

Timber Inventory of State Forest Lands in the Copper River Basin 2014



Doug Hanson

Statewide Inventory Forester
Department of Natural Resources
Division of Forestry

1/6/2014

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I. EXECUTIVE SUMMARY

The inventory of timber and biomass resources on state lands classified for forestry use in the Copper River Basin has been initiated in part by the need to support potential development of biomass energy systems in this rural area of Alaska. Through funding provided by the Alaska Energy Authority, State Division of Geologic and Geophysical Surveys, and State Division of Forestry, a timber and biomass inventory has been conducted using satellite and aerial photography, ground plots and other information sources. Automated eCognition object based image classification software together with Summit Evolution stereo viewing software were

Inventory Area Land Classification	<u>Acres</u>		
Timberland	219,550		
Dwarf Forests	96,880		
Non-Forest	<u>119,227</u>		
Total Inventory Area:	435,657		
Timberland Area by Timber Type Size Class			
Sawtimber	6,756		
Mixed Sawtimber/Poletimber	11,372		
Poletimber	96,408		
Reproduction	<u>105,014</u>		
Total Timberland Area:	219,550		
Timberland Area by Timber Type Species Class			
White Spruce	6,756		
Black Spruce/White Spruce	105,014		
Aspen	11,738		
White Spruce/Aspen	33,822		
White Spruce/Balsam Poplar	<u>11,372</u>		
Total Timberland Area:	219,550		
Total Net Volume			
Cubic Feet ($\geq 5''$ dbh)	Tons ($\geq 5''$ dbh)	Board Feet ($\geq 9''$ dbh)	
143,687,950	2,562,639	244,711,676	

TABLE 1. INVENTORY VOLUME AND ACREAGE SUMMARY.

used to facilitate forest typing of individual stand polygons. The inventory provides detailed stand type maps and internet mapping and querying capability. It is the first widespread stand based inventory to be performed on state lands in the area and can be used by the Division of

Forestry (DOF) for general forest and fire management planning. State lands that are included have been classified for forestry use through the Copper River Basin Area Plan. The volume data has been generated from timber stand data collected in September, 2009 and August, 2013.

II. OBJECTIVES

The objective of this report is to provide reliable inventory data to assist in the management of forest resources in the Copper River Basin. 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.
- Timber harvest sustainability data to evaluate potential project development.
- Biomass resource information to supplement statewide energy atlas data.

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. Timber types sampled included sawtimber, poletimber and reproduction types, dwarf timber stands (mostly black spruce less than 25 feet tall at maturity) were not sampled.

Timber types to be sampled were selected randomly through the GIS. Access to stands was by foot and four-wheeler. A total of 73 stands were field sampled. The timber cruise

measurements from the sample stands provide estimates of volume, stocking, defect and growth by individual tree species.

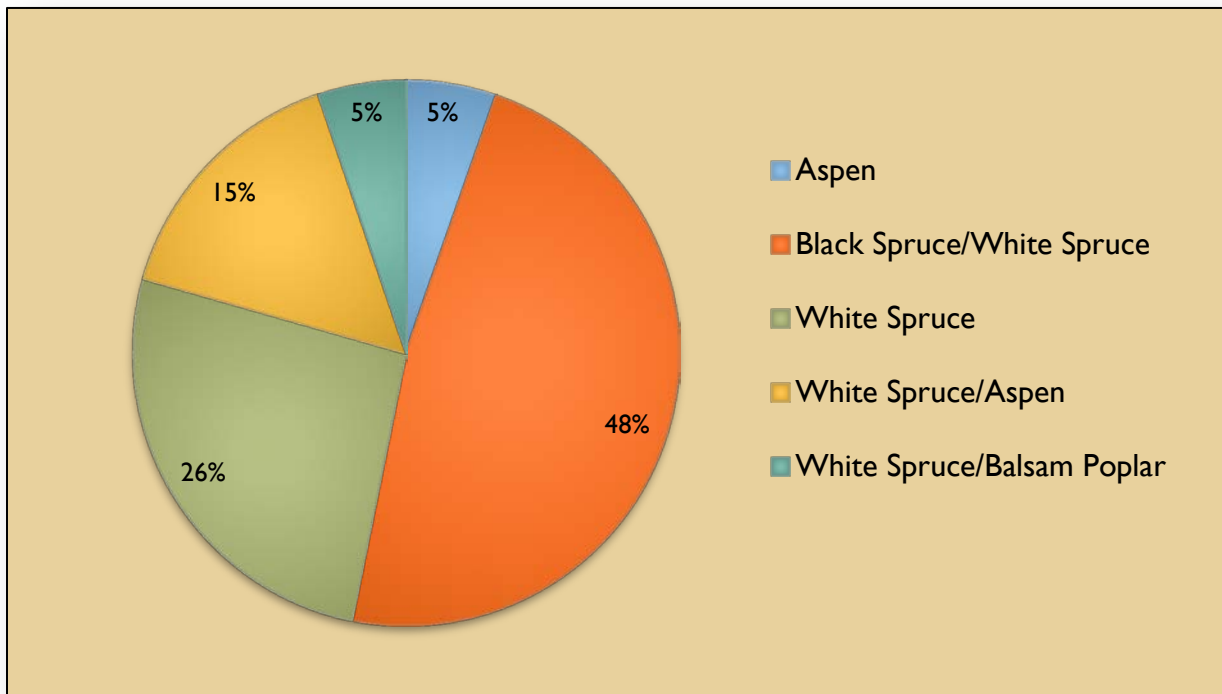


FIGURE 1. PERCENT OF TIMBERLAND AREA BY VEGETATION TYPE CLASS.

A. IMAGERY SOURCES

Scanned high altitude aerial photography at a scale of 1:60,000 and Spot 5 meter resolution satellite imagery were used for the project. The date of the aerial photography was 1978 and the date of the Spot scenes was 2003. The scanned color infrared photos were orthorectified, georeferenced to the Spot scenes, and mosaiced into a series of east-west flight lines across the project area. PCI image processing software was used for this process. Digital stereo epipolar pairs were then created from the photos for the stereo interpretation process.

B. VEGETATION TYPING

The vegetation interpretation process as originally conceived was to use the automated object based image classification software eCognition to classify the Spot satellite scenes. Epipolar

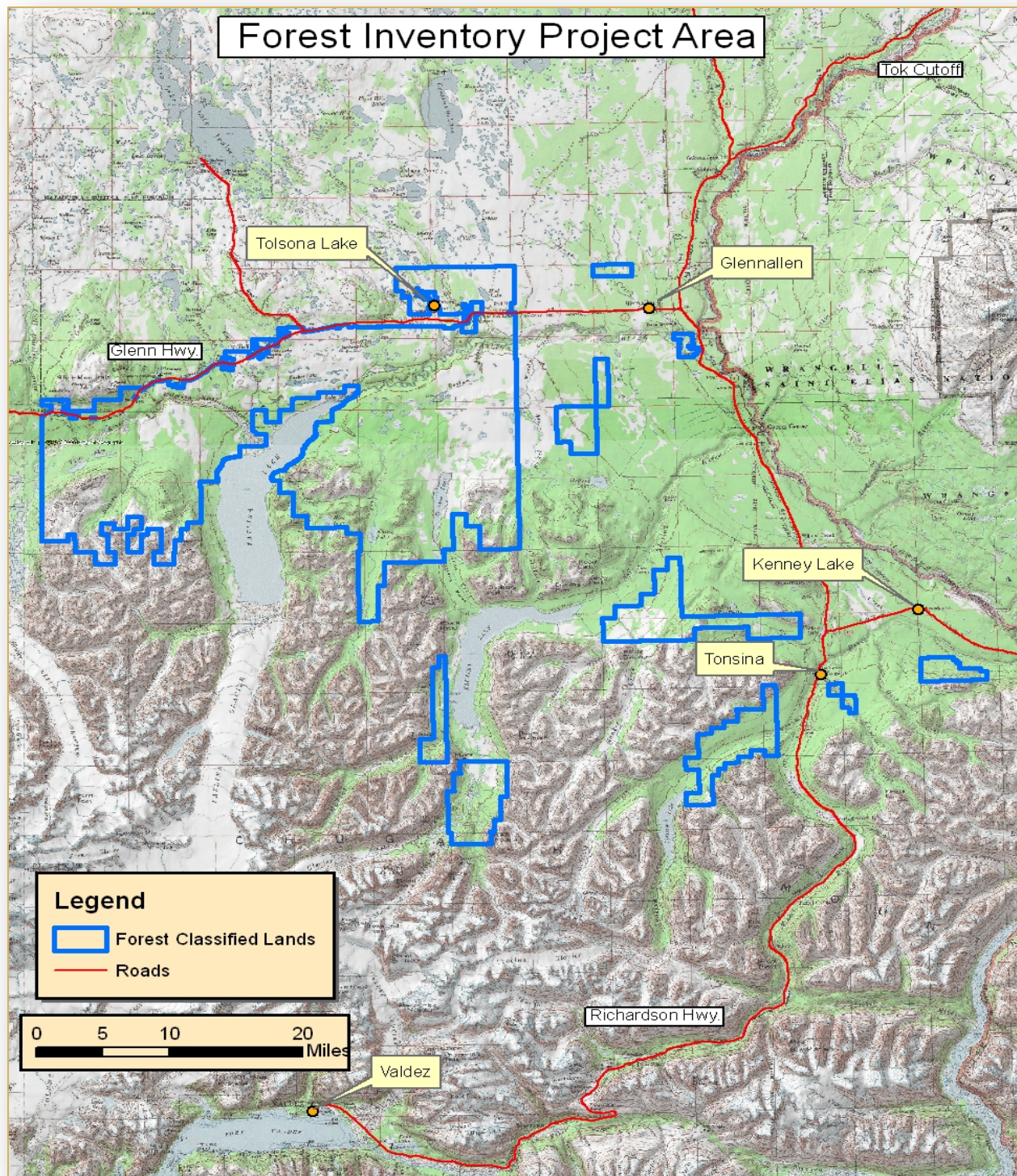


FIGURE 2. PROJECT AREA MAP.

pairs were to be created from the overlapping satellite scenes using PCI allowing a forester to view the scenes in stereo and edit polygons created by eCognition in 3-D format. The polygon editing process would correct errors in stand height where eCognition classification was less accurate. By correcting stand heights, the correlating size class calls of sawtimber, poletimber, reproduction or dwarf timber types would be more accurate. For this project, Spot Corporation donated six Spot 5 scenes to demonstrate this technology. A test of this new technology was conducted by DOF for the Tanana Valley in November of 2008 with good results. Unfortunately when eCognition was first run on the Glennallen Spot scenes the results were less than satisfactory. Individual polygon timber type delineation was not consistent across the scene and spruce and aspen stands were being combined with other vegetation types. Upon closer examination it was found that the scenes were acquired at a 5 meter pixel resolution versus 2.5 meter for the Tanana Valley scenes. In addition, color balancing between scenes was quite variable. The reduction in resolution and variation in color negatively affected the ability of eCognition to consistently classify the major forest types of the Glennallen area.

