Noorvik Biomass Heating

Prefeasibility Assessment

Dan Smith
Project Technician, Alaska Energy Authority
dsmith@aidea.org
907-771-3983

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813 West Northern Lights Boulevard Anchorage, Alaska 99503 **T** 907.771.3000 **Toll Free** (Alaska Only) 888.300.8534 **F** 907.771.3044

Executive Summary

The Native Village of Noorvik has expressed interest in using woody biomass heating systems to displace existing oil based heating and stimulate the local economy. Specifically, the community would like to heat the Tribal Office (IRA Building) with a cordwood boiler module.

Evaluation of several different possibilities resulted in potential annual fuel savings ranging from $1,000 to over $30,000. The most plausible of these scenarios would save roughly $20,000 in annual heating costs. However, due to high upfront capital costs and **limited woody biomass availability**, not all of the scenarios evaluated have long term viability.

Community Disposition

Background

On June 14th 2016 Dan Smith and Devany Plentovich of Alaska Energy Authority (AEA) traveled to Noorvik accompanied by Jackie Schaeffer of WH Pacific. The purpose of this visit was to engage the community about the benefits of biomass heating systems and ascertain the feasibility of such a system. The Tribal Council had submitted a statement of interest to the Alaska Wood Energy Development Task Group (AKWEDTG) seeking more information about the possibility of using a cordwood biomass boiler to heat the Tribal Office (IRA Building).

Existing Systems

The current heating system employed in nearly every building in the community is either an oil fired boiler or a space heating stove (Toyo stove). In buildings with a boiler, a hydronic (baseboard) system is typically employed to distribute the heat throughout the building.

The community is currently constructing a heat recovery system that will pull waste heat from the generators in the AVEC powerhouse to heat the Water Treatment Plant (WTP). This system is estimated to displace 87% of the current heating oil used by the WTP; this figure is expected to climb to 100% once certain energy efficiency measures have been enacted. Based on current oil prices, this heat recovery loop will save the community an estimated $70,000 every year.

Community-wide Fuel Savings

In order to calculate any benefit gained from implementing a biomass system the current heating system must first be assessed. In Table 1, estimates were created based on given usage values and values from nearby communities. The estimates, combined with the fact that 1 cord of wood is equivalent to 130 gallons of heating oil[1], translate into cords of wood required to heat a given building each year. From there a new cost and subsequent savings are found.

Table 1 only takes into account the fuel costs and does not consider any capital costs or Operations and Maintenance (O&M) costs typically associated with woody biomass systems. This table is primarily to show the benefits various buildings would receive from using cord wood for heat, rather that oil.

Table 1: Community Wide Fuel Savings

Building	**Size (ft^2)**	**Oil Used (gal) Annually**	**Cords of Wood Annually**	**Annual Savings**
Tribal Office (IRA)	1404	950	7	$ 2,301.92
City Office/Community Hall*	4315	3625	28	$ 8,782.68
Youth Center*	1200	900	7	$ 2,180.77
City Garage*	3500	1750	13	$ 4,240.38
City Shop*	900	450	3	$ 1,090.38
Public Safety Building*	1600	1517	12	$ 3,675.81
OTZ Telephone Building*	850	638	5	$ 1,544.71
Old Hotel (after refurbishment)**	2300	3000	23	$ 7,269.23
Morris Trading Post*	2600	3276	25	$ 7,938.00
Teaching Housing (4 buildings)*	18230	12936	100	$ 31,344.92
Clinic*	3200	5000	38	$ 12,115.38
Native Store + Warehouse*	7300	8614	66	$ 20,872.38
*Estimated values				
**Assumes building will be retrofitted and repurposed				

[1] 1 cord of wood assumes a 20% moisture content and a volume of 100 ft^3, this equates to 130 gallons of #1 heating oil. A typical cord is 4X4X8 ft, but due to the nature of log stacking there is inevitable void space, thus the volume used in calculations is reduced from 128ft^3 to 100ft^3.

Scenarios

To adequately evaluate all possibilities, several scenarios were considered and assessed. These scenarios were based on information collected during a site visit on June 14, 2016. Estimates were created from this information as well as data from previous, similar projects. These estimates assume the cost of heating oil to be $5.50/gallon and the cost of wood to be $400/cord.

Sensitivity analyses were also conducted to show how changing the cost of heating oil and cordwood affects the Benefit/Cost (B/C) ratio of each project. The B/C ratio acts as a simplified decision making tool. B/C ratios greater than 1.0 mean that the project will save more money than it costs to implement. When the B/C ratio is above 1.0 the project becomes economically viable, these are shown in green. The values highlighted in Orange are B/C ratios of less than 1.0 and are therefore not economically justifiable. This number is generally driven primarily by the amount of heating oil displaced; the higher the number, the higher the ratio, and the more beneficial it will be.

The Operations and Maintenance (O&M) cost for these scenarios are based on the assumption that stoking the boiler will be added to the daily duties of people regularly using the building. The O&M cost is for any replacement parts and/or any cleaning/maintenance that must be done on an annual basis.

1 – Individual Buildings

Several buildings were considered for biomass heating; the fuel savings for these buildings are outlined in Table 1. Key buildings were evaluated more in depth; the results are shown in Table 2. These buildings form the basis for other possible scenarios.

The Tribal Council and City of Noorvik originally submitted a statement of interest for heating the Tribal Office (IRA building) with a cordwood biomass boiler. However, as shown in Table 2, heating only this building with a biomass boiler would not result in lower heating costs. Heating the City Office/Hall results in a better B/C ratio of 1.00. In spite of this, the high capital cost barely justifies the savings that would result; in fact, based purely on the economic analysis, the community would lose a marginal amount of money. However, when all the periphery items are considered (local job creation, energy independence, etc…) this option becomes more appealing.

The teacher housing was also evaluated, and while the building is not owned by the City or Tribe, it would still result in a very impressive B/C ratio of 2.89. This is due to the fact that the building(s) use enough oil that replacing the oil with cordwood would save enough money to justify the high capital cost. This option could be a good starting point for local biomass technology as it would keep over $500,000 in the community over the life of the boiler. This money could be redirected towards other efforts throughout the community. It is important to note that the configuration outlined in this scenario would require approximately **100 cords of wood per year** to function.

Table 2: Heating Individual Buildings with Biomass Boilers

Individual Buildings	Tribal Office (IRA)	City Office/Hall	Teacher Housing
Boiler life	25	25	25
Capital cost	$208,000.00	$208,000.00	$258,700.00
Annual O&M	$500.00	$500.00	$500.00
Cords of Wood Annually	7	28	100
Oil Used Annually (gal.)	950	3,624	12,936
Annual Fuel Savings	$2,301.92	$8,782.68	$31,344.92
Total O&M	$12,500.00	$12,500.00	$12,500.00
Total Fuel Savings	$57,548.08	$219,567.12	$783,623.08
Lifetime Total Savings	-$162,951.92	-$932.88	$512,423.08
Simple Payback (years)	115.43	25.11	8.39
B/C ratio	0.26	1.00	2.89

The sensitivity analyses below show that both the City Office/Hall and the Teacher Housing would see benefits from biomass boilers over a wide range of fuel prices. The analyses also show that under every fuel circumstance evaluated, a biomass boiler for the IRA building would not be a fiscally sound decision.

Sensitivity Analysis: City Hall						
B/C Ratios	**$150/Cord**	**$200/cord**	**$250/cord**	**$300/cord**	**$350/cord**	**$400/cord**
$3.50/gal	0.96	0.81	0.65	0.49	0.33	0.17
$4.00/gal	1.17	1.01	0.85	0.70	0.54	0.38
$4.50/gal	1.38	1.22	1.06	0.90	0.74	0.58
$5.00/gal	1.58	1.42	1.26	1.11	0.95	0.79
$5.50/gal	1.79	1.63	1.47	1.31	1.15	1.00
$6.00/gal	1.99	1.83	1.68	1.52	1.36	1.20
$6.50/gal	2.20	2.04	1.88	1.72	1.56	1.41
$7.00/gal	2.40	2.24	2.09	1.93	1.77	1.61

Sensitivity Analysis: Teacher Housing						
B/C Ratios	**$150/Cord**	**$200/cord**	**$250/cord**	**$300/cord**	**$350/cord**	**$400/cord**
$3.50/gal	2.80	2.34	1.88	1.42	0.96	0.50
$4.00/gal	3.39	2.94	2.48	2.02	1.56	1.10
$4.50/gal	3.99	3.53	3.07	2.61	2.16	1.70
$5.00/gal	4.59	4.13	3.67	3.21	2.75	2.29
$5.50/gal	5.18	4.72	4.27	3.81	3.35	2.89
$6.00/gal	5.78	5.32	4.86	4.40	3.94	3.49
$6.50/gal	6.38	5.92	5.46	5.00	4.54	4.08
$7.00/gal	6.97	6.51	6.05	5.60	5.14	4.68

Sensitivity Analysis: IRA Building						
B/C Ratios	**$150/Cord**	**$200/cord**	**$250/cord**	**$300/cord**	**$350/cord**	**$400/cord**
$3.50/gal	0.25	0.21	0.17	0.13	0.09	0.05
$4.00/gal	0.31	0.27	0.22	0.18	0.14	0.10
$4.50/gal	0.36	0.32	0.28	0.24	0.19	0.15
$5.00/gal	0.41	0.37	0.33	0.29	0.25	0.21
$5.50/gal	0.47	0.43	0.39	0.34	0.30	0.26
$6.00/gal	0.52	0.48	0.44	0.40	0.36	0.31
$6.50/gal	0.58	0.53	0.49	0.45	0.41	0.37
$7.00/gal	0.63	0.59	0.55	0.51	0.46	0.42

2 – District Heating Loop

This heating loop was conceived based on the idea of combining the heating requirements of several buildings in the area around the City Office/Hall area. This large district heating loop would serve the following buildings: The old Hotel, The OTZ Telephone Building, The City Office/Hall, The Public Safety Building, The City Shop and The City Garage, The Boys & Girls Club, and The Morris Trading Post.

Table 3: District Heating Loop

Boiler life	25
Capital cost	$557,700.00
Annual O&M	$500.00
Cords of Wood Annually	117
Oil Used Annually	15,155.10
Annual Fuel Savings	$36,721.97
Total O&M	$12,500.00
Total Fuel Savings	$918,049.33
Lifetime Total Savings	$347,849.33
Simple Payback (years)	15.40
B/C ratio	1.61

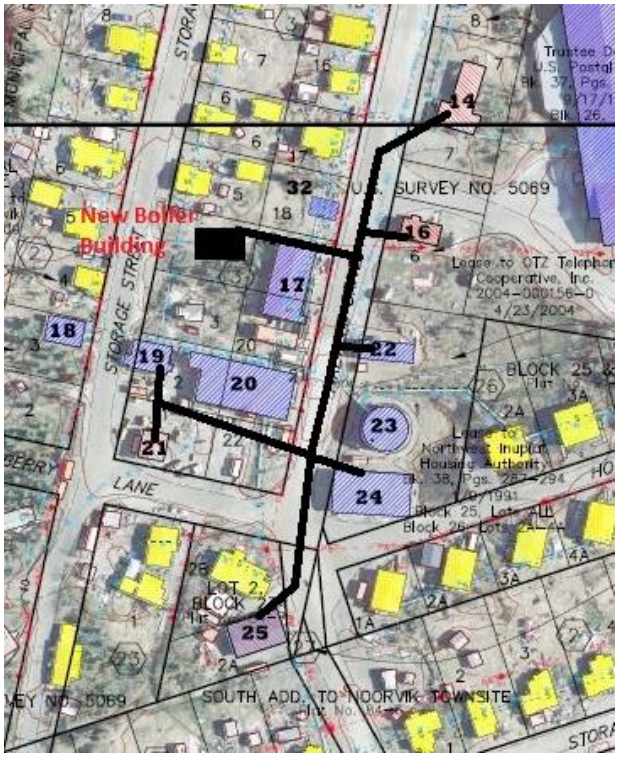

Figure 1: Potential District Heating Loop Configuration

The heating loop shown in figure 1 illustrates a tentative design that would incorporate buildings: 14, 16, 17, 19, 21, 22, 24, 25. The new boiler housing (not to scale) would likely be situated behind the City Office/Hall.

Sensitivity Analysis: District Heating Loop						
B/C Ratios	**$150/Cord**	**$200/cord**	**$250/cord**	**$300/cord**	**$350/cord**	**$400/cord**
$3.50/gal	1.56	1.30	1.05	0.79	0.54	0.28
$4.00/gal	1.89	1.64	1.38	1.12	0.87	0.61
$4.50/gal	2.22	1.97	1.71	1.46	1.20	0.95
$5.00/gal	2.56	2.30	2.04	1.79	1.53	1.28
$5.50/gal	2.89	2.63	2.38	2.12	1.87	1.61
$6.00/gal	3.22	2.96	2.71	2.45	2.20	1.94
$6.50/gal	3.55	3.30	3.04	2.79	2.53	2.27
$7.00/gal	3.88	3.63	3.37	3.12	2.86	2.61

Under present conditions, this district heating loop would cost roughly $560K and result in a lifetime total savings of roughly $350K. This gives the heating loop a B/C ratio of 1.61. As shown in the sensitivity analysis above, there are several scenarios that would cause this project to be a financially sound investment.

However, this heating loop would require **117 cords** of wood every year to operate, which is approximately 100% of the regional sustainable harvest. Typical woody biomass projects use **less than 5%** of the sustainable timber harvest. This will be further detailed in this report; and because of this fact, this heating loop configuration is **not recommended**.

3 – Wood Stoves

Due to the nature of large woody biomass boilers and the limited woody biomass resource in the Noorvik area, heating smaller buildings with wood stoves would be a better solution for supplementing oil boilers. Wood stoves can come in many configurations that can be easily tailored to fit a particular building's needs, but are best suited for large rooms (such as public assembly areas)

Masonry wood stoves function more efficiently by providing a steady source of heat over a longer period of time than conventional wood stoves. There is currently a light weight masonry wood stove being developed by the College of Engineering at UAA with rural Alaskan villages in mind. The ***burnwise*** website run by the US EPA has a wealth of information and guidelines on this topic: https://www.epa.gov/burnwise. This would be an excellent resource to aid in selection of appropriate heating units for key buildings in the community

In Table 4 heating the IRA building would require two conventional wood stoves while the City Office/Hall would likely require four conventional wood stoves; these configurations would provide heat equivalent to the existing oil boilers. By using wood stoves, the IRA building would be able to save over $2,000 every year on heating costs; after the initial capital cost and O&M expenses are considered this equates to being almost $5,000 less expensive than operating an oil boiler over the life of the heating units. However, using wood stoves in an office building such as the IRA building, may cause some uncomfortable conditions. The nature of wood stoves would cause some rooms to be very hot, while others would be left too cold.

Using wood stoves in the City Office/Hall could displace over 3,500 gallons of heating oil every year and save the community about $8,700 annually. Over the life of the heating units this would add up to over $90,000. However, the most reasonable use of a wood stove in the City Hall would be in the large meeting space to supplement the oil boilers that supply heat to the whole building.

Table 4: Wood Stove Feasibility

Wood Stoves	Tribal Office (IRA building)	City Office/Hall
Boiler life	20	20
Capital cost	$31,200.00	$62,400.00
Annual O&M	$500.00	$1000.00
Cords of Wood Annually	7	28
Oil Used Annually	950.00	3624.60
Annual Fuel Savings	$2,301.92	$8,782.68
Total O&M	$10,000.00	$20,000.00
Total Fuel Savings	$46,038.46	$175,653.69
Lifetime Total Savings	**$4,838.46**	**$93,253.69**
Simple Payback (years)	17.31	7.53
B/C ratio	1.12	2.43

The wood stove sensitivity analyses for these buildings show that there is a wide range of scenarios that would save the community money.

