husch et al. 2002. *Forest Mensuration, Fourth Edition.*) are shown in the appendix. Mortality estimates have been determined by dividing the recently dead volume estimates by 16 to get annual mortality. The 16 year time period corresponds to the beginning of the bark beetle infestation on the Kenai Peninsula. These trees were easily identified during the field measurements as bark beetle killed trees. The net growth (gross growth minus mortality) is exceedingly small due to the massive mortality rates. The gross growth figures may be a better indicator of the future growth potential considering that the bark beetle outbreak has mostly run its course. Gross growth rates somewhat exceed Forest Service estimates of between 2 and 3% (softwoods) and up to 4% (hardwoods) on unmanaged interior boreal forests (Smith et al. 2007. *Forest Resources of the United States,* 2007).

	Strata Description	% Annual Gross Growth	% Annual Mor-tality	% Annual Net Growth	CF/Ac/ Yr Gross Growth	CF/Ac/ Yr Net Growth	Tons/Ac /Yr Gross Growth	Tons/Ac /Yr Net Growth
1	Dead White/Sitka	6.29%	5.80%	0.49%	24	2	0.50	0.04
2	Live White/Sitka Pole	3.87%	1.56%	2.31%	5	3	0.08	0.05
3	Live White/Sitka Seed Sap	4.04%	3.17%	0.87%	3	1	0.04	0.01
4	Black Spruce Pole	3.55%	1.40%	2.15%	6	4	0.11	0.06
5	Mountain Hemlock	1.92%	0.31%	1.61%	55	46	1.11	0.93
6	Broadleaf Pole/Saw	6.20%	2.19%	4.01%	23	15	0.50	0.32
7	Mixed: Broadleaf Dom.	3.47%	0.91%	2.56%	32	23	0.66	0.49
8	Mxd: Dead Needleleaf Dm	5.52%	4.47%	1.05%	20	4	0.44	0.08
	Total Growing Stock	4.11%	3.68%	0.43%	**17**	**2**	**0.31**	**0.03**

Table 22. Growth and mortality estimates.

VI. SUSTAINED YIELD ESTIMATES

Estimates of sustained yield have been made for the inventory project area. Spruce and mixed timber types use a rotation age of 120 years which includes 10 years for establishment. Hardwood timber types use a rotation age of 80 years which includes 10 years for establishment. The sustained yield has been calculated using area control, which divides the acreage of each stratum by the rotation age. A total of 406 acres per year is the sustained yield on these lands. Dead trees account for over 37% of the cubic volume and 43% of the board foot volume.

#	Strata Description	Acres	Rota-tion	Ac./ Yr.	Net CF/ Ac.	Net CF/ Yr.	Net Tons/ Ac.	Net Tons/ Yr.	Net BF/ Ac.	Net BF/ Yr.
1	Dead White/Sitka	21,673	120	181	747	134,914	12	2,167	2,553	461,093
2	Live White/Sitka Pole	1,346	120	11	160	1,795	2	22	418	4,689
3	Live White/Sitka Seed Sap	4,863	120	41	110	4,458	2	81	406	16,453
4	Black Spruce Pole	2,776	120	23	218	5,043	4	93	294	6,801
5	Mountain Hemlock	791	120	7	3,029	19,966	61	402	9,490	62,555
6	Broadleaf Pole/Saw	3,893	80	49	493	23,991	10	487	1,566	76,205
7	Mixed: Broadleaf Dom.	3,372	120	28	1,046	29,393	22	618	3,193	89,723
8	Mxd: Dead Needleleaf Dom.	8,066	120	67	626	42,078	12	807	1,700	114,268
	Totals	**46,780**		**406**		**261,637**		**4,677**		**831,788**
	Species Totals									
	Aspen					7,954		84		15,539
	Birch					34,770		910		126,361
	Black Spruce					5,109		23		0
	Cottonwood					1,733		49		4,382
	Hemlock					20,984		447		68,389
	Sitka Spruce					27,488		424		117,118
	White Spruce					163,599		2,740		499,999
	Totals					**261,637**		**4,677**		**831,788**

Table 23. Sustained yield estimate.

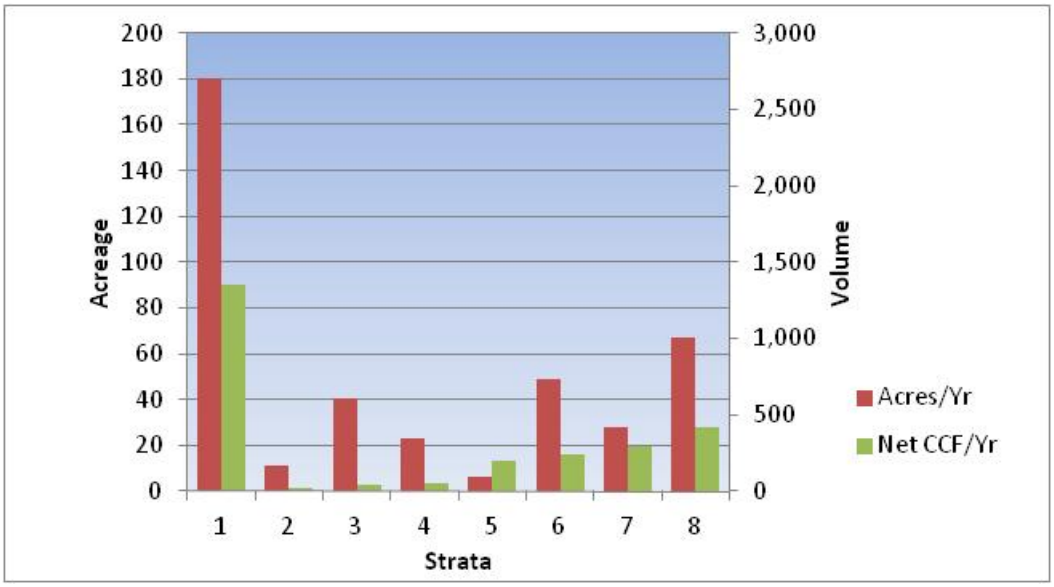


Figure 9. Sustained yield comparison between strata, total timberland area.

VII. ECONOMIC AVAILABILITY OF SUSTAINABLE BIOMASS FUELS

The economics of available biomass is examined in context to three communities in the project area; Ionia which is located near Kasilof, Seward and Homer. Additional Garn solid wood boilers are proposed to be installed in Ionia and Seward is evaluating the use of biomass for heating its school buildings. Homer currently does not have plans for biomass but it is not served by natural gas and a potential may exist for Homer to develop biomass resources. For biomass projects to be successful an accurate estimate of an economic and sustainable raw material supply is needed. This is especially important in Alaska because there is little urban, logging residue or wood manufacturing wood waste available as a supplemental biomass resource. Energy plantations of fast growing woody crops are also not available. For the most part, the biomass supply for these projects will consist solely of harvested firewood and commercial grade timber. When biomass is used in this form it is referred to as "fuelwood". This is the most expensive of biomass sources (Ashton et al. 2008. *Woody Biomass Desk Guide and Toolkit*). This supply scenario is quite different than the Lower 48 where biomass projects generally rely on a combination of urban wood waste, mill waste and logging residues.

Delivered firewood costs to the three communities are quite variable depending on the extent of processing, volume and load configuration. Much of the wood is beetle killed spruce and is being sourced from State of Alaska timber sales located between Kenai and Anchor Point. Prices range from around $100.00 to $200.00 per cord. Prices are roughly 50% higher if the material is delivered to Seward. Average haul distances from the sale areas to Kasilof/Homer are 10-30 miles and to Seward 120 miles.

A. Volume Availability Ionia/Kasilof

Volume availability on an annual basis is determined by utilizing the inventory growth rates. The gross growth rates indicated in Table 22 are 17 cubic feet per acre. Using an average 90 cubic feet of solid wood per cord (Sturgeon 1979. *Wood As A Fuel*) the forest is increasing in volume by about 2-tenths of a cord per acre per year. In its simplest form, if timber harvest is equivalent to projected growth, then the harvest would be considered sustainable over the long term. Timber stands between Ninilchik and Kasilof (Figure 10) are considered mostly accessible to Ionia and are considered in this analysis. The State Division of Forestry has several timber sales listed in its 2011-2015 Five Year Schedule of Timber Sales within this area. The annual volume availability is determined by multiplying gross growth percentages by strata by the Ninilchik-Kasilof volume estimates. In addition to this amount the dead volume is also included and is considered wholly available. The volume of dead however will continue to decline as trees fall down. In addition to the 40,324 cords of dead wood, projected gross growth in these units is estimated to be 3,839 cords per year. This volume could be made available for about $150.00 per cord.

B. Volume Availability Seward

Timber stands in the vicinity of the Hope Road turnoff, Cooper Landing and Crown Point (Figure 11) are considered mostly accessible to Seward and are considered in this analysis. Although currently the State Division of Forestry does not have timber sales listed in its 2011-2015 Five Year Schedule of Timber Sales within this area, timber sales could be scheduled if a demand materialized. In addition to the 6,668 cords of dead wood, projected gross growth in these units is estimated to be 1,106 cords per year. This volume could be made available for about $225.00 per cord.

C. Volume Availability Homer

Timber stands between Ninilchik and the head of Kachemak Bay (Figure 12) are considered mostly accessible to Homer and are considered in this analysis. The State Division of Forestry has several timber sales listed in its 2011-2015 Five Year Schedule of Timber Sales within this area. In addition to the 69,112 cords of dead wood, projected gross growth in these units is estimated to be 4,752 cords per year. This volume could be made available for about $150.00 per cord.

Stratum	Acres	Dead Cords	Dead Tons	Annual Growth Cords	Annual Growth Tons	Total Available Cords	Total Available Tons
1	2,344	9,350	13,915	634	1,050	9,984	14,965
2	150	52	78	8	13	60	91
3	1,795	746	1,108	59	90	805	1,198
4	2,759	1,219	1,984	194	348	1,413	2,332
5	0	0	0	0	0	0	0
6	3,290	4,672	7,147	827	1,618	5,499	8,765
7	1,004	1,487	2,268	354	665	1,841	2,933
8	7,865	22,798	34,363	1,763	3,509	24,561	37,872
Totals	19,207	40,324	60,863	3,839	7,293	44,163	68,156

Table 24. Sustainable available volume Ionia/Kasilof area.

Stratum	Acres	Dead Cords	Dead Tons	Annual Growth Cords	Annual Growth Tons	Total Available Cords	Total Available Tons
1	828	3,303	4,916	224	371	3,527	5,287
2	0	0	0	0	0	0	0
3	664	276	410	22	33	298	443
4	0	0	0	0	0	0	0
5	714	1,140	1,888	440	800	1,580	2,688
6	161	229	350	41	79	270	429
7	1,035	1,532	2,336	364	685	1,896	3,021
8	65	188	283	15	29	203	312
Totals	3,467	6,668	10,183	1,106	1,997	7,774	12,180

Table 25. Sustainable available volume Seward area.

Stratum	Acres	Dead Cords	Dead Tons	Annual Growth Cords	Annual Growth Tons	Total Available Cords	Total Available Tons
1	16,942	67,579	100,572	4,583	7,589	72,162	108,161
2	1,164	406	603	64	103	470	706
3	2,302	956	1,420	75	115	1,031	1,535
4	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0
6	120	171	261	30	59	201	320
7	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0
Totals	20,528	69,112	102,856	4,752	7,866	73,864	110,722

Table 26. Sustainable available volume Homer area.

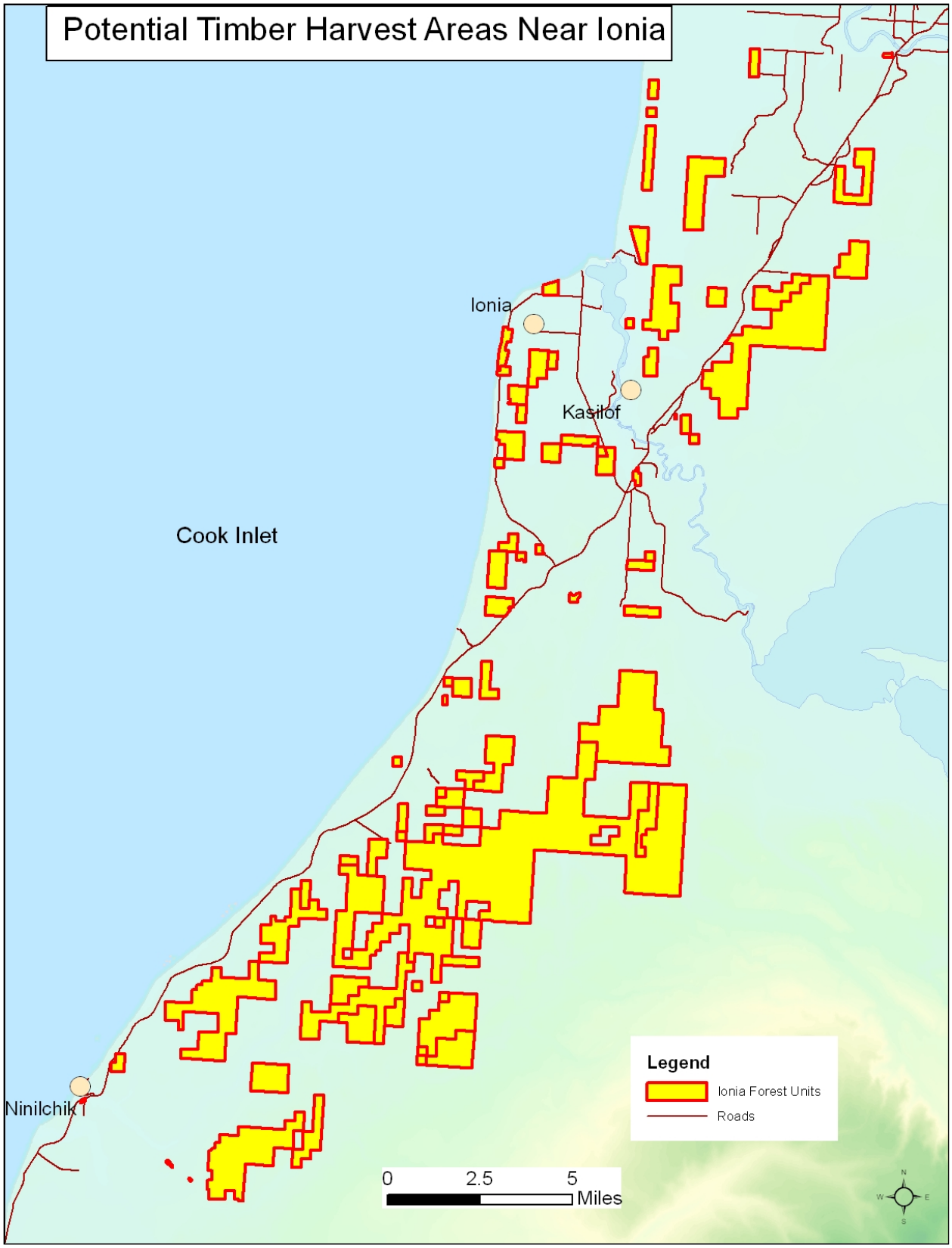


Figure 10 Forest units near Ionia.