Due to funding and time limitations that precluded acquiring new scenes at the desired 2.5 meter resolution, 1978 scanned high altitude aerial photography at a scale of 1:60,000 was used for the automated eCognition classification process. The best results were achieved when eCognition was used to classify open and closed aspen, spruce and mixed stands and the non-forest vegetation types. Stand size class delineation was applied to the types by viewing the photos in stereo on a computer screen with Summit Evolution stereo viewing software. Spot images were used as the base image to correct changes that occurred over time between 1978 and 2003. Using the Spot images allowed for adjusting polygon boundaries to match changes in river locations, housing development and other land use changes. The Spot images also allowed more accurate delineation of the aspen timber types. The large outbreak of spruce bark beetles and resulting spruce mortality that occurred in the region in the early 90's was not visible on the photos and was difficult to see on the Spot scenes. Ground sampling however reflected the mortality and the volume estimates include this dead material. At the time of field sampling, the bark beetle epidemic was mostly over and few new trees were being infested.

Sawtimber, poletimber and reproduction stands were classified as timberland and represent the areas of greater productivity. These stands are a component of a larger class of ground cover called forestland. Forestland is defined as land that is at least 10% covered by trees. The other component of Forestland; dwarf forests, generally comprise black spruce stands that are less than 25 feet tall at maturity. These stands were identified on the imagery, but were not field sampled. It was determined that these stands currently were non-commercial even for the use of biomass. Most of the trees were significantly less than 25 feet tall. Delineation of timber

types was based on tree species, size class and stand density. The most prevalent species determined the timber type. In mixed timber types, the secondary species represented at least 30% density of the type in question. Besides utilizing the stereo images to assign size class calls to the eCognition classified vegetation, physical location of the stands in question contributed to the vegetation classification process. For example, numerous spruce stands adjacent to the Tazlina and Nelchina Rivers' productive floodplain were classified sawtimber. Timber types within the Copper River Basin itself that occurred on small rises were classified either sawtimber or poletimber because these growing sites were more productive.

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 300 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 1/250th acre plot (7.45 foot radius).

D. GEOGRAPHIC INFORMATION SYSTEM COVERAGE

Together with the tabular data, a GIS coverage was prepared for the inventory. A standardized vegetation key/mapping scheme was used for describing vegetation polygons (*table 2*). The acreage of individual polygons was calculated using ESRI ArcMap GIS software. Storage in the GIS allows for queries of individual portions of the project area to be accomplished for planning

purposes. Through the GIS, acreage and volume estimates as reported in this forest inventory can be recalculated to reflect any future changes in the forest land base.

LAND COVER KEY			
FOREST SPECIES			
1	Black Spruce	31	White Spruce-Birch
2	White Spruce	32	White Spruce-Black Spruce-Birch
3	Black Spruce-White Spruce	33	Black Spruce-Aspen
16	Balsam Poplar	34	White Spruce-Aspen
17	Birch	35	White Spruce-Black Spruce-Aspen
18	Aspen	37	White Spruce-Birch-Aspen
19	Birch-Aspen	38	White Spruce-Balsam Poplar
30	Black Spruce-Birch	39	White Spruce-Black Spruce-Birch-Aspen
DESCRIPTORS (Forests - Tree Size Class)			
S	Sawtimber	≥	9.0 inches DBH
P	Poletimber	5.0 inches to 8.9 inches DBH	
R	Reproduction	<	5.0 inches DBH
D	Dwarf	<	25 feet at maturity
BR Recently Burned			
W Wetland			
FOREST DENSITY			
	X	60-100%	Calls are based on crown closure percent.
	Y	25-59%	
	Z	10-24%	
NON-FOREST			
68	Mixed Tall Shrub	95	Urban-Suburban
71	Mixed Low Shrub	96	Agriculture
76	Dry Midgrass-Herb-Sedge	97	Gravel pits, mines, quarries
79	Wet Sedge-Grass	98	Roads
80	Lakes-Ponds	99	Pipelines/Power lines
88	Rivers-Flowing Water	100	Clouds
94	Bare Ground	101	Timber Sales Harvested

TABLE 2, LAND COVER KEY.

E. 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. 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. Combinations of sampled and un-sampled timber types and the corresponding strata are shown in Appendix A. The inventory contains eight separate sample strata for which estimates of gross and net volume per acre have been calculated (Appendix B). The strata contain field data from 73 individual timber stands containing 730 plots (table 3). 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.

Stratum	Strata Description	Acres	Percent	Number Of Stands
1	White Spruce Sawtimber	6,756	3	11
2	White Spruce Poletimber Closed	20,637	9	11
3	White Spruce Poletimber Open	30,210	14	10
4	Black & White Spruce Reproduction Closed	10,220	5	9
5	Black & White Spruce Reproduction Open	94,794	43	9
6	Aspen	11,738	6	5
7	White Spruce-Aspen	33,822	15	9
8	White Spruce-Balsam Poplar	11,372	5	9
		219,550	100	73

TABLE 3. NUMBER OF SAMPLE STANDS BY STRATA.

F. DESCRIPTION OF STRATA

The eight strata are described below. Pictures are shown for selected strata where available.

I. STRATUM I WHITE SPRUCE SAWTIMBER

This stratum is found in limited amounts across the project area. It occurs on the most productive sites (Viereck et al. 1992) and had the highest volume per acre within the project. The sites generally were well drained to moderately well drained with silt and silt loam soil types. Stands with the highest volumes per acre were found along the Tazlina and Nelchina Rivers. Stands found on upland sites generally were on high ground with a southerly aspect. Average age of the stratum was 149 years. Bark beetle mortality was severe in the stratum and

most trees greater than 13 inches dbh have been killed. Fortunately many of the dead trees are standing and merchantability for fuelwood and biomass is still good. Stands on the more productive sites, i.e. river bottoms, had somewhat less mortality than on the upland sites. Stands located in the south edge of the project area in the vicinity of the Edgerton Highway had greater amounts of blow down, which probably reflects that the bark beetle epidemic began in this area and the trees have been dead for 3-4 years longer than in the north portion of the project area. Increased wind speeds in this area may also be contributing to blow down. The stratum contains 4,879 board feet per acre, but 22% of the board foot volume was in dead trees. The stratum averages 1,680 cubic feet per acre and has a net annual yield of 11 cubic feet per acre per year.



FIGURE 3. STRATUM I, WHITE SPRUCE SAWTIMBER, NELCHINA RIVER.

2. STRATUM 2 WHITE SPRUCE POLETIMBER CLOSED

This stratum is found across the project area on sites that are of poor to medium productivity. Permafrost is probably present on numerous sites. In some stands black spruce is mixed in, but with generally minor amounts compared to white spruce. Occasionally some aspen is also present. Average age of the stratum was 136 years, which is similar to the white spruce sawtimber stratum indicating sites of lower productivity. Although somewhat old, the stem count is fairly high and averaged 255 trees per acre 5-inches and greater dbh. The stratum contains 1,253 cubic feet per acre, with 14% of this volume in dead trees. The stratum has a net annual yield of 10 cubic feet per acre per year.



FIGURE 4. STRATUM 2, WHITE SPRUCE POLETIMBER CLOSED, SOUTH OF TAZLINA LODGE.

3. STRATUM 3 WHITE SPRUCE POLETIMBER OPEN

This stratum is found across the project area on sites that are of poor productivity. On higher elevations of the project area such as near the Little Nelchina River, the stands appear to have a high percentage of black spruce trees. During field measurements however, these trees were indeed white spruce which reflects the species' ability to out compete black spruce at higher elevations. Unfortunately however, these trees exhibit the slow growth characteristic of black

spruce. The stem count is 162 trees per acre. Many of the sawtimber sized trees have succumbed to the bark beetle infestation. Average age of the stratum was 182 years, the highest of all eight strata. These stands contain an average of 955 cubic feet per acre, with 21% of this volume in dead trees. The combination of slow growth and beetle mortality resulted in the slowest growth rate of all the strata. Annual yield was 2.1 cubic feet per acre per year.



FIGURE 5. STRATUM 3, WHITE SPRUCE POLETIMBER OPEN, NORTH OF LITTLE NELCHINA RIVER.

4. STRATUM 4 BLACK AND WHITE SPRUCE REPRODUCTION CLOSED

This stratum is found across the project area on sites that are of poor productivity. Although these stands contain a majority of trees less than five inches dbh, they are not true reproduction stands, but stands of very slow growing trees. They are however more productive than the common black spruce dwarf stands that occur widespread across the project area. These stands have measurable cubic foot volume and contain useable biomass. Average age was 122 years and the stands that were sampled have put on very little growth in the past 30 years. It is likely that productivity can be improved by opening these sites and

increasing soil warming. The stem count five inches dbh and greater averages 166 trees per acre, but a substantial number of trees less than five inches dbh are present that totals 1,744 trees per acre. The majority of the trees greater than five inches dbh are white spruce and the majority of trees less than five inches dbh are black spruce. Within the reproduction size class, 351 trees per acre are between three and five inches dbh. The stratum contains 478 cubic feet per acre, and has a net annual yield of 3.2 cubic feet per acre per year.



FIGURE 6. STRATUM 4, BLACK AND WHITE SPRUCE REPRODUCTION CLOSED, SOUTHEAST OF GLENNALLEN.

5. STRATUM 5 BLACK AND WHITE SPRUCE REPRODUCTION OPEN

This is the largest stratum by acreage comprising over 43% of the total timberland acreage. This stratum is found across the project area on sites that are of poor productivity. It is similar to stratum 4 in that the productivity is greater than dwarf timber types and has been determined to have useable biomass. Tree stem count five inches dbh and greater totals 81 trees per acre. The stem count of trees less than five inches dbh totals 1,939 trees per acre.

Within this size class, 245 trees per acre are between three and five inches dbh. The stratum contains 211 cubic feet per acre, and has a net annual yield of 7.1 cubic feet per acre per year.



FIGURE 7. STRATUM 5, BLACK AND WHITE SPRUCE REPRODUCTION OPEN.