Sensitivity Analysis: Wood Stove, City Hall						
B/C Ratios	**$150/Cord**	**$200/cord**	**$250/cord**	**$300/cord**	**$350/cord**	**$400/cord**
$3.50/gal	2.35	1.96	1.58	1.19	0.81	0.42
$4.00/gal	2.85	2.46	2.08	1.69	1.31	0.92
$4.50/gal	3.35	2.97	2.58	2.20	1.81	1.42
$5.00/gal	3.85	3.47	3.08	2.70	2.31	1.93
$5.50/gal	4.35	3.97	3.58	3.20	2.81	2.43
$6.00/gal	4.85	4.47	4.08	3.70	3.31	2.93
$6.50/gal	5.35	4.97	4.58	4.20	3.81	3.43
$7.00/gal	5.85	5.47	5.08	4.70	4.31	3.93

Sensitivity Analysis: Wood Stove, IRA Building						
B/C Ratios	**$150/Cord**	**$200/cord**	**$250/cord**	**$300/cord**	**$350/cord**	**$400/cord**
$3.50/gal	1.08	0.90	0.73	0.55	0.37	0.20
$4.00/gal	1.31	1.14	0.96	0.78	0.60	0.43
$4.50/gal	1.54	1.37	1.19	1.01	0.83	0.66
$5.00/gal	1.77	1.60	1.42	1.24	1.06	0.89
$5.50/gal	2.00	1.83	1.65	1.47	1.29	1.12
$6.00/gal	2.23	2.06	1.88	1.70	1.53	1.35
$6.50/gal	2.47	2.29	2.11	1.93	1.76	1.58
$7.00/gal	2.70	2.52	2.34	2.16	1.99	1.81

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Biomass Resource

In January 2013, Tanana Chiefs Conference (TCC) was contracted by Maniilaq Association to conduct an inventory of forestry resources within the Northwest Arctic Borough; specifically, in the Noatak and Kobuk subunits. Based on information in this report it was found that the region surrounding Noorvik contains 1,376,514 ft^3 of timber. This equates to a total of 11,724 cords of wood available to the community

The wood resource surrounding Noorvik is comprised primarily of white spruce with some cottonwood and trace amounts of other species interspersed. Assuming a uniform species distribution of spruce and cottonwood as 65% and 8% respectively, this equates to 7,167 cords of harvestable spruce and 3,418 cords of cottonwood within roughly a 5-mile radius of the community. The energy content of each species of wood assumes an air dry moisture content of roughly 20%.

Table 5: Biomass Resource Information

	Resource Composition	Cord Weight (lbs/cord)	Energy (MMBtu/cord)	Harvestable Cords
Spruce Harvest	65%	3,100	18.1	7,167
Cottonwood Harvest	8%	2,400	15.0	1,139
Other Harvest	27%	2,700	16.5	3,418
Weighted Average		2,936	17.4	
Total				**11,724**

With an average tree maturation rate of over 100 years, the wood used by the community every year **cannot exceed 1% of the total available resource** in order to maintain sustainability. With 11,724 cords of wood in the harvest area the sustainable harvest equates to **117 cords per year**. This figure includes **all** woody biomass harvest in the community, including timber harvest by residents for personal use. As mentioned earlier, a district heating loop could use 117 cords of wood annually; 100% of the allowable sustainable harvest. This is ***very*** concerning as over harvest could negatively affect the local environment and have dire consequences for the local subsistence lifestyle. In addition to the environmental impacts of over harvest, large scale biomass would possibly prevent, personal harvest that residents rely on wood for heating individual homes.

AEA strongly recommends a more detailed forestry evaluation of the surrounding wood resources before developing a harvest plan and/or further pursuing any *woody* biomass heating systems.

AEA Recommendations

As stated in the Biomass Resource section of this report, the woody biomass availability in the harvest area of Noorvik is marginal at best. Based on the local woody biomass availability **a woody biomass boiler project is not recommended.** That being said, there are several smaller biomass options available to the community. There are several very efficient cord wood stoves that would be ideal to heat smaller buildings (such as the City Hall). More information about choosing an appropriate wood stove can be found at the US EPA website, ***burnwise*** (https://www.epa.gov/burnwise/choosing-right-wood-stove). Using a wood stove would require less wood than a biomass boiler unit, but would still need a steady supply of cordwood.

To reiterate, the limiting factor for any woody biomass project in Noorvik is the availability of woody biomass. Any sizeable woody biomass project should be carefully planned around the limitations of the forestry resources, and should account for wood already being harvested by residents for personal use.

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Appendix

A – Fuel Assumptions

1. Annual heating fuel use by building is based on available data.
2. When data was unavailable, estimates were created based on building size and equivalent buildings in nearby communities with similar heating requirements.
3. Calculations were conducted assuming a heating oil price of $5.50/gallon and the price of Cordwood is $400/cord which is based on the price in Kobuk as of summer 2016
4. Cords of wood required to heat a given building was based on the energy content of the weighted average of available timber in the region. A typical cord used would be 65% spruce, 8% poplar and contain 17.42 MMBtu/cord.
5. Energy content of wood assumes a general moisture content of 20% which would have been achieved by air drying the wood for 12 months.

B – Capital Costs

1. Construction costs are based on estimates from previous studies and completed projects
2. Construction assumes a separate boiler building will be constructed.
3. The District Heating Loop costs assumes two GARN 2000 unit will provide sufficient heat for the target locations.
4. Wood stove construction assumes $2000 for labor, $5,000 for the physical device, $5,000 for shipping per stove

Capital Costs	1 Garn 2000	1 Garn 3200	District Heating Loop	1 Wood Stove
Housing construction/installation	$50,000.00	$50,000.00	$50,000.00	$2,000.00
Boiler Cost	$20,000.00	$46,500.00	$50,000.00	$5,000.00
Artic Pipe ($175/ft)	-	-	$131,250.00	-
Heat Exchanger/Piping	$50,000.00	$50,000.00	$114,000.00	-
Extra Thermal Storage	$5,000.00	$5,000.00	$5,000.00	-
Controls/Electrical	$10,000.00	$10,000.00	$10,000.00	-
Freight	$25,000.00	$37,500.00	$68,750.00	$5,000.00
Subtotal	$160,000.00	$199,000.00	$429,000.00	$12,000.00
Engineering (15%)	$24,000.00	$29,850.00	$64,350.00	$1,800.00
Contingency (15%)	$24,000.00	$29,850.00	$64,350.00	$1,800.00
Total	$208,000.00	$258,700.00	$557,700.00	$15,600.00

C – Biomass Assumptions

1. Based on data from 2012 forestry measurements by TCC in various parcels in the Noatak subunit.
2. Approximately 35% of the subunit is within approximately 5-miles of Noatak. This yielded harvestable amounts used in calculations.
3. The distribution of tree species is:
    1. 65% white spruce
    2. 8% cottonwood
    3. 27% other/deadwood
4. Cord calculations used 100 ft^3 to account for void space in wood stacking, this differs from the conventional 128 ft^3 figure used in a 4X4X8ft cord.

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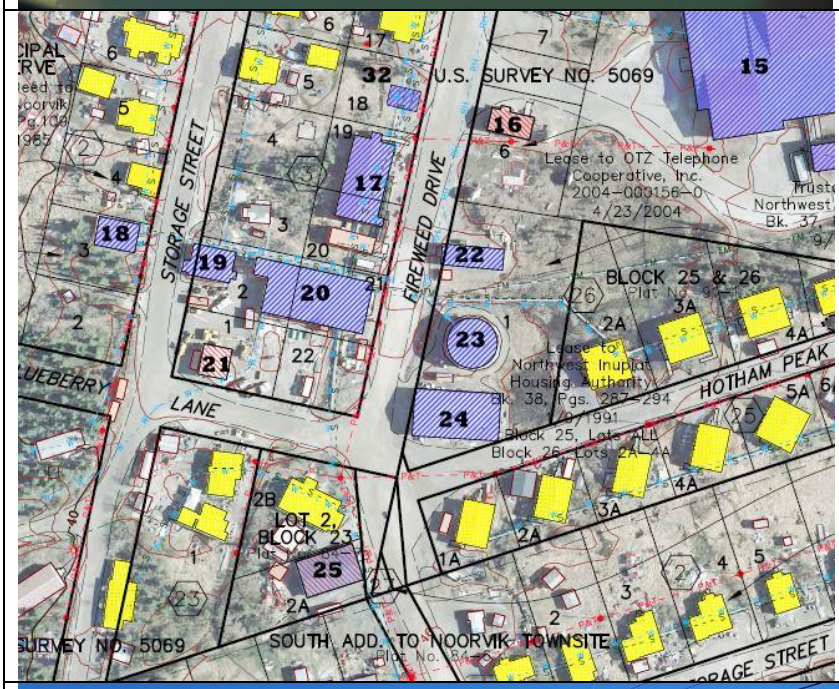
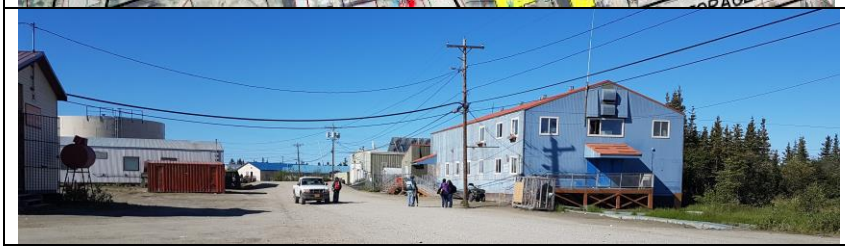
D – Site Photos

	Aerial view of Noorvik. The School is the largest building, it is near the center of the image with a red roof.
	Map of Central Noorvik. Building Numbers: 15 – School 16 – OTZ building 17 – City Office/Hall 18 – City Storage 19 – Public Safety 20 – Water Treatment Plant 21 – City Shop 22 – Boys & Girls Club 23 – Water Tank 24 – City Garage 25 – Morris Trading Post 32 – Municipal Storage Shed
	Left Edge: OTZ building Left: Boys & Girls Club Right: City Office/Hall

	City Office/Hall
	Existing Weil-McClain Boiler in IRA Building
	Toyo Stove (Space Heater) in the Boys & Girls Club

E – Statement of Interest

See Attached

F – Maniilaq Forestry Inventory

See Attached

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Appendix E: Statement of Interest

Statement of Interest
In Developing Wood-Fired Heating Projects

Information from this form will be used in ranking your project for a pre-feasibility assessment that will be conducted by a contractor hired on behalf of the Alaska Wood Energy Task Group.

Not all applications can be funded

Electronic copies of this form can be downloaded from the Alaska Energy Authority website at http://www.akenergyauthority.org/biomasswoodenergygrants.html

Applicant:	Native Village of Noorvik / Noorvik Native Community		
Eligibility:	[ ] Local Government [ ] School [ ] State Agency [ ] Not-For-Profit Organization [ ] Federal Agency [X] Federally Recognized Tribe: ___Native Village of Noorvik_____ [ ] ANCSA Corporation: _____ [ ]Other: _____ [ ] Commercial Enterprise (identify industry sector): _____		
Contact Name:	Lonnie Tibbitts		
Mailing Address:	PO Box 209		
City:	Noorvik		
State:	AK	**Zip Code:**	99763
Telephone:	907-636-2144		
Fax:	907-636-2284		
Email:	environmental@nuurvik.org		

Please refer to Frequently asked Questions for more information on completing this Statement of Interest.

Please respond to the following evaluation criteria: (Attach additional pages as necessary)

1. **Please include a short paragraph on what your objectives are with this project.**
   Our objectives with this pre-feasibility assessment is to truly assess if our biomass resource can sustain one or more projects in our community. In 2011, with funding from the Alaska Energy Authority (AEA), the Northwest Arctic Borough contracted Tetra Tech to complete a Feasibility and Design report for the Upper Kobuk, our neighboring northern communities. This study proved not only that it was feasible, but these projects are currently under construction and show great potential for energy-cost savings for those communities. Our local topography is very similar to our sister communities and we are hopeful that we too can help lower the cost of energy in our village.

Questions 2-3 are specific to individual buildings. Applications can include more than one building. PLEASE SUBMIT A COPY OF THIS PAGE FOR EACH BUILDING

Facility Identification/Name: ___Tribal Office Building_____

2. Facility information

Approximate size (square footage) of building	1404
Type of construction (wood, cement, etc.)	Wood
Age of building	Unknown
What is building used for?	Tribal offices and meetings
Has building had a recent energy audit?	Yes
What is the age of the current heating system?	Toyo Stove, Weil McClain Boiler 2011
What type of current heating system is in place? (Radiant, forced air, baseboard etc.)	Baseboard, Forced Air

3. Current fuel situation

Type of fuel used (#1 fuel oil, #2 fuel oil, propane, etc.)	#1 Fuel Oil
Annual fuel consumption (gallons)	950
Cost of fuel per gallon	$ 7.31
Cost of electricity per kWh	$ 0.65

Please attach other facility information that would be useful, such as Maps, Photographs, As-built Survey, etc.

Questions 4 – 10 are general questions – answer only once per application – not required for every building.

4. Presence of high-hazard forest fuels Describe any forest fires or insect outbreaks in the past 5 years:

- Discuss any activities to utilize dead/dying material:
  Our region has not seen or experienced any forest fires or insect outbreaks in the past 5 years.
- Discuss any activities or programs that would mitigate the effects of future fires or infestations:
  Our region is not affected by this.

5. Resource Issues

- Where would you plan on getting wood from?
  Dry wood, bought from local wood cutters.
- Discuss the ownership of nearby forest lands and any agreements there may be to harvest trees (live or dead) from those lands.
  NANA Regional Corporation owns the surrounding land and an agreement would be signed to access NANA lands for extraction of wood.
  - Discuss the extent and sustainability of local forest resources and wood supply:
    We think there is enough local fire wood to sustain a few projects.
  - Discuss wildlife habitat or other forest health issues you may have:
    None
  - Is there a LAND MANAGEMENT PLAN in place for the area of wood source?
    No
  - Do you have access to other wood (i.e. drift wood, wood pellets, bio bricks etc.)?
    Yes , driftwood

6. Availability of local wood processing residues (e.g., slabs, chips, bark, sawdust, shavings, etc.) -

- List any known wood processors near your community. Include owners' names and contact information.
  None
- What do those processors currently do with their residues?
  N/A

7. Wood Fuel Availability

- What type of woody biomass are you interested in for your system (pellets, chips, cordwood, etc.)
  Cordwood

- Provide anticipated cost for the woody biomass planned on being used.
  Unknown, but a cost comparison could be done with the Kobuk system.

8. Discuss community support/advocacy, or which agency will be the project champion for this project

- Please tell us about your community advocate (or advocacy group)
  Our community stakeholders engaged in the Regional Energy Plan efforts meet regularly, but the Noorvik Traditional Council will be the advocate on this project.
- Does your community have any other wood energy systems? If yes, please identify the system. No systems in place.
- Have you had any meetings to discuss wood energy?
  It has been discussed in the NWA Regional Energy Plan as a viable alternative resource to offset the cost of dependency on diesel fuel.

9. Please provide a narrative or description on how you see this project being operated and maintained in your community.

This project would allow a local resource to be assessed and possibly be utilized by locals. The operation and maintenance would be a collaborative effort between local stakeholders, the Noorvik Traditional Council, NANA Regional Corporation and Northwest Arctic Borough.

10. Discuss what, if any, public benefit will result from this project.

Public benefits would include, a new "local" renewable energy resource that could sustain the Tribal building and possibly households that would like to convert to Biomass.

11. Please include any other information that should be considered for this project.

Return Statement of Interest to:

Karen Petersen
University of Alaska
Cooperative Extension Service
P.O. Box 19190
Thorne Bay, AK 99919
(907) 821-2681
khpetersen@alaska.edu

It is preferred that Statements of Interest are submitted electronically (via e-mail) but paper copies will be accepted via mail (no fax).

Appendix F: Maniilaq Forestry Inventory

NANA Region Native Allotment Forest Inventory

Presented to:
Maniilaq Association
733 2nd Avenue
Kotzebue, AK 99752

By:
Tanana Chiefs Conference, Forestry Program
122 First Ave., Suite 600
Fairbanks, AK 99701

Will Putman, Forestry Director
Fabian Keirn, Forester
Jeremy Douse, Forester

January, 2013

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Introduction

Tanana Chiefs Conference Forestry Program staff was contacted by Maniilaq Association's Lands and Resources Department about conducting a forest inventory on Native allotments within the NANA region of northwestern Alaska. TCC agreed to conduct the inventory, and work was initiated in early 2012. Field work was conducted in August of 2012, and the project was completed in January, 2013. This report summarizes the project and the results of the forest inventory.