Figure 11. Forest units near Seward.

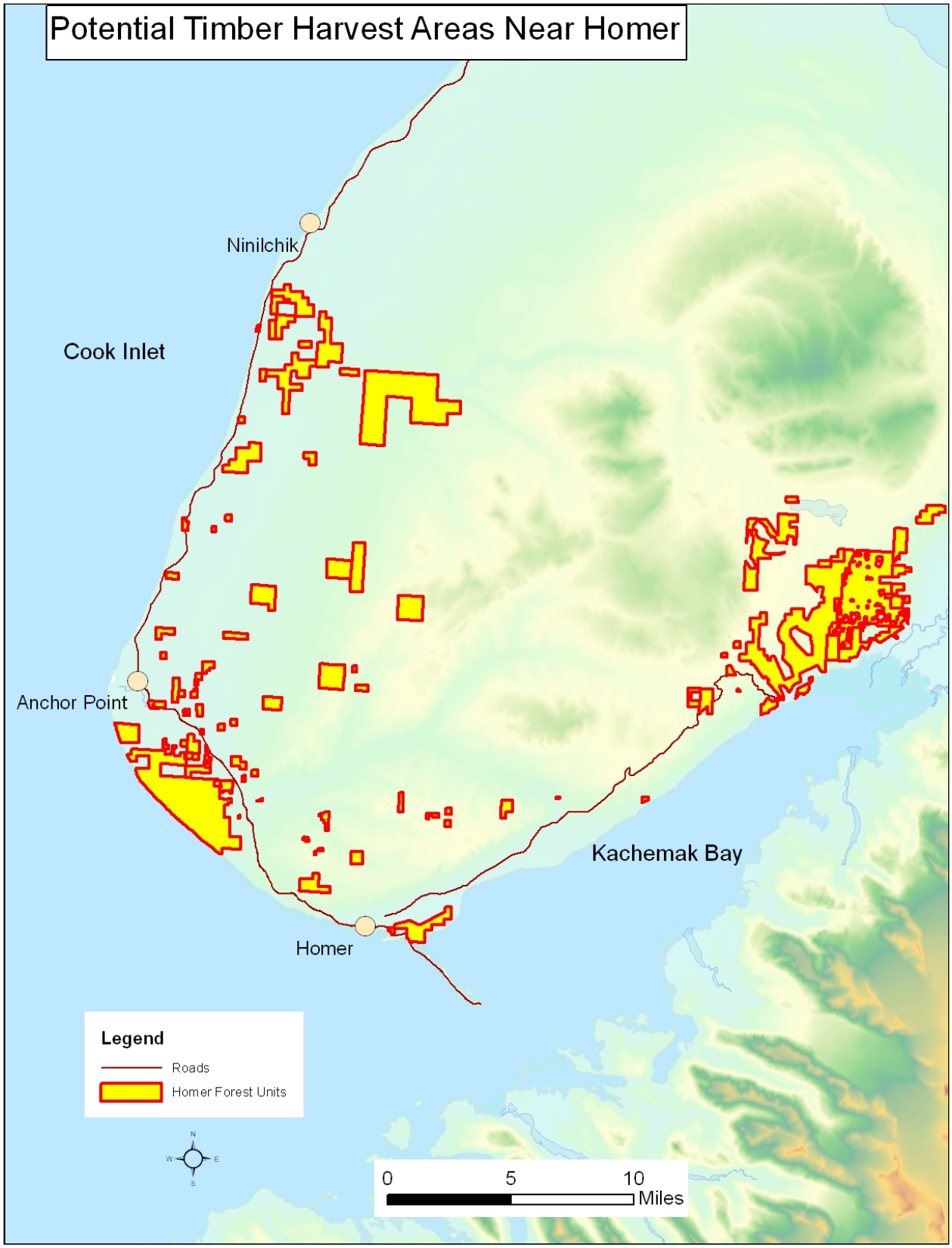


Figure 12. Forest units near Homer.

VIII. LITERATURE CITED

Ashton, S., L. McDonell, and K. Barnes. 2008. *Woody biomass desk guide and toolkit*. National Association of Conservation Districts. U.S. Department of Interior and the USDA Forest Service.

Husch, B., T.W. Beers, J.A. Kershaw. 2002. *Forest Mensuration, Fourth Edition*. John Wiley and Sons.

Sanders, R. 2006. *Matanuska-Susitna Borough: Forest Inventory Report.* Matanuska-Susitna Borough.

Smith, B., P.D. Miles, C.H. Perry, S.A. Pugh. 2007. *Forest Resources of the United States, 2007.* USDA Forest Service.

Sturgeon, J. 1979 *Wood as a Fuel*. Series No. R10-40 USDA Forest Service Alaska Region.

Van Hees. W. 2005. *Spruce Reproduction Dynamics on Alaska's Kenai Peninsula, 1987-2000.* USDA Forest Service Research Paper PNW-RP-563. March, 2005.

Appendix A
Acres by Vegetation Type and Strata

	Vegetation Type		Acres	Field Sampled?
Stratum	1	NEEDLELEAF: DEAD WHITE OR SITKA SPRUCE		
	DWS3MH2C		517	No
	DWS3WS3C		35	No
	DWS3WS2C		330	No
	DWS3W/WS2		4	No
	DWS3W/ALD		9	No
	DWS3W		1,576	Yes
	DWS3O/WS2		137	Yes
	DWS3O/ALD		0	No
	DWS3WS3MH2C		71	No
	DWS3MH3C		208	No
	DWS1W		99	No
	DWS3C/WS2		123	No
	DWS3C		13,045	Yes
	WS3W		61	Yes
	DSS3W		95	No
	DSS3SS3W		26	No
	DSS3SS3O		1,075	No
	DSS3MH2C		26	No
	DWS3O		4,058	Yes
	SS3C		55	No
	WS3DWS3C		31	Yes
	WS3DWS3MH3C		7	No
	SS3O		50	No
	WS3O		33	No
Summary for 'stratum' = 1 (24 detail records)				
Sum			*21,673*	
Stratum	2	NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, POLE		
	DWS2W		516	No
	WS2O		114	Yes
	WS2W		336	Yes
	WS2C		10	No
	DWS2C		12	No
	DWS2O		325	Yes
	SS2W		1	No
	SS2O		31	No
Summary for 'stratum' = 2 (8 detail records)				
Sum			*1,346*	
Stratum	3	NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, SEEDLINGS AND SAPLINGS		
	HVST		3,346	No
	WS1W		1,086	Yes
	WS1O		386	Yes
	WS1C		44	No
Summary for 'stratum' = 3 (4 detail records)				
Sum			*4,863*	

Vegetation Type		Acres	Field Sampled?
Stratum 4	NEEDLELEAF: BLACK SPRUCE, POLE SIZE OR LARGER		
BS2O		1,098	No
BS2W		44	No
BS3O		71	No
BS2C		1,563	Yes
Summary for 'stratum' = 4 (4 detail records)			
Sum		*2,776*	
Stratum 5	NEEDLELEAF: MOUNTAIN HEMLOCK		
MH2C		442	Yes
MH3DWS3C		341	No
MH3C		4	No
MH3DWS3W		4	No
Summary for 'stratum' = 5 (4 detail records)			
Sum		*791*	
Stratum 6	BROADLEAF: POLE SIZE OR LARGER		
CW3O		31	Yes
CW2O		2	No
B3C		3	No
CW3W		47	No
B2W		0	No
B2O		3,198	Yes
B2C/WS1		230	No
B2C		75	No
AB2C/WS1		14	No
AB2C		12	No
A2W		3	No
A2O		20	No
A2C		110	No
A2B2C		109	Yes
B3O		27	Yes
HVST/B2O		14	Yes
HD2O		0	No
Summary for 'stratum' = 6 (17 detail records)			
Sum		*3,893*	
Stratum 7	MIXED FOREST: BROADLEAF DOMINATING		
AB3WS2C		10	No
B3WS3DWS3C		439	No
B3WS3O		16	Yes
B2WS2C		76	Yes
A2BS2C		1	No
CW3WS3O		3	No
B2DWS3O		195	Yes
B2DWS3C		315	No
B1WS1O		30	No
AB3WS3O		291	No
B3WS3C		339	Yes
AB3WS3C		634	No
A3DWS3O		61	No
A2BS1C		15	No
A2DWS3C		33	Yes
A2DWS3O		22	No
A2WS1C		24	No

Vegetation Type		Acres	Field Sampled?
CW3DWS3O		43	No
A2WS2C		28	No
B2WS2O		1	No
HD3WS3DWS3O		374	No
HD3WS3C		184	No
AB2SS2C		17	No
AB2WS2C		148	No
AB3DWS3C		56	No
AB3DWS3O		16	No
Summary for 'stratum' = 7 (26 detail records)			
Sum		*3,372*	
Stratum	*8*	MIXED FOREST: DEAD NEEDLELEAF DOMINATING	
DWS3WS3A2C		5	No
DWS3A2C		121	No
DWS3HD2O		202	No
DWS3A2B2C		41	No
DWS3A2O		84	No
DWS3B2C		5,359	Yes
WS3B2W		56	No
WS3B3O		2	No
DWS3B2O		1,501	Yes
WS3B2O		281	No
WS3B2C		0	No
DSS3CW3C		27	No
DSS3AB2C		7	No
DWS3HD2C		271	No
BS1A2C		2	No
DWS3HD3C		29	No
DWS3WS2B2C		23	No
WS3AB2O		1	No
WS3AB2C		3	No
DWS3HD3O		26	No
DSS3A2C		25	No
Summary for 'stratum' = 8 (21 detail records)			
Sum		*8,066*	
Stratum	*10*	NEEDLELEAF: BLACK SPRUCE, SEEDLINGS AND SAPLINGS (Dwarf Forests)	
BS1C		1,523	No
BS1O		2,508	No
BS1W		4,322	No
Summary for 'stratum' = 10 (3 detail records)			
Sum		*8,353*	

Vegetation Type		*Acres*	*Field Sampled?*
Stratum *20*	NON-FOREST: SHRUB		
OS		673	No
A1C		38	No
WIL		301	No
A1BS1C		118	No
AB1O		1	No
A1O		472	No
CW1O		1	No
A1BS1W		11	No
B1C		26	No
ALD		7,055	No
AB1C		29	No
Summary for 'stratum' = 20 (11 detail records)			
Sum		*8,726*	
Stratum *30*	NON-FOREST: GRASSLAND		
GH_DEV		236	No
GH		7,492	No
GH_AGRI		171	No
Summary for 'stratum' = 30 (3 detail records)			
Sum		*7,899*	
Stratum *40*	NON-FOREST: WETLAND		
MSH		10,312	No
Summary for 'stratum' = 40 (1 detail record)			
Sum		*10,312*	
Stratum *50*	NON-FOREST: OTHER		
NF		637	No
Summary for 'stratum' = 50 (1 detail record)			
Sum		*637*	
Stratum *60*	NON-FOREST: WATER		
W		471	No
Summary for 'stratum' = 60 (1 detail record)			
Sum		*471*	
Grand Total		***83,178***	

Appendix B
Stand Tables Per Acre by Strata and Species

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Stratum 1 NEEDLELEAF: DEAD WHITE OR SITKA SPRUCE						*Acreage =*	*21,673*	
Aspen								
8	*1*	*0*	*3*	*3*	*0*	*0*		
9	*0*	*0*	*2*	*2*	*0*	*0*	*1*	*1*
10	*0*	*0*	*2*	*2*	*0*	*0*	*3*	*3*
11	*0*	*0*	*3*	*3*	*0*	*0*	*11*	*10*
12	*0*	*0*	*2*	*2*	*0*	*0*	*8*	*7*
13	*0*	*0*	*2*	*2*	*0*	*0*	*9*	*8*
14	*0*	*0*	*1*	*1*	*0*	*0*	*0*	*0*
16	*0*	*0*	*2*	*2*	*0*	*0*	*9*	*8*
Totals	*2*	*1*	*17*	*16*	*0*	*0*	*40*	*36*
Birch								
6	*1*	*0*	*2*	*0*	*0*	*0*		
7	*1*	*0*	*2*	*1*	*0*	*0*		
8	*1*	*0*	*2*	*2*	*0*	*0*		
9	*1*	*0*	*7*	*5*	*0*	*0*	*10*	*7*
10	*2*	*1*	*7*	*6*	*0*	*0*	*31*	*27*
11	*2*	*1*	*18*	*13*	*1*	*0*	*67*	*48*
12	*1*	*1*	*5*	*4*	*0*	*0*	*32*	*19*
13	*1*	*0*	*8*	*0*	*0*	*0*	*34*	*2*
14	*1*	*1*	*5*	*4*	*0*	*0*	*19*	*16*
15	*1*	*1*	*4*	*3*	*0*	*0*	*19*	*14*
16	*1*	*1*	*7*	*6*	*0*	*0*	*44*	*38*
17	*0*	*1*	*6*	*5*	*0*	*0*	*43*	*36*
18	*0*	*0*	*2*	*2*	*0*	*0*	*22*	*17*
19	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
24	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Totals	*12*	*8*	*76*	*51*	*2*	*1*	*321*	*224*
Black Spruce								
5	*3*	*0*	*3*	*3*	*0*	*0*		
6	*3*	*1*	*4*	*4*	*0*	*0*		
Totals	*6*	*1*	*7*	*6*	*0*	*0*		
Cottonwood								
6	*1*	*0*	*2*	*2*	*0*	*0*		
Totals	*1*	*0*	*2*	*2*	*0*	*0*		