6. STRATUM 6 ASPEN CLOSED

Stands comprising this stratum occur on the warmest of sites with a southerly aspect. The sites generally are well drained with silt and silt loam soil types. Average age of the stratum was 87 years and some stands have vigorous white spruce regeneration growing under the aspen. The stem count five inches dbh and greater averages 334 trees per acre. The stratum contains 1,236 cubic feet per acre and has a net annual yield of 48.7 cubic feet per acre per year. This stratum has lower volume per acre than stratum 1, but has the highest annual yield of all strata.



FIGURE 8. STRATUM 6, ASPEN CLOSED, SOUTHWEST OF TONSINA .

7. STRATUM 7 WHITE SPRUCE-ASPEN POLETIMBER

This stratum occurs across the project area on variable sites. Average age of the stratum is 98 and stand composition is quite variable. The aspen component varies in density with the older stands containing fewer stems. The stem count five inches dbh and greater averages 168 trees per acre. The stratum contains 753 cubic feet per acre and has a net annual yield of 22.1 cubic feet per acre per year.



FIGURE 9. STRATUM 7, WHITE SPRUCE-ASPEN POLETIMBER, WEST OF TOLSONA CREEK.

8. STRATUM 8 WHITE SPRUCE-BALSAM POPLAR

This stratum occurs along the active floodplains of the larger river systems within the project area. These drainages include the Tazlina, Nelchina, Little Nelchina and Tonsina Rivers and Bernard Creek. Average age of the stratum is 89. Stands in the stratum are quite variable. Some stands are mostly balsam poplar where others are a mix of white spruce and balsam poplar. The stem count five inches dbh and greater averages 196 trees per acre. The stratum contains 1,126 cubic feet per acre and has a net annual yield of 37.2 cubic feet per acre per year.

9. NON-FOREST

Figure 10 illustrates non-forest dwarf shrub with scattered black spruce dwarf trees. The picture is looking south near the Little Nelchina River. Shrub species include low bush cranberry, low bush blueberry, Labrador tea and dwarf birch. Vegetation pictured here also includes sedge tussock tundra.



FIGURE 10. NON-FOREST DWARF SHRUB, NORTH OF LITTLE NELCHINA RIVER.

G. FOREST VOLUME DEFINITIONS

Estimates of timber volume are calculated with four different measurements; cubic foot volume, board foot volume, green tons and above ground biomass tons. The first two measurements are derived from published equations and are considered more statistically valid measurements. For example sample accuracy shown later in the report is based on the live cubic foot estimate. The cubic, board and green ton measurements are related to traditional log based timber harvesting where volume only includes the merchantable bole of the tree, for example, a minimum 5 inch diameter at breast height (dbh) and a minimum top diameter of 4 inches.

I. CUBIC AND BOARD FOOT MEASUREMENTS

Volume calculations for both cubic and board foot measurements are based on volume equations produced for Interior Alaska; U.S. Forest Service research notes NOR-5, NOR-6 and PNW-59. Cubic volume is reported in Smalian's rule and for spruce and hardwoods includes volume to a 4-inch top (NOR-6) (Gregory and Haack 1964). Cubic volume is applied to trees greater than or equal to 5-inches dbh. Board foot volume is reported in Scribner Decimal C scale and is based on 16-foot log segments (short log scale). For spruce it is reported to a 6-

inch top (PNW-59) (Farr 1967a) and for hardwoods to an 8-inch top (NOR-5) (Haack 1963). Board foot volume is applied to trees greater than or equal to 9-inches dbh.

Volume Formula Name	Volume Unit	Species	Formula
NOR-6	Cubic Foot 4-inch Top	White and Black Spruce	$(-2.055)+0.2982*(dbh)+0.00181*(dbh)^2*ht$
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 and Black 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	$(-46.7415)+0.00956*dbh^2*ht$

TABLE 4. VOLUME FORMULAS BY SPECIES FOR POLETIMBER AND SAWTIMBER SIZE CLASSES.

2. TON MEASUREMENTS

Computation of green tons is somewhat less straight forward because published local volume tables by ton are not available. In the absence of local tables various publications have been produced that list the weight of green cordwood by species. These values can then be converted into pounds per cubic feet (Sturgeon 1979). The ton measurement represents the same diameter ranges as included in the cubic feet measurements (≥ 5 "dbh to a 4 inch minimum top).

Species	Pounds per Cubic Foot
White Spruce	34
Black Spruce	34
Birch	50
Aspen	43
Balsam Poplar	43

TABLE 5. INVENTORY SPECIES AND WEIGHT FOR POLETIMBER AND SAWTIMBER.

3. ABOVE GROUND BIOMASS TON MEASUREMENTS

Computation of above ground biomass tons was derived from biomass regression equations that relate the weight of the total above ground portion of the tree including branches and needles to total height and dbh measurements. The DOF Tok Area Forestry Office conducted green weight measurements on 1/100th acre plots for white spruce and aspen between 2008 and 2013. From these datasets regression equations were computed in Microsoft Excel. Due to inaccuracies in projecting weight of very small trees (negative regression values) the equations were only applied to trees greater than or equal to 1.5-inches dbh. The diameter limit also reflects what may constitute actual biomass harvest utilization. For the purpose of a naming convention, the measurement is referred to as biomass tons or bio tons.

Species	Green Weight in Pounds
White Spruce	$-51.272*[\text{dbh}] + 11.28*([\text{dbh}]^2 + 3.752*[\text{ht}])$
Black Spruce	
Birch	$-65.425*[\text{dbh}] + 12.687*([\text{dbh}]^2 + 4.272*[\text{ht}])$
Aspen	
Balsam Poplar	

TABLE 6. REGRESSION EQUATION FOR GREEN WEIGHT OF ABOVE GROUND BIOMASS.

IV. RESULTS

Selected results of the analysis are displayed in the following tables. “Timberland Area” refers to the portions of the land area that have been associated with forest inventory volume strata and have woody biomass estimates. It does not include shrubland vegetation types or dwarf forests. The results present inventory data by species and by various groupings of the individual 8 volume strata. Additional detailed inventory data reports appear in the appendix.

A. 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 219,550 acres there is an average volume of 654 net cubic feet per acre. Similarly, overall there is an average of 11.7 net tons per acre, 35.9 biomass tons per acre and 1,115 net board feet per acre. The values for cubic feet and tons are reported for trees equal to or greater than five inches dbh. Biomass ton value is reported for trees equal to or greater than 1.5 inches dbh and board foot values are reported for trees equal to or greater than nine inches dbh.

Species	Gross CF/Ac	Net CF/Ac	Gross Tons/Ac	Net Tons/Ac	Biomass Tons/Ac	Gross BF/Ac	Net BF/Ac
Aspen	89	87	1.9	1.9	4.2	43	41
Balsam Poplar	35	32	0.8	0.7	1.7	62	57
Birch	2	1	0.0	0.0	0.2	4	2
Black Spruce	35	32	0.6	0.5	2.9	9	8
White Spruce	525	502	8.9	8.5	26.8	1,084	1,007
	687	654	12.3	11.7	35.9	1,201	1,115

TABLE 7. TIMBERLAND VOLUME PER ACRE BY SPECIES ACROSS STRATA.

B. INVENTORY VOLUME BY PRODUCT AND SPECIES

Inventory volume is reported in Table 8 by tree product and species across all strata. Sawtimber refers to trees greater than or equal to 9-inches dbh. Poletimber refers to trees greater than or equal to 5-inches dbh and less than 9-inches dbh. Sapling refers to trees less than 5-inches dbh but the biomass volume is only applied to trees between 1.5 and 4.9-inches dbh. In terms of net cubic volume within live trees, sawtimber size trees account for 40% of the volume and poletimber size trees account for 60% of the volume.

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Product	Species	Gross CF (Thousands)	Net CF (Thousands)	Gross Tons (Thousands)	Net Tons (Thousands)	Biomass Tons (Thousands)	Gross BF (Thousands)	Net BF (Thousands)
Saw Live								
	Aspen	4,237	3,995	91	86	225	9,532	8,925
	Balsam Poplar	5,290	4,776	114	103	223	13,653	12,425
	Birch	211	169	5	4	19	732	461
	Black Spruce	411	398	7	7	12	1,867	1,821
	White Spruce	43,975	42,209	748	718	1,757	190,836	183,024
	Sum	54,124	51,547	965	917	2,236	216,620	206,655
Saw Dead								
	Balsam Poplar	0	28	0	1	2	0	0
	Birch	0	0	0	0	7	89	32
	White Spruce	10,818	8,867	184	151	415	47,061	38,025
	Sum	10,818	8,894	184	151	424	47,150	38,057
Pole Live								
	Aspen	15,360	15,076	330	324	656	0	0
	Balsam Poplar	2,491	2,260	54	49	127	0	0
	Birch	154	123	4	3	7	0	0
	Black Spruce	6,746	6,134	115	104	388	0	0
	White Spruce	56,120	55,042	954	936	2,711	0	0
	Sum	80,872	78,636	1,456	1,416	3,890	0	0
Pole Dead								
	Balsam Poplar	0	0	0	0	1	0	0
	Black Spruce	594	545	10	9	33	0	0
	White Spruce	4,446	4,067	76	69	192	0	0
	Sum	5,040	4,612	86	78	225	0	0
Sapling Live								
	Aspen	0	0	0	0	50	0	0
	Balsam Poplar	0	0	0	0	18	0	0
	Birch	0	0	0	0	0	0	0
	Black Spruce	0	0	0	0	215	0	0
	White Spruce	0	0	0	0	819	0	0
	Sum	0	0	0	0	1,102	0	0
Grand Total		150,853	143,688	2,691	2,563	7,878	263,770	244,712

TABLE 8. PRODUCT SUMMARY BY SPECIES.

C. DEFECT ESTIMATES BY SPECIES

Defect renders portions of individual trees unusable or of very limited use as forest products due to damage such as broken stems, sweep, crook and rot. Table 9 ranks the most common defect types by species. Net volume however does not take into account all defects because some hidden defect is difficult to determine. Rot indicators such as conks however can be used as a proxy for hidden defect. Defect is the difference between gross and net volume. Defect percentage by species is shown in Table 10.

Species	Defect Type					
	Conks	Crook	Sweep	Scars	Broken Top	Forked Top
Aspen	6	1	3	2	5	4
Balsam Poplar	6	1	2	3	4	5
Birch	2	3	6	5	4	1
Black Spruce	4	1	3	6	5	2
White Spruce	6	1	2	5	4	3
Overall Defect Rank	6	1	3	4	5	2

TABLE 9. DEFECT TYPE RANKING BY SPECIES.