Both Maniilaq Association (Maniilaq) and Tanana Chiefs Conference (TCC) are non-profit regional Native corporations that, among many other responsibilities, have assumed land management trust functions on Native allotments within their respective regions. These land management responsibilities include overseeing forestry and realty activities, which require information on the forest resources present on the allotments. Collecting and managing forest resource information has been problematic in the remote rural settings in which many of these allotments exist; the parcels are remote and can be difficult to efficiently access, aerial photography may be outdated, remote sensing data may be expensive and difficult to reference to a coordinate system, and basic timber data such as stand tables and volume equations may be sketchy or nonexistent for a particular area. Even the most basic required information, such as where the parcels are located on the landscape, may be difficult to determine. In this environment of uncertainty, the TCC Forestry Program has been able to successfully complete forest inventories on Native allotments in the TCC region of interior Alaska, and has been able to provide valuable information on allotment resources to aid trust management functions at TCC. Because of TCC Forestry's experience in completing forest inventories of this nature, staff at Maniilaq contracted with TCC Forestry staff to conduct a forest inventory on Native allotments within the NANA region.

TCC Forestry may be contacted at:

Tanana Chiefs Conference, Forestry Program
122 First Ave., Suite 600
Fairbanks, AK 99701
Phone: (907) 452-8251
Fax: (907) 459-3852

Will Putman, Forestry Director, wputman@tananachiefs.org, ext 3373.

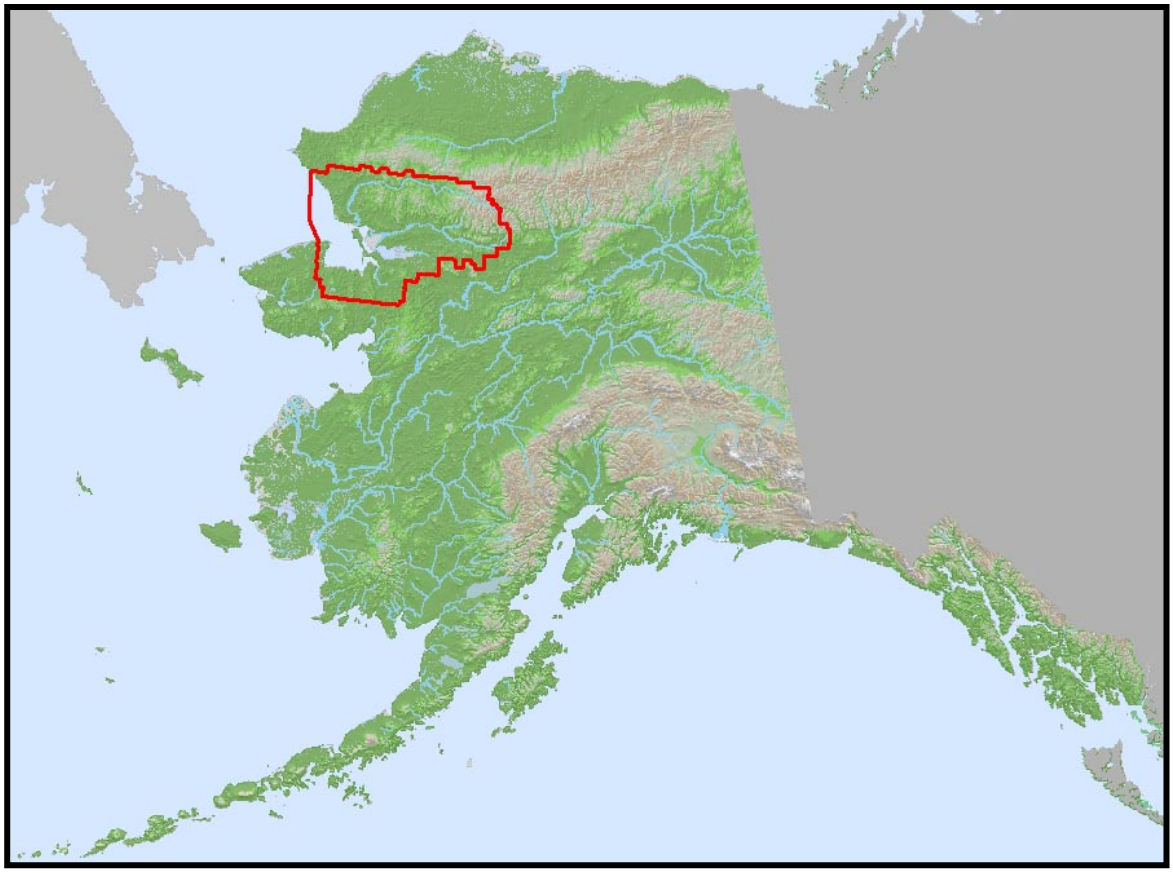


Figure 1. The NANA Region in Alaska.

The Region

The Alaska Native Claims Settlement Act of 1971 designated 12 regions to be defined within Alaska for the purposes of establishing regional Native Corporations and the land selections they were entitled to. The region designated for Northwest Alaska came to be known as the NANA Region, and is the home of NANA Regional Corporation, Inc., the for-profit Native Corporation established for the region, and Maniilaq Association, the non-profit Native organization responsible for providing a variety of services to the tribes and tribal members of the NANA region.

The NANA region comprises just under 40,000 square miles in northwestern Alaska, and includes those lands in the area of Kotzebue Sound drained by the Noatak River to the north and east, the Kobuk River to the east, and the Buckland River and Kiwalik River to the south (Figure 1). The largest community in the region, and the location of the main offices of Maniilaq Association and NANA Regional Corporation, Inc., is Kotzebue (Figure 2).

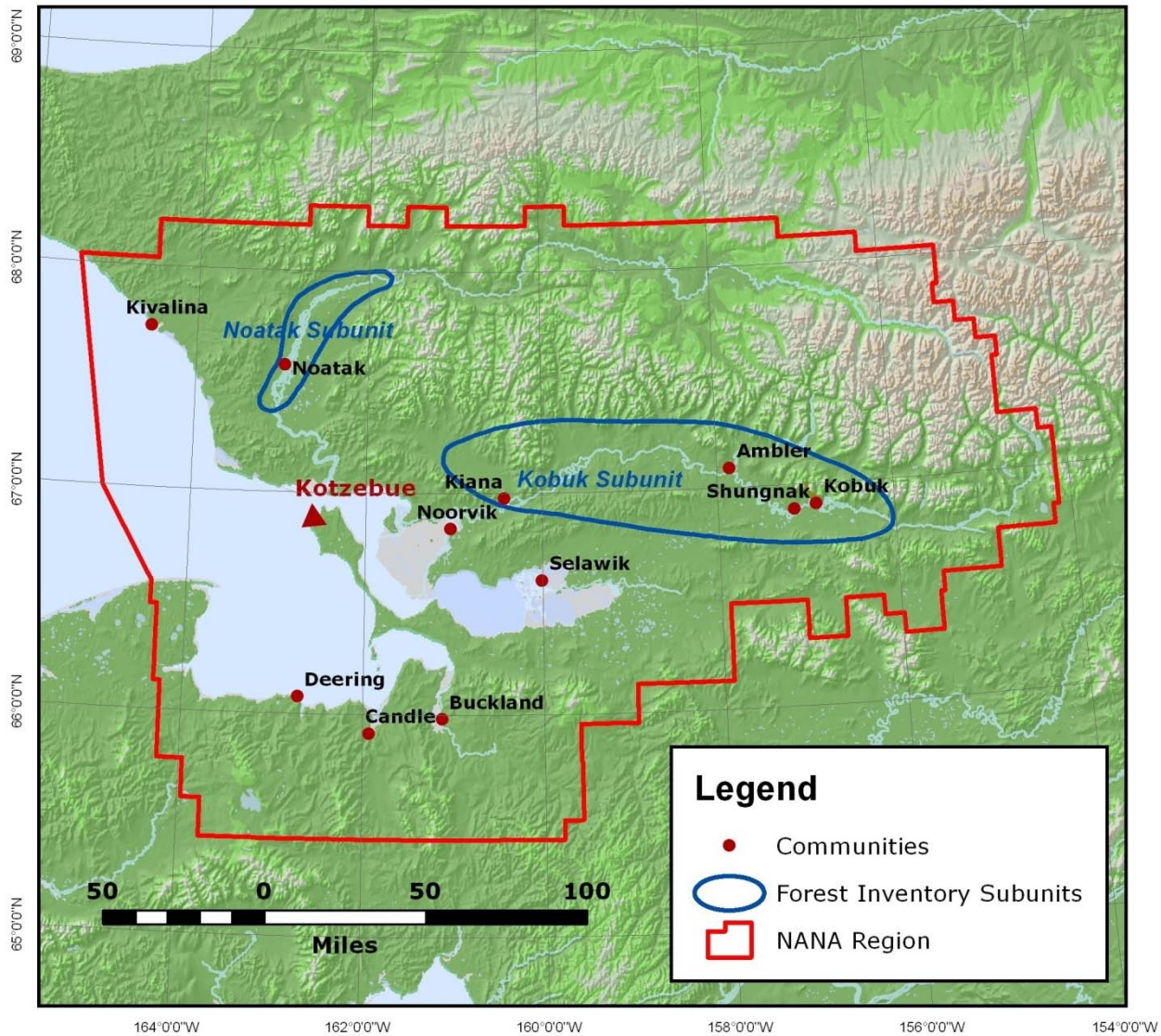


Figure 2. Communities and the location of Forest Inventory Subunits in the NANA Region.

Definition of Subunits

According to a spatial dataset of Native allotments developed and maintained by the Bureau of Land Management, there are 1,619 Native allotment parcels in the NANA region. Much of the region is made up of the drainages of the Kobuk and Noatak Rivers, which are also the location of much of the forested land in the region. Aerial photography was acquired over most of the forested allotment parcels along these 2 river systems, and the scope and extent of this forest inventory project was defined by the extent and coverage of that aerial photography. A total 385 of the allotment parcels were covered by the aerial photography, and the project was split into a Kobuk Subunit and a Noatak Subunit based on river drainage (Figure 2). The parcels defined as being included in the subunits include 291 parcels covered by aerial photography in the Kobuk Subunit, and 94 parcels covered by aerial photography in the Noatak Subunit (Figures 3 and 4 respectively).

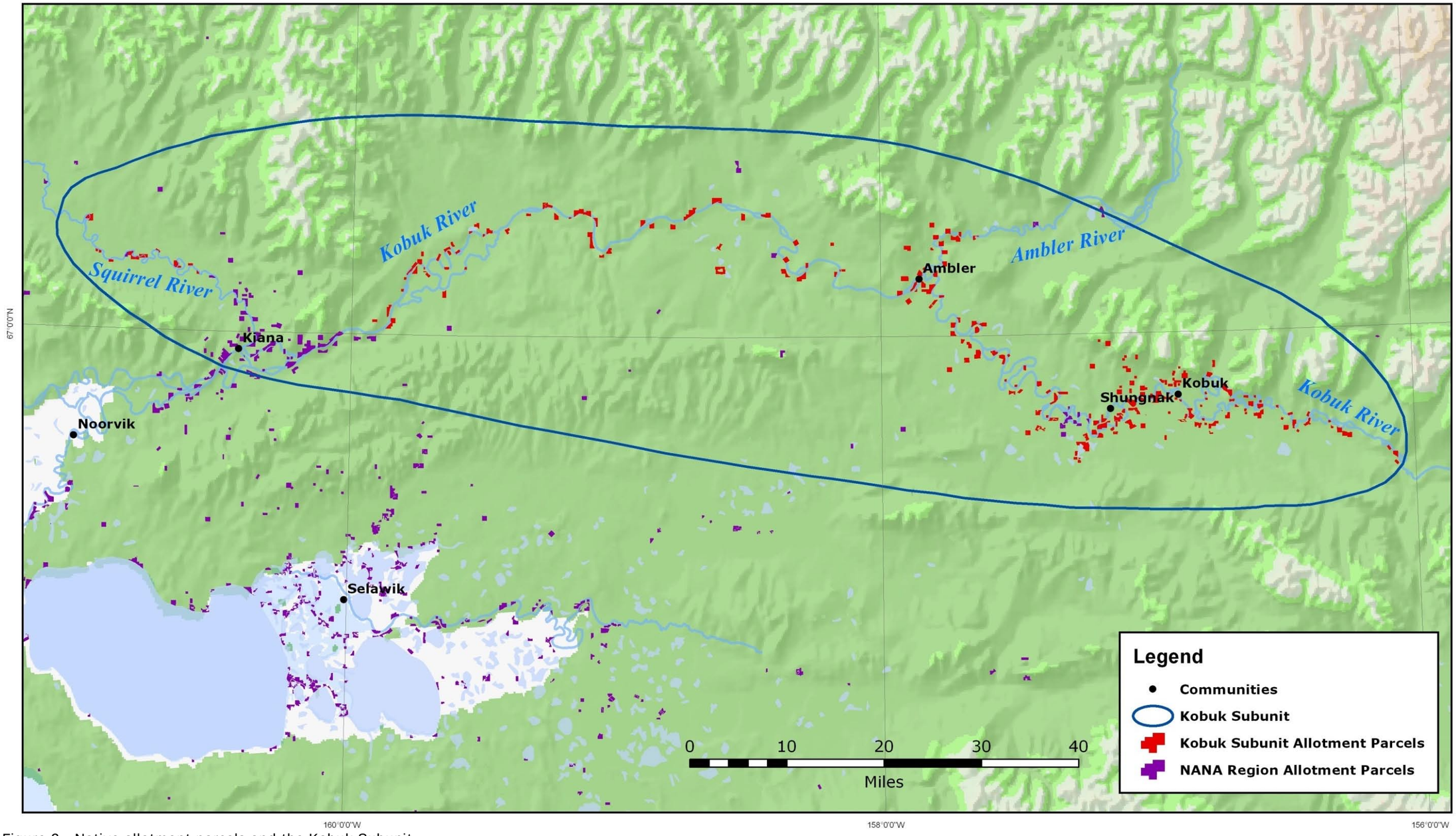


Figure 3. Native allotment parcels and the Kobuk Subunit.

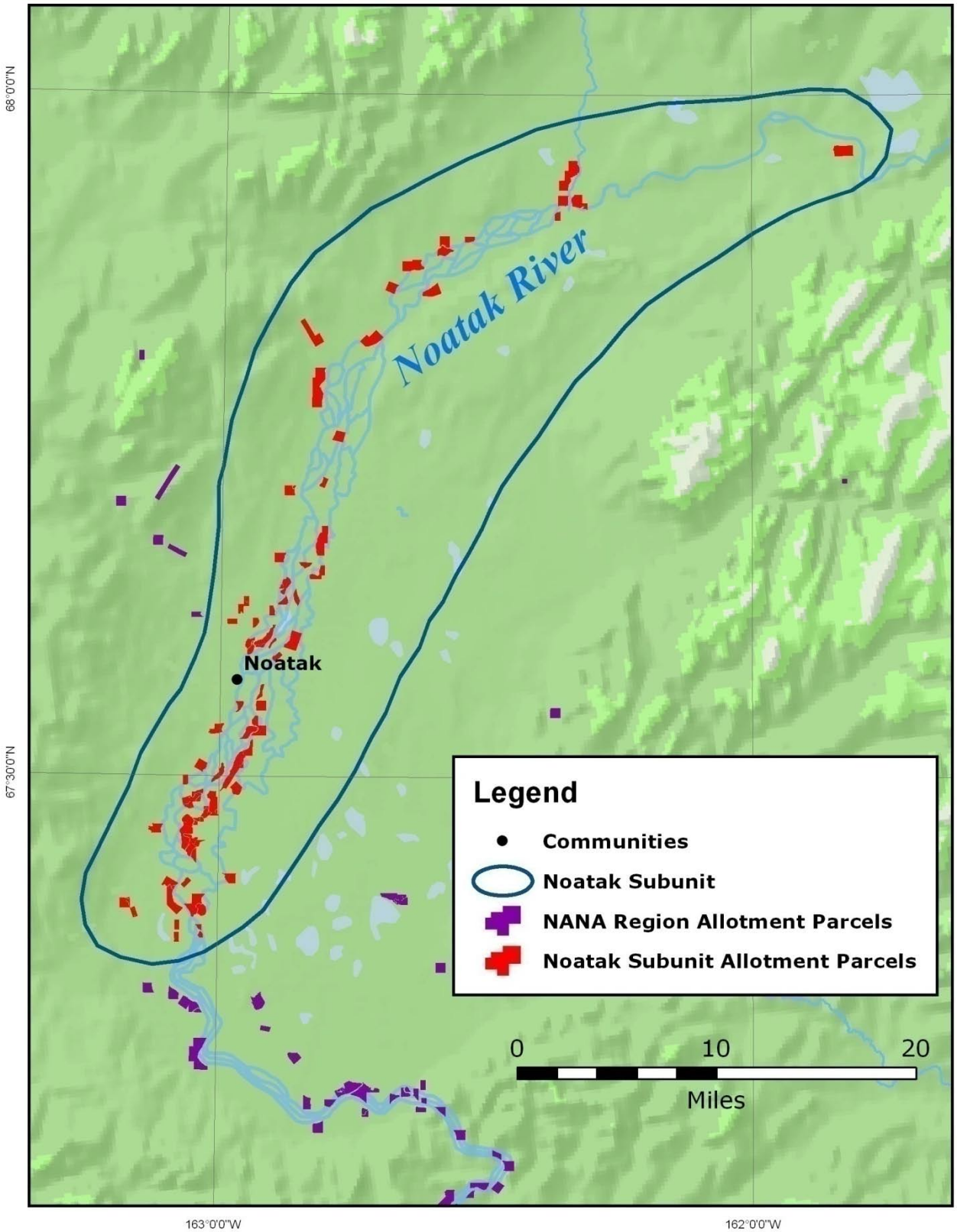


Figure 4. Native allotment parcels and the Noatak Subunit.