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Sitka Spruce								
7	1	0	2	2	0	0		
9	1	1	9	9	0	0	13	13
10	1	1	12	11	0	0	54	53
11	2	2	28	28	0	0	129	129
12	1	1	9	9	0	0	41	41
13	0	0	5	5	0	0	12	12
14	1	1	18	18	0	0	84	84
15	1	1	24	24	0	0	116	116
16	0	0	8	8	0	0	41	41
17	0	1	15	15	0	0	75	75
20	0	0	4	4	0	0	24	24
Totals	9	7	135	135	2	2	590	589
White Spruce								
5	7	1	10	10	0	0		
6	17	4	38	38	1	1		
7	15	4	47	46	1	1		
8	11	4	50	49	1	1		
9	9	4	57	57	1	1	129	128
10	8	4	66	63	1	1	294	280
11	4	3	54	44	1	1	252	204
12	4	3	67	61	1	1	312	279
13	2	2	38	36	1	1	174	167
14	1	1	26	19	0	0	124	87
15	2	2	55	48	1	1	261	230
16	1	1	19	15	0	0	91	75
17	1	1	25	18	0	0	132	92
18	0	0	5	5	0	0	23	22
19	0	0	3	3	0	0	16	15
20	0	0	10	7	0	0	51	35
22	0	0	11	10	0	0	62	58
24	0	0	5	5	0	0	31	31
27	0	0	4	2	0	0	0	0
Totals	83	35	592	537	10	9	1,952	1,704
Totals for stratum NEEDLELEAF: DEAD WHITE OR SITKA SPRUCE								
	113	***53***	***828***	***746***	***15***	***13***	***2,904***	***2,552***

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Stratum	**2** NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, POLE					***Acreage =***	***1,346***	
Birch								
7	*2*	*1*	*3*	*3*	*0*	*0*		
8	*0*	*0*	*2*	*0*	*0*	*0*		
9	*2*	*1*	*1*	*1*	*0*	*0*	*4*	*4*
10	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
11	*1*	*1*	*10*	*8*	*0*	*0*	*30*	*22*
12	*1*	*1*	*0*	*0*	*0*	*0*	*9*	*9*
13	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Totals	*6*	*3*	*16*	*12*	*0*	*0*	*43*	*36*
Black Spruce								
6	*3*	*1*	*6*	*6*	*0*	*0*		
Totals	*3*	*1*	*6*	*6*	*0*	*0*		
White Spruce								
5	*6*	*1*	*4*	*4*	*0*	*0*		
6	*13*	*3*	*24*	*23*	*0*	*0*		
7	*4*	*1*	*8*	*8*	*0*	*0*		
8	*6*	*2*	*19*	*19*	*0*	*0*		
9	*3*	*1*	*19*	*19*	*0*	*0*	*57*	*58*
10	*5*	*2*	*35*	*35*	*1*	*1*	*177*	*178*
11	*1*	*1*	*12*	*12*	*0*	*0*	*59*	*60*
12	*1*	*1*	*12*	*7*	*0*	*0*	*58*	*34*
15	*1*	*0*	*8*	*3*	*0*	*0*	*38*	*13*
17	*0*	*0*	*3*	*0*	*0*	*0*	*13*	*2*
19	*0*	*0*	*3*	*4*	*0*	*0*	*17*	*18*
20	*0*	*0*	*4*	*4*	*0*	*0*	*18*	*19*
21	*0*	*0*	*3*	*3*	*0*	*0*	*0*	*0*
Totals	*39*	*13*	*155*	*142*	*3*	*2*	*437*	*382*
Totals for stratum	***NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, POLE***							
	49	***16***	***176***	***160***	***3***	***3***	***480***	***418***
Stratum	**3** NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, SEEDLINGS AND SAPLINGS					***Acreage =***	***4,863***	
Birch								
14	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Totals	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Black Spruce								
6	*5*	*1*	*6*	*5*	*0*	*0*		
Totals	*5*	*1*	*6*	*5*	*0*	*0*		

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
White Spruce								
6	2	0	4	4	0	0		
7	5	1	13	13	0	0		
8	3	1	12	10	0	0		
9	0	0	2	2	0	0	34	34
10	3	2	24	24	0	0	127	127
11	2	1	29	29	0	0	141	141
12	0	0	7	7	0	0	33	33
13	0	0	7	6	0	0	31	28
14	0	0	9	9	0	0	43	43
Totals	16	7	107	105	2	2	409	406
Totals for stratum	***NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, SEEDLINGS AND SAPLINGS***							
	21	***9***	***113***	***110***	***2***	***2***	***409***	***406***

Stratum 4 NEEDLELEAF: BLACK SPRUCE, POLE SIZE OR LARGER — *Acreage = 2,776*

Birch								
10	2	1	23	19	1	1	75	5
17	1	1	25	20	1	1	108	0
Totals	3	3	47	39	1	1	183	5
Black Spruce								
5	10	1	12	12	0	0		
6	3	1	9	9	0	0		
7	8	2	19	19	0	0		
Totals	21	4	40	40	1	1		
White Spruce								
6	3	1	5	5	0	0		
7	3	1	7	7	0	0		
8	4	1	21	21	0	0		
9	5	2	34	34	1	1	82	82
10	1	1	19	17	0	0	81	20
11	2	1	25	25	0	0	112	42
12	1	1	12	12	0	0	58	57
13	1	1	19	19	0	0	87	88
Totals	20	9	141	139	2	2	420	289
Totals for stratum	***NEEDLELEAF: BLACK SPRUCE, POLE SIZE OR LARGER***							
	45	***15***	***228***	***218***	***5***	***4***	***603***	***294***

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Stratum 5 NEEDLELEAF: MOUNTAIN HEMLOCK						*Acreage =*	*791*	
Aspen								
10	*1*	*0*	*5*	*1*	*0*	*0*	*4*	*0*
16	*0*	*0*	*5*	*5*	*0*	*0*	*26*	*21*
Totals	*1*	*1*	*10*	*6*	*0*	*0*	*31*	*21*
Birch								
5	*3*	*0*	*4*	*3*	*0*	*0*		
8	*2*	*1*	*6*	*2*	*0*	*0*		
9	*1*	*1*	*10*	*10*	*0*	*0*		
11	*1*	*0*	*6*	*3*	*0*	*0*	*16*	*8*
14	*0*	*0*	*6*	*6*	*0*	*0*	*27*	*26*
16	*0*	*0*	*6*	*5*	*0*	*0*	*30*	*26*
Totals	*7*	*3*	*37*	*30*	*1*	*1*	*72*	*61*
Hemlock								
5	*21*	*3*	*42*	*40*	*1*	*1*		
6	*37*	*8*	*116*	*114*	*2*	*2*		
7	*53*	*15*	*241*	*236*	*5*	*5*		
8	*44*	*16*	*293*	*284*	*6*	*6*		
9	*35*	*16*	*280*	*269*	*6*	*6*	*807*	*762*
10	*27*	*15*	*283*	*258*	*6*	*5*	*1,221*	*1,111*
11	*17*	*11*	*235*	*221*	*5*	*5*	*995*	*937*
12	*22*	*18*	*361*	*332*	*7*	*7*	*1,623*	*1,497*
13	*20*	*19*	*409*	*393*	*8*	*8*	*1,855*	*1,784*
14	*9*	*9*	*203*	*192*	*4*	*4*	*940*	*891*
15	*6*	*6*	*140*	*135*	*3*	*3*	*639*	*615*
16	*1*	*2*	*40*	*38*	*1*	*1*	*178*	*168*
17	*3*	*3*	*81*	*72*	*2*	*1*	*388*	*347*
18	*1*	*1*	*25*	*21*	*1*	*0*	*117*	*101*
19	*2*	*2*	*55*	*54*	*1*	*1*	*271*	*265*
Totals	*299*	*145*	*2,804*	*2,659*	*57*	*55*	*9,035*	*8,478*
Sitka Spruce								
8	*2*	*1*	*13*	*12*	*0*	*0*		
9	*2*	*1*	*16*	*16*	*0*	*0*	*71*	*71*
10	*1*	*0*	*5*	*5*	*0*	*0*	*17*	*17*
11	*0*	*0*	*7*	*7*	*0*	*0*	*27*	*27*
13	*1*	*1*	*24*	*24*	*0*	*0*	*111*	*111*
15	*1*	*1*	*15*	*15*	*0*	*0*	*69*	*69*
Totals	*7*	*4*	*80*	*79*	*1*	*1*	*295*	*295*

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
White Spruce								
5	12	2	22	22	0	0		
6	19	4	48	47	1	1		
7	11	3	30	30	0	0		
8	4	1	21	21	0	0		
9	3	1	19	20	0	0	99	99
10	3	2	19	19	0	0	96	97
11	2	2	32	31	1	1	133	130
12	2	1	17	17	0	0	82	82
13	0	0	6	6	0	0	24	26
14	1	1	25	21	0	0	116	101
15	0	0	6	4	0	0	26	18
20	2	1	24	16	0	0	130	82
Totals	60	19	269	255	4	4	706	635
Totals for stratum	***NEEDLELEAF: MOUNTAIN HEMLOCK***							
	374	***171***	***3,200***	***3,029***	***65***	***61***	***10,139***	***9,490***

Stratum 6 BROADLEAF: POLE SIZE OR LARGER — *Acreage = 3,893*

Aspen								
13	0	0	3	1	0	0	14	4
14	0	0	8	6	0	0	31	25
16	0	0	4	4	0	0	16	16
18	0	0	9	8	0	0	41	35
Totals	1	1	24	19	1	0	103	81
Birch								
6	9	2	17	17	0	0		
7	3	1	8	7	0	0		
8	1	0	2	2	0	0		
9	3	1	9	7	0	0	17	12
10	2	1	10	6	0	0	30	19
11	4	3	24	17	1	0	127	75
12	3	3	36	28	1	1	166	122
13	2	2	13	9	0	0	54	37
14	1	2	12	10	0	0	53	45
15	2	2	13	10	0	0	66	48
16	1	1	10	8	0	0	75	61
17	0	1	12	11	0	0	61	55
18	0	0	2	1	0	0	22	15
19	0	1	8	5	0	0	51	33
20	0	1	2	1	0	0	11	5
Totals	32	20	178	138	5	4	733	528

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Black Spruce								
6	4	1	6	6	0	0		
7	3	1	9	8	0	0		
8	1	0	7	7	0	0		
Totals	8	2	22	22	1	0		
Cottonwood								
6	2	0	3	3	0	0		
7	2	0	5	5	0	0		
8	1	0	3	3	0	0		
10	0	0	5	5	0	0	3	3
16	0	0	5	3	0	0	21	16
19	0	0	1	0	0	0	21	15
Totals	5	2	21	20	1	1	44	34
White Spruce								
5	2	0	1	1	0	0		
6	3	0	7	7	0	0		
7	10	3	38	38	1	1		
8	6	2	22	22	0	0		
9	5	3	43	39	1	1	126	110
10	5	3	52	49	1	1	221	207
11	1	1	15	15	0	0	50	49
12	3	3	54	50	1	1	225	207
13	2	2	33	31	1	1	155	144
14	1	1	27	27	0	0	129	129
15	0	0	11	11	0	0	51	51
17	0	0	5	5	0	0	25	25
Totals	39	18	307	294	5	5	982	923
Totals for stratum BROADLEAF: POLE SIZE OR LARGER	***85***	***42***	***553***	***493***	***12***	***10***	***1,862***	***1,566***

Stratum 7 MIXED FOREST: BROADLEAF DOMINATING *Acreage = 3,372*

Aspen								
6	4	1	7	7	0	0		
7	2	1	11	10	0	0		
8	5	2	31	30	1	1		
9	5	2	43	40	1	1	36	35
10	2	1	23	20	1	1	45	42
11	2	1	22	15	1	0	65	43
Totals	20	8	137	122	3	3	146	119

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Birch								
6	13	3	38	36	1	1		
7	8	2	31	30	1	1		
9	4	2	23	15	1	0	9	3
10	2	1	0	0	0	0	19	13
11	2	1	14	13	0	0	53	48
12	5	4	68	52	2	1	259	195
13	1	1	22	14	1	0	96	64
14	2	2	41	25	1	1	193	119
15	2	2	9	2	0	0	55	18
16	1	2	10	8	0	0	70	51
17	1	1	8	7	0	0	57	45
18	1	2	36	18	1	0	179	89
Totals	42	23	299	220	8	6	991	646
Black Spruce								
5	4	1	5	5	0	0		
6	2	0	3	3	0	0		
7	1	0	3	2	0	0		
Totals	6	1	11	10	0	0		
Cottonwood								
7	1	0	2	1	0	0		
16	0	1	5	5	0	0	58	54
Totals	2	1	7	7	0	0	58	54
Hemlock								
5	6	1	6	6	0	0		
6	2	0	4	4	0	0		
7	4	1	11	10	0	0		
8	3	1	11	11	0	0		
9	1	0	9	9	0	0	42	42
10	3	2	24	22	0	0	112	102
11	1	0	9	8	0	0	37	35
12	1	1	18	18	0	0	87	87
13	1	0	11	11	0	0	57	57
17	0	0	11	11	0	0	57	57
19	0	0	12	12	0	0	65	65
Totals	22	9	126	123	3	3	456	445
Sitka Spruce								
5	5	1	8	8	0	0		
7	4	1	11	11	0	0		
9	3	1	18	18	0	0	77	77
10	3	2	34	34	1	1	150	150
11	2	1	20	20	0	0	86	86
Totals	17	6	92	92	2	2	313	313