Species	Gross Cubic Feet/Ac	Net Cubic Feet/Acre	Percent Defect
Aspen	89	87	2.7
Balsam Poplar	35	32	9.2
Birch	2	1	20.0
Black Spruce	35	32	8.7
White Spruce	525	502	4.5
Total	687	654	4.7

TABLE 10. CUBIC FOOT DEFECT BY SPECIES.

D. INVENTORY VOLUME BY SIZE AND TIMBER TYPE CLASS

Volume is reported below by grouping the 8 strata into sizes and timberland vegetation type class. In terms of net cubic volume, sawtimber types contain 8% of the total. Mixed sawtimber/poletimber and poletimber types contain 75% and reproduction types contain 17% of the total.

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Size	Timber Type Class	Gross CF (000s)	Net CF (000s)	Gross Tons (000s)	Net Tons (000s)	Biomass Tons (000s)	Gross BF (000s)	Net BF (000s)
Sawtimber								
	White spruce	12,305	11,350	210	193	461	36,078	32,964
	Subtotal	12,305	11,350	210	193	461	36,078	32,964
Sawtimber/Poletimber								
	White Spruce/Balsam poplar	13,470	12,806	270	256	610	23,993	22,385
	Subtotal	13,470	12,806	270	256	610	23,993	22,385
Poletimber								
	Aspen	15,001	14,512	309	298	755	10,064	9,932
	White Spruce	57,832	54,692	986	932	2,634	129,643	119,437
	White Spruce/Aspen	26,077	25,470	469	458	1,385	37,446	36,353
	Subtotal	98,910	94,674	1,764	1,688	4,774	177,153	165,722
Reproduction								
	Black and White Spruce	26,168	24,859	447	425	2,034	26,546	23,640
	Subtotal	26,168	24,859	447	425	2,034	26,546	23,640
	Grand Total	150,853	143,688	2,691	2,563	7,878	263,770	244,712

TABLE 11. VOLUME BY SIZE AND TIMBER TYPE CLASS.

E. TIMBER VOLUMES BY STRATA

Timber volume by strata is reported below in Table 12.

Trees ≥ 5"	Basal Area (Ft ²)	Gross CF (≥5"dbh)	Net CF (≥5"dbh)	Gross Tons (≥5"dbh)	Net Tons (≥5"dbh)	Biomass Tons (≥1.5"dbh)	Gross BF (≥9"dbh)	Net BF (≥9"dbh)
Stratum 1 White Spruce Sawtimber 6,756 Acres								
218	93	1,821	1,680	31.02	28.60	68.30	5,340	4,879
Stratum 2 White Spruce Poletimber Closed 20,637 Acres								
255	78	1,281	1,253	21.91	21.40	63.22	2,647	2,572
Stratum 3 White Spruce Poletimber Open 30,210 Acres								
162	61	1,039	955	17.67	16.23	43.99	2,483	2,197
Stratum 4 Black & White Spruce Reproduction Closed 10,220 Acres								
166	40	490	478	8.40	8.20	34.44	602	580
Stratum 5 Black & White Spruce Reproduction Open 94,794 Acres								
81	20	223	211	3.81	3.60	17.74	215	187
Stratum 6 Aspen 11,738 Acres								
334	87	1,278	1,236	26.29	25.41	64.31	857	846
Stratum 7 White Spruce-Aspen 33,822 Acres								
168	50	771	753	13.88	13.55	40.95	1,107	1,075
Stratum 8 White Spruce-Balsam Poplar 11,372 Acres								
196	75	1,184	1,126	23.74	22.52	53.63	2,110	1,968

TABLE 12. VOLUME PER ACRE BY STRATA.

F. SAMPLING ERROR BY VOLUME

Sample error was calculated for the live gross cubic foot estimate by strata and size class. 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. Overall sample error for all strata and size classes combined was also calculated. This value, weighted by number of plots, was 3.1%. Strata 4 and 5 somewhat exceeded the design sample error of approximately 10%. This was due to the small volumes of poletimber and sawtimber size trees in these stands and the correspondingly high variability between sample plots.

Strata	Live Poletimber			Live Sawtimber		Combined	
	Number of Plots	Gross CF/Ac	% Sampling Error	Gross CF/Ac	% Sampling Error	Gross CF/Ac	% Sampling Error
1	110	429	8.3	901	9.4	1,330	6.9
2	110	588	9.3	492	12.7	1,080	7.7
3	100	381	10	376	10.8	757	7.4
4	90	343	12.1	130	28.6	473	11.8
5	90	169	12.5	42	30.3	211	11.7
6	50	951	8.3	285	10.4	1,236	6.8
7	90	473	10.7	236	17.1	709	9.1
8	90	475	13.2	645	12.1	1,120	8.9
Total	730	451	3.7	411	5.0	861	3.1

TABLE 13. GROSS LIVE CUBIC FOOT PERCENT SAMPLING ERROR.

G. 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 white spruce 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 (Farr 1967b). Site index calculations for aspen are based on site index equations produced for Interior Alaska; U.S. Forest Service

research paper NOR-2 (Gregory and Haack 1965). Balsam poplar measurements were also applied to the aspen NOR-2 values.

Strata		Site Index in Feet		
		White Spruce	Aspen	Balsam Poplar
1	White Spruce Sawtimber	56	---	---
2	White Spruce Poletimber Closed	54	---	---
3	White Spruce Poletimber Open	42	---	---
4	Black & White Spruce Reproduction Closed	49	---	---
5	Black & White Spruce Reproduction Open	43	---	---
6	Aspen	68	41	---
7	White Spruce-Aspen	58	45	---
8	White Spruce-Balsam Poplar	80	44	42
	Weighted Averages	53	42	42

TABLE 14. SITE INDEX BY STRATA AND SPECIES.

H. TIMBERLAND AREA AGE CLASS

Ages of the sampled timberland vegetation types reflect a mature mostly unmanaged forest and ranged from a low of 50 years to a high of 220 years. Younger ages are probably present but may be comprised of burned vegetation types not sampled in the inventory. The oldest stand sampled was a white spruce sawtimber stand located just south of the Glenn Highway 3.5 miles east of the Little Nelchina River. 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. *Table 15* shows the age class distribution in acres and percent of the total acreage. Over one half of the timberland acreage is older than 120 years and 38% of the timberland acreage is older than 150 years. The advanced age of many of the white spruce stands may have contributed to the widespread beetle infestation throughout the project area. Stands between 50 and 80 years of age comprise 32% of the timberland area. Most of these stands were hardwood or mixed hardwood-spruce strata. The age class distribution indicates a lengthy fire return interval and the low site index numbers in *table 14* correspond to stands growing in cold soils covered by moss. The primary disturbance factor for soils in the Copper River basin is the wild fire regime (Swanson 1996). Fire results in the

clearing of vegetation, partial or entire removal of the organic mat, and thawing of permafrost. Changing these factors has profound effects on the characteristics of the soil profile and subsequently on the trees growing on top. A wet-cold-frozen soil, with permafrost insulated by a thick organic mat can become a dry-warm soil type after a fire. During field measurements, trees that had the greatest 10-year increment growth were almost always associated with warmer soils and thinner moss depth.

Stand Age Class	Average Age	Acres	Percent of Total
50 - 60	53	12,030	5%
60 - 70	65	18,045	8%
70 - 80	75	39,098	18%
80 - 90	84	15,038	7%
90 - 100			0%
100 - 110	103	18,045	8%
110 - 120	118	3,008	1%
120 - 130	128	6,015	3%
130 - 140	134	9,023	4%
140 - 150	145	15,038	7%
150 - 160	154	39,098	18%
160 - 170	167	12,030	5%
180 - 190	185	9,023	4%
190 - 200	199	3,008	1%
200 - 210	205	15,038	7%
210 - 220	217	3,008	1%
220 - 230	220	3,008	1%

TABLE 15. PERCENT OF AREA BY AGE CLASS.

Table 16 reports the average age by individual stratum. Average age weighted by strata acreage was determined to be about 112 years. From the age data it is evident that strata 4 and 5 are not true reproduction stands, but are in fact timber growing on poor sites. These timber types have significant numbers of trees less than 5 inches in diameter and a limited number of poletimber trees. It is this poletimber component however, that makes these stands have a potential for providing firewood and biomass resources.

Strata		Average Age
1	White Spruce Sawtimber	119
2	White Spruce Poletimber Closed	136
3	White Spruce Poletimber Open	182
4	Black & White Spruce Reproduction Closed	122
5	Black & White Spruce Reproduction Open	93
6	Aspen	87
7	White Spruce-Aspen	98
8	White Spruce-Balsam Poplar	89
Weighted Average		112

TABLE 16. AVERAGE AGE BY STRATA AND VOLUME UNIT.

I. REGENERATION

Interior Alaska tree species are mostly even-aged and are replaced through natural regeneration following fire, flooding or insect outbreaks. In the absence of disturbance, stands are slowly replaced by understory regeneration. In many cases such as the extensive mixed black and white spruce stands, regeneration is slow to develop because of cold soils with thick moss. The larger saplings in these stands generally developed quickly after a wildfire disturbance when soil temperatures were more conducive to growth. In other cases stands are actively being replaced even in the absence of disturbance. These stands typically are closed hardwood stands that contain a well stocked spruce understory, flood plain balsam poplar stands or upland mixed spruce/hardwood stands. The regeneration tables give numbers of trees per acre less than 5 inches by species and stratum for each volume unit. Trees are of desirable and acceptable quality as determined in the field. Undesirable trees not expected to become future crop trees are not included in the table.

Trees <5" DBH						
Strata		White Spruce	Black Spruce	Aspen	Birch	Balsam Poplar
1	White Spruce Sawtimber	841	32			
2	White Spruce Poletimber Closed	600	186			
3	White Spruce Poletimber Open	410	280			25
4	Black & White Spruce Reproduction Closed	322	433			11
5	Black & White Spruce Reproduction Open	639	461			28
6	Aspen	570		250		10
7	White Spruce-Aspen	367	400	39	144	
8	White Spruce-Balsam Poplar	1,111		100	33	239

TABLE 17. NUMBER OF SEEDLINGS/SAPLINGS BY STRATA AND SPECIES.