Methods

Terms and Definitions

In the following discussion, the following terms may have special meaning:

- A "GIS" is a geographic information system, a general term referring in this case to a computerized system where spatial data may be collected, organized, analyzed, and displayed. The system consists of computer hardware, software, and data integrated together.
- A "spatial dataset" is a collection of digital data that contains information about features on a landscape, and can include vector datasets such as ArcGIS shapefiles or geodatabase feature classes, and raster or image datasets such as digital aerial photography or satellite images.
- A spatial dataset is "georeferenced" when the features in the dataset are referenced to the proper geographic location using a standard coordinate system.
- A "polygon" refers to a feature in a spatial dataset that represents an area on the landscape.
- A "Native Allotment" refers to land applied for by an individual Native Alaskan under the authority of the Native Allotment Act of 1906. A single allotment application may include up to 4 separate "parcels" of land totaling no more than 160 acres. A single parcel may exist in more than one piece if an otherwise contiguous parcel is split by the presence of a water body or other features, resulting in a single parcel being represented by more than one polygon in a GIS.
- An "attribute" is a particular kind of information about features in a spatial dataset. An "attribute table" is a database table containing information about spatial features, where each record or row in the table is unique to an individual feature, and each column, or item, in the table is an attribute, or kind of information, stored for each feature.
- A "land cover type", or "cover type" is a class or category of vegetation or other land cover describing an area with relatively homogenous cover, and is an attribute of cover type polygons in a GIS.
- A "timber type" is a forested cover type.
- A "stand" is a timber type polygon.
- "DBH" is "Diameter at Breast Height", or the diameter of the bole of a tree at a height of 4.5 feet.

Process Summary

The forest inventory process consisted of a number of phases:

- Available information was compiled and integrated into a GIS.
- Land cover types were interpreted from aerial photographs and digitized into the GIS.
- A subset of timbered areas, or stands, was identified for field sampling.
- The selected sample stands were visited in the field and data were collected with tree measurements and other sampled information.
- The field sample data were entered into a computer program for processing.
- The resulting timber volume data were organized and processed in a relational database. Using information from the GIS, volumes were calculated and output as reports.
- The timber volume data in the relational database were integrated into the GIS, and an application was constructed to facilitate dynamic querying and calculation of timber volumes from within the GIS.

Data acquisition and integration

Locations of Native allotments were determined by acquiring Native allotment boundary digital spatial data from the Bureau of Land Management (BLM) through their Spatial Data Management Syste (SDMS) (http://sdms.ak.blm.gov/sdms/). The NANA region was described in a spatial dataset of ANCSA regions downloaded from the State of Alaska Department of natural Resources (DNR) (http://www.asgdc.state.ak.us). The polygon describing the NANA region was used to extract those Native allotment parcels within the NANA region from the BLM allotment data, resulting in a spatial dataset containing the location of 1,969 allotment parcel polygons. The allotment parcel data were incorporated into a geodatabase schema constructed through a joint effort by TCC and BIA to manage allotment forest inventory data. This geodatabase also included feature classes for allotment cover types and other layers pertinent to allotment forest inventory data management. The geodatabase was in a personal geodatabase format managed with ArcGIS software by ESRI, Inc.

The forest inventory results are driven by the determination of relatively homogenous cover type areas stored in a cover type feature class in the geodatabase. For this project, these cover types were determined by interpreting digital aerial photographs that were provided by Maniilaq Association on a series of compact discs. The photographs were available as georeferenced digital natural-color photographs at a spatial resolution of 1 foot, and had been acquired relatively recently - within several years of the inventory

Land cover typing

The process of creating the land cover type data involved the following steps:

- A GIS display was set up on a computer workstation using ArcGIS 10.0 software and several layers of spatial data, including the aerial photography and Native allotment parcel boundaries.
- The operator zoomed into the GIS to a particular native allotment parcel or group of parcels.
- The operator manually interpreted the land cover on the native allotment parcels. The operator determined the location of the boundaries of the cover type polygons, and entered them into the GIS using a “heads-up” digitizing technique – that is, the operator clicked in the location of new feature directly on the computer screen while viewing allotment boundaries and an image of the aerial photograph on the computer. As a general rule, areas less than 2 acres in size were not typed out, although exceptions to this rule were made, particularly with small portions of stands near allotment boundaries.
- After the new cover type polygons were created or edited, the operator coded the attribute table for the new features for the land cover type, using a land cover classification system described in Table 1. As the polygons were created, they were also automatically coded for allotment serial number, stand number, and acreage. An example of an allotment parcel interpreted and attributed for land cover from an aerial photograph is shown in Figure 5.

Table 1. Land cover typing system used.

Land Cover Typing Codes

Forestland

WS	White spruce (*Picea glauca*)
BS	Black spruce (*Picea mariana*)
CW	Cottonwood (balsam poplar, *Populus balsamifera*)
BI	Paper birch (*Betula neoalaskana*)
AS	Aspen (*Populus tremuloides*)

Shrubland

TS	Tall shrub (alder,willow)
DS	Dwarf shrub (bog birch, other)
Tu	Tundra (herb, sedge, grass)

Wetlands, water

W	Lakes, ponds
B	Bog, herbaceous species
TSw	Tall shrub wet
WM	Wet meadow
DSw	Dwarf shrub wet
R	River

Special Cover Types

Ba	Bare ground, gravel bar
Cu	Cultural/village, roads, airstrips, gravel pits, quarries, mines

Forestland calls are further described with size and density codes:

Forest size codes:

D	Dwarf forest/scrub forest	< 25 feet tall, < 4.5” DBH
R	Reproduction	< 4.5” DBH on productive sites
P	Poletimber	4.5” to 8.9” DBH
S	Sawtimber	$\geq$ 9.0” DBH

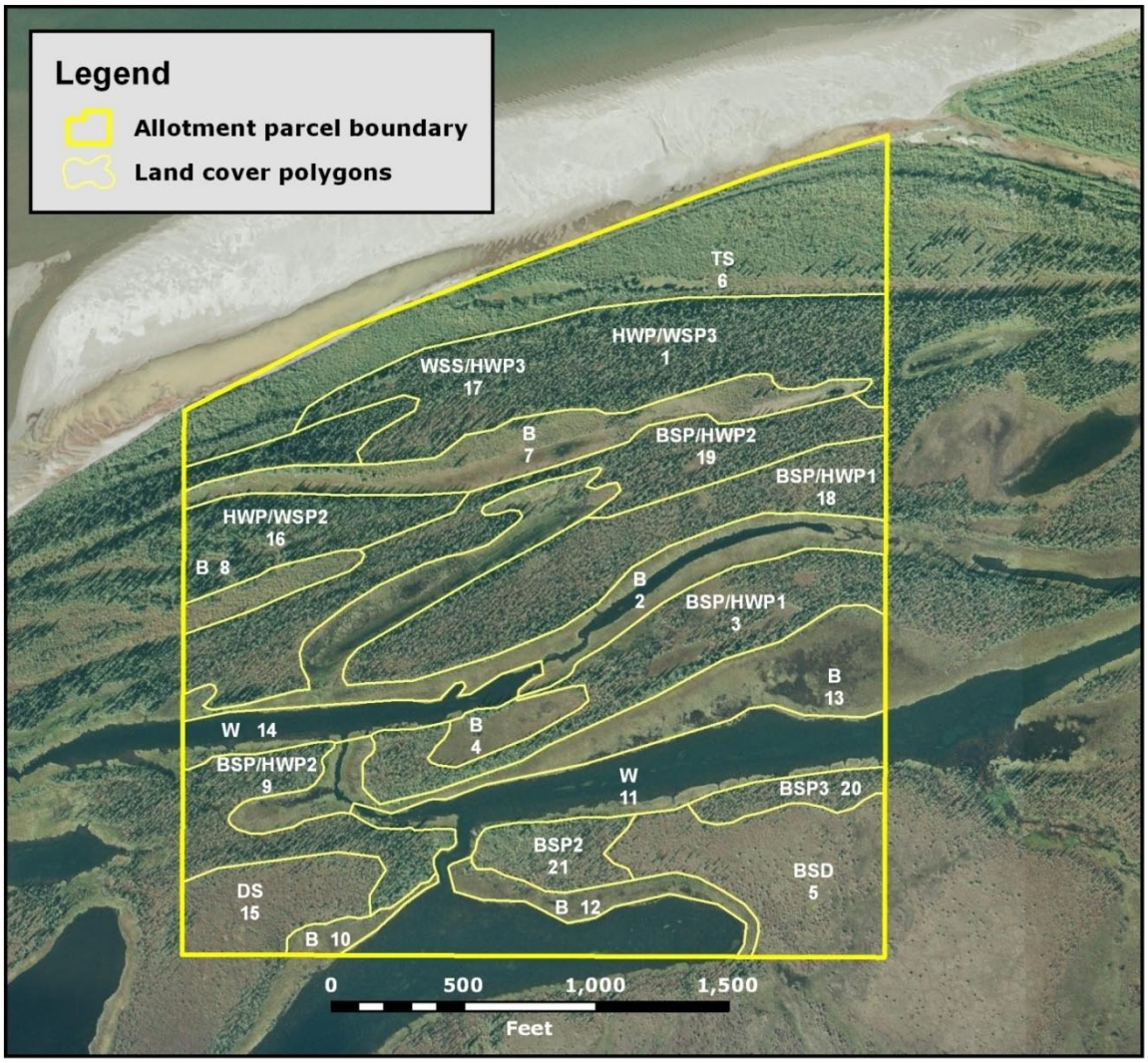
Forest stand density codes:

1	Low density, 10-24% crown closure
2	Medium density, 25-59% crown closure
3	High density, 60-100% crown closure

Mixtures of species/size class combinations may be coded, with one density code for the overall type. In such a case, the predominant species is given first, and the secondary species must comprise at least 30% of the stand.

Example: WSP/BIP3; a mix of white spruce poletimber and birch poletimber with the white spruce being predominant, and the overall stand density being 60-100% crown closure.

Figure 5. Land cover typing on allotment parcel AKFF 013027, Kobuk Subunit. Cover type polygons are labeled with cover type code and stand number.



Identifying Stands for Field Sampling

Only stands interpreted with timber type calls were considered for selection for field sampling. The total number of stands to be selected for sampling was based on the amount of time available during a scheduled field trip and an estimate of how many stands could be accessed in a typical work day. The field work was planned for 7 days of field work in the Kobuk Subunit and 5 days of field work in the Noatak Subunit, not counting travel days. The field work was attempted in one continuous trip by 4 foresters working in 2 crews of 2 foresters each with each crew attempting to access an average of 3 stands per day, resulting in 42 stands being selected for field sampling in the Kobuk Subunit and 30 stands being selected for field sampling in the Noatak Subunit.

For each subunit, the number of stands visited in the field for each timber type were proportionally allocated among the timber type calls based on the total acreage of each timber type. For example, there were 12,530 acres of timbered stands in the Kobuk Subunit, of which 799 acres, or 6.4%, was typed as high density white spruce sawtimber (WSS3). Of the 42 stands to be visited in the Kobuk Subunit, 6.4% means that 3 stands (2.7 rounded up) in the WSS3 cover type were selected for field sampling.

To determine which stands within a timber type were to be selected for sampling, all stands were assigned a random number between 0 and 1. Those stands within a timber type with the highest random number were selected for sampling. After looking at a map, if any of the selected stands were deemed to be impractical to access, they were dropped and the next highest available stand was selected. The stands that were ultimately selected were coded as selected in the attribute table for the cover type features in the GIS. In addition, within each timber type to be visited, 2 alternate stands were selected off the random number listing in case difficulties were encountered in the field trying to access selected stands within that type. Field work was to be accomplished by camping and traveling by boat along the navigable river systems by boat and walking up to a couple miles from the river to access allotment parcels.

Field Sampling

For each stand selected for field sampling, the stand was attempted to be accessed on the ground and a transect crossing a representative portion of the stand was determined from aerial photographs. Along each transect, 10 plots were established. Using a variable-radius sampling system, trees were selected for measurement based on their DBH and proximity to the plot center. A “BigBAF” system was used to determine which trees near the plot centers were selected for measurement. With this system, one basal area factor (BAF) is selected to determine which trees are to be measured, and another BAF is used to count trees by species and estimated 2-inch diameter class. In this way, an estimate of the basal area of a stand is based on a relatively larger number of trees, while the tree measurement data, used to calculate and estimate the timber volume represented by the basal area, was taken on a subset of sample trees. The actual basal area factors used varied between stands and was based on the relative density and size of trees; typically, a BAF of 40 was used for the measure trees, and a BAF of 10 or 20 was used for the trees counted for the basal area estimates.

A subset of trees were selected for collection of radial growth and age measurements by increment coring. Sample trees were cored at breast height (4.5 feet), and the growth rings in the removed cores counted for total age and growth measured in units of 1/20th inches radial growth in the most recent 10 years. An attempt was made to select relatively well-growing trees whose growth was representative of site quality, and collection of growth and age data was attempted on any tree species found in each sample stand.

In addition to the variable-radius plot data collected for trees with a measurable diameter breast height (DBH), a fixed radius plot was taken at each sample plot to estimate stocking levels of small trees important to forest growth and regeneration. On these fixed-radius “regeneration” plots, trees less than 1” DBH were counted by species and height class.

An attempt was made to take digital photographs in each sampled stand.

Field work was scheduled from August 1 to August 15, 2012. August 2 through August 8 was spent visiting stands along the Kobuk River while traveling downriver by inflatable boat from about 30 miles upstream of Kobuk to Kiana. Access and logisitical difficulties resulted in only 36 of the 42 selected stands being visited in the Kobuk Subunit. The crew traveled by chartered aircraft from Kiana to Noatak on August 9, and spent August 10 to August 14 traveling and visiting stands along the Noatak River. There were 30 stands selected for field sampling along the Noatak River and 30 stands were sampled, but access and logistical difficulties resulted in only 18 of the originally selected stands being sampled, with the remaining sampled stands being made up of alternate selected stands. The crew left Noatak on August 15 and returned to Fairbanks via Kotzebue and Anchorage.

Data Processing

Upon returning to the office, the field data were entered on a computer into a forest inventory data processing system. The system used was "AK_OpTICS" (Alaska Region Operations Timber Inventory Cruise System), a timber cruise data compilation software package developed by Dr. Tom Burke of the University of Minnesota for the BIA Alaska Region Office specifically for use on Native allotments in Alaska. AK_OpTICS uses species-specific taper equations to model tree bole dimensions from collected field data and bases timber volume estimates from those bole dimensions. AK_OpTICS itself is a stand-alone Visual Basic program that uses a MS Access database for data storage.

While the AK_OpTICS databases are suitable for storing and processing individual cruise data, the role of maintaining forest inventory data for an entire region is filled by another database developed several years ago by TCC Forestry and Dave Wilson of the Branch of Forest Resources and Planning, BIA. This database, called "AROSI" (Alaska Region Office Stand Inventory), is designed to hold cruise, stand, and strata data on a Statewide basis, and is also maintained in a MS Access format. In this case, a version of the database specific to the NANA region was used. Sampled tree data and cruise record information were transferred from the AK_OpTICS databases into corresponding tables in the AROSI database. AK_OpTICS cruise summary output data are not stored in the database, but were printed out and hand entered into tables in the AROSI database. Stand information was transferred from the geodatabase into corresponding tables in the AROSI database.

Using MS Access, a series of database queries were defined in the AROSI database. Through these queries, each polygon from the GIS with a timber type was associated with a timber stratum in the database, and each stratum was associated with stand/stock tables and statistics produced by the AK_OpTICS application. Reports were defined to summarize the timber volumes and cover type acreages using the defined relationships between cover type polygons and the calculated strata timber volume data, and were used to produce the tabular information in this report.