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
White Spruce								
5	6	1	6	6	0	0		
6	2	0	5	4	0	0		
7	7	2	26	25	0	0		
8	11	4	62	62	1	1		
9	5	2	49	50	1	1	109	110
10	4	2	50	49	1	1	203	200
11	3	2	51	51	1	1	219	220
12	2	1	29	22	0	0	134	102
13	3	3	67	65	1	1	316	304
14	2	3	61	59	1	1	288	280
15	0	1	11	4	0	0	54	22
16	1	1	32	32	1	1	154	154
17	1	2	41	34	1	1	198	164
41	0	1	9	9	0	0	61	61
Totals	48	25	498	472	8	8	1,736	1,616
Totals for stratum	***MIXED FOREST: BROADLEAF DOMINATING***							
	156	***72***	***1,170***	***1,047***	***24***	***21***	***3,700***	***3,193***

Stratum 8 MIXED FOREST: DEAD NEEDLELEAF DOMINATING *Acreage = 8,066*

Aspen								
12	0	0	3	2	0	0	9	8
13	1	1	16	6	0	0	30	8
14	0	0	0	0	0	0	0	0
17	0	0	4	2	0	0	9	6
18	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	4	3
Totals	2	2	22	10	1	0	52	24
Birch								
5	2	0	1	1	0	0		
6	7	1	14	13	0	0		
7	6	2	19	17	1	0		
8	1	1	7	4	0	0		
9	1	0	4	3	0	0	4	5
10	1	1	12	11	0	0	18	18
11	3	2	24	17	1	0	93	68
12	2	2	26	19	1	1	112	89
13	4	4	54	43	1	1	212	179
14	1	2	25	17	1	0	111	84
15	1	1	13	12	0	0	64	58
16	0	1	7	3	0	0	35	22
17	1	2	9	7	0	0	90	76
18	0	1	3	1	0	0	22	13
21	0	1	0	0	0	0	0	0
Totals	30	18	216	170	6	5	763	612

DBH	# of Trees	BA	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Black Spruce								
5	*12*	*2*	*14*	*13*	*0*	*0*		
6	*6*	*1*	*9*	*8*	*0*	*0*		
Totals	*18*	*3*	*22*	*22*	*1*	*0*		
Cottonwood								
25	*0*	*0*	*4*	*3*	*0*	*0*	*20*	*18*
Totals	*0*	*0*	*4*	*3*	*0*	*0*	*20*	*18*
White Spruce								
5	*13*	*2*	*15*	*15*	*0*	*0*		
6	*13*	*3*	*34*	*34*	*1*	*1*		
7	*19*	*5*	*74*	*71*	*1*	*1*		
8	*13*	*5*	*66*	*65*	*1*	*1*		
9	*6*	*3*	*44*	*43*	*1*	*1*	*100*	*95*
10	*4*	*2*	*42*	*40*	*1*	*1*	*192*	*183*
11	*4*	*3*	*57*	*54*	*1*	*1*	*282*	*267*
12	*2*	*1*	*19*	*19*	*0*	*0*	*98*	*98*
13	*3*	*3*	*50*	*47*	*1*	*1*	*245*	*230*
14	*1*	*1*	*15*	*15*	*0*	*0*	*71*	*71*
15	*1*	*1*	*11*	*11*	*0*	*0*	*55*	*55*
16	*1*	*1*	*9*	*9*	*0*	*0*	*47*	*47*
Totals	*78*	*29*	*435*	*421*	*7*	*7*	*1,091*	*1,046*
Totals for stratum MIXED FOREST: DEAD NEEDLELEAF DOMINATING	***128***	***52***	***699***	***626***	***14***	***12***	***1,927***	***1,700***

Appendix C
Volume Per Acre and Total Volume by Stratum

Stratum 1 NEEDLELEAF: DEAD WHITE OR SITKA SPRUCE *Acreage = 21,673*

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Aspen														
Pole Live	1	0	3	3	0	0			67,497	65,879	1,687	1,647		
Saw Live	1	1	14	13	0	0	40	36	305,281	272,511	7,632	6,813	870,380	773,704
Species Totals	**2**	**1**	**17**	**16**	**0**	**0**	**40**	**36**	**372,777**	**338,390**	**9,319**	**8,460**	**870,380**	**773,704**
Birch														
Saw Live	8	7	61	48	2	1	284	224	1,314,668	1,037,240	36,153	28,524	6,158,552	4,846,076
Pole Dead	2	0	4	0	0	0			75,943	515	2,088	14		
Pole Live	1	0	3	3	0	0			70,309	65,441	1,933	1,800		
Saw Dead	1	1	8	0	0	0	37	0	175,745	1,149	4,833	32	809,421	7,106
Species Totals	**12**	**8**	**76**	**51**	**2**	**1**	**321**	**224**	**1,636,665**	**1,104,343**	**45,008**	**30,369**	**6,967,974**	**4,853,182**
Black Spruce														
Pole Live	4	1	5	4	0	0			98,458	95,739	2,215	2,154		
Pole Dead	2	0	2	2	0	0			43,063	43,063	969	969		
Species Totals	**6**	**1**	**7**	**6**	**0**	**0**			**141,521**	**138,802**	**3,184**	**3,123**		
Cottonwood														
Pole Live	1	0	2	2	0	0			39,375	39,375	984	984		
Species Totals	**1**	**0**	**2**	**2**	**0**	**0**			**39,375**	**39,375**	**984**	**984**		
Sitka Spruce														
Pole Dead	0	0	4	4	0	0			78,599	78,624	1,297	1,297		
Pole Live	1	0	4	4	0	0			90,298	90,298	1,490	1,490		
Saw Dead	5	4	83	82	1	1	380	379	1,790,454	1,779,928	29,542	29,369	8,236,339	8,205,259
Saw Live	3	3	45	45	1	1	210	210	971,021	971,027	16,022	16,022	4,557,208	4,557,221
Species Totals	**9**	**7**	**135**	**135**	**2**	**2**	**590**	**589**	**2,930,373**	**2,919,877**	**48,351**	**48,178**	**12,793,547**	**12,762,480**
White Spruce														
Pole Dead	14	3	39	38	1	1			839,410	813,294	13,850	13,419		
Pole Live	41	11	134	134	2	2			2,914,429	2,897,135	48,088	47,803		
Saw Dead	15	13	283	234	5	4	1,347	1,105	6,142,554	5,064,066	101,352	83,557	29,194,841	23,951,823
Saw Live	13	8	135	132	2	2	605	599	2,925,416	2,854,723	48,269	47,103	13,121,892	12,974,065
Species Totals	**83**	**35**	**592**	**537**	**10**	**9**	**1,952**	**1,704**	**12,821,809**	**11,629,218**	**211,560**	**191,882**	**42,316,733**	**36,925,888**
Strata Totals	**113**	**53**	**828**	**746**	**15**	**13**	**2,904**	**2,552**	**17,942,520**	**16,170,006**	**318,407**	**282,997**	**62,948,633**	**55,315,253**

Stratum 2 NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, POLE *Acreage = 1,346*

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Birch														
Saw Live	2	1	10	8	0	0	34	26	13,419	10,496	369	289	45,590	35,168
Saw Dead	1	1	0	0	0	0	9	9	0	0	0	0	12,731	12,731
Pole Live	3	1	6	4	0	0			7,467	5,324	205	146		
Species Totals	**6**	**3**	**16**	**12**	**0**	**0**	**43**	**36**	**20,886**	**15,820**	**574**	**435**	**58,321**	**47,899**
Black Spruce														
Pole Live	3	1	6	6	0	0			7,835	7,835	176	176		
Species Totals	**3**	**1**	**6**	**6**	**0**	**0**			**7,835**	**7,835**	**176**	**176**		
White Spruce														
Pole Live	21	5	44	43	1	1			59,175	58,253	976	961		
Saw Dead	2	1	23	14	0	0	120	74	31,406	18,464	518	305	161,994	99,615
Saw Live	7	4	69	67	1	1	316	308	92,838	90,540	1,532	1,494	425,866	415,045
Pole Dead	9	2	18	18	0	0			24,609	23,797	406	393		
Species Totals	**39**	**13**	**155**	**142**	**3**	**2**	**437**	**382**	**208,028**	**191,053**	**3,432**	**3,152**	**587,860**	**514,660**
Strata Totals	**49**	**16**	**176**	**160**	**3**	**3**	**480**	**418**	**236,749**	**214,708**	**4,183**	**3,764**	**646,180**	**562,559**

Stratum 3 NEEDLELEAF: LIVE WHITE OR SITKA SPRUCE, SEEDLINGS AND SAPLINGS *Acreage = 4,863*

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Birch														
Saw Dead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Species Totals	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Black Spruce														
Pole Live	5	1	6	5	0	0			29,129	26,332	655	592		
Species Totals	**5**	**1**	**6**	**5**	**0**	**0**			**29,129**	**26,332**	**655**	**592**		
White Spruce														
Saw Live	3	3	46	45	1	1	245	242	222,667	220,054	3,674	3,631	1,191,274	1,179,004
Saw Dead	3	2	32	32	1	1	164	164	156,401	156,682	2,581	2,585	796,219	797,539
Pole Live	8	2	24	22	0	0			116,925	108,030	1,929	1,783		
Pole Dead	2	1	5	5	0	0			25,160	25,160	415	415		
Species Totals	**16**	**7**	**107**	**105**	**2**	**2**	**409**	**406**	**521,153**	**509,926**	**8,599**	**8,414**	**1,987,493**	**1,976,543**
Strata Totals	**21**	**9**	**113**	**110**	**2**	**2**	**409**	**406**	**550,282**	**536,258**	**9,254**	**9,006**	**1,987,493**	**1,976,543**

Stratum 4 NEEDLELEAF: BLACK SPRUCE, POLE SIZE OR LARGER — Acreage = 2,776

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Birch														
Saw Live	3	3	47	39	1	1	183	5	131,540	108,191	3,617	2,975	508,033	14,439
Species Totals	**3**	**3**	**47**	**39**	**1**	**1**	**183**	**5**	**131,540**	**108,191**	**3,617**	**2,975**	**508,033**	**14,439**
Black Spruce														
Pole Dead	3	1	10	10	0	0			29,132	29,132	655	655		
Pole Live	18	3	30	30	1	1			82,283	82,283	1,851	1,851		
Species Totals	**21**	**4**	**40**	**40**	**1**	**1**			**111,414**	**111,414**	**2,507**	**2,507**		
White Spruce														
Saw Live	7	4	79	78	1	1	359	228	219,958	215,397	3,629	3,554	996,963	633,501
Pole Dead	6	2	16	16	0	0			44,775	44,775	739	739		
Saw Dead	1	1	13	13	0	0	60	60	36,518	36,518	603	603	167,732	167,732
Pole Live	6	2	32	32	1	1			89,723	89,723	1,480	1,480		
Species Totals	**20**	**9**	**141**	**139**	**2**	**2**	**420**	**289**	**390,975**	**386,414**	**6,451**	**6,376**	**1,164,694**	**801,232**
Strata Totals	**45**	**15**	**228**	**218**	**5**	**4**	**603**	**294**	**633,930**	**606,020**	**12,575**	**11,858**	**1,672,727**	**815,672**

Stratum 5 NEEDLELEAF: MOUNTAIN HEMLOCK — Acreage = 791

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Aspen														
Saw Live	1	1	10	6	0	0	31	21	8,141	4,935	204	123	24,197	16,252
Species Totals	**1**	**1**	**10**	**6**	**0**	**0**	**31**	**21**	**8,141**	**4,935**	**204**	**123**	**24,197**	**16,252**
Birch														
Pole Live	6	2	20	16	1	0			16,016	12,498	440	344		
Saw Live	1	1	17	14	0	0	72	61	13,526	11,212	372	308	57,254	48,033
Species Totals	**7**	**3**	**37**	**30**	**1**	**1**	**72**	**61**	**29,542**	**23,710**	**812**	**652**	**57,254**	**48,033**
Hemlock														
Saw Live	126	94	1,973	1,850	40	38	8,901	8,348	1,561,716	1,463,928	32,015	30,011	7,044,273	6,606,802
Pole Dead	5	2	40	39	1	1			31,915	30,746	654	630		
Saw Dead	2	1	31	30	1	1	134	130	24,189	23,431	496	480	105,780	102,727
Pole Live	166	48	759	741	16	15			601,014	586,265	12,321	12,018		
Species Totals	**299**	**145**	**2,804**	**2,659**	**57**	**55**	**9,035**	**8,478**	**2,218,834**	**2,104,370**	**45,486**	**43,140**	**7,150,054**	**6,709,529**
Sitka Spruce														
Saw Dead	1	0	1	1	0	0	9	9	947	947	16	16	7,119	7,119
Saw Live	4	3	66	66	1	1	286	286	51,976	51,976	858	858	226,719	226,719

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Pole Live	2	1	13	12	0	0			10,345	9,827	171	162		
Species Totals	**7**	**4**	**80**	**79**	**1**	**1**	**295**	**295**	**63,268**	**62,751**	**1,044**	**1,035**	**233,838**	**233,838**
White Spruce														
Pole Dead	15	4	45	45	1	1			35,674	35,674	589	589		
Pole Live	31	6	76	75	1	1			60,329	59,625	995	984		
Saw Dead	3	2	30	29	0	0	144	138	23,775	22,888	392	378	113,922	109,407
Saw Live	11	6	118	105	2	2	562	496	93,168	83,452	1,537	1,377	444,694	392,905
Species Totals	**60**	**19**	**269**	**255**	**4**	**4**	**706**	**635**	**212,946**	**201,639**	**3,514**	**3,327**	**558,616**	**502,311**
Strata Totals	**374**	**171**	**3,200**	**3,029**	**65**	**61**	**10,139**	**9,490**	**2,532,730**	**2,397,405**	**51,060**	**48,277**	**8,023,958**	**7,509,962**