J. GROWTH AND MORTALITY ESTIMATES

Growth estimates have been determined through projections made with the timber cruise software TCruise. Periodic annual gross growth has been projected utilizing the past 10-year diameter growth increment and bark thickness measurements collected in the field and software generated diameter/height coefficients. Growth increment and bark thickness measurements were collected from trees 5-inch dbh and greater across all diameter classes. The desired growth projection interval used was 10 years. The increased volume growth was then 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. Diameter-height relationships, diameter growth and calculated bark thickness ratios (Husch et al. 2002) are shown in Appendix D.

Mortality estimates have been determined by dividing the recently dead volume estimates by 16 years to get annual mortality. The 16 year time period corresponds to the beginning of the bark beetle infestation in the project area. These trees were easily identified during field measurements as bark beetle killed trees.

The mortality estimates were then subtracted from the gross growth figures to calculate net growth. The average net annual growth for the project area is 14 cubic feet per acre (*table 18*).

When the entire growing stock volume is combined across strata a total of 130,182,271 net cubic feet is present. Timberland is growing annually at 2.27% of net volume or 295,514 cubic feet. Growth rates are consistent with Forest Service estimates of between 2 and 3% (Smith et al. 2007) for unmanaged interior forests.

Strata	% Annual Growth	% Annual Mortality	% Annual Net Growth	CF Per Acre Per Year Growth
1 White Spruce Sawtimber	2.48%	1.64%	0.84%	11
2 White Spruce Poletimber Closed	2.41%	1.00%	1.41%	15
3 White Spruce Poletimber Open	1.91%	1.63%	0.28%	2
4 Black & White Spruce Reproduction Closed	2.66%	0.07%	2.59%	12
5 Black & White Spruce Reproduction Open	3.38%	0.00%	3.38%	7
6 Aspen	3.94%	0.00%	3.94%	49
7 White Spruce-Aspen	3.51%	0.39%	3.12%	22
8 White Spruce-Balsam Poplar	3.34%	0.02%	3.32%	37
Total Live Volume	2.92%	0.65%	2.27%	14

TABLE 18. GROWTH AND MORTALITY ESTIMATES.

V. SUSTAINED YIELD ANALYSIS

Estimates of sustained yield have been made to guide future management decisions. The estimates in this analysis only include the timberland acreage and volume. Dwarf forests are not included. The sustained yield has been calculated using area control, which divides the acreage of each stratum by the rotation age. To convert from area to volume, stratum volume per acre values were used. White spruce and mixed white spruce types use a rotation age of 120 years, which includes 10 years for establishment. The aspen timber type uses a rotation of 80 years, which includes 10 years for establishment. There have been no acreage reductions made for operability concerns.

Strata	Acres	Rotation	Acres/Yr	Net CF/Ac	Net CF/Yr	Net Tons/Ac	Net Tons/Yr	Bio Tons/Ac	Bio Tons/Yr	Net BF/Ac	Net BF/Yr
1	6,756	120	56	1,680	94,584	29	1,611	68	3,845	4,879	274,688
2	20,637	120	172	1,253	215,485	21	3,680	63	10,872	2,572	442,320
3	30,210	120	252	955	240,421	16	4,086	44	11,074	2,197	553,095
4	10,220	120	85	479	40,795	8	698	34	2,933	580	49,397
5	94,794	120	790	211	166,679	4	2,844	18	14,014	187	147,721
6	11,738	80	147	1,236	181,352	25	3,728	64	9,436	846	124,129
7	33,822	120	282	754	212,515	14	3,816	41	11,542	1,074	302,707
8	11,372	120	95	1,126	106,707	23	2,134	54	5,082	1,969	186,596
Totals	219,550		1,878		1,258,538		22,597		68,799		2,080,651

TABLE 19. SUSTAINED YIELD ESTIMATE, TOTAL TIMBERLAND AREA.

Species	Net CF/Yr	Net Tons/Yr	Bio Tons/Yr	Net BF/Yr
Aspen	206,701	4,443	10,204	92,975
Balsam Poplar	59,079	1,263	3,137	103,568
Birch	2,352	60	278	3,961
Black Spruce	58,956	1,005	5,396	14,977
White Spruce	931,449	15,825	49,784	1,865,171
Totals	1,258,538	22,597	68,799	2,080,651

TABLE 20. SUSTAINED YIELD ESTIMATE BY SPECIES, TOTAL TIMBERLAND AREA.

FIGURE 11. SUSTAINED YIELD COMPARISON BETWEEN STRATA, TOTAL TIMBERLAND AREA.

I. LITERATURE CITED

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Appendix A
ACREAGE SUMMARY BY STRATUM AND VEGETATION TYPE

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Vegetation Type	Acres	Field Sampled?	Vegetation Type	Acres	Field Sampled?
Stratum 1 White Spruce Sawtimber			18SX	7	No
3SY	5	No	Sum	11,738	
2SY	1,736	Yes	Stratum 7 White Spruce Aspen		
2SX	5,016	Yes	18RY	9,948	Yes
Sum	6,756		18RZ	1,024	No
Stratum 2 White Spruce Poletimber Closed			34SX	54	No
3PX	2,670	Yes	31PX	2	No
2PX	17,954	Yes	31PY	34	No
1PX	13	No	31RX	30	No
Sum	20,637		34PY	3,127	No
Stratum 3 White Spruce Poletimber Open			34PX	1,185	Yes
3PY	8,185	Yes	34PZ	263	No
1PY	2	No	34RX	1,927	No
2PY	22,023	Yes	34RY	9,376	Yes
Sum	30,210		34RZ	1,367	Yes
Stratum 4 Black & White Spruce Reproduction Closed			18PZ	119	No
1RX	354	Yes	37PX	5	No
2RX	2,852	Yes	37RY	6	No
3RX	7,014	Yes	34SY	5	No
Sum	10,220		39RY	3,860	Yes
Stratum 5 Black & White Spruce Reproduction Open			39RX	624	No
1RY	44,950	Yes	39PZ	57	No
2RY	10,810	Yes	39PY	400	Yes
2RZ	1,473	No	39PX	141	Yes
10I	46	No	39RZ	267	No
2PZ	4,152	Yes	Sum	33,822	
3PZ	916	Yes	Stratum 8 White Spruce Balsam Poplar		
3RY	28,857	Yes	16RX	2,155	No
1RZ	215	No	16SZ	1	No
3RZ	3,375	No	16SY	19	No
Sum	94,794		16SX	198	Yes
Stratum 6 Aspen			16RY	1,958	No
18PY	5,020	Yes	38PZ	221	No
17PY	3	No	16PX	1,160	Yes
18PX	3,092	Yes	38PX	649	Yes
19PX	1	No	16RZ	30	No
18RX	3,615	No	38PY	1,629	Yes

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Vegetation Type	Acres	Field Sampled?	Vegetation Type	Acres	Field Sampled?
38SY	149	Yes	76	768	No
16PZ	10	No	Sum	768	
38RX	476	No	Stratum50 Water		
38RY	1,682	No	80	10,802	No
38RZ	58	No	Sum	10,802	
38SX	216	Yes	Stratum60 Rivers		
16PY	760	Yes	88	2,969	No
Sum	11,372		Sum	2,969	
Stratum20 Black and White Spruce-Hardwood Dwarf			Stratum70 Bare Ground		
1DX	3,738	No	94	8,628	No
18DY	61	No	Sum	8,628	
18DZ	11	No	Stratum73 Gravel Pits, Mines, Quarries		
3DZ	493	No	97	18	No
3DX	60	No	Sum	18	
38DX	3	No	Stratum74 Roads		
34DY	176	No	98	78	No
39DX	832	No	Sum	78	
39DY	4,680	No	Grand Total	435,657	
39DZ	123	No			
2DZ	732	No			
2DY	143	No			
3DY	676	No			
2DX	8	No			
1DY	13,313	No			
34DZ	429	No			
1DZ	71,401	No			
Sum	96,880				
Stratum30 Tall Shrub					
68	16,732	No			
Sum	16,732				
Stratum35 Low Shrub					
71	77,077	No			
Sum	77,077				
Stratum40 Wet Meadow					
79	2,155	No			
Sum	2,155				
Stratum45 Dry Meadow					

Appendix B
STAND TABLES PER ACRE BY STRATUM AND SPECIES

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Stand Table For Trees Greater Than or Equal to 5" dbh										
DBH	Trees	Basal Area	Gross CF	Net CF	Gross Tons	Net Tons	Biomass Tons	Gross BF	Net BF	
Stratum 1	White Spruce Sawtimber									
Aspen										
9	1	0	0	0	0	0	0	4	2	
Sum	1	0	0	0	0	0	0	4	2	
Balsam Poplar										
10	0	0	3	2	0	0	0	3	2	
11	1	1	6	4	0	0	0	6	4	
13	0	0	4	3	0	0	0	16	14	
Sum	1	1	13	10	0	0	1	25	21	
Black Spruce										
5	1	0	1	1	0	0	0			
6	5	1	8	8	0	0	1			
Sum	6	1	9	9	0	0	1			
White Spruce										
5	16	2	22	22	0	0	1			
6	29	6	73	71	1	1	4			
7	40	11	177	166	3	3	7			
8	28	10	181	167	3	3	7			
9	34	16	321	301	5	5	11	841	801	
10	30	16	350	325	6	6	12	1,441	1,337	
11	13	9	197	181	3	3	7	843	769	
12	10	8	186	176	3	3	6	819	781	
13	5	5	125	97	2	2	4	572	440	
14	2	3	80	79	1	1	2	378	376	
15	2	3	48	43	1	1	2	223	194	
16	2	2	38	32	1	1	2	194	157	
Sum	210	91	1,799	1,661	31	28	65	5,311	4,856	
Totals for stratum	White Spruce Sawtimber									
	218	93	1,821	1,680	31	29	67	5,340	4,879	
Stratum 2	White Spruce Poletimber Closed									
Balsam Poplar										
13	1	1	12	8	0	0	1	33	29	
15	0	0	9	8	0	0	0	35	32	
16	0	0	8	8	0	0	0	38	34	
Sum	1	2	29	24	1	1	1	106	95	
Black Spruce										
5	17	3	20	19	0	0	1			
6	13	3	28	27	0	0	1			
7	4	1	16	15	0	0	1			
8	2	1	15	14	0	0	0			
10	0	0	2	2	0	0	0	11	9	
Sum	37	7	81	77	1	1	4	11	9	
White Spruce										
5	35	5	46	45	1	1	3			
6	66	14	169	166	3	3	8			
7	39	11	168	167	3	3	7			