Results

Forest Volume Definitions

In this report, estimates of timber volume on forested lands have been calculated with cubic foot volume measurements. Cubic volume units such as the cubic foot refer to the total volume of the bole of a tree regardless of form defect such as sweep or crook, although net cubic volume takes into account other defects such as rot that reduce the usable volume of wood. Often it is considered as the volume below a minimum top bole diameter; in this project, cubic foot volumes are calculated below a minimum top bole diameter of 2 inches.

Another unit often used in forest inventory estimates and analyses is the board foot, which is defined as the amount of solid recoverable wood equivalent to a board measuring 12”x12”x1”. It does not include any material not normally recoverable in a sawmill producing solid board products, and as such does not include small material and material usually slabbed off in a sawmilling process. Estimation of board foot volume measurements have been used when compiling timber volumes in previous forest inventory projects, but the lack of a forest industry in the region, the potential importance of the resource as an energy resource, and the generic usefulness of cubic foot volume estimates led to the decision to focus on cubic foot estimates for this project.

Another unit used to measure wood is the cord, traditionally used to measure fuelwood. A cord is defined as the amount of minimally processed wood (bucked, split) that can be stacked in a space measuring 4’x4’x8’. Because of the airspace and inconsistency inherent in stacking cordwood, the cord is a relatively imprecise measure, but is nonetheless in common use in fuelwood transactions. The volume space of a cord, 128 cubic feet, is sometimes thought to contain roughly 100 cubic feet of wood (a “cunit”) when the air space between wood chinks in the stacked wood is considered. Other more conservative estimates put the conversion at 85 cubic-feet of wood per cord.

When using wood as an energy resource, it is common to report woody biomass in units of weight, commonly tons (1 ton=2,000 lbs), because the energy value of wood per unit volume varies by species because of varying wood densities. This matter is further complicated by the variability of wood weight per unit volume because of moisture levels in the wood. There are three units commonly used to report woody biomass by weight: Green tons, or the weight of the wood in tons at moisture levels found when the material is freshly cut, often in the neighborhood of 50% moisture by weight; air dry tons, or the weight of the wood when enough moisture has been removed from the wood to make it feasible to efficiently recover energy from the wood through combustion, commonly in the neighborhood of 20% moisture by weight; and bone-dry tons, the weight of the wood with all moisture removed. The literature is inconsistent in terms of wood density values for the species found in Interior and Northwestern Alaska, but representative values (and their sources) are presented in Table 2. These wood density values can be used to convert the cubic foot volume estimates found elsewhere in this report to units of weight if so desired.

Table 2: Wood density of tree species in Interior Alaska.
White spruce, Paper birch, Aspen and Balsam poplar figures are from the State of Alaska, Department of Commerce (http://www.commerce.state.ak.us/ded/dev/forest_products/forest_products5.htm); Black spruce figures are from a Canadian website maintained by Lakehead University in Ontario (http://www.borealforest.org/);

Tree Species	Green Density (lbs/cubic foot)	Air-dry density (lbs/cubic foot)	Air-dry tons/cord
White spruce	36	31	1.31
Black spruce	32	28	1.19
Paper birch	48	38	1.62
Aspen	43	27	1.15
Balsam poplar	38	24	1.02

In this report, the seedling/sapling component of the forest includes all trees greater than 1 inch and less than 4.5 inches DBH, the poletimber component includes trees 4.5 inches to 8.9 inches DBH, and the sawtimber component includes trees equal to or greater than 9.0 inches DBH. The cubic foot estimates include all timber greater than 4.5 inches DBH and is divided among poletimber, sawtimber and recently dead components of the forest. Volume for recently dead trees includes all size classes.

Timber cubic foot volume calculations are based on a net figure for all size classes, where the net volume equals gross volume minus observed defect. Defect renders portions of individual trees unusable or of very limited use as forest products due to insect damage, rot and physical damage such as broken stems. The net timber volumes shown however do not take into account all defect because hidden defect (usually internal rot) has not been estimated.

Timber Volume Summaries

Timber volume estimated for the entire inventory is 12,329,735 cubic feet, with 7,413,611 cubic feet (60%) in the Kobuk Subunit and 4,916,124 cubic feet (40%) in the Noatak Subunit (Tables 3, 4, 5). Tables 3, 4, and 5 summarize volume estimates and acreages by cover class for each subunit and overall. Tables 6, 7, and 8 summarize volume estimates by product class (size class) and species for each subunit and overall.

Table 3. Net Timber Volume by Cover Class, Kobuk Subunit.

Land Cover Type	Acres	%	Cubic Feet Per Acre	Cubic Feet Total	%
Forest					
Sawtimber					
White spruce	1,238	4.4%	1,532	1,896,746	25.6%
Cottonwood	7	0.0%	610	4,536	0.1%
White spruce - Hardwood	412	1.5%	1,115	459,467	6.2%
White spruce - Cottonwood	274	1.0%	1,156	316,855	4.3%
Sawtimber Totals:	1,932	6.9%	1,386	2,677,604	36.1%
Poletimber					
White spruce	3,376	12.1%	565	1,908,649	25.7%
Black spruce	1,522	5.5%	93	141,558	1.9%
Hardwood	491	1.8%	609	299,337	4.0%
Cottonwood	530	1.9%	487	257,739	3.5%
White spruce - Black spruce	738	2.6%	103	76,202	1.0%
White spruce - Hardwood	2,728	9.8%	588	1,603,679	21.6%
White spruce - Cottonwood	111	0.4%	878	97,414	1.3%
Black spruce - Hardwood	1,103	4.0%	319	351,429	4.7%
Poletimber Totals:	10,598	38.0%	447	4,736,008	63.9%
Dwarf/repro					
White spruce	192	0.7%	0	0	0.0%
Black spruce	2,819	10.1%	0	0	0.0%
Hardwood	176	0.6%	0	0	0.0%
Cottonwood	572	2.1%	0	0	0.0%
White spruce - Hardwood	24	0.1%	0	0	0.0%
Black spruce - Hardwood	6	0.0%	0	0	0.0%
Dwarf/repro Totals:	3,789	13.6%	0	0	0.0%
Forest Totals:	16,319	58.6%	454	7,413,611	100.0%
Shrubland					
Shrubland Totals:	6,464	23.2%	0	0	0.0%
Wetland					
Wetland Totals:	3,697	13.3%	0	0	0.0%
Rivers and Lakes					
Rivers and Lakes Totals:	1,117	4.0%	0	0	0.0%
Barren and Cultural					
Barren and Cultural Totals:	172	0.6%	0	0	0.0%
Unknown					
Unknown Totals:	88	0.3%	0	0	0.0%
Total:	**27,857**	**100.0%**	**266**	**7,413,611**	**100.0%**

Table 4. Net Timber Volume by Cover Class, Noatak Subunit.

Land Cover Type	Acres	%	Cubic Feet Per Acre	Cubic Feet Total	%
Forest					
Sawtimber					
White spruce	2,779	23.4%	1,010	2,808,020	57.1%
Cottonwood	53	0.4%	703	37,495	0.8%
White spruce - Cottonwood	252	2.1%	959	241,860	4.9%
Sawtimber Totals:	3,084	26.0%	1,001	3,087,375	62.8%
Poletimber					
White spruce	2,303	19.4%	415	956,806	19.5%
Hardwood	7	0.1%	832	5,882	0.1%
Cottonwood	1,017	8.6%	626	636,185	12.9%
White spruce - Hardwood	71	0.6%	892	63,750	1.3%
White spruce - Cottonwood	190	1.6%	874	166,125	3.4%
Poletimber Totals:	3,588	30.3%	510	1,828,749	37.2%
Dwarf/repro					
White spruce	17	0.1%	0	0	0.0%
Cottonwood	394	3.3%	0	0	0.0%
White spruce - Cottonwood	40	0.3%	0	0	0.0%
Dwarf/repro Totals:	451	3.8%	0	0	0.0%
Forest Totals:	7,124	60.1%	690	4,916,124	100.0%
Shrubland					
Shrubland Totals:	2,679	22.6%	0	0	0.0%
Wetland					
Wetland Totals:	1,230	10.4%	0	0	0.0%
Rivers and Lakes					
Rivers and Lakes Totals:	530	4.5%	0	0	0.0%
Barren and Cultural					
Barren and Cultural Totals:	185	1.6%	0	0	0.0%
Unknown					
Unknown Totals:	109	0.9%	0	0	0.0%
Total:	**11,858**	**100.0%**	**415**	**4,916,124**	**100.0%**

Table 5. Net Timber Volume by Cover Class, All Subunits.

Land Cover Type	Acres	%	Cubic Feet Per Acre	Cubic Feet Total	%
Forest					
Sawtimber					
White spruce	4,017	10.1%	1,171	4,704,765	38.2%
Cottonwood	61	0.2%	691	42,031	0.3%
White spruce - Hardwood	412	1.0%	1,115	459,467	3.7%
White spruce - Cottonwood	526	1.3%	1,061	558,716	4.5%
Sawtimber Totals:	5,016	12.6%	1,149	5,764,979	46.8%
Poletimber					
White spruce	5,679	14.3%	505	2,865,456	23.2%
Black spruce	1,522	3.8%	93	141,558	1.1%
Hardwood	498	1.3%	613	305,219	2.5%
Cottonwood	1,546	3.9%	578	893,924	7.3%
White spruce - Black spruce	738	1.9%	103	76,202	0.6%
White spruce - Hardwood	2,799	7.0%	596	1,667,430	13.5%
White spruce - Cottonwood	301	0.8%	876	263,539	2.1%
Black spruce - Hardwood	1,103	2.8%	319	351,429	2.9%
Poletimber Totals:	14,186	35.7%	463	6,564,757	53.2%
Dwarf/repro					
White spruce	209	0.5%	0	0	0.0%
Black spruce	2,819	7.1%	0	0	0.0%
Hardwood	176	0.4%	0	0	0.0%
Cottonwood	967	2.4%	0	0	0.0%
White spruce - Hardwood	24	0.1%	0	0	0.0%
White spruce - Cottonwood	40	0.1%	0	0	0.0%
Black spruce - Hardwood	6	0.0%	0	0	0.0%
Dwarf/repro Totals:	4,240	10.7%	0	0	0.0%
Forest Totals:	23,443	59.0%	526	12,329,735	100.0%
Shrubland					
Shrubland Totals:	9,143	23.0%	0	0	0.0%
Wetland					
Wetland Totals:	4,928	12.4%	0	0	0.0%
Rivers and Lakes					
Rivers and Lakes Totals:	1,647	4.1%	0	0	0.0%
Barren and Cultural					
Barren and Cultural Totals:	357	0.9%	0	0	0.0%
Unknown					
Unknown Totals:	198	0.5%	0	0	0.0%
Total:	**39,715**	**100.0%**	**310**	**12,329,735**	**100.0%**

Table 6. Net Timber Volume by Species/Size Class Without Regard to Timber Type, Kobuk Subunit.

Species/Size Class	Total Net Cubic Feet	%	% Defect
Sawtimber			
White Spruce	2,410,070	32.5%	13.0%
Black Spruce	8,354	0.1%	0.0%
Paper Birch	42,799	0.6%	25.2%
Quaking Aspen	6,273	0.1%	0.0%
Balsam Poplar	73,425	1.0%	14.0%
Sawtimber Totals:	2,540,920	34.3%	13.2%
Poletimber			
White Spruce	2,133,011	28.8%	12.1%
Black Spruce	633,534	8.5%	3.5%
Paper Birch	106,006	1.4%	28.2%
Quaking Aspen	210,132	2.8%	0.0%
Balsam Poplar	269,152	3.6%	2.2%
Misc. Hardwoods	6,999	0.1%	12.5%
Poletimber Totals:	3,358,834	45.3%	9.8%
Seed/sap			
White Spruce	513,231	6.9%	9.1%
Black Spruce	430,209	5.8%	4.0%
Paper Birch	46,860	0.6%	23.6%
Quaking Aspen	177,503	2.4%	0.0%
Balsam Poplar	37,972	0.5%	4.7%
Misc. Hardwoods	95,180	1.3%	11.1%
Seed/sap Totals:	1,300,956	17.5%	7.0%
Dead			
White Spruce	170,158	2.3%	53.3%
Black Spruce	18,476	0.2%	61.6%
Balsam Poplar	24,267	0.3%	10.6%
Dead Totals:	212,901	2.9%	51.6%
Total:	**7,413,611**	**100.0%**	**12.7%**

Table 7. Net Timber Volume by Species/Size Class Without Regard to Timber Type, Noatak Subunit.

Species/Size Class	Total Net Cubic Feet	%	% Defect
Sawtimber			
White Spruce	1,579,915	32.1%	18.6%
Balsam Poplar	91,047	1.9%	25.1%
Sawtimber Totals:	1,670,962	34.0%	19.0%
Poletimber			
White Spruce	1,881,161	38.3%	12.3%
Balsam Poplar	515,505	10.5%	20.5%
Misc. Hardwoods	628	0.0%	0.0%
Poletimber Totals:	2,397,295	48.8%	14.2%
Seed/sap			
White Spruce	423,890	8.6%	14.6%
Balsam Poplar	160,877	3.3%	17.3%
Misc. Hardwoods	10,477	0.2%	24.7%
Seed/sap Totals:	595,245	12.1%	15.6%
Dead			
White Spruce	209,600	4.3%	43.8%
Balsam Poplar	43,022	0.9%	43.0%
Dead Totals:	252,623	5.1%	43.7%
Total:	**4,916,124**	**100.0%**	**18.2%**

Table 8. Net Timber Volume by Species/Size Class Without Regard to Timber Type, All Subunits.

Species/Size Class	Total Net Cubic Feet	%	% Defect
Sawtimber			
White Spruce	3,989,985	32.4%	15.3%
Black Spruce	8,354	0.1%	0.0%
Paper Birch	42,799	0.3%	25.2%
Quaking Aspen	6,273	0.1%	0.0%
Balsam Poplar	164,471	1.3%	20.5%
Sawtimber Totals:	4,211,882	34.2%	15.6%
Poletimber			
White Spruce	4,014,172	32.6%	12.2%
Black Spruce	633,534	5.1%	3.5%
Paper Birch	106,006	0.9%	28.2%
Quaking Aspen	210,132	1.7%	0.0%
Balsam Poplar	784,657	6.4%	15.0%
Misc. Hardwoods	7,627	0.1%	11.6%
Poletimber Totals:	5,756,129	46.7%	11.7%
Seed/sap			
White Spruce	937,121	7.6%	11.7%
Black Spruce	430,209	3.5%	4.0%
Paper Birch	46,860	0.4%	23.6%
Quaking Aspen	177,503	1.4%	0.0%
Balsam Poplar	198,849	1.6%	15.2%
Misc. Hardwoods	105,658	0.9%	12.6%
Seed/sap Totals:	1,896,201	15.4%	9.8%
Dead			
White Spruce	379,758	3.1%	48.5%
Black Spruce	18,476	0.1%	61.6%
Balsam Poplar	67,289	0.5%	34.4%
Dead Totals:	465,524	3.8%	47.6%
Total:	**12,329,735**	**100.0%**	**15.0%**

Land Classification

Through database and GIS compilations all allotment parcel areas in the forest inventory data were classified into broad land classifications:

- **Accessible forest land:** Forested areas that are physically and economically accessible to harvest and are located within two miles from a navigable river or within five miles of a road.
- **Commercial timberland:** Accessible forest land capable of being stocked with commercial tree species suitable for lumber and available for intensive forest management and sustained timber production. It comprises stands classified as reproduction, poletimber or sawtimber stands with crown cover greater than 30%.
- **Commercial woodland:** Accessible forest land suitable for producing merchantable woody products, comprised of stands with a predominate timber type classification of black spruce poletimber with crown cover greater than 30%.
- **Forest:** At least 10% crown cover of any size, or formally having had such tree cover and currently not developed nor planned for exclusive non forest use.
- **Inaccessible:** An area where access currently is not practical due to economic criteria. Stands that are located greater than two miles from a navigable river or greater than five miles from a road.
- **Non forest:** Land that comprises less than 10% tree cover. Tall shrub, tundra and bogs as well as cultural features are examples of non forest areas.
- **Noncommercial timberland:** Accessible land that may be harvested, but with site quality or current stocking levels that do not warrant investments towards future forest products. This includes stands classified as poletimber or sawtimber with crown cover of 10-30%. It also comprises stands classified as dwarf other than black spruce.
- **Noncommercial woodland:** Accessible land consisting of poor sites. It comprises stands with a predominate timber type classification of black spruce poletimber with crown cover of 10-30%. It also comprises stands with a predominate timber type classification of black spruce dwarf.
- **Productive inaccessible forest land:** Commercial forest land that is unavailable for harvest because it is inaccessible.
- **Reserved:** Forest land that has been administratively withdrawn from harvest for environmental, political, wildlife, archeological or other reasons. Currently no land designation of this type exists in the region.
- **Timberland:** Forest land that is stocked or capable of being stocked with commercial tree species suitable for lumber. The predominate species are white spruce, paper birch, quaking aspen and cottonwood.
- **Unproductive inaccessible forest land:** Noncommercial forest land that is unavailable for harvest because it is inaccessible.
- **Woodland:** Forest land that is stocked or capable of being stocked with tree species of such form and size that the wood content is generally marketable within the region for products other than lumber. Typically these products would be fuelwood. The predominate tree species is black spruce

Acreage and timber volume summaries using this land classification hierarchy are displayed in Table 9. The Bureau of Indian Affairs has found it useful to report allotment acres in a hierarchical display showing the breakdown of land cover class, reserved class, accessibility, forest class, and productivity class; Table 10 presents the land classification breakdown in such a way.