Stratum 6 BROADLEAF: POLE SIZE OR LARGER *Acreage = 3,893*

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Aspen														
Saw Live	1	1	24	19	1	0	103	81	94,666	73,983	2,367	1,850	400,412	314,439
Species Totals	**1**	**1**	**24**	**19**	**1**	**0**	**103**	**81**	**94,666**	**73,983**	**2,367**	**1,850**	**400,412**	**314,439**
Birch														
Saw Live	17	16	146	110	4	3	718	521	566,902	427,182	15,590	11,748	2,795,398	2,026,379
Pole Dead	1	0	2	2	0	0			7,917	7,991	218	220		
Pole Live	13	3	28	25	1	1			108,908	97,746	2,995	2,688		
Saw Dead	1	1	2	1	0	0	15	7	7,865	3,179	216	87	57,972	27,999
Species Totals	**32**	**20**	**178**	**138**	**5**	**4**	**733**	**528**	**691,593**	**536,098**	**19,019**	**14,743**	**2,853,370**	**2,054,379**
Black Spruce														
Pole Live	7	1	17	16	0	0			66,021	63,989	1,485	1,440		
Pole Dead	1	0	5	5	0	0			20,639	20,639	464	464		
Species Totals	**8**	**2**	**22**	**22**	**1**	**0**			**86,660**	**84,628**	**1,950**	**1,904**		
Cottonwood														
Saw Live	1	1	10	9	0	0	44	34	39,112	34,084	978	852	172,032	132,464
Pole Live	4	1	11	11	0	0			44,080	44,080	1,102	1,102		
Species Totals	**5**	**2**	**21**	**20**	**1**	**1**	**44**	**34**	**83,192**	**78,164**	**2,080**	**1,954**	**172,032**	**132,464**
White Spruce														
Saw Live	10	7	124	121	2	2	561	550	481,429	472,248	7,944	7,792	2,185,835	2,142,499
Pole Dead	6	2	27	27	0	0			103,777	103,826	1,712	1,713		
Pole Live	17	4	53	53	1	1			207,105	206,539	3,417	3,408		
Saw Dead	6	5	104	93	2	2	420	373	404,797	362,024	6,679	5,973	1,636,942	1,452,151
Species Totals	**39**	**18**	**307**	**294**	**5**	**5**	**982**	**923**	**1,197,108**	**1,144,637**	**19,752**	**18,887**	**3,822,776**	**3,594,650**
Strata Totals	**85**	**42**	**553**	**493**	**12**	**10**	**1,862**	**1,566**	**2,153,218**	**1,917,510**	**45,167**	**39,337**	**7,248,590**	**6,095,931**

Stratum 7 MIXED FOREST: BROADLEAF DOMINATING *Acreage = 3,372*

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Aspen														
Pole Live	13	4	66	63	2	2			223,611	212,601	5,590	5,315		
Saw Live	6	4	64	52	2	1	126	99	215,735	176,673	5,393	4,417	426,062	332,492
Saw Dead	0	0	7	7	0	0	20	21	22,622	23,474	566	587	67,844	70,349
Species Totals	**20**	**8**	**137**	**122**	**3**	**3**	**146**	**119**	**461,967**	**412,748**	**11,549**	**10,319**	**493,905**	**402,841**
Birch														
Saw Live	18	17	220	148	6	4	991	646	742,812	498,195	20,427	13,700	3,340,183	2,177,425
Pole Live	24	6	79	73	2	2			266,255	244,963	7,322	6,736		
Species Totals	**42**	**23**	**299**	**220**	**8**	**6**	**991**	**646**	**1,009,068**	**743,158**	**27,749**	**20,437**	**3,340,183**	**2,177,425**
Black Spruce														
Pole Live	6	1	11	10	0	0			37,174	34,451	836	775		
Species Totals	**6**	**1**	**11**	**10**	**0**	**0**			**37,174**	**34,451**	**836**	**775**		
Cottonwood														
Saw Live	0	1	5	5	0	0	58	54	18,311	18,311	458	458	196,989	182,248
Pole Live	1	0	2	1	0	0			6,620	4,634	165	116		
Species Totals	**2**	**1**	**7**	**7**	**0**	**0**	**58**	**54**	**24,931**	**22,945**	**623**	**574**	**196,989**	**182,248**
Hemlock														
Saw Live	7	5	94	91	2	2	456	445	315,778	307,780	6,473	6,309	1,537,939	1,500,859
Pole Live	15	4	32	32	1	1			108,329	107,380	2,221	2,201		
Species Totals	**22**	**9**	**126**	**123**	**3**	**3**	**456**	**445**	**424,107**	**415,160**	**8,694**	**8,511**	**1,537,939**	**1,500,859**
Sitka Spruce														
Saw Live	8	4	72	72	1	1	313	313	242,955	242,955	4,009	4,009	1,053,892	1,053,892
Pole Live	9	2	20	20	0	0			65,867	65,867	1,087	1,087		
Species Totals	**17**	**6**	**92**	**92**	**2**	**2**	**313**	**313**	**308,822**	**308,822**	**5,096**	**5,096**	**1,053,892**	**1,053,892**
White Spruce														
Pole Live	17	5	77	76	1	1			258,732	257,185	4,269	4,244		
Saw Dead	5	5	107	85	2	1	486	385	360,526	288,190	5,949	4,755	1,639,546	1,298,790
Saw Live	14	13	274	269	5	4	1,250	1,231	922,595	908,494	15,223	14,990	4,213,789	4,149,848
Pole Dead	11	3	41	41	1	1			138,415	137,677	2,284	2,272		
Species Totals	**48**	**25**	**498**	**472**	**8**	**8**	**1,736**	**1,616**	**1,680,269**	**1,591,546**	**27,724**	**26,261**	**5,853,335**	**5,448,638**
Strata Totals	**156**	**72**	**1,170**	**1,047**	**24**	**21**	**3,700**	**3,193**	**3,946,337**	**3,528,830**	**82,272**	**71,971**	**12,476,243**	**10,765,902**

Stratum 8 MIXED FOREST: DEAD NEEDLELEAF DOMINATING *Acreage = 8,066*

	Trees/ Ac	BA/ Ac	Gross CF/ Ac	Net CF/ Ac	Gross Tons/ Ac	Net Tons/ Ac	Gross BF/ Ac	Net BF/ Ac	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Gross BF	Total Net BF
Aspen														
Saw Live	2	2	22	10	1	0	52	24	180,827	82,484	4,521	2,062	421,380	195,622
Species Totals	**2**	**2**	**22**	**10**	**1**	**0**	**52**	**24**	**180,827**	**82,484**	**4,521**	**2,062**	**421,380**	**195,622**
Birch														
Saw Live	13	14	168	131	5	4	749	607	1,354,516	1,055,151	37,249	29,017	6,041,532	4,892,664
Saw Dead	1	1	4	1	0	0	14	5	30,192	10,046	830	276	109,496	43,798
Pole Live	16	4	44	38	1	1			356,890	307,970	9,814	8,469		
Species Totals	**30**	**18**	**216**	**170**	**6**	**5**	**763**	**612**	**1,741,599**	**1,373,167**	**47,894**	**37,762**	**6,151,028**	**4,936,462**
Black Spruce														
Pole Live	12	2	14	13	0	0			113,048	107,057	2,544	2,409		
Pole Dead	6	1	8	8	0	0			68,357	68,357	1,538	1,538		
Species Totals	**18**	**3**	**22**	**22**	**1**	**0**			**181,404**	**175,413**	**4,082**	**3,947**		
Cottonwood														
Saw Live	0	0	4	3	0	0	20	18	28,505	25,655	713	641	164,479	148,031
Species Totals	**0**	**0**	**4**	**3**	**0**	**0**	**20**	**18**	**28,505**	**25,655**	**713**	**641**	**164,479**	**148,031**
White Spruce														
Saw Live	6	5	66	63	1	1	355	337	533,219	508,771	8,798	8,395	2,866,197	2,715,538
Saw Dead	11	8	157	151	3	2	736	709	1,264,053	1,214,023	20,857	20,031	5,936,330	5,717,882
Pole Live	34	9	109	107	2	2			875,715	860,468	14,449	14,198		
Pole Dead	26	7	103	101	2	2			832,574	811,868	13,737	13,396		
Species Totals	**78**	**29**	**435**	**421**	**7**	**7**	**1,091**	**1,046**	**3,505,561**	**3,395,129**	**57,842**	**56,020**	**8,802,527**	**8,433,420**
Strata Totals	**128**	**52**	**699**	**626**	**14**	**12**	**1,927**	**1,700**	**5,637,896**	**5,051,848**	**115,051**	**100,432**	**15,539,414**	**13,713,536**

Grand Totals = 46,780 Acres

33,633,663 Gross Cubic Feet ***30,422,585 Net Cubic Feet***

110,543,239 Gross Board Feet ***96,755,359 Net Board Feet***

637,970 Gross Tons ***567,642 Net Tons***

Appendix D
Total Volume Across Strata

	Gross CF	Net CF	Gross Tons	Net Tons	Gross BF	Net BF
Saw Live						
Aspen	804,649	610,586	20,116	15,265	2,142,430	1,632,509
Birch	4,137,385	3,147,667	113,778	86,561	18,946,542	14,040,185
Cottonwood	85,928	78,050	2,148	1,951	533,500	462,744
Hemlock	1,877,494	1,771,708	38,489	36,320	8,582,213	8,107,661
Sitka Spruce	1,265,953	1,265,958	20,888	20,888	5,837,818	5,837,831
White Spruce	5,491,290	5,353,679	90,606	88,336	25,446,509	24,602,404
Size Totals	13,662,697	12,227,648	286,026	249,321	61,489,012	54,683,332
Saw Dead						
Aspen	22,622	23,474	566	587	67,844	70,349
Birch	213,803	14,374	5,880	395	989,620	91,634
Hemlock	24,189	23,431	496	480	105,780	102,727
Sitka Spruce	1,791,401	1,780,875	29,558	29,384	8,243,458	8,212,378
White Spruce	8,420,031	7,162,855	138,931	118,187	39,647,525	33,594,939
Size Totals	10,472,046	9,005,009	175,430	149,034	49,054,227	42,072,027
Pole Live						
Aspen	291,107	278,480	7,278	6,962		
Birch	825,845	733,941	22,711	20,183		
Black Spruce	433,947	417,686	9,764	9,398		
Cottonwood	90,075	88,089	2,252	2,202		
Hemlock	709,343	693,645	14,542	14,220		
Sitka Spruce	166,510	165,993	2,747	2,739		
White Spruce	4,582,133	4,536,959	75,605	74,860		
Size Totals	7,098,960	6,914,792	134,898	130,564		
Pole Dead						
Birch	83,860	8,506	2,306	234		
Black Spruce	161,191	161,191	3,627	3,627		
Hemlock	31,915	30,746	654	630		
Sitka Spruce	78,599	78,624	1,297	1,297		
White Spruce	2,044,394	1,996,070	33,733	32,935		
Size Totals	2,399,959	2,275,136	41,617	38,723		
	33,633,663	30,422,585	637,970	567,642	110,543,239	96,755,359

Appendix E
Log Grade by Species

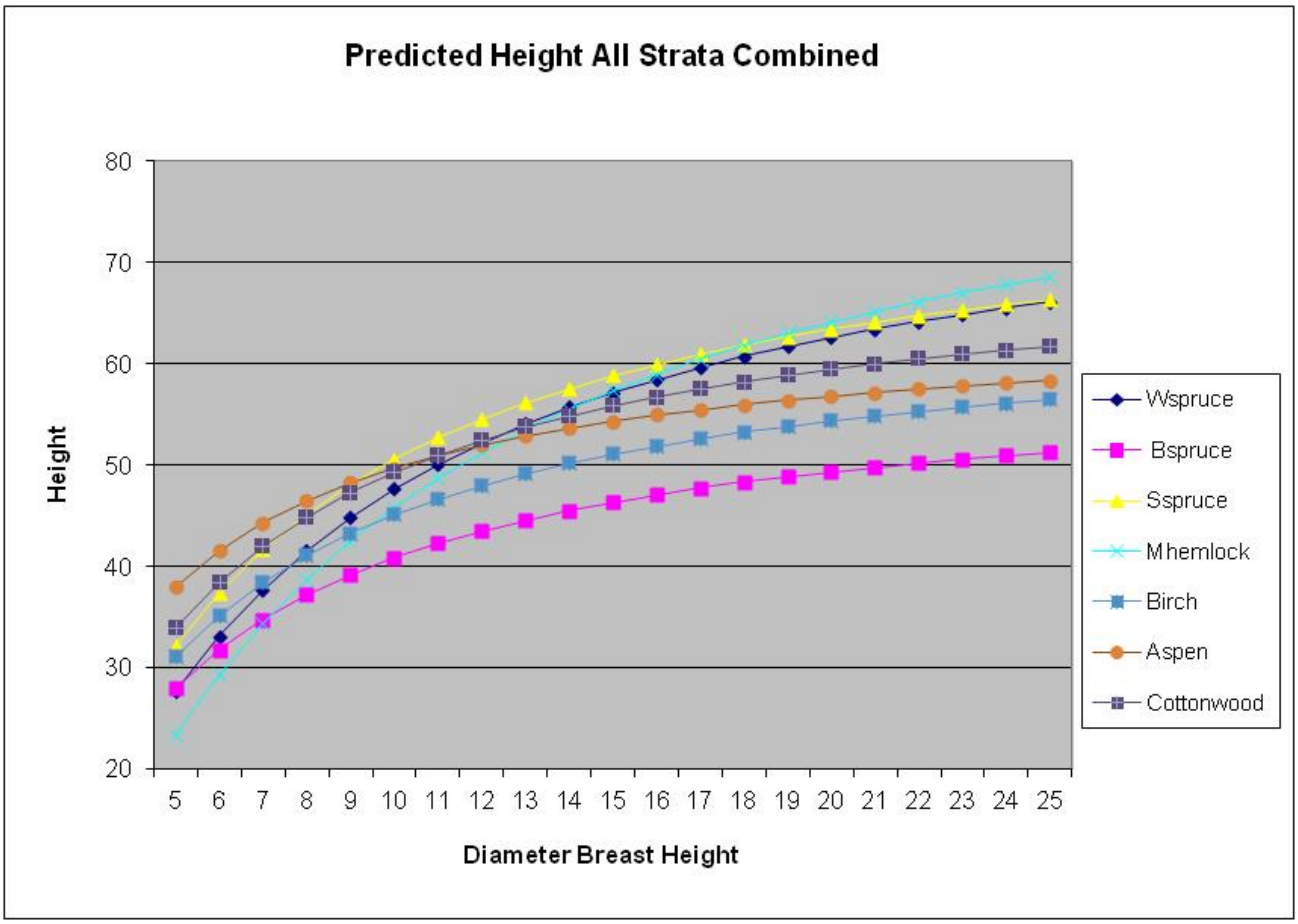
Puget Sound Log Scaling and Grading Bureau Specifications