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Basal Area	Gross CF	Net CF	Gross Tons	Net Tons	Biomass Tons	Gross BF	Net BF
8	20	7	110	109	2	2	5		
9	20	9	172	170	3	3	7	370	359
10	16	9	187	184	3	3	7	766	756
11	8	5	96	93	2	2	4	400	385
12	6	5	111	111	2	2	4	484	483
13	3	2	44	44	1	1	2	198	194
14	1	1	14	14	0	0	1	62	62
15	3	2	42	41	1	1	3	191	187
17	0	0	8	7	0	0	0	40	34
19	0	0	5	2	0	0	0	21	9
Sum	217	69	1,172	1,152	20	20	50	2,531	2,468
Totals for stratum White Spruce Poletimber Closed									
	255	78	1,281	1,253	22	21	56	2,647	2,572
Stratum	3	White Spruce Poletimber Open							
Black Spruce									
5	8	1	9	8	0	0	1		
6	4	1	12	11	0	0	0		
7	6	2	21	20	0	0	1		
8	2	1	14	12	0	0	0		
Sum	19	4	55	51	1	1	3		
White Spruce									
5	22	4	28	27	0	0	2		
6	24	5	54	52	1	1	3		
7	25	7	96	92	2	2	4		
8	29	10	160	155	3	3	7		
9	16	7	133	128	2	2	5	200	199
10	6	3	61	52	1	1	2	262	223
11	3	2	49	47	1	1	2	209	199
12	7	5	115	109	2	2	4	502	476
13	4	4	74	64	1	1	3	315	269
14	2	2	43	40	1	1	2	192	180
15	2	2	52	49	1	1	2	237	224
16	1	1	18	9	0	0	1	86	41
17	1	1	26	18	0	0	1	121	86
18	1	1	21	10	0	0	1	98	46
19	0	1	16	15	0	0	1	75	69
23	0	1	19	18	0	0	1	92	91
24	0	1	19	19	0	0	1	93	92
Sum	142	57	984	904	17	15	40	2,483	2,197
Totals for stratum White Spruce Poletimber Open									
	162	61	1,039	955	18	16	43	2,483	2,197
Stratum	4	Black & White Spruce Reproduction Closed							
Balsam Poplar									
7	3	1	9	9	0	0	1		
8	1	0	5	5	0	0	0		
Sum	5	1	14	14	0	0	1		
Black Spruce									
5	42	6	39	38	1	1	3		

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Basal Area	Gross CF	Net CF	Gross Tons	Net Tons	Biomass Tons	Gross BF	Net BF
6	16	3	31	29	1	0	2		
7	4	1	14	13	0	0	1		
8	2	1	8	7	0	0	0		
Sum	64	11	91	88	2	1	6		
White Spruce									
5	18	3	18	18	0	0	1		
6	37	7	74	73	1	1	4		
7	20	5	72	70	1	1	3		
8	10	4	55	54	1	1	2		
9	7	3	55	55	1	1	2	113	112
10	3	2	40	39	1	1	1	174	167
11	1	1	11	11	0	0	0	48	49
12	0	0	7	7	0	0	0	32	33
14	1	1	18	18	0	0	1	85	81
15	0	0	3	2	0	0	0	9	6
16	1	1	17	16	0	0	1	74	69
20	0	1	15	14	0	0	1	67	63
Sum	98	28	385	377	7	6	17	602	580
Totals for stratum Black & White Spruce Reproduction Closed									
	166	40	490	478	8	8	24	602	580
Stratum	5	Black & White Spruce Reproduction Open							
Balsam Poplar									
5	2	0	1	1	0	0	0		
6	1	0	1	1	0	0	0		
9	0	0	2	2	0	0	0		
Sum	3	1	4	4	0	0	0		
Black Spruce									
5	7	1	6	5	0	0	1		
6	1	0	2	1	0	0	0		
7	1	0	4	3	0	0	0		
8	1	0	5	4	0	0	0		
9	1	0	2	2	0	0	0		
10	0	0	4	4	0	0	0	17	17
Sum	11	2	22	19	0	0	1	17	17
White Spruce									
5	12	2	18	15	0	0	1		
6	28	6	58	59	1	1	3		
7	12	3	36	36	1	1	2		
8	6	2	24	24	0	0	1		
9	4	1	16	16	0	0	1		
10	3	1	23	17	0	0	1	104	78
11	1	0	9	9	0	0	0	40	40
12	0	0	4	4	0	0	0	19	19
13	0	0	8	8	0	0	0	35	33
Sum	67	16	197	188	3	3	10	198	170
Totals for stratum Black & White Spruce Reproduction Open									
	81	20	223	211	4	4	12	215	187
Stratum	6	Aspen							

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Basal Area	Gross CF	Net CF	Gross Tons	Net Tons	Biomass Tons	Gross BF	Net BF
Aspen									
5	91	13	162	160	3	3	8		
6	83	16	211	206	5	4	11		
7	51	14	228	221	5	5	9		
8	27	10	176	167	4	4	7		
9	17	7	116	110	2	2	5	95	88
10	12	4	47	45	1	1	5	74	72
11	5	3	58	58	1	1	2	188	186
12	0	0	8	8	0	0	0	38	37
Sum	285	69	1,005	976	22	21	47	395	383
Balsam Poplar									
8	3	1	8	0	0	0	1		
Sum	3	1	8	0	0	0	1		
White Spruce									
5	3	0	0	0	0	0	0		
6	7	1	14	14	0	0	1		
7	5	1	26	25	0	0	1		
8	14	5	73	71	1	1	3		
9	9	4	60	58	1	1	3	53	53
10	2	1	17	17	0	0	1	74	74
11	5	2	24	24	0	0	2	107	107
13	2	2	31	31	1	1	1	137	137
15	1	1	20	20	0	0	1	92	92
Sum	46	17	265	260	4	4	13	463	463
Totals for stratum Aspen									
	334	87	1,278	1,236	26	25	60	857	846
Stratum	7	White Spruce Aspen							
Aspen									
6	11	2	37	37	1	1	2		
7	5	2	28	28	1	1	1		
8	7	2	48	48	1	1	2		
9	4	2	29	29	1	1	1	17	17
10	2	1	12	10	0	0	1	30	25
Sum	28	9	155	153	3	3	6	48	42
Birch									
7	1	0	5	4	0	0	0		
9	1	1	5	4	0	0	0	10	7
10	0	0	0	0	0	0	0	6	1
13	0	0	0	0	0	0	0	1	0
Sum	3	1	9	7	0	0	1	17	8
Black Spruce									
5	16	2	10	10	0	0	1		
6	2	1	4	4	0	0	0		
7	7	2	24	21	0	0	1		
Sum	25	4	39	35	1	1	3		
White Spruce									
5	12	2	14	14	0	0	1		
6	31	6	83	82	1	1	4		

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Basal Area	Gross CF	Net CF	Gross Tons	Net Tons	Biomass Tons	Gross BF	Net BF
7	25	7	103	103	2	2	4		
8	17	6	101	99	2	2	4		
9	9	4	66	61	1	1	3	201	185
10	4	2	37	37	1	1	2	165	165
11	5	3	57	57	1	1	3	243	243
12	4	3	49	49	1	1	2	178	178
13	1	1	30	29	1	1	1	135	133
15	1	1	12	12	0	0	1	50	50
18	1	1	15	15	0	0	2	71	71
Sum	111	36	568	559	10	9	26	1,043	1,024
Totals for stratum White Spruce Aspen									
	168	50	771	753	14	14	36	1,107	1,075
Stratum	8	White Spruce Balsam Poplar							
Aspen									
6	6	2	18	17	0	0	1		
7	13	4	35	34	1	1	2		
8	12	4	58	58	1	1	3		
9	2	1	25	24	1	1	1	23	21
10	2	1	26	26	1	1	1	59	57
11	3	2	28	25	1	1	1	93	81
12	3	2	33	31	1	1	2	113	104
Sum	41	15	224	215	5	5	11	287	262
Balsam Poplar									
5	4	1	3	3	0	0	0		
6	9	2	16	16	0	0	1		
7	7	2	34	33	1	1	1		
8	11	4	60	59	1	1	3		
9	13	6	96	95	2	2	4	36	34
10	17	9	156	142	3	3	7	209	202
11	6	5	81	73	2	2	3	189	179
12	3	3	57	53	1	1	2	189	183
13	1	2	31	29	1	1	1	122	118
14	1	2	27	18	1	0	1	141	99
17	0	1	9	7	0	0	1	108	93
Sum	73	35	568	528	12	11	24	994	908
Birch									
15	0	0	5	4	0	0	0	23	18
Sum	0	0	5	4	0	0	0	23	18
White Spruce									
5	24	4	37	37	1	1	2		
6	26	5	61	61	1	1	3		
7	9	2	31	30	1	1	2		
8	9	4	64	63	1	1	2		
9	4	1	25	24	0	0	1	59	59
10	4	2	39	38	1	1	2	168	160
11	3	2	39	38	1	1	1	167	159
12	3	2	43	43	1	1	2	188	187
13	1	1	15	15	0	0	1	70	67
14	0	0	8	8	0	0	0	34	34

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Basal Area	Gross CF	Net CF	Gross Tons	Net Tons	Biomass Tons	Gross BF	Net BF
15	0	0	12	11	0	0	0	57	54
16	0	0	13	12	0	0	0	63	60
Sum	83	24	387	379	7	6	16	806	781
Totals for stratum White Spruce Balsam Poplar									
	196	75	1,184	1,126	24	23	51	2,110	1,968

Stand Table For Trees Greater Than or Equal to 1.5" dbh and Less Than 5" dbh

DBH	Trees	Biomass Tons
Stratum 1	White Spruce Sawtimber	
Black Spruce		
2	14	
3	5	0
Sum	18	0
White Spruce		
2	64	0
3	18	0
4	9	0
5	5	0
Sum	95	1
Totals for stratum White Spruce Sawtimber		
	114	2
Stratum 2	White Spruce Poletimber Closed	
Black Spruce		
2	23	
3	5	0
4	32	1
5	5	0
Sum	64	1
White Spruce		
2	127	0
3	41	1
4	95	4
5	14	1
Sum	277	6
Totals for stratum White Spruce Poletimber Closed		
	341	7
Stratum 3	White Spruce Poletimber Open	
Balsam Poplar		
2	5	
Sum	5	
Black Spruce		
2	35	
3	5	0
Sum	40	0
White Spruce		