Table 9. Summary of Land Classification acreages and associated timber volumes, both subunits.

Forest: *23,443 acres; 12,329,735 CF*
- Accessible: *23,123 acres; 12,202,129 CF*
  - Timberland: *18,172 acres; 12,001,288 CF*
    - Commercial: *2,878 acres; 1,027,923 CF*
    - Non-commercial: *15,294 acres; 10,973,365 CF*
  - Woodland: *4,951 acres; 200,841 CF*
    - Commercial: *3,120 acres; 28,378 CF*
    - Non-commercial: *1,831 acres; 172,463 CF*
- Inaccessible: *320 acres; 127,606 CF*
  - Timberland: *305 acres; 126,544 CF*
    - Non-productive: *57 acres; 12,031 CF*
    - Productive: *248 acres; 114,513 CF*
  - Woodland: *15 acres; 1,063 CF*
    - Non-productive: *4 acres; 0 CF*
    - Productive: *11 acres; 1,063 CF*

Shrubland: *9,143 acres*

Wetland: *4,928 acres*

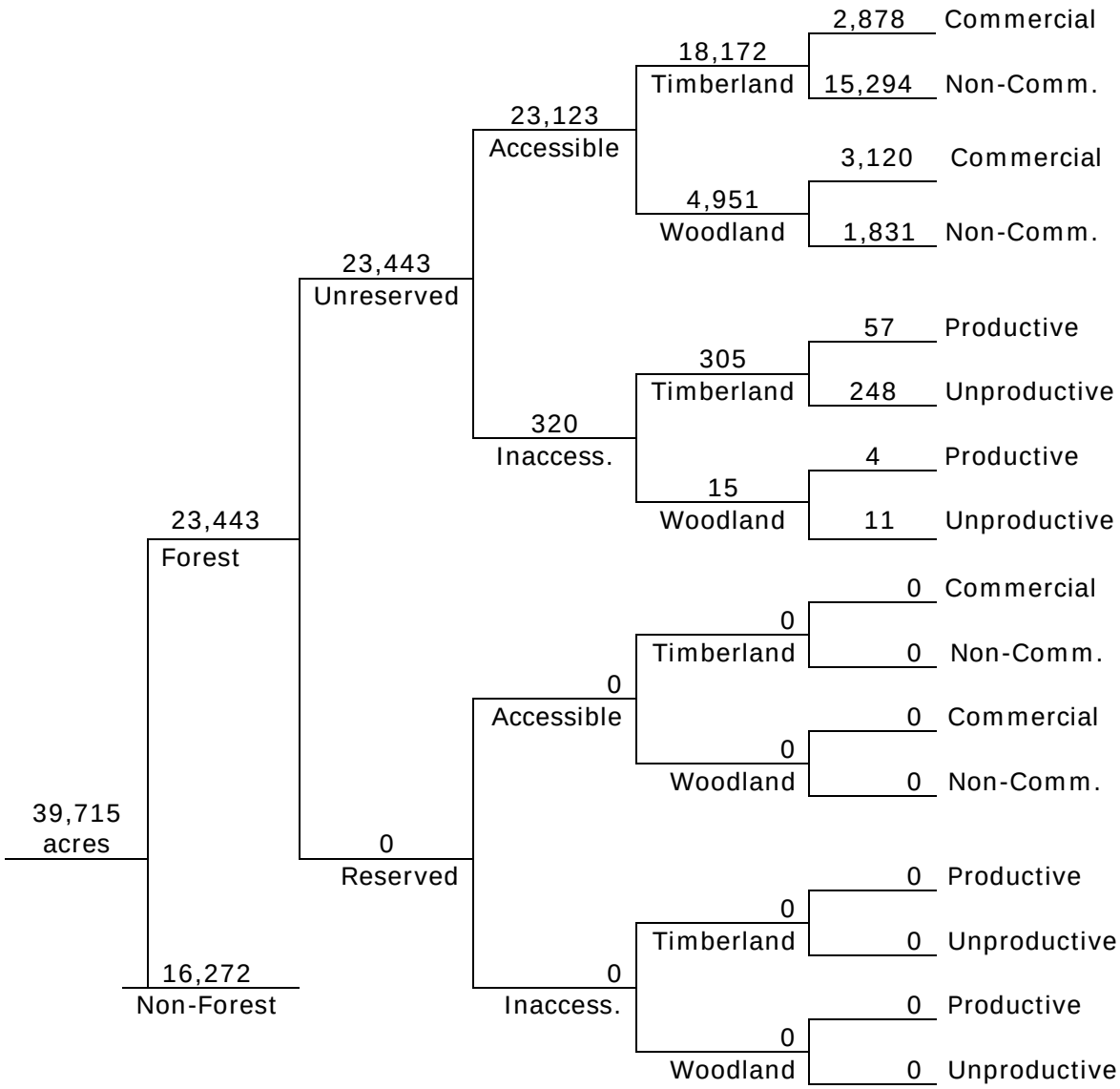
Rivers and Lakes: *1,647 acres*

Barren and Cultural: *357 acres*

Unknown: *198 acres*

Totals: *39,715 acres; 12,329,735 CF*

Table 10. Bureau of Indian Affairs land classification acreage chart.



Estimated Sampling Error

Sampling errors were calculated for the net cubic foot estimates for the NANA forest inventory and are reported by strata, by subunit, and overall (Table 11.). Sampling error is a measure of the precision of an estimate (in this case, cubic foot volume), and is calculated from the standard deviation of the sample. It is the standard error of the mean expressed as a percentage of the mean.

Sampling errors were calculated for each stratum by the software routines in the inventory application and stored in the strata records in the inventory database. An overall sampling error was calculated for each subunit by combining the sampling errors from the strata for the subunit with the following formula:

$$SE = \sqrt{\frac{\sum\left[(Ns^2)*(S\bar{x}^2)\right]}{\sum(Ns^2)}}$$

where:

SE = overall standard error of mean in cubic feet for a subunit

N_s = number of plots in a stratum

$S\bar{x}$ = standard error of the mean of a stratum

Overall mean for a subunit was calculated from the strata means weighted by the number of plots in each stratum:

$$X = \sum[(\bar{X}_s)*(PS)]$$

where:

$\bar{X}$ = weighted mean cubic feet/acre

X_s = mean cubic feet/acre (CF/Acre) in a stratum or size class

PS = percent sample based on number of plots for a stratum

Sampling error percent is calculated as the standard error expressed as a percentage of the mean multiplied by the number of standard deviations required for the desired precision:

$$E\% = \frac{t*(SE)*(100)}{\bar{X}}$$

where:

t = number of standard deviations (used 1)

E% = sampling error in percent

Similarly, a sample error was calculated for the entire project by combining strata from all subunits together. These statistics are summarized in Table 11.

When determining a sampling error at one standard deviation, there is a 66% chance (one standard deviation) that the actual volume is within plus or minus the sampling error percentage of the inventory mean. For example, the statistics shown in Table 11 show a sampling error of 2.45% for the cubic foot volume for the entire inventory. This means that for a total volume of 7,731,036 cubic feet there is a 66% chance that the volume is within 189,410 cubic feet (2.45%) of the total volume estimate, based on the variation observed in the sample stands.

Table 11. NANA Inventory Statistics.

Kobuk Subunit

Strata	# of plots	CF/Acre	CF Std. Err.
BSP/WSP2	30	103	16.5
BSP2	20	98	34.3
CWP1	10	142	49.7
CWP2	30	625	125.0
HWP/WSP3	60	613	49.0
WSP/BSP1	40	164	27.9
WSP2	40	372	52.1
WSP3	60	933	102.6
WSS/HP3	30	1,192	119.2
WSS2	10	1,160	232.0
WSS3	30	1,651	148.6
Total Plots:	360		

Mean Cubic Feet/Acre (weighted by plots): 641
Standard Error of the Mean: 85.8
Sampling Error %: 13.4%

Noatak Subunit

Strata	# of plots	CF/Acre	CF Std. Err.
CWP1	10	800	208.0
CWP2	40	453	72.5
CWP3	10	821	180.6
WSP1	30	117	29.3
WSP2	50	291	34.9
WSP3	20	853	93.8
WSS/CWP3	20	966	164.2
WSS1	10	468	117.0
WSS2	20	783	140.9
WSS3	90	1,149	68.9
Total Plots:	300		

Mean Cubic Feet/Acre (weighted by plots): 708
Standard Error of the Mean: 74.9
Sampling Error %: 10.6%

All Subunits:

Total Plots: 660
Mean Cubic Feet/Acre: 671
Standard Error of the Mean: 19
Sampling Error %: 2.9%

Land Cover Typing Accuracy Assessment

Land cover type accuracy was assessed by comparing the land cover type interpreted from the aerial photographs to field observations in those stands where sampling occurred. Table 2 compares the ground calls to land cover type calls made on the aerial photographs. Levels of accuracy depicted for the land cover type calls are independent of timber volume accuracy shown elsewhere in this report. However, they do provide the user with an idea as the variability of land cover classification and error that may have occurred from misclassification. Since only timbered stands were sampled, only timber types are included in this accuracy assessment.

The contingency table shown in Table 12 shows how many stands within each timber type sampled actually were found to be that timber type. Producer's accuracy is the probability that a type on the ground will be adequately represented by the types as interpreted on the photos, and is calculated by dividing the number of stands where the ground call was the same as the photo call for a timber type by the total number of sampled stands for that ground call. User's accuracy or photo accuracy is the probability that a timber type shown on the photo actually represents that timber type on the ground, and is calculated by dividing the number of stands where the ground call was the same as the photo call by the total number of sampled stands with that photo call. The overall photo accuracy is the average of the user's accuracies for the timber types weighted by the acreages for each timber type, and is calculated to be 39%.

One consideration when analyzing timber type accuracy is that a timber type call is composed of several elements; species, size class and density, and in the case of mixed type calls, 2 species each with an associated size class. Additional contingency tables were prepared to examine the individual components separately; Table 13 for the species component, Table 14 for the size class component, and Table 15 for the density component. Calculated overall user accuracies for the individual components reveal accuracies of 57% for species, 67% for size class, and 63% for crown density. The accuracy for any individual component is a function of the number of possible classes for the component and the ability to determine the component with photo interpretation. Species, size class, and density combined together produce a relatively more difficult attribute to accurately interpret, hence the lower overall combined accuracy. In particular, mixed-species stands are particularly difficult to interpret accurately with regard to all the components of the type calls, and 25% of the timbered acreage was interpreted as mixed-species stands.

Table 12. Contingency table comparing cover type calls to ground observations.

Photo Calls	Ground Calls																													
	BSP/WSP2	BSP2	BSP3	CWP1	CWP1/TS	CWP2	CWP3	HWP/WSP2	HWP/WSP3	HWP1	HWP3	WSP/BSP2	WSP/BSP3	WSP/HWP2	WSP/HWP3	WSP1/DS	WSP1/TS	WSP1	WSP2	WSP3	WSS/CWP3	WSS/CWS3	WSS/HWP3	WSS1	WSS2	WSS3	Other	Total	User Accuracies	Acreage
BSP/WSP2	**1**																											1	100%	225
BSP2																											1	1	0%	645
BSP3																											1	1	0%	640
CWP1				**1**																								1	100%	243
CWP1/TS																											1	1	0%	103
CWP2				1		**3**																					1	5	60%	839
CWP3							**1**																				1	2	50%	355
HWP/WSP2	1																											1	0%	326
HWP/WSP3								1																			2	3	0%	800
HWP1																											1	1	0%	203
HWP3						1																						1	0%	141
WSP/BSP2												**1**																1	100%	297
WSP/BSP3																											1	1	0%	413
WSP/HWP2																	1											1	0%	576
WSP/HWP3																										1		1	0%	800
WSP1/DS																		1									1	2	0%	600
WSP1/TS																	**1**							1			1	3	33%	491
WSP1																											2	2	0%	321
WSP2																		1	**7**								1	9	78%	2,056
WSP3	1	1											1						3	**1**						1		8	13%	2,208
WSS/CWP3																					**1**					1		2	50%	175
WSS/CWS3																							1					1	0%	124
WSS/HWP3																									1			1	0%	371
WSS1																								**1**				1	100%	191
WSS2																									**3**			3	100%	1,201
WSS3																			1						3	**8**		12	67%	2,476
Total	3	1	0	2	0	4	1	1	0	0	0	1	1	0	0	0	2	2	11	1	1	0	1	2	7	11	14	**66**	**39%**	
Producer's Accuracies	33%	0%	0%	50%	0%	75%	50%	0%	0%	0%	0%	100%	100%	0%	0%	0%	50%	0%	64%	100%	100%	0%	0%	50%	43%	73%				

Table 13. Contingency table comparing species component of cover type calls to ground observations.

Photo Calls	Ground Calls													
	BS	BS/HW	BS/WS	CW	HW/BS	HW/WS	WS	WS/BS	WS/CW	WS/HW	Other	Total	User Accuracies	Acreage
BS	**1**										1	2	50%	4,319
BS/WS			**1**									1	100%	330
CW				**7**							2	9	78%	2,573
HW				1							1	2	0%	664
HW/WS		1	1		1	**1**						4	25%	1,243
WS	1		1				**30**	5			3	40	75%	9,794
WS/BS	1							**1**				2	50%	738
WS/CW							1		**1**	1		3	33%	700
WS/HW							3					3	0%	1,974
Total	3	1	3	8	1	1	34	6	1	1	7	**66**	**57%**	
Producer's Accuracies	33%	0%	33%	88%	0%	100%	88%	17%	100%	0%				

Table 14. Contingency table comparing size class component of cover type calls to ground observations.

Photo Calls	Ground Calls								
	P	P/P	S	S/P	S/S	Other	Total	User's Accuracies	Acreage
P	**22**	6	2			7	37	59%	9,245
P/P	2	**6**	1				9	67%	4,701
S	1		**15**				16	94%	4,078
S/P			2	**1**			3	33%	747
S/S				1			1	0%	127
Total	25	12	20	2	0	7	66	67%	
Producer's Accuracies	88%	50%	75%	50%	0%				

Table 15. Contingency table comparing crown density component of cover type calls to ground observations.

Photo Calls	Ground Calls						
	1	2	3	Other	Total	User's Accuracies	Acreage
1	**8**			3	11	73%	3,323
2	4	**15**		3	22	68%	6,873
3	1	13	**18**	1	33	55%	9,145
Total	13	28	18	7	66	63%	
Producer's Accuracies	62%	54%	100%				

Figure 6. An example of the "spruce needle blight" found on spruce on allotment parcel AKFF 013613 in the Noatak Subunit.

Tree Damages and Problems

Damages and problems, such as insect attacks, stem rots, and form defects were observed and coded for individual trees, plots and stands. The results for damages and problems found in individual trees encountered in the sample are summarized by subunit in Tables 16 and 17. These data were collected only for those trees sampled on measure plots in sample stands.