Species	Grade No.	Gross Diameter	Gross Length	Minimum Volume	Surface	Annual Ring Count	Slope of Grain
Sitka Spruce/ Hemlock/ White Spruce/ Black Spruce	1	24 Inches	12 Feet			8 per Inch	< 3 inches/foot
	2	12 Inches	12 Feet	60BF Net	Knots < 2.5 inches in diameter		< 2 inches/foot
	3	6 Inches	12 Feet	50 BF Net	Knots < 3 inches in diameter		May include excessive slope with deduction
	4	5 Inches	12 Feet	10 BF Net			
Aspen/Birch	1	16 Inches	8 Feet		75% Clear		
	2	12 Inches	8 Feet		50% Clear		
	3	10 Inches	8 Feet	10 BF Net			
	4	5 Inches	8 Feet	10 BF Net			
Cottonwood	1	10 Inches	8 Feet		< 4 Knots per log		
	2	6 Inches	8 Feet				
	4	5 Inches	8 Feet	10 BF Net			
All Species Utility Logs	5	4 Inches	12 Feet	10 BF Net			
	Logs do not meet sawmill grades, but are suitable for the production of firm usable chips to an amount not less than 50% of gross scale. A log that is burned or charred or is not mechanically barkable, shall not qualify as a Utility Log.						

	Grade 1st Log	Grade 2nd Log	# Of Trees Measured	% Of Trees Measured
Aspen				
	Cull	Cull	10	30%
	2	Cull	1	3%
	3	4	1	3%
	4	5	3	9%
	5	Cull	3	9%
	5	5	15	45%
Total for Aspen			*33*	
Birch				
	Cull	Cull	49	25%
	Cull	5	2	1%
	3	4	1	1%
	3	5	4	2%
	4	Cull	3	2%
	4	4	1	1%
	4	5	13	7%
	5	Cull	33	17%
	5	5	88	45%
Total for Birch			*194*	
Cottonwood				
	Cull	Cull	2	22%
	1	2	3	33%
	1	5	3	33%
	5	5	1	11%
Total for Cottonwood			*9*	
Hemlock				
	Cull	Cull	3	2%
	2	2	3	2%
	2	3	3	2%
	3	3	2	1%
	3	4	21	13%
	3	5	3	2%
	4	Cull	12	8%
	4	4	38	24%
	4	5	30	19%
	5	Cull	14	9%
	5	4	1	1%
	5	5	28	18%
Total for Hemlock			*158*	

Grade 1st Log	Grade 2nd Log	# Of Trees Measured	% Of Trees Measured
Sitka Spruce			
2	3	2	8%
3	4	2	8%
4	Cull	6	24%
4	4	7	28%
4	5	8	32%
Total for Sitka Spruce		*25*	
White Spruce			
Cull	Cull	10	6%
2	2	2	1%
2	3	1	1%
3	3	4	3%
3	4	10	6%
3	5	1	1%
4	Cull	21	14%
4	4	53	34%
4	5	42	27%
5	Cull	10	6%
5	4	2	1%
5	5	2	1%
Total for White Spruce		*158*	
Grand Total Trees Measured		*577*	

Appendix F
Diameter/Height Relationships, Ten Year Growth, and Bark Thickness



Reciprocal dbh height prediction model:

$$ht_{top} = ae^{\frac{-b}{dbh^c}}$$

Species	A Coefficient	B Coefficient	C Coefficient
White Spruce	82.23	-5.4626	1
Black Spruce	59.62	-3.7847	1
Sitka Spruce	79.57	-4.5351	1
Mountain Hemlock	89.76	-6.7312	1
Birch	65.53	-3.7386	1
Aspen	64.93	-2.6792	1
Cottonwood	71.67	-3.7481	1

"e" is a numerical constant that is equal to 2.71828

The corresponding Microsoft Excel equation appears as follows:

Height = A Coefficient*POWER (e, B Coefficient/dbh)

Ten Year Radial Growth and Bark Thickness by Species

Species		Radial Growth (In.)	Single Bark Thickness (In.)
Aspen	(31 detail records)		
	Average=	0.45	0.85
Birch	(187 detail records)		
	Average=	0.54	0.55
Black Spruce	(27 detail records)		
	Average=	0.31	0.38
Cottonwood	(14 detail records)		
	Average=	0.87	0.81
Hemlock	(104 detail records)		
	Average=	0.32	0.89
Sitka Spruce	(24 detail records)		
	Average=	0.95	0.51
White Spruce	(279 detail records)		
	Average=	0.72	0.47

Bark Thickness Ratio by Species

		DBH	DIB*	Bark Thickness Ratio
Aspen	(31 detail records)			
	Sum=	383.40	330.50	0.862
Birch	(187 detail records)			
	Sum=	2,368.60	2,164.46	0.914
Black Spruce	(27 detail records)			
	Sum=	164.70	144.10	0.875
Cottonwood	(14 detail records)			
	Sum=	168.20	145.50	0.865
Hemlock	(104 detail records)			
	Sum=	1,135.30	949.80	0.837
Sitka Spruce	(24 detail records)			
	Sum=	271.70	247.20	0.910
White Spruce	(279 detail records)			
	Sum=	2,704.10	2,444.50	0.904
Grand Total	**Sum=**	**7,196.00**	**6,426.06**	**0.893 Average All Species**

*DIB = Diameter Inside Bark

Appendix G
Forest Inventory Field Instructions

Table of Contents

I. FIELD PROCEDURES

A. Locating Sample Plots in the Field

1. General

The field crew must find, on the ground, the exact stand polygon identified on the map for sampling. Crews are furnished with maps, aerial photo images, a selected sample plot list, and possibly a GPS receiver containing digital images of the stand polygons. The objective is to sample the polygon with ten plots that will represent the variability of the stand.

2. Variable Plots from Maps or Aerial Photo Images

The first plot will be a minimum of 33 feet inside the stand polygon to ensure that the selected polygon is truly being represented. The remaining plots will be spaced evenly across the stand polygon. The line of plots can vary in direction to obtain a representative sample of an odd shaped stand polygon. Interval spacing between plots is determined by measuring the distance in inches across the polygon and dividing by the total number of plots (ten). By utilizing the known scale of the image, distance in inches can be converted to feet. Maximum interval between plots will be 330 feet. Verify pacing distance with the logger's tape to accurately pace between plots.

3. Navigating to Plots

Using the compass as a protractor, with orienting lines parallel to the map north line, determine the true north azimuth of the line of travel. The declination must be accurately set on the compass to get the true north azimuth. Local declination can be determined prior to field work by downloading the Geographic Magnetic Calculator from the internet. Once at the point, check the aerial photo images to ensure that you are within the stand polygon. The plot center point will be marked by a wooden stake driven into the ground and tied with ribbon flagging. A long ribbon flag will also be hung from a tree or bush above the plot center point with the plot number marked on it.

4. GPSing Plot Locations

Plot locations of measured plots will be GPS'd when possible. A recreation grade receiver (Garmin or equivalent) will be used for this procedure. The map datum will be set at NAD83 and the position format will be degrees and decimal minutes.

5. Determining "In" and "Out" Trees

Hold a 20 basal area factor (BAF) relaskop over the plot center point. The instrument and not the cruiser's body must be held directly over the plot center while turning the circle. Walk the instrument around; do not stand in one place and move the relaskop around you. Determine those live trees 5.0 inches DBH and larger that are within the fixed critical angle of the instrument. "Borderline" trees (difficult to determine ocularly as "in" or "out") will be resolved by examining the Limiting Distances and Slope Correction tables in the appendix. To be considered "in" the tree must be equal to or less than the calculated distance as shown in the tables. This limiting distance is calculated from point center to face of tree.

II. FOREST PLOT RECORD CARD

The field form corresponds with a computer program designed to store, process and compile data collected on the forest inventory. An asterisk indicates items to be completed in the office. Leading zeros do not need to be entered. Where certain items do not pertain to a line entry, a dash should be entered to prevent confusion with missing data.

A. Plot Record Card Header Information Items

The purpose of these items is to record information about the sample stand.

Item #

1. Project Name
Record the project name for the forest inventory.

2. Crew
Record the crew members who are collecting the field data.

3. Date
Record the date the information is taken in the field. Use the following numeric code order – month, day and 4 digit year.

4. Section
Record the section number in which the data is being collected.

5. Township
Record the three digit code for recording the township in the first two columns and north or south designation in the third.

6. Range
The range is the three digit code for recording the range in the first two columns and the east or west designation in the third.

7. Meridian
The Prime Meridian is recorded as follows:

Code	Meridian
C	Copper River
K	Kateel River
S	Seward
F	Fairbanks
U	Umiat

8. Quad
Enter the USGS quad map name and identification using the first two letters of the name and map number. When the quad name includes two words, use the first letter of each word.

9. Region
Record the code for the district in which the data is collected

Code	Region
1	Northern
2	Coastal

10. Area

Code	Area	District
1	Kantishna	Northern
2	Fairbanks	
3	Delta	
4	Tok	
5	Valdez/Copper River	
6	Southern Southeast	Coastal
7	Northern Southeast	
8	Kenai/Kodiak	
9	Mat-Su	

11. Unit
Record the one digit code of the locally defined unit in which the data is collected. See Section III (C2) for definition.

12. Stand Number
Record the pre-assigned five digit code of the stand in which the data is collected.

13. Basal Area Factor
Record the pre-assigned basal area factor used at the sample plots.

14. Number of Plots
Record the number of plots sampled for the particular stand.

15. Photo Stand Call
Record the stand call for the sampled stand as it appears on the aerial photo image or a selected sample plot list. This includes the species, size class, and stocking level for the primary and secondary call. The Vegetation Key is shown below:

Forestland Vegetation		Non-Forestland Vegetation	
A	Aspen	AGRI	Agriculture
B	Birch	ALD	Alder
CW	Cottonwood	ALP	Alpine
HD	Hardwood	ALPS	Alpine Shrub
BS	Black Spruce	BN	Barren/Snow Ice
WS	White Spruce	CC	Calamagrostis
SS	Sitka Spruce	DEV	Developed Area
MH	Mountain Hemlock	GH	Grasses and Herbs
HVST	Harvest Area	MSH	Marsh
		NF	Non-Forest
		OG	Other Grasses
		OS	Other Shrub
Stand Size Class		99	NF
1	Reproduction (less or equal to 4.9 inches DBH)	W	Water
2	Poletimber (5.0-8.9 inches DBH)	WIL	Willow
3	Sawtimber (9.0 inches and greater)		
Crown Closure		Descriptors	
C	Closed (60-100% canopy coverage)	D	Dead
O	Open (25-59% canopy coverage)		
W	Woodland (10-24% canopy coverage)		

16. Ground Stand Call

Record the ground stand call after a plot is complete. The ground stand call is determined from the following stand call procedures:

Timber stands in Interior Alaska tend to be single layered and type calls were designed to describe the structure and composition of these stands. Some gray areas still exist in this system and these guidelines are an attempt to develop consistent calls by the field crews. Type calls are written in this fashion: tree species, stand density and tree size class such as WS3C (white spruce, sawtimber, closed). Vegetation type definitions are included in Section IV. Procedures for determining these calls in the field are outlined below:

Initial Type Call

To make a call in the field, walk through at least 10% of the stand to get some idea of the variability, predominate size and structure, and range of DBH measurements. (This walk through can be accomplished while traversing between predetermined points). Get an overall view by using the aerial photography at the same time. If several plots are to be taken in the stand, it is better to make (or confirm) the type call afterwards to get the most accurate "feel" of the stand.

Mentally, call the stand in the following order (different than the order you'll write down later).

1. Species - If the stand is mixed, call the predominate species first. The second species must make up at least 30% of the overall stand composition. If that species is only in one portion of the stand, type that area separately. Any additional species included in the call must also make up 30% of the stand, Therefore, it is rare that a three species call would be made. One exception to this rule is in a mixed hardwood stand where no single species makes up 30% of the stand but the combined group (ie., hardwoods) does. In this case, a call of mixed hardwoods such as HD (Hardwood) is permissible. If trees do not comprise 10% of an area, the area is classified as non-forested.

2. Next determine the predominate size class. If, for example, the trees range from 4"-12" DBH, you will have to determine which size class (2 or 3) occurs in over 50% of the stand (use mode rather than mean for this determination). Rarely will the stand be truly a 50/50 split.