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Biomass Tons
2	95	0
3	40	0
4	20	1
Sum	155	1
Totals for stratum White Spruce Poletimber Open		
	200	1
Stratum	4	Black & White Spruce Reproduction Closed
Balsam Poplar		
DBH	Trees	Biomass Tons
2	6	
3	11	0
Sum	17	0
Black Spruce		
2	189	
3	117	2
4	56	2
5	17	1
Sum	378	5
White Spruce		
2	83	1
3	44	1
4	78	3
5	28	2
Sum	233	6
Totals for stratum Black & White Spruce Reproduction Closed		
	628	11
Stratum	5	Black & White Spruce Reproduction Open
Balsam Poplar		
4	6	0
Sum	6	0
Black Spruce		
2	89	
3	78	0
4	17	0
Sum	183	1
White Spruce		
2	83	
3	61	1
4	61	2
5	28	2
Sum	233	5
Totals for stratum Black & White Spruce Reproduction Open		
	422	6
Stratum	6	Aspen
Aspen		
2	20	

Timber Inventory of State Forest Lands in the Copper River Basin 2014

DBH	Trees	Biomass Tons
3	80	2
4	30	2
Sum	130	3
White Spruce		
2	20	
3	10	0
4	20	1
Sum	50	1
Totals for stratum Aspen		
	180	4
DBH	Trees	Biomass Tons
Stratum 7	White Spruce Aspen	
Aspen		
2	11	
4	6	0
Sum	17	0
Black Spruce		
2	22	
3	44	0
4	44	2
Sum	111	2
White Spruce		
2	72	0
3	28	0
4	33	1
5	11	1
Sum	144	3
Totals for stratum White Spruce Aspen		
	272	5
Stratum 8	White Spruce Balsam Poplar	
Aspen		
3	11	
4	6	0
5	6	0
Sum	22	0
Balsam Poplar		
2	33	
3	17	0
5	6	0
Sum	56	0
White Spruce		
2	111	0
3	56	1
4	17	1
Sum	183	2
Totals for stratum White Spruce Balsam Poplar		
	261	3

Appendix C
TOTAL VOLUME BY STRATUM

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Total Volume Trees Greater Than or Equal to 5" dbh							
	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Biomass Tons	Total Gross BF	Total Net BF
Stratum 1	White Spruce Sawtimber					Acreage =	6,756
Aspen							
Saw Live	0	0	0	0	1,716	27,406	13,703
Sum	0	0	0	0	1,716	27,406	13,703
Balsam Poplar							
Saw Live	88,120	68,660	1,895	1,476	4,496	169,489	139,703
Sum	88,120	68,660	1,895	1,476	4,496	169,489	139,703
Black Spruce							
Pole Live	62,258	59,358	1,058	1,009	4,054		
Sum	62,258	59,358	1,058	1,009	4,054		
White Spruce							
Saw Dead	2,126,561	1,710,649	36,152	29,081	70,759	9,296,153	7,324,679
Pole Live	2,912,468	2,837,792	49,512	48,242	122,134		
Pole Dead	835,589	652,897	14,205	11,099	36,154		
Saw Live	6,279,970	6,020,914	106,759	102,356	211,681	26,585,020	25,486,309
Sum	12,154,588	11,222,252	206,628	190,778	440,728	35,881,173	32,810,988
Stratum Total	12,304,965	11,350,270	209,581	193,264	450,993	36,078,068	32,964,395
Stratum 2	White Spruce Poletimber Closed					Acreage =	20,637
Balsam Poplar							
Saw Live	528,469	475,622	11,362	10,226	25,444	2,182,602	1,964,342
Pole Live	59,906	14,976	1,288	322	3,275		
Sum	588,375	490,599	12,650	10,548	28,719	2,182,602	1,964,342
Black Spruce							
Saw Live	47,386	34,136	806	580	1,491	230,034	184,027
Pole Live	1,369,797	1,312,785	23,287	22,317	68,420		
Pole Dead	251,161	236,182	4,270	4,015	14,665		
Sum	1,668,345	1,583,103	28,362	26,913	84,576	230,034	184,027
White Spruce							
Pole Dead	847,526	824,599	14,408	14,018	44,557		
Saw Dead	2,650,454	2,509,138	45,058	42,655	88,508	11,077,872	10,434,926
Saw Live	9,786,531	9,638,562	166,371	163,856	400,620	41,145,388	40,489,645
Pole Live	10,897,526	10,806,572	185,258	183,712	505,750		
Sum	24,182,037	23,778,871	411,095	404,241	1,039,435	52,223,260	50,924,571
Stratum Total	26,438,756	25,852,573	452,107	441,701	1,152,730	54,635,896	53,072,941
Stratum 3	White Spruce Poletimber Open					Acreage =	30,210
Black Spruce							
Pole Live	1,666,630	1,538,205	28,333	26,149	75,995		
Sum	1,666,630	1,538,205	28,333	26,149	75,995		
White Spruce							
Saw Dead	5,131,434	3,745,998	87,234	63,682	213,542	22,893,674	16,510,874
Pole Live	10,308,739	9,969,919	175,249	169,489	471,946		
Saw Live	11,871,722	11,344,273	201,819	192,853	429,304	52,112,939	49,852,971
Pole Dead	2,414,382	2,240,895	41,044	38,095	97,879		
Sum	29,726,277	27,301,086	505,347	464,118	1,212,672	75,006,612	66,363,845
Stratum Total	31,392,907	28,839,291	533,679	490,268	1,288,666	75,006,612	66,363,845
Stratum 4	Black & White Spruce Reproduction Closed					Acreage =	10,220
Balsam Poplar							

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	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Biomass Tons	Total Gross BF	Total Net BF
Pole Live	147,802	143,453	3,178	3,084	8,922		
Sum	147,802	143,453	3,178	3,084	8,922		
Black Spruce							
Pole Live	932,675	897,094	15,855	15,251	57,695		
Sum	932,675	897,094	15,855	15,251	57,695		
White Spruce							
Saw Live	1,387,138	1,333,592	23,581	22,671	51,552	6,157,056	5,925,369
Pole Live	2,494,941	2,465,774	42,414	41,918	120,593		
Pole Dead	48,898	48,898	831	831	3,413		
Sum	3,930,977	3,848,265	66,827	65,421	175,558	6,157,056	5,925,369
Stratum Total	5,011,454	4,888,811	85,860	83,755	242,176	6,157,056	5,925,369
Stratum 5	Black & White Spruce Reproduction Open					Acreage =	94,794
Balsam Poplar							
Pole Live	401,756	359,602	8,638	7,731	25,193		
Sum	401,756	359,602	8,638	7,731	25,193		
Black Spruce							
Saw Live	363,368	363,368	6,177	6,177	10,434	1,636,959	1,636,959
Pole Live	1,736,546	1,468,055	29,521	24,957	113,934		
Sum	2,099,914	1,831,423	35,699	31,134	124,367	1,636,959	1,636,959
White Spruce							
Saw Live	4,179,557	3,597,436	71,052	61,156	175,612	18,752,218	16,078,013
Pole Live	14,475,497	14,181,243	246,083	241,081	817,687		
Sum	18,655,055	17,778,679	317,136	302,238	993,299	18,752,218	16,078,013
Stratum Total	21,156,725	19,969,705	361,472	341,103	1,142,859	20,389,177	17,714,973
Stratum 6	Aspen					Acreage =	11,738
Aspen							
Saw Live	2,204,397	2,115,318	47,395	45,479	127,703	4,632,947	4,500,628
Pole Live	9,597,461	9,343,289	206,345	200,881	421,519		
Sum	11,801,858	11,458,607	253,740	246,360	549,222	4,632,947	4,500,628
Balsam Poplar							
Pole Live	93,705	937	2,015	20	9,661		
Sum	93,705	937	2,015	20	9,661		
White Spruce							
Saw Live	1,234,291	1,234,291	20,983	20,983	61,725	5,431,381	5,431,381
Pole Live	1,871,499	1,817,778	31,815	30,902	86,555		
Sum	3,105,790	3,052,069	52,798	51,885	148,281	5,431,381	5,431,381
Stratum Total	15,001,353	14,511,613	308,553	298,265	707,164	10,064,328	9,932,009
Stratum 7	White Spruce Aspen					Acreage =	33,822
Aspen							
Pole Live	4,368,093	4,358,637	93,914	93,711	161,474		
Saw Live	880,256	807,124	18,925	17,353	47,665	1,608,066	1,431,704
Sum	5,248,349	5,165,761	112,839	111,064	209,140	1,608,066	1,431,704
Birch							
Saw Live	154,878	123,902	3,872	3,098	16,978	470,259	251,043
Pole Live	153,618	122,895	3,840	3,072	7,462		
Saw Dead	0	0	0	0	6,520	89,392	31,683
Sum	308,496	246,797	7,712	6,170	30,960	559,651	282,725