Tree problem and damage highlights:

- In the Kobuk Subunit, evidence of spruce bark beetle activity was found on 7% of the measured white spruce trees.
- In the Kobuk Subunit, a substantial portion of white and black spruce trees (11%) had broken tops, possibly from a singular storm event several years ago that appeared focused in the lower portion of the subunit between Ambler and Kiana.
- In the Noatak Subunit, 30% of the cottonwood trees measured had dead tops.
- In both subunits, an unusual discoloration of foliage on new growth of white and black spruce was commonly observed (Figure 6). It appeared similar to symptoms common to fungal rust infections and was coded in the damage data as such, but after some discussion following the field trip it was decided that a likely culprit was drought stress, brought on by unusually dry, warm weather during the first part of the growing season in 2012.

Table 16. Tree Damage and Problem Summary. Kobuk Subunit.

Problem / Damage	White spruce		Black spruce		Birch		Aspen		Cotton wood		Willow		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
No damage	176	38%	72	16%	13	3%	9	2%	12	3%	5	1%	287	62%
Spruce bark beetle	20	4%		0%		0%		0%		0%		0%	20	4%
Engraver bark beetles	4	1%		0%		0%		0%		0%		0%	4	1%
Spruce needle rust/blight	24	5%	17	4%		0%		0%		0%		0%	41	9%
Spruce broom rust	7	2%	1	0%		0%		0%		0%		0%	8	2%
Birch conk		0%		0%	3	1%		0%		0%		0%	3	1%
Frost	3	1%		0%		0%		0%		0%		0%	3	1%
Lean > 15%	4	1%	2	0%		0%		0%		0%		0%	6	1%
Forked top	7	2%	5	1%		0%		0%		0%		0%	12	3%
Broken top	14	3%	20	4%		0%	1	0%	1	0%	1	0%	37	8%
Dead top	4	1%		0%	1	0%		0%	5	1%	1	0%	11	2%
Crook	8	2%	1	0%		0%	2	0%		0%		0%	11	2%
Sweep	3	1%		0%		0%		0%		0%		0%	3	1%
Scar	8	2%	1	0%		0%	3	1%	1	0%	3	1%	16	3%
Human caused	1	0%		0%		0%		0%		0%		0%	1	0%
Unknown		0%	1	0%		0%		0%		0%		0%	1	0%
Totals:	283	61%	120	26%	17	4%	15	3%	19	4%	10	2%	464	100%

Table 17. Tree Damage and Problem Summary. Noatak Subunit.

	White spruce		Cottonwood		Willow		Total	
Problem / damage	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
No damage/problem	210	43%	51	10%	5	1%	266	54%
Forest defoliator General		0%	6	1%		0%	6	1%
Engraver bark beetles	26	5%		0%		0%	26	5%
Foliar disease general	1	0%		0%		0%	1	0%
Spruce needle rust	86	17%		0%		0%	86	17%
Stem and branch disease general		0%	1	0%		0%	1	0%
Porcupine girdling	5	1%		0%		0%	5	1%
Wildlife browse		0%		0%	1	0%	1	0%
Wind	3	1%		0%		0%	3	1%
Frost	2	0%		0%		0%	2	0%
Lean > 15%	15	3%	3	1%	1	0%	19	4%
Forked top	12	2%	3	1%		0%	15	3%
Broken top	3	1%	3	1%		0%	6	1%
Dead top	9	2%	31	6%		0%	40	8%
Wolf tree	1	0%		0%		0%	1	0%
Crook	2	0%	1	0%		0%	3	1%
Sweep	4	1%	3	1%		0%	7	1%
Scar	4	1%		0%		0%	4	1%
Totals:	383	78%	102	21%	7	1%	492	100%

Regeneration Plot Data Results

The stocking data of small trees less than 1” DBH collected on 1/300th acre fixed radius plots are summarized in Tables 18 and 19. The fixed plot data were compiled and processed for each sampled stand, and the presented results by strata are the results of straight averaging of the data from sampled stands within each stratum.

Table 18. Regeneration data by Strata, Kobuk Subunit.

	Species	Trees/acre	Avg.
Stratum: BSP2			
	Black Spruce	1,140	6
	Paper Birch	30	9
	White Spruce	480	8
	Stratum BSP2 Totals:	**1,650**	**23**
Stratum: BSP/WSP2			
	Black Spruce	910	5
	White Spruce	1,245	5
	Stratum BSP/WSP2 Totals:	**2,155**	**10**
Stratum: CWP1			
	Misc. Hardwoods	210	13
	White Spruce	90	2
	Stratum CWP1 Totals:	**300**	**15**
Stratum: CWP2			
	Balsam Poplar	660	10
	Black Spruce	150	4
	Misc. Hardwoods	240	12
	White Spruce	675	6
	Stratum CWP2 Totals:	**1,725**	**32**
Stratum: HWP/WSP3			
	Black Spruce	1,130	4
	Misc. Hardwoods	150	12
	Paper Birch	165	9
	Quaking Aspen	300	6
	White Spruce	795	5
	Stratum HWP/WSP3 Totals:	**2,540**	**36**
Stratum: WSP2			
	Balsam Poplar	120	4
	Black Spruce	660	7
	Misc. Hardwoods	420	9
	Paper Birch	30	10
	Quaking Aspen	1,140	2
	White Spruce	795	6
	Stratum WSP2 Totals:	**3,165**	**38**
Stratum: WSP3			
	Black Spruce	2,040	5
	White Spruce	675	6
	Stratum WSP3 Totals:	**2,715**	**11**
Stratum: WSP/BSP1			
	Black Spruce	270	6
	Paper Birch	90	7
	Quaking Aspen	270	5
	White Spruce	330	4
	Stratum WSP/BSP1 Totals:	**960**	**20**
Stratum: WSS2			
	White Spruce	90	316
	Stratum WSS2 Totals:	**90**	**316**
Stratum: WSS3			
	Paper Birch	30	3
	White Spruce	1,220	4
	Stratum WSS3 Totals:	**1,250**	**7**
Stratum: WSS/HWP3			
	Misc. Hardwoods	30	5
	Paper Birch	120	15
	White Spruce	495	12
	Stratum WSS/HWP3 Totals:	**645**	**31**

Table 18. Regeneration data by Strata, Noatak Subunit

	Species	Trees/acre	Avg.
Stratum: CWP1			
	Balsam Poplar	450	6
	White Spruce	1,170	2
	Stratum CWP1 Totals:	**1,620**	**8**
Stratum: CWP2			
	Balsam Poplar	1,980	5
	Misc. Hardwoods	240	11
	White Spruce	1,538	3
	Stratum CWP2 Totals:	**3,758**	**20**
Stratum: CWP3			
	Balsam Poplar	1,260	5
	White Spruce	870	3
	Stratum CWP3 Totals:	**2,130**	**8**
Stratum: WSP1			
	Balsam Poplar	225	3
	White Spruce	2,930	4
	Stratum WSP1 Totals:	**3,155**	**7**
Stratum: WSP2			
	White Spruce	1,620	3
	Stratum WSP2 Totals:	**1,620**	**3**
Stratum: WSP3			
	Balsam Poplar	705	4
	White Spruce	1,905	4
	Stratum WSP3 Totals:	**2,610**	**8**
Stratum: WSS1			
	Balsam Poplar	330	6
	White Spruce	2,700	1
	Stratum WSS1 Totals:	**3,030**	**7**
Stratum: WSS2			
	Balsam Poplar	60	2
	Tamarack	30	6
	White Spruce	2,220	2
	Stratum WSS2 Totals:	**2,310**	**10**
Stratum: WSS3			
	Balsam Poplar	96	4
	White Spruce	1,383	3
	Stratum WSS3 Totals:	**1,479**	**7**
Stratum: WSS/CWP3			
	Balsam Poplar	435	5
	White Spruce	3,225	2
	Stratum WSS/CWP3 Totals:	**3,660**	**7**

Table 19. Number of trees measured for age and radial growth by species and subunit.

Subunit	White Spruce	Black Spruce	Paper birch	Quaking aspen	Balsam poplar	Total
Kobuk	58	32	10	3	5	108
Noatak	53				13	66
Total	111	32	10	3	18	174

Figure 7. A sample tree being cored for age and growth measurements, allotment parcel AFFF 018763A, Kobuk subunit.

Tree Ages and Growth

As mentioned above, trees were selected in the sample stands for collection of age and growth data using an increment core tool (Figure 7). Attempts were made to collect this data for any tree species encountered on the sample plots, and to select individual trees that demonstrated growth and form characteristics that were representative of the site (that appeared to have been relatively free to grow throughout their life, were not suppressed, did not have substantial damage or defects, etc.). Beyond that criteria, the selection of the trees was entirely subjective, and included collection of data from trees that were in the sample stands but not part of the variable-radius plot sample. A total of 176 trees were sampled. Growth was measured in terms of radial growth in the last 10 years; both age and growth were measured at breast height (4.5').

Table 19 summarizes the number of trees that were measured for age and growth by species and subunit, and Table 20 shows the average age, growth, and total height of the sampled trees by subunit, strata, and species. The age is shown with height because of the common practice to evaluate site potential by analyzing the age/height relationship of trees. Further summaries of the age and height data by species and subunit are displayed graphically in Figure 8.

Table 20. Mean age, height, and 10-year radial growth by tree species and strata.

Mgt. Unit - Strata	White spruce			Black spruce			Paper Birch			Quaking Aspen			Balsam poplar		
	Mean Age	Mean Height	Mean Rad. Growth	Mean Age	Mean Height	Mean Rad. Growth	Mean Age	Mean Height	Mean Rad. Growth	Mean Age	Mean Height	Mean Rad. Growth	Mean Age	Mean Height	Mean Rad. Growth
Kobuk – BSP/WSP2	73	33	0.2	61	25	0.2									
Kobuk – BSP2	110	32	0.2	60	24	0.4									
Kobuk – CWP1													83	54	0.3
Kobuk – CWP2	49	35	0.6	61	28	0.2							52	46	0.5
Kobuk – HWP/WSP3	92	44	0.3	68	34	0.3	55	28	0.3	54	37	0.3			
Kobuk – WSP/BSP1	81	39	0.4	57	29	0.3	80	33	0.2						
Kobuk – WSP2	85	37	0.3	81	33	0.3									
Kobuk – WSP3	103	49	0.2	91	34	0.2									
Kobuk – WSS/HWP3	97	65	0.5				68	45	0.4						
Kobuk – WSS2	144	53	0.4												
Kobuk – WSS3	116	60	0.4												
Noatak – CWP1													74	42	0.3
Noatak – CWP2	63	38	0.7										69	37	0.4
Noatak – CWP3													48	24	0.3
Noatak – WSP1	86	30	0.3												
Noatak – WSP2	109	25	0.2												
Noatak – WSP3	86	46	0.4										50	33	0.3
Noatak – WSS/CWP3	150	59	0.4										66	31	0.4
Noatak – WSS1	133	50	0.5												
Noatak – WSS2	179	51	0.4												
Noatak – WSS3	137	50	0.3												

Figure 8. Scatterplots of height as a function of age for sampled trees by species and subunit.

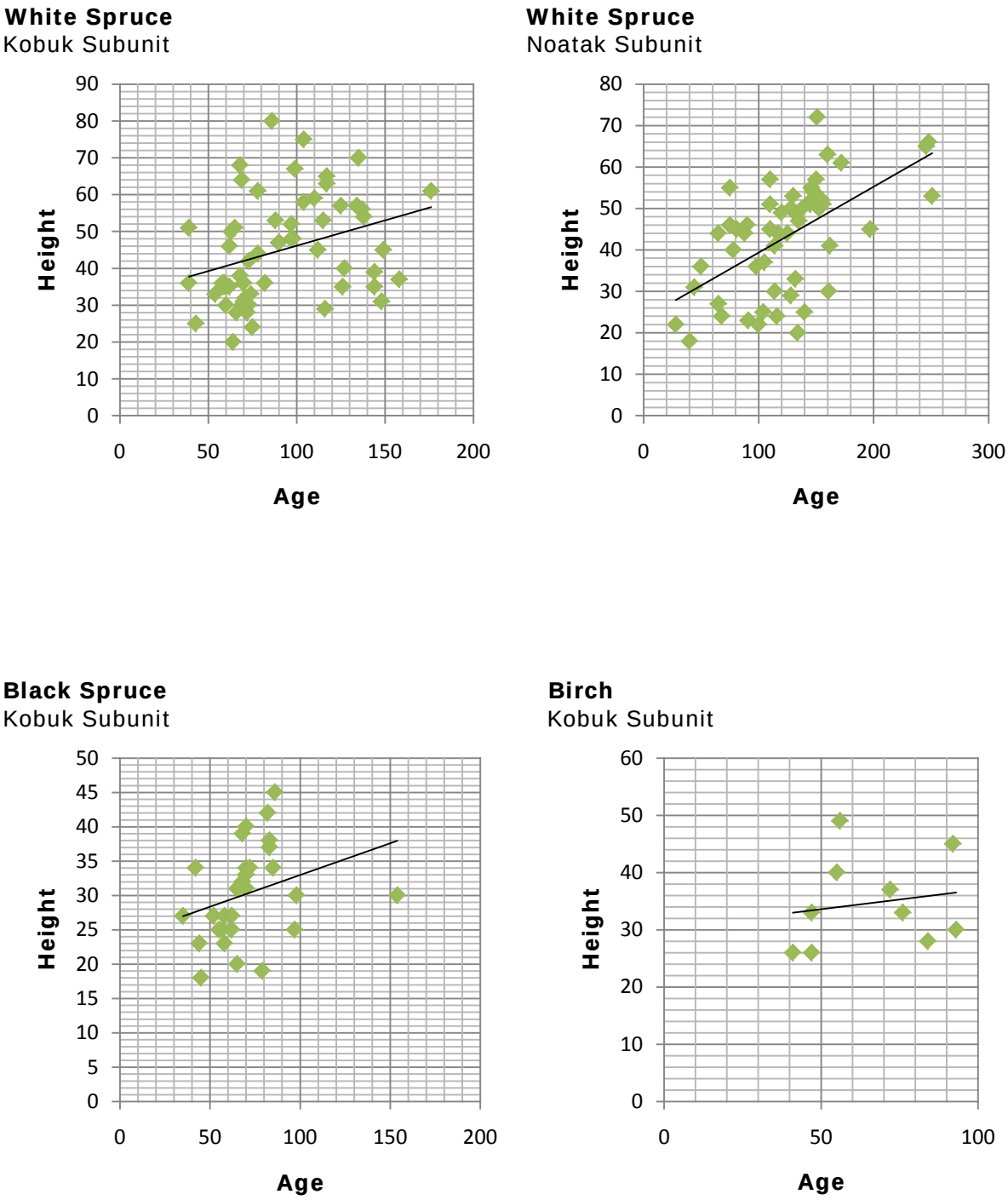


Figure 8. Scatterplots of height as a function of age for sampled trees by species and subunit (continued).

Table A-1. Cover types and strata, Kobuk Subunit.

Cover Class: Forest

Stratum: BSP/WSP2	Land Cover Type	polygons	Acres	Sampled Stands
	BSP/WSP1	1	2	0
	BSP/WSP2	6	225	1
	BSP/WSP3	8	104	0
	WSP/BSP2	37	297	1
	WSP/BSP3	43	413	1
	Stratum Totals:	95	1,041	3

Stratum: BSP2	Land Cover Type	polygons	Acres	Sampled Stands
	BSP/HWP1	6	67	0
	BSP/HWP2	12	116	0
	BSP/HWP3	13	111	0
	BSP1	38	237	0
	BSP2	60	645	1
	BSP3	59	640	1
	Stratum Totals:	188	1,816	2

Stratum: CWP1	Land Cover Type	polygons	Acres	Sampled Stands
	CWP/WSS1	1	4	0
	CWP1	16	67	0
	CWP1/TS	7	73	1
	Stratum Totals:	24	144	1

Stratum: CWP2	Land Cover Type	polygons	Acres	Sampled Stands
	CWP/WSP2	5	45	0
	CWP/WSP3	2	5	0
	CWP2	28	247	1
	CWP2/TS	1	2	0
	CWP3	28	140	1
	CWS2	1	7	0
	HWP/WSP1	12	72	0
	HWP1	59	203	1
	HWP3	29	134	1
	Stratum Totals:	165	856	4

Stratum: HWP/WSP3	Land Cover Type	polygons	Acres	Sampled Stands
	HWP/BSP1	5	44	0
	HWP/BSP2	12	113	0
	HWP/BSP3	21	249	0
	HWP/WSP2	31	316	1
	HWP/WSP3	63	783	3
	HWP/WSS2	1	24	0
	HWP/WSS3	1	7	0
	HWP1/BSD	4	72	0
	HWP1/DS	2	15	0
	HWP1/HWR	1	10	0
	HWP1/TS	5	12	0
	HWP1/WSR	1	11	0
	HWP2	36	116	0
	WSP/HWP2	53	555	1
	WSP/HWP3	69	776	1
	WSS/HWP2	8	31	0
	Stratum Totals:	313	3,136	6

Table A-1. Cover types and strata, Kobuk Subunit (continued).