3. Now, determine the crown closure by examining the overhead canopy. The reason for deciding on this factor last is that occasionally it will need to be adjusted depending on what the predominate size class call was. This adjustment will be needed only in a mixed 2/1 or 3/2 stand where the predominate size class call (the larger size class) is only slightly in the majority. (Where there is no question as to the predominate size class - ie. It makes up over 60% of the stand, other size classes will be inconsequential). In a close call, however, the adjustment may be needed to more accurately reflect stand volume.
Example

4. Take for instance a birch stand that contains trees in which 55% are over 5"DBH and 45% are less than 5" DBH. The two conditions have been met; (1) The larger size class (pole) predominates but (2) it doesn't have the clear majority. The size class will be a 2 (poletimber). Most likely the crown closure of all the trees would be over 60% so it would first appear to be a 2C call. This may not accurately reflect the conditions on the ground, however, since the pole size trees themselves may only constitute a crown closure of, say, 40% (the rest of the crowns are from the reproduction trees). Here a B2O call would be more accurate. This is an example of the case where the density call may be used to adjust the size class call based on the predominant size class. A plot tally should confirm this because although you're in a pole stand there are likely to be a few "in" trees (trees < 5"DBH wouldn't be tallied).

Again this case is only used where the predominant size class is the larger one in the stand. A WS2O stand with some sawtimber wouldn't be upgraded to a WS2C stand because the independent density call was made including the sawtimber crowns already. They contribute to increasing the stand density by their larger size.

Summary

Rules for possible reduction of density call:
1. Consider only if the type call is debatable throughout the stand.
2. Consider only after a walk through.
3. Consider only when the size class call is mixed with trees of a smaller size class. Therefore, only used where it may result in a reduction of the density call.

The result should be that the adjusted calls more accurately describe the volume. Density will drop where the volume is lost due to the abundance of small diameter trees.

17. Stand Acreage
Record the acreage associated with the sampled stand polygon. Stand acreage will be determined prior to field work. Acreage is available from selected sample plot list.

18. Stand Origin

Stand origin is a single digit code for identifying the interpreted origin of the sampled stand. Stands are considered evenaged if the age range of dominants and codominates is within ± 20 years of the average age.

Code	Stand Origin: Even-Aged Stands
1	Fire
2	Windthrow
3	Flood
4	Glacial Retreat
5	Timber Harvest
6	Other (Specify in Notes)
7	Unknown

Code	Stand Origin: Uneven-Aged Stands
8	Old Growth Forest
9	Timber Harvest (Selective Cutting)
0	Other (Specify in Notes)

19. Stand Age

For even-aged stands, record the stand establishment year based upon the age of the oldest site tree cored. Record the year for predominate cover type and size class.

E.g., Oldest core age + 7 years to reach breast height
Current year – estimated stand age = year of origin

For uneven-aged stands, record the stand establishment year based upon the age of the oldest site tree cored. Record the year for predominate cover type and size class.

Code	Years
1	less than 150
2	150-200
3	200-250
4	250-300
5	300-350
6	350-400
7	400+

20. Non-Stocked Condition Class

Record a one digit code for those forest lands which do not support a forest for the reasons listed below.

Code	Cause
0	Does not apply; stand at least 10% stocked.
1	Logging (within 5 years)
2	Logging (more than 5 years)
3	Water or Glacial Action
4	Slides
5	Windthrow
6	Insect Activity
7	Fire
8	Other (specify in notes)

21. Slope

Record the angle of slope to the nearest 1 percent.

22. Aspect

Record a three digit code for the general direction of slope within the stand based on true north, to the nearest degree. If the stand is considered to be level, record 0. This can also be obtained from a USGS topographic map.

Code	Degrees
0	No aspect, stand is considered level
1	1
5	5
90	90 (Due East)
360	360 (Due North)

23. Elevation

Record the average elevation of the plot traverse to the nearest fifty feet.

24. Soil Description

Record the average soil description within the stand polygon.

Code	Description	Texture
1	Sand and Gravel	Heavy
2	Mostly Sand	Moderately Heavy
3	Silt Loam	Medium
4	Loam	Moderately Light
5	Mostly Silt	Light
6	Silty Clay	Very Light
7	Clay	Muck
8	Bog	- -

25. Soil Drainage Class

Code	Description
1	Excessively Drained - Water is drained from the soil rapidly due to the absence of fines and organic material. Gravelly soils, often on steep slopes.
2	Well Drained - Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured.
3	Poorly Drained – Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods.

26. Soil Erosion Rating

Code	Cause
1	Slight
2	Moderate
3	Severe

27. Topographic Position

Code	Description
1	Ridge top or mountain peak, > 130 ft wide
2	Narrow ridge top or peak, <130 ft wide
3	Side hill, upper 1/3
4	Side hill, middle 1/3
5	Side hill, lower 1/3
6	Canyon bottom, < 660 ft wide
7	Bench, terrace or dry flat
8	Broad alluvial flat, > 660 ft wide
9	Swamp or wet flat

28. Stand Condition

Stand Condition codes are used to express differences between stands in terms relating to the desired management of the stand. High risk stands are composed of a majority of trees not expected to live for more than 20 years.

Code	Description
1	High Risk
2	Mature
3	Overstocked
4	Sparse
5	Low Quality
6	Good-Fully Stocked
7	In process of regeneration

29. Operability

Operability codes are used to give a general evaluation of timber harvest opportunity for a site. Considerations are made relative to access costs, available volumes, environmental constraints, and administrative restrictions. This and other information is used to develop a forest wide operability map which defines the available timber base upon which the allowable annual harvest may be computed.

Code	Description
1	Operable – No apparent restrictions to access.
2	Operable/Seasonal – Access is restricted to winter because of local wetlands or ice bridge requirements.

3	Operable/Marginal – Difficult terrain for road construction, poor conditions for conventional yarding systems, marginal stand volume not justifying high operating costs. Unlikely to be logged on a first entry because of economic constraints.
4	Operable/Restricted – Special interest takes precedence over timber resources, e.g., mountain goat habitat.
5	Inoperable – Physical features of landscape and quality of timber prevent any reasonable means of harvesting.

30. Wind Hazard

The recent blowdown history of a forest area may be observed and used as an indicator of blowdown expected in the future. It is possible to get a general idea of frequency of wind damage by observing the various states of decay of windthown trees or uproots. Wind hazard codes indicate the probability of wind damage.

Code	Description
1	No history of windthrow hazard.
2	Recent evidence of windthrow.
3	Long term windthrow history.
4	Recent and long term evidence of windthrow.
5	Past cutting or roading has made stand susceptible to windthrow.
6	Shallow rooting.
7	Wind accelerated by topography in area.
8	Stand height exceeds general forest canopy.

31. Wind Hazard Direction

Record a three digit code for the general direction (degrees) of blowdown within the stand based on true north (coding similar to item 19).

32. Diagram

Diagram the overall shape of the sample stand polygon, illustrating the line of travel and sample plot locations. Provide the plot spacing in feet and the line of travel in true north azimuth.

B. Plot Record Card Variable Plot Tree Measurement Information Items

The purpose of these items is to record information about the individual trees sampled with the variable plot method.

Item #

33. Plot Number

Record the plot number for the data being recorded. Record only once for each plot taken.

34. Tree Number

Record the tree number for the data being reported. Begin tree number sequence for each plot.

35. Site Tree

Record the number 1 for all site trees. Site trees are selected based on the following tree characteristics:

Site index is the commonly used method of estimating site quality. For white spruce in interior Alaska, site index is the height attainable by the average dominant and codominant trees at a DBH age of 100 years. For birch, aspen and balsam poplar, site index is the height attainable by the average dominant and codominant trees at a DBH age of 50 years. Site trees should be species exhibiting vigorous growth and still putting on height. All site trees should have been dominant or codominant throughout their lives. Do not use trees that have been suppressed during early years and then released. These can be identified by increment cores which show narrow growth rings in early years followed by a sudden and widening of growth. Avoid trees with major injuries or insect and disease problems. Site trees should be near the index age of the site index curves for that species (i.e. 100 years for spruce, 50 years for hardwoods). Select a suitable tree on or adjacent to the plot so long as the tree is within the same forest habitat type and site condition. Careful measurements of tree diameter, height, age, and ten year growth are essential for a good estimate of site index. Every effort should be taken to record at least 4 site trees per sampled stand.

36. Off Plot Tree

Record the number 1 for all trees tallied that are not included in the variable radius sample plot. This includes site trees or other trees solely measured for growth or age.

37. Species

Record the species code from the list below:

Code	Common Name	Timber Type Symbol
094	White Spruce	WS
095	Black Spruce	BS
098	Sitka Spruce	SS
264	Mountain Hemlock	MH
375	Paper Birch	B
746	Quaking Aspen	A
747	Black Cottonwood	CW

38. Diameter Breast Height

Record the DBH to the last tenth inch (a 9.18-inch tree will be coded 91).

1. All "in" tally trees (live or dead) 5.0 inches DBH and larger are measured. Diameter will be measured at a point 4.5 feet above ground on the uphill side of the tree. In cases of irregularities at DBH, such as swellings, bumps, depressions, branches, etc., diameters will be measured immediately above the irregularity, and at a place where the irregularity ceases to affect the normal stem form. Remove all moss from the tree bole at DBH before taking the measurement.

2. If the tree forks below 4.5 feet, consider the tree as two trees. A forked stem, on the variable radius plot, is a tally tree if the stem is “in” at the point where the diameter is measured. Forked trees on the fixed radius plot are tally trees if the radius of the fixed plot passes beyond the center of the forked stem at the point where it is measured. Measure the diameter of each fork that is an “in” tree at a point 3 ½ feet above the crotch of the fork. Consider the fork as the base of the tree for height determination and log quality assessment.

3. Any forked tree not having and 8-foot log between forks in hardwoods, or a 12-foot log between forks in softwoods will be called a sound cull (class 9 under the form column of item 53)

BASAL AREA COUNT PLOT PROCEDURES

Basal area count plots will record all trees 5.0 inches DBH and larger by species and product class i.e. poletimber or sawtimber and all dead trees estimated to have died within the last five years. Record the tree count in item 38 and the size class description (POL, SAW) in item 39. If the tree is dead within the last fifteen years (e.g. Kenai Beetle Kill), either salvable or non-salvable, record an X in item 43 Tree History.

39. Total Height

Record the total height to the nearest foot for all tally trees. For trees with broken tops, estimate the expected total height using adjacent trees of similar diameter class as a guide and provide an appropriate defect amount for the trees. Total height is measured from the ground (or top of root collar) to the tip.

1. Baselines for tree height measurements should always be taped as near as possible to the contour of the slope to minimize or eliminate the need for slope correction. Where the baseline is taped up and down slopes exceeding 15 percent, slope correcting should be made. The appendix contains slope correction tables that can be used in correcting baselines in horizontal distances.

2. On trees that fork at or above DBH, measure length along the principle fork.

40. Single Bark Thickness

Record a single bark thickness to the nearest 1/20th inch at breast height for each species and two inch diameter class present at sample plots 1 and 3 for each sample stand polygon. Select the healthiest tree within each class for coring. Some bark gauges read in 1/10th increments, be sure to record to nearest 1/20th inch.

Diameter Class	Description
6 inch	5.0 to 6.9 inches
8 inch	7.0 to 8.9 inches
10 inch	9.0 to 10.9 inches
12 inch	11.0 to 12.9 inches
Etc.	Etc.

41. Breast Height Age

Record the breast height age of site trees and trees cored to age the stand. Whenever possible, borings must reach the pith. Rings may be counted in the field or prepared for sending to the office. The

appendix contains instructions on collecting cores. Ring counting in hardwoods is difficult. The application of a small amount of Thompson's Water Seal to the core can help in distinguishing rings.

42. Ten Year Growth

Record the ten year radial growth to the nearest 1/20th inch at breast height for each species and two inch diameter class present. Measurements are for the same trees as in item 40. If tree rings are unable to be read,

43. Tree History Code

Tree history codes are used to express differences between trees in terms relating to the desired management of the stand.

Code	Description
1	Desirable crop trees. a. Less than rotation age (assume 150 years spruce, 100 years hardwood) b. Alive c. Noncull d. A commercial species e. Capable of producing one merchantable sawlog f. Isolated, dominant, or codominate trees g. At least 40 percent covered with live crown h. Of good form i. Free of defect indicators
2	Acceptable crop trees. a. Less than rotation age (assume 150 years spruce, 100 years hardwood) b. Alive c. Noncull d. A commercial species e. Capable of producing one merchantable sawlog f. Normal conical shaped crown. No evidence of flattening crown. Pole sized crop trees with deformed crowns will be classed as sound cull.
3	Mature high risk trees. a. Over rotation age (assume 150 years spruce, 100 years hardwood) b. Alive c. Noncull d. A commercial species e. Capable of producing one merchantable sawlog f. Of fair or poor vigor, as indicated by low crown ratio, dead branches, disease, internal rot, and/or mechanical damage.
4	Mature low risk trees. Trees will be coded low-risk only if obviously healthy and vigorous and if no damage code applies to it. a. Over rotation age (assume 150 years spruce, 100 years hardwood) b. Alive c. Noncull d. A commercial species e. Capable of producing one merchantable sawlog f. Of good vigor, as indicated by high crown ratio, vigorous leader, no evidence of disease, rot or mechanical damage.
5	Rotten cull trees. Trees not able to produce one merchantable log, primarily due to defect. a. Alive b. More than 75 percent rotten cull in softwoods and more than 50 percent rotten cull in hardwoods
6	Sound cull trees. Trees not able to produce one merchantable sawlog, primarily due to defect. a. Alive b. Not rotten cull trees c. Trees not able to produce one merchantable sawlog, now or in the future, primarily due to bole roughness and poor form, or deformed or sparsely needled crown, or is a noncommercial species.
7	Salvable dead trees.

a. Dead within the last fifteen years (e.g. Kenai Beetle Kill)
b. Sawtimber
c. A commercial species
d. Contain at least one merchantable log

8 Non-salvable dead trees.
a. Dead within the last fifteen years (e.g. Kenai Beetle Kill)
b. A commercial species
c. No salvable sawlogs

9 Other dead trees. All trees that have been dead more than fifteen years.

Guidelines for Estimating Time Since Mortality

Died Within Past 15 Years	Species	Dead More Than 15 Years
No foliage remaining	Conifers	No foliage
30% or more of twigs remain		Less than 30% of twigs remaining
50% or more of branches remain		Large limbs falling
Considerable sloughing of bark		Less than 50% of branches remaining
		Bark mostly absent
Small amount of bark still attached in some degree to the bole	Populus spp.	No foliage Bark fallen off completely free of bole, or less than 50% attached in any degree
No foliage	Birch	No foliage
50% or more branchlets remaining		Less than 50% of branchlets remaining
Bark not curling abnormally		Bark shows abnormal curling
Occasional secondary branches falling		

44. Crown Ratio

For each live tree on the plot, estimate the percent of total tree height that supports green, live foliage that is effectively contributing to tree growth. For trees of uneven crown length, ocularly transfer lower branches on the longer side to fill holes in the upper portion until a full, even crown has been generated. Do not compact branches to form an unnaturally dense crown. Record crown ratio as a one-digit code for all live trees.