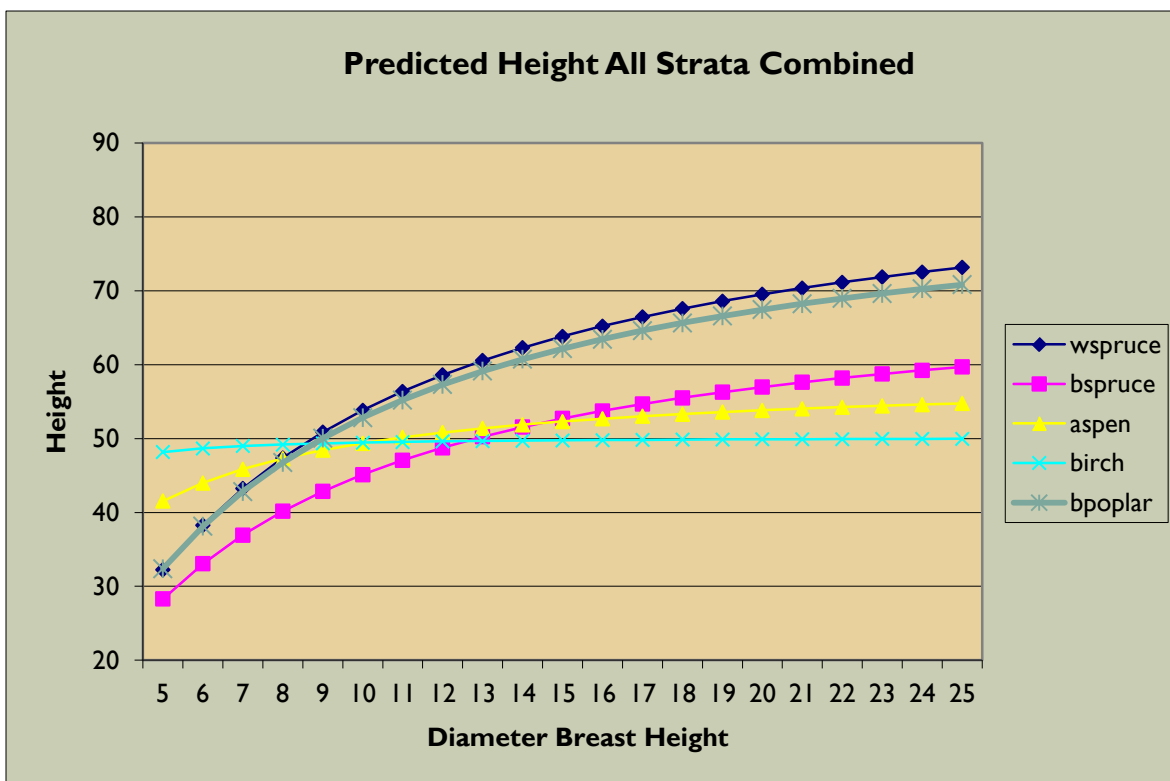
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	Total Gross CF	Total Net CF	Total Gross Tons	Total Net Tons	Total Biomass Tons	Total Gross BF	Total Net BF
Black Spruce							
Pole Live	978,537	858,905	16,635	14,601	68,032		
Pole Dead	342,638	308,374	5,825	5,242	18,179		
Sum	1,321,175	1,167,280	22,460	19,844	86,211		
White Spruce							
Pole Dead	299,666	299,666	5,094	5,094	10,055		
Pole Live	10,838,525	10,672,425	184,255	181,431	481,492		
Saw Dead	865,197	865,197	14,708	14,708	40,635	3,600,434	3,600,434
Saw Live	7,195,868	7,053,044	122,330	119,902	354,076	31,677,626	31,037,877
Sum	19,199,255	18,890,333	326,387	321,136	886,259	35,278,060	34,638,310
Stratum Total	26,077,275	25,470,170	469,399	458,213	1,212,570	37,445,777	36,352,740
Stratum 8	White Spruce Balsam Poplar					Acreage =	11,372
Aspen							
Pole Live	1,394,470	1,374,415	29,981	29,550	73,187		
Saw Live	1,152,203	1,072,818	24,772	23,066	47,887	3,263,990	2,978,565
Sum	2,546,673	2,447,233	54,753	52,616	121,074	3,263,990	2,978,565
Balsam Poplar							
Pole Dead	0	0	0	0	547		
Saw Live	4,673,304	4,231,857	100,476	90,985	192,944	11,300,606	10,320,845
Saw Dead	0	27,654	0	595	2,108	0	148
Pole Live	1,787,848	1,740,718	38,439	37,425	80,329		
Sum	6,461,153	6,000,229	138,915	129,005	275,928	11,300,606	10,320,993
Birch							
Saw Live	56,427	45,142	1,411	1,129	2,244	261,936	209,549
Sum	56,427	45,142	1,411	1,129	2,244	261,936	209,549
White Spruce							
Saw Dead	44,414	35,531	755	604	1,966	192,461	153,969
Saw Live	2,039,968	1,986,472	34,679	33,770	72,897	8,974,311	8,722,331
Pole Live	2,321,304	2,290,909	39,462	38,945	105,088		
Sum	4,405,686	4,312,912	74,897	73,320	179,951	9,166,772	8,876,300
Stratum Total	13,469,939	12,805,516	269,976	256,068	579,197	23,993,304	22,385,406
Grand Totals	150,853,374	143,687,950	2,690,627	2,562,639	6,776,354	263,770,219	244,711,676
						Acreage =	219,550

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Total Volume For Trees Greater Than or Equal to 1.5" dbh and Less Than 5" dbh			
Total Biomass Tons			
Stratum 1	White Spruce Sawtimber	Acreage =	6,756
Aspen			
Balsam Poplar			
Black Spruce	608		
White Spruce	9,864		
Stratum Total	10,473		
Stratum 2	White Spruce Poletimber Closed	Acreage =	20,637
Balsam Poplar			
Black Spruce	26,828		
White Spruce	125,062		
Stratum Total	151,890		
Stratum 3	White Spruce Poletimber Open	Acreage =	30,210
Black Spruce	3,021		
White Spruce	37,159		
Stratum Total	40,180		
Stratum 4	Black & White Spruce Reproduction Closed	Acreage =	10,220
Balsam Poplar	715		
Black Spruce	46,808		
White Spruce	62,241		
Stratum Total	109,764		
Stratum 5	Black & White Spruce Reproduction Open	Acreage =	94,794
Balsam Poplar	12,323		
Black Spruce	68,252		
White Spruce	457,854		
Stratum Total	538,429		
Stratum 6	Aspen	Acreage =	11,738
Aspen	37,209		
Balsam Poplar			
White Spruce	10,564		
Stratum Total	47,773		
Stratum 7	White Spruce Aspen	Acreage =	33,822
Aspen	8,456		
Birch			
Black Spruce	68,997		
White Spruce	95,041		
Stratum Total	172,494		
Stratum 8	White Spruce Balsam Poplar	Acreage =	11,372
Aspen	4,549		
Balsam Poplar	5,345		
Birch			
White Spruce	20,811		
Stratum Total	30,704		
Grand Total	1,101,706		
	Acreage =	219,550	

Appendix D
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	89.77	-5.1154	1
Black Spruce	71.93	-4.6633	1
Birch	51.43	-2.1043	1
Aspen	58.68	-1.7266	1
Balsam Poplar	86.12	-4.8886	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

			Radial Growth (In.)	Single Bark Thickness (In.)
Aspen	(61 detail records)	Average=	0.35	0.38
Balsam Poplar	(57 detail records)	Average=	0.25	1.09
Birch	(4 detail records)	Average=	0.26	0.46
Black Spruce	(49 detail records)	Average=	0.10	0.39
White Spruce	(431 detail records)	Average=	0.32	0.41

Bark Thickness Ratio by Species

			DBH	DIB*	Bark Thickness Ratio
Aspen	(61 detail records)	Sum=	492	446	0.905
Balsam Poplar	(57 detail records)	Sum=	627	503	0.801
Birch	(4 detail records)	Sum=	44	40	0.916
Black Spruce	(49 detail records)	Sum=	308	270	0.876
White Spruce	(431 detail records)	Sum=	4,005	3,652	0.912
Over All		Sum=	5,477	4,910	0.890

*DIB = Diameter Inside Bark

Appendix E
SITE INDEX DISTRIBUTION

Site Index Distribution (Acres) by Stratum

White Spruce Site Index (100 Year)

	20-30	30-40	40-50	50-60	60-70	70-80	80-90
Stratum							
1			2,457	3,071	1,228		
2		2,064	8,255	6,191	4,127		
3	3,021	9,063	15,105		3,021		
4		6,813			3,407		
5	37,918	18,959	18,959	18,959			
6					11,738		
7		5,637	5,637	5,637	11,274	5,637	
8					5,686		5,686
Percent	19%	19%	23%	15%	18%	3%	3%

Aspen Site Index (50 Year)

	20-30	30-40	40-50	50-60
Stratum				
6		2,934	8,803	
7			33,822	
8		3,791	7,581	
Percent		12%	88%	

Balsam Poplar Site Index (50 Year)

	20-30	30-40	40-50	50-60
Stratum				
8			11,372	
Percent			100%	

Appendix F
TREE QUALITY

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Puget Sound Log Scaling and Grading Bureau Specifications

Species	Grade No.	Gross Diameter	Gross Length	Minimum Volume	Surface	Annual Ring Count	Slope of Grain
White/Black Spruce	1	20 Inches	16 Feet		75% Clear	8 per Inch	< 3 inches/foot
	2	12 Inches	12 Feet		50% Clear, Knots < 2.5 inches in diameter	8 per Inch	< 2 inches/foot
	3	6 Inches	12 Feet	50 BF Net			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			
Balsam Poplar	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.		
All Species Cull Logs	0	Logs do not qualify as a Utility Log					

Percent of Measured Sawtimber Trees by Log Grade

	Grade 1 st 16' Log	Grade 2 nd 16' Log	# Of Trees Measured	% Of Trees Measured
Aspen				
	4	-	3	10%
	4	4	10	34%
	4	5	11	38%
	5	5	5	17%
Total for Aspen			29	
Balsam Poplar				
	-	-	6	8%
	1	2	7	10%
	1	4	4	5%
	2	2	11	15%
	2	3	5	7%
	2	4	9	12%
	2	5	8	11%
	4	-	1	1%
	4	4	2	3%
	4	5	5	7%
	5	5	15	21%
Total for Balsam Poplar			73	
Birch				
	-	-	2	50%
	4	4	1	25%
	5	5	1	25%
Total for Birch			4	
Black Spruce				
	5	0	1	50%
	5	5	1	50%
Total for Black Spruce			2	
White Spruce				
	-	-	8	3%
	2	3	6	2%
	2	4	1	0%
	2	5	1	0%
	3	3	4	1%
	3	4	37	13%

Timber Inventory of State Forest Lands in the Copper River Basin 2014

	Grade 1st Log	Grade 2nd Log	# Of Trees Measured	% Of Trees Measured
	3	5	4	1%
	4	-	10	3%
	4	4	131	46%
	4	5	58	20%
	5	-	6	2%
	5	5	21	7%
Total for White Spruce			287	
Grand Total Trees Measured			395	

Tree History Codes

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

<u>Code</u>	<u>Description</u>
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 five years
 - b. Sawtimber
 - c. A commercial species
 - d. Contain at least one merchantable log
- 8 Non-salvable dead trees.
 - a. Dead within the last five years
 - b. A commercial species
 - c. No salvable sawlogs

Percent of Measured Trees by Tree History

	Tree History	# Of Trees Measured	% Of Trees Measured
Aspen	1	5	4%
	2	107	75%
	5	1	1%
	6	26	18%
	8	3	2%
Total for Aspen		142	

Timber Inventory of State Forest Lands in the Copper River Basin 2014

Tree History	# Of Trees Measured	% Of Trees Measured
Balsam Poplar		
1	2	2%
2	51	49%
3	7	7%
4	11	10%
5	9	9%
6	23	22%
8	2	2%
Total for Balsam Poplar	105	
Birch		
5	2	33%
6	3	50%
8	1	17%
Total for Birch	6	
Black Spruce		
2	48	56%
6	33	38%
8	5	6%
Total for Black Spruce	86	
White Spruce		
1	119	17%
2	475	66%
3	23	3%
4	10	1%
5	1	0%
6	73	10%
7	9	1%
8	5	1%
Total for White Spruce	715	
Grand Total Trees Measured	1,054	