Code	Description
0	Less than 10%
1	10% - 19%
2	20% - 29%
3	30% - 39%
4	40% - 49%
5	50% - 59%
6	60% - 69%
7	70% - 79%
8	80% - 89%
9	90% - 100%

45. Defect Percent

Record the total board foot defect percent for conifer sawtimber tally trees. Record the total cubic defect for hardwood tally and conifer poletimber tally trees. Record defect for all Tree History codes except code 9 (other dead trees). Use only identified external, visible indicators. Use the "Procedures for Deduction of Visible Defect" found in the appendix. Record cull trees as 99.

46. Defect Type

Record the major tree defect contributing to the majority of the lost volume.

Code	Defect Type
0	No defect
1	Conks
2	Swollen Knots
3	Scars
4	Frost Cracks

5	Rotten Stubs
6	Sucker limbs
7	Dead side or strip
8	Old broken top in merchantable stem (> than 5 years old)
9	Sweep
10	Crook
11	Forked top
12	Fluting
13	Other

47. Tree Problem

Tree problem describes major damage or other conditions affecting tree growth, vigor or form.

Code	Tree Problem Class
0	No damage
	Insects
1	Bark Beetles
2	Defoliators
3	Sap-Suckers
	Disease
4	Stem Rust
5	Butt Rots
6	Broom Rusts
7	Foliage Disease
	Fire
8	Fire Damage
	Animal
9	Porcupine Girdling
10	Big Game Browse
11	Hare Browse
12	Small Rodent Browse
	Elements
13	Wind
14	Lightning
15	Snow
16	Frost
17	Drought
18	Sun Scald
19	Erosion
20	Flooding
	Suppression
21	Forked Top
22	Broken Top
23	Crook
24	Sweep
25	Scar

48. Log Grade First Log

For sawtimber sized trees only (≥ 9" dbh), record first log grade as a one digit code. The quality of sawlog tally trees is rated by grading the first two 16 foot sawlogs. Grading will follow Puget Sound Log Scaling and Grading Rules, and use the following published species. Sitka Spruce= Sitka Spruce, White Spruce, Black Spruce, Hemlock. Cottonwood=Cottonwood. Red Alder=Birch and Aspen.

49. Log Grade Second Log

Record second log grade as a one digit code.

Code	Log Grade
1	Number one
2	Number two
3	Number three
4	Number four
5	Utility (pulp)

Logs will meet the minimum exterior characteristics. Diameter refers to top of log diameter.

1. Sitka Spruce, White Spruce, Black Spruce, Hemlock

Grade No. 1

Gross Diameter:	24 inches
Surface:	75% clear

Grade No. 2

Gross Diameter:	12 inches
Surface:	Sound, tight knots not to exceed 2 ½ inches in diameter. Any larger knots must be well distributed.

Grade No. 3

Gross Diameter:	6 inches
Surface:	Sound, tight knots not to exceed 3 inches in diameter. Any larger knots must be well distributed.
Minimum volume	50 board feet NET scale
Slope of Grain	May include logs with "excessive slope of grain" with proper deduction. **Note: A 16' log segment must be a minimum 10" top to equal 50 board feet.**

Grade No. 4

Gross Diameter:	5 inches
Minimum volume	10 board feet NET scale

2. Cottonwood

Grade No. 1

Gross Diameter:	10 inches
Surface:	Not to exceed 4 knots per log

Grade No. 2

Gross Diameter:	6 inches

Grade No. 4

Gross Diameter:	5 inches
Minimum volume	10 board feet NET scale

3. Birch/Aspen

Grade No. 1

Gross Diameter:	16 inches
Surface:	75% clear

Grade No. 2

Gross Diameter:	12 inches
Surface:	50% clear

Grade No. 3

Gross Diameter:	10 inches

Grade No. 4

Gross Diameter:	5 inches
Minimum volume	10 board feet NET scale

4. All Species

Grade No. 5 Utility Logs

Shall be logs that do not meet the minimum requirements for sawmill grades, but are suitable for the production of firm useable chips to an amount not less than 50% of GROSS scale.

Gross Diameter:	4 inches
Minimum volume	10 board feet NET scale

Note: A log that is burned or charred or is not mechanically barkable, shall not qualify as a Utility log.

C. Plot Record Card Fixed Plot Tree Measurement Information Items

The purpose of these items is to record information about the individual seedling and sapling size trees sampled with the fixed plot method. A seedling and sapling count will be recorded for tree species not included in the variable radius plot (i.e. all trees less than 5.0 inches DBH). The dominate species of understory vegetation will also be recorded. A seedling and sapling count will be made at each point using a 1/250 acre plot (radius 7.45 feet). Plot centers will be the same as the variable plot sample point centers.

50. Species

Record the seedling and sapling tree species present on the 1/250th acre plot. Species are recorder for each one inch diameter class present on the plot. Record the species code as in Item 33.

51. Diameter Class

Record the diameter class of the tree species found on the 1/250th acre plot.

Code	DBH Class
0	Less than 0.5 inch
1	0.5 inch to 1.4 inches
2	1.5 inches to 2.4 inches
3	2.5 inches to 3.4 inches
4	3.5 inches to 4.4 inches
5	More than 4.4 inches

52. Number of Trees

Record the number of trees by diameter class and species found on the plot.

53. Height

Record the average height of each species at each fixed area plot.

Code	Height Class
1	0-6 inches
2	7-18 inches
3	18 inches – 3 feet
4	3-9 feet
5	10-19 feet
6	20-29 feet
7	30-39 feet
8	40-49 feet
9	50+ feet

54. Tree History

Record the code for tree history which best describes the condition of the trees found on the fixed plot.

Code	Tree History
1	Desirable growing stock trees
2	Acceptable growing stock trees
3	Undesirable growing stock trees

55. Ground Cover

Record ground cover for all plots, whether stocked or non-stocked. If more than one type of ground cover is important, record the dominant species.

Code	Brush Vegetation		
0	No Vegetation		
1	Rose		
2	Buffalo Berry		
3	Raspberry		
4	Labrador Tea		
5	Blueberry		
6	Willow		
7	Alder		
	Other Vegetation		
8	Grass	14	Fern
9	Moss	15	Devils Club
10	Forbs	16	Menziesii
11	High Bush Cranberry		
12	Equisetum		
13	Low Bush Cranberry		

56. Percent Cover

Code	Description
0	Less than 10%
1	10% - 19%
2	20% - 29%
3	30% - 39%
4	40% - 49%
5	50% - 59%
6	60% - 69%
7	70% - 79%
8	80% - 89%
9	90% - 100%

57. Comments

Record any comments about the specific sample stand or individual trees.

III. APPENDIX

A. Procedures for Deduction of Visible Defect

Visible defect is divided into two major categories (board foot defect conifer trees, cubic foot defect hardwood trees and conifer poletimber) under item 44, Defect Percent. Measurements of both board foot and cubic foot defect refer to the merchantable portion of the tree. A merchantable tree must be capable of producing at least one merchantable sawlog which is at least 33 percent sound in softwoods or at least 50 percent sound in hardwoods, in terms of board foot measure. All poletimber which is less than 50 percent sound, in terms of cubic foot measure, and all saplings with any sign of rot will not be considered merchantable, but rotten culls. All trees which are of such poor form that they will never produce a merchantable sawlog will not be classed as merchantable trees, but as sound culls or rough trees.

A merchantable log for a softwood sawtimber tree must have a minimum length of 12 feet to a minimum top of 6 inches diameter outside bark (d.o.b.) and with one-third of its board foot volume in sound recoverable wood. A merchantable log for a hardwood sawtimber tree must have a minimum length of 8 feet to a minimum top of 6 inches diameter outside bark (d.o.b.) and with one-half of its board foot volume in sound recoverable wood.

1. Defects Causing Loss of Sound Wood Volume

These defects include rots and missing portions of the tree which reduce both the board foot and cubic foot volumes and constitute losses of actual wood fiber. Fungus diseases such as butt rot and heart rot can cause significant volume loss. Field crews will make deductions only for visible defect. Hidden defect deductions should not be made in the field for rot discovered when boring trees for age or growth, unless an external indicator accompanies the rot. Where rot is encountered in borings, or suspected, however, make a careful examination for the presence of indicators.

2. Defects Causing Loss of Board Foot Volume Only

These defects include deformities such as seams, cracks, fluting, serious crooks, sweep, etc., which reduce the volume of wood useable for board foot products, but do not reduce the cubic foot volume of sound wood. Such defects can cause extensive board foot volume loss. Defects which can be removed with the slab in sawing do not constitute a loss of board foot volume.

3. Common Parasitic Diseases of the Major Interior Alaska Tree Species

White Spruce—

Disease	Location	Indicators	Visible Entrance Port
Tomentosus Root Rot	Confined mostly to butt and roots	Fruiting bodies are leathery and small, usually less than 4" in diameter. Red-brown stain in heartwood. Windthrown trees are broken off at roots.	Spreads buy root contact. Occurs in groups, mortality results in stand openings.
Fomes pini Red Ring Rot	Any location in main bole of tree.	Shelf-shaped conk with a sharp edge. Dark brown with concentric ridges. Resinous punk knots (swollen knots filled with golden-brown mycelium) are common.	Old branch stubs, seams, mechanical wounds.
Fomes pinicola Red Belt Fungus	Confined mostly to butt or lower bole of both live and dead trees.	Woody hoof-shaped conk, gray to black, with reddish band near the margin	Seams, fire scars, mechanical wounds.

Hardwoods--

Disease	Location	Indicators	Visible Entrance Port
Fomes igniarius Hardwood Trunk Rot	Any location in main bole of tree.	Woody hoof-shaped conk, grayish-black, above, brown below.	Branch stubs or open wounds, fire scars.
Pholiota spp. Yellow Cap Fungus	Confined to butt portion of tree.	Annual mushroom, produced in clusters, cap is yellow-brown and usually scaly and/or sticky.	Fire scars, butt seams or wounds.
Ganoderma applanatum Artist's Conk	Confined mostly to butt or lower bole of both live and dead trees.	Woody shelf-shaped conk, tan gray to gray black, often covered with a tan dusting of spores.	Mechanical wounds, broken tops.

4. Percentage of Tree Volume in 16-foot Logs

Tree Ht.	1	2	3	4	5	6	7
1 Log	100						
2 Log	85	13					
3 Log	55	35	15				
4 Log	41	31	20				
5 Log	32	27	21	14	6		
6 Log	27	23	19	15	11	5	
7 Log	23	20	17	15	12	8	5

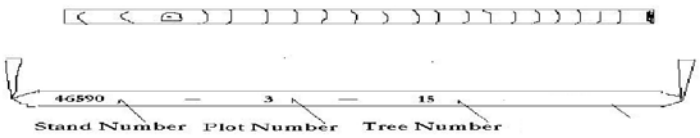
If section of bole is cull, deduct percent of log length affected. For example 4/16=25 percent cull in section. For a three log tree if the 4' defect is in log 2, then .25 X 35=9 percent cull for the entire tree.

B. Procedure for Collecting Increment Cores

The project leader may specify collection of site tree cores. When cores are collected for office evaluation, these procedures shall be used.

All site trees will be bored to the center of the tree at d.b.h.

1. Mark outside (bark end) of core with heavy pencil or permanent fine tip marker line.
2. Put core in plastic straw and leave ½ inch of straw at each end. Fold once and pinch tight.
3. Place masking tape on straw and record core information on tape as shown below, preferably with a permanent marker pen.
4. Note on straw if a portion of the core is in another straw (1 of 2 etc.). If core consists of two portions, draw match lines on each piece. If center is not reached, note reason (rot, etc.).
5. After returning from the sample stand, place the cores for each location/plot in PVC pipe labeled with the stand numbers.



C. Field Plot Sheet

State of Alaska, Department of Natural Resources, Division of Forestry

FOREST PLOT RECORD Page __ of __

PROJECT NAME		DATE			LEGAL					QUAD	
1		MONTH	DAY	YEAR	SECTION	TOWNSHIP	RANGE	MERIDIAN	NAME	LETTER
CREW											
2		3			4	5	6	7	8		

MGT. AREA			STAND NO.		STAND								
REGION	AREA	UNIT	12		PHOTO STAND CALL				GROUND STAND CALL				STAND ACRES
					VEG	SIZE	DENSITY	DESCRPT	VEG	SIZE	DENSITY	DESCRPT	17
			BAF	NO PLTS									STAND ORIGIN
9	10	11	13	14	15				16				18

STAND	SITE						
STAND AGE	SLOPE	ELEV	SOIL DRAIN	TOPO POS	OPERBLTY	WIND HAZ DIR	
19	21	23	25	27	29	31	
SITE							
NS CON CLS	ASPECT	SOIL DESC	SOIL EROS	STND COND	WIND HAZD		
20	22	24	26	28	30		

DIAGRAM 32

1	TREE MEASUREMENTS																FIXED AREA								COMMENTS
PLOT NUM	TREE NUM		STR	OFF	SPECIES	DBH	HEIGHT	BARK	AGE	GRO 1/20"	HIST	CRWN	PCT DEF	DEF TYP	TREE	PROB	GRD 1	GRD 2	SPECIES	DIA	NUM TREES	HGT	HIST	COV	% COV	
33	34		35	36	37	38	39	40	41	42	43	44	45	46	47		48	49	50	51	52	53	54	55	56	