Stratum:	Land Cover Type	polygons	Acres	Sampled Stands
Stratum: WSP/BSP1	WSP/BSP1	4	27	0
	WSP1	79	436	2
	WSP1/DS	35	315	1
	WSP1/HWR	5	44	0
	WSP1/TS	23	112	1
	Stratum Totals:	146	935	4
Stratum: WSP2	Land Cover Type	polygons	Acres	Sampled Stands
	WSP/HWP1	24	139	0
	WSP2	147	1,019	4
	WSP2/TS	1	3	0
	Stratum Totals:	172	1,161	4
Stratum: WSP3	Land Cover Type	polygons	Acres	Sampled Stands
	WSP3	127	1,490	6
	Stratum Totals:	127	1,490	6
Stratum: WSS/HWP3	Land Cover Type	polygons	Acres	Sampled Stands
	WSP/CWP2	4	24	0
	WSP/CWP3	3	33	0
	WSS/CWP1	3	18	0
	WSS/CWP2	3	62	0
	WSS/CWP3	3	28	0
	WSS/CWS3	4	109	1
	WSS/HWP1	1	10	0
	WSS/HWP3	31	371	1
	Stratum Totals:	52	656	2
Stratum: WSS2	Land Cover Type	polygons	Acres	Sampled Stands
	WSS1	12	63	0
	WSS1/CWR	3	57	0
	WSS1/TS	9	68	0
	WSS2	53	309	1
	Stratum Totals:	77	496	1
Stratum: WSS3	Land Cover Type	polygons	Acres	Sampled Stands
	WSS3	77	799	3
	Stratum Totals:	77	799	3
Dwarf/repro types	Land Cover Type	polygons	Acres	Sampled Stands
Not assigned to strata:	Br/BSD	1	4	0
	Br/BSP1	1	19	0
	Br/WSP1	1	1	0
	BrHWP3	1	11	0
	BrHWR/WSR	1	19	0
	BrWSP1	2	76	0
	BrWSP1/WSr	1	33	0
	BSD	187	2,796	0
	BSR	1	1	0
	CWR	74	572	0
	HWR	26	166	0
	HWR/BSR	1	6	0
	HWR/WSR	1	3	0
	WSR	25	81	0
	WSR/HWR	1	2	0
	Stratum Totals:	324	3,789	0
	Forest Cover Class Totals:	1760	16,319	36

Table A-1. Cover types and strata, Kobuk Subunit (continued).

Cover Class:Shrubland	Land Cover Type	polygons	Acres	Sampled Stands
	BrDS	2	20	0
	DS	242	3,741	0
	TS	320	2,703	0
Shrubland Cover Class Totals:		564	6,464	0

Cover Class: Wetland	Land Cover Type	polygons	Acres	Sampled Stands
	B	460	2,426	0
	DSw	57	1,135	0
	TSw	31	137	0
Wetland Cover Class Totals:		548	3,697	0

Cover Class: Rivers and Lakes	Land Cover Type	polygons	Acres	Sampled Stands
	R	191	507	0
	W	235	610	0
Rivers and Lakes Cover Class Totals:		426	1,117	0

Cover Class: Barren and Cultural	Land Cover Type	polygons	Acres	Sampled Stands
	Ba	33	99	0
	Cu	27	73	0
Barren and Cultural Cover Class Totals:		60	172	0

Cover Class: Unknown	Land Cover Type	polygons	Acres	Sampled Stands
	Untyped	1	88	0
Unknown Cover Class Totals:		1	88	0

Kobuk Subunit Totals:	3359	27,857	36

Table A-2. Cover types and strata, Noatak Subunit.

Cover Class: Forest

	Land Cover Type	polygons	Acres	Sampled Stands
Stratum: CWP1	CWP/WSP1	1	8	0
	CWP1	27	176	1
	CWP1/TS	7	30	0
	CWS1	1	4	0
	Stratum Totals:	36	218	1
Stratum: CWP2	CWP/WSP2	1	4	0
	CWP2	69	592	4
	CWP2/CWR	1	3	0
	CWS2	4	19	0
	HWP/WSP2	1	9	0
	Stratum Totals:	76	628	4
Stratum: CWP3	CWP3	50	215	1
	CWS3	3	30	0
	HWP/WSP3	1	17	0
	HWP3	1	7	0
	Stratum Totals:	55	269	1
Stratum: WSP1	WSP1	22	163	0
	WSP1/CWR	2	23	0
	WSP1/DS	23	176	1
	WSP1/TS	37	208	2
	Stratum Totals:	84	571	3
Stratum: WSP2	WSP2	75	1,037	5
	Stratum Totals:	75	1,037	5
Stratum: WSP3	WSP3	53	718	2
	Stratum Totals:	53	718	2
Stratum: WSS/CWP3	CWP/WSP3	4	24	0
	CWP/WSS2	8	26	0
	CWP/WSS3	3	29	0
	WSP/CWP2	3	37	0
	WSP/CWP3	5	38	0
	WSP/HWP2	4	21	0
	WSP/HWP3	2	24	0
	WSS/CWP2	13	70	0
	WSS/CWP3	17	147	2
	WSS/CWS2	1	1	0
	WSS/CWS3	2	15	0
	Stratum Totals:	62	433	2

Table A-2. Cover types and strata, Noatak Subunit (continued).

	Land Cover Type	polygons	Acres	Sampled Stands
Stratum: WSS1	WSS/CWP1	1	9	0
	WSS1	20	128	1
	WSS1/CWR	2	8	0
	WSS1/TS	13	82	0
	Stratum Totals:	36	227	1
Stratum: WSS2	WSS2	86	892	2
	Stratum Totals:	86	892	2
Stratum: WSS3	WSS3	103	1,677	9
	Stratum Totals:	103	1,677	9
Dwarf/repro types Not assigned to strata	CWR	48	394	0
	CWR/WSR	2	19	0
	CWS/WSS2	1	2	0
	WSR	8	17	0
	WSR/CWR	2	20	0
	Dwarf/repro Totals:	61	453	0
	Forest Cover Class Totals:	727	7,124	30
Cover Class:Shrubland	DS	50	1,032	0
	TS	197	1,647	0
	Shrubland Cover Class Totals:	247	2,679	0
Cover Class:Wetland	B	165	862	0
	DSw	12	223	0
	TSw	16	146	0
	Wetland Cover Class Totals:	193	1,230	0
Cover Class: Rivers and Lakes	R	114	463	0
	W	22	67	0
	Rivers and Lakes Cover Class Totals:	136	530	0
Cover Class: Barren and Cultural	Ba	42	182	0
	Cu	3	3	0
	Barren and Cultural Cover Class Totals:	45	185	0

Table A-2. Cover types and strata, Noatak Subunit (continued).

Cover Class: Unknown			
Land Cover Type	polygons	Acres	Sampled Stands
Untyped	2	109	0
Stratum Totals:	2	109	0
Unknown Cover Class Totals:	2	109	0
Noatak Subunit Totals:	1350	11,858	30

Appendix B: Net Timber Volume by Strata Summaries

Table B-1. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum BSP2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Poletimber			
White Spruce	5	5.4%	9,079
Black Spruce	12	12.9%	21,790
Subtotal:	**17**	**18.3%**	**30,869**
Seed / sap			
White Spruce	35	37.6%	63,555
Black Spruce	41	44.1%	74,450
Subtotal:	**76**	**81.7%**	**138,004**
TOTAL:	**93**	**100.0**	**168,874**

Stratum Acreage in this Subunit: 1,816

Table B-2. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum BSP/WSP2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
Black Spruce	2	2.0%	2,082
Subtotal:	**2**	**2.0%**	**2,082**
Poletimber			
White Spruce	7	7.0%	7,285
Black Spruce	11	11.0%	11,448
Subtotal:	**18**	**18.0%**	**18,734**
Seed / sap			
White Spruce	17	17.0%	17,693
Black Spruce	56	56.0%	58,282
Subtotal:	**73**	**73.0%**	**75,975**
Dead			
Black Spruce	7	7.0%	7,285
Subtotal:	**7**	**7.0%**	**7,285**
TOTAL:	**100**	**100.0**	**104,075**

Stratum Acreage in this Subunit: 1,041

Table B-3. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum CWP1.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
Balsam Poplar	82	56.9%	11,777
Subtotal:	**82**	**56.9%**	**11,777**
Poletimber			
White Spruce	12	8.3%	1,723
Balsam Poplar	14	9.7%	2,011
Misc. Hardwoods	7	4.9%	1,005
Subtotal:	**33**	**22.9%**	**4,739**
Seed / sap			
Balsam Poplar	14	9.7%	2,011
Misc. Hardwoods	7	4.9%	1,005
Subtotal:	**21**	**14.6%**	**3,016**
Dead			
Balsam Poplar	8	5.6%	1,149
Subtotal:	**8**	**5.6%**	**1,149**
TOTAL:	**144**	**100.0**	**20,681**

Stratum Acreage in this Subunit: 144

Table B-4. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum CWP2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	2	0.3%	1,712
Balsam Poplar	72	11.8%	61,648
Subtotal:	**74**	**12.1%**	**63,360**
Poletimber			
White Spruce	23	3.8%	19,693
Balsam Poplar	312	51.1%	267,141
Misc. Hardwoods	7	1.1%	5,994
Subtotal:	**342**	**56.1%**	**292,828**
Seed / sap			
White Spruce	14	2.3%	11,987
Black Spruce	12	2.0%	10,275
Balsam Poplar	42	6.9%	35,961
Misc. Hardwoods	99	16.2%	84,766
Subtotal:	**167**	**27.4%**	**142,989**
Dead			
Balsam Poplar	27	4.4%	23,118
Subtotal:	**27**	**4.4%**	**23,118**
TOTAL:	**610**	**100.0**	**522,296**

Stratum Acreage in this Subunit: 835

Table B-5. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum HWP/WSP3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	103	16.9%	323,039
Black Spruce	2	0.3%	6,273
Quaking Aspen	2	0.3%	6,273
Subtotal:	**107**	**17.6%**	**335,584**
Poletimber			
White Spruce	105	17.3%	329,311
Black Spruce	161	26.5%	504,944
Paper Birch	4	0.7%	12,545
Quaking Aspen	67	11.0%	210,132
Subtotal:	**337**	**55.4%**	**1,056,932**
Seed / sap			
White Spruce	39	6.4%	122,316
Black Spruce	49	8.1%	153,679
Paper Birch	11	1.8%	34,499
Quaking Aspen	56	9.2%	175,633
Misc. Hardwoods	3	0.5%	9,409
Subtotal:	**158**	**26.0%**	**495,535**
Dead			
White Spruce	6	1.0%	18,818
Subtotal:	**6**	**1.0%**	**18,818**
TOTAL:	**608**	**100.0**	**1,906,869**

Stratum Acreage in this Subunit: 2,382

Table B-6. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum WSP2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	57	16.4%	66,183
Subtotal:	**57**	**16.4%**	**66,183**
Poletimber			
White Spruce	214	61.7%	248,478
Black Spruce	6	1.7%	6,967
Subtotal:	**220**	**63.4%**	**255,444**
Seed / sap			
White Spruce	38	11.0%	44,122
Black Spruce	19	5.5%	22,061
Subtotal:	**57**	**16.4%**	**66,183**
Dead			
White Spruce	13	3.7%	15,094
Subtotal:	**13**	**3.7%**	**15,094**
TOTAL:	**347**	**100.0**	**402,905**

Stratum Acreage in this Subunit: 1,161

Table B-7. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum WSP3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	389	41.6%	579,582
Subtotal:	**389**	**41.6%**	**579,582**
Poletimber			
White Spruce	343	36.7%	511,046
Black Spruce	45	4.8%	67,047
Paper Birch	1	0.1%	1,490
Subtotal:	**389**	**41.6%**	**579,582**
Seed / sap			
White Spruce	74	7.9%	110,255
Black Spruce	61	6.5%	90,886
Subtotal:	**135**	**14.5%**	**201,140**
Dead			
White Spruce	16	1.7%	23,839
Black Spruce	5	0.5%	7,450
Subtotal:	**21**	**2.2%**	**31,289**
TOTAL:	**934**	**100.0**	**1,391,593**

Stratum Acreage in this Subunit: 1,490

Table B-8. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum WSP/BSP1.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	33	17.6%	30,866
Paper Birch	3	1.6%	2,806
Subtotal:	**36**	**19.1%**	**33,672**
Poletimber			
White Spruce	57	30.3%	53,314
Black Spruce	13	6.9%	12,159
Paper Birch	3	1.6%	2,806
Subtotal:	**73**	**38.8%**	**68,280**
Seed / sap			
White Spruce	45	23.9%	42,090
Black Spruce	22	11.7%	20,577
Paper Birch	2	1.1%	1,871
Quaking Aspen	2	1.1%	1,871
Subtotal:	**71**	**37.8%**	**66,409**
Dead			
White Spruce	4	2.1%	3,741
Black Spruce	4	2.1%	3,741
Subtotal:	**8**	**4.3%**	**7,483**
TOTAL:	**188**	**100.0**	**175,844**

Stratum Acreage in this Subunit: 935

Table B-9. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum WSS2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	981	85.2%	486,854
Subtotal:	**981**	**85.2%**	**486,854**
Poletimber			
White Spruce	142	12.3%	70,472
Subtotal:	**142**	**12.3%**	**70,472**
Dead			
White Spruce	28	2.4%	13,896
Subtotal:	**28**	**2.4%**	**13,896**
TOTAL:	**1,151**	**100.0**	**571,223**

Stratum Acreage in this Subunit: 496

Table B-10. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum WSS3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	797	45.8%	636,636
Subtotal:	**797**	**45.8%**	**636,636**
Poletimber			
White Spruce	752	43.2%	600,690
Subtotal:	**752**	**43.2%**	**600,690**
Seed / sap			
White Spruce	75	4.3%	59,909
Subtotal:	**75**	**4.3%**	**59,909**
Dead			
White Spruce	117	6.7%	93,458
Subtotal:	**117**	**6.7%**	**93,458**
TOTAL:	**1,741**	**100.0**	**1,390,694**

Stratum Acreage in this Subunit: 799

Table B-11. Net Timber Volume by Species and Size Class for Kobuk Subunit, Stratum WSS/HP3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	435	37.6%	285,197
Paper Birch	61	5.3%	39,993
Subtotal:	**496**	**42.9%**	**325,190**
Poletimber			
White Spruce	430	37.2%	281,919
Black Spruce	14	1.2%	9,179
Paper Birch	136	11.8%	89,165
Subtotal:	**580**	**50.1%**	**380,262**
Seed / sap			
White Spruce	63	5.4%	41,304
Paper Birch	16	1.4%	10,490
Subtotal:	**79**	**6.8%**	**51,794**
Dead			
White Spruce	2	0.2%	1,311
Subtotal:	**2**	**0.2%**	**1,311**
TOTAL:	**1,157**	**100.0**	**758,558**

Stratum Acreage in this Subunit: 1,432

Table B-12. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum CWP1.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
Balsam Poplar	80	9.5%	17,471
Subtotal:	**80**	**9.5%**	**17,471**
Poletimber			
Balsam Poplar	624	73.8%	136,275
Subtotal:	**624**	**73.8%**	**136,275**
Seed / sap			
Balsam Poplar	118	13.9%	25,770
Misc. Hardwoods	19	2.2%	4,149
Subtotal:	**137**	**16.2%**	**29,919**
Dead			
Balsam Poplar	5	0.6%	1,092
Subtotal:	**5**	**0.6%**	**1,092**
TOTAL:	**846**	**100.0**	**184,758**

Stratum Acreage in this Subunit: 218

Table B-13. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum CWP2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	21	4.4%	13,198
Balsam Poplar	10	2.1%	6,285
Subtotal:	**31**	**6.5%**	**19,483**
Poletimber			
White Spruce	7	1.5%	4,399
Balsam Poplar	224	47.2%	140,779
Misc. Hardwoods	1	0.2%	628
Subtotal:	**232**	**48.8%**	**145,807**
Seed / sap			
White Spruce	40	8.4%	25,139
Balsam Poplar	116	24.4%	72,903
Misc. Hardwoods	8	1.7%	5,028
Subtotal:	**164**	**34.5%**	**103,070**
Dead			
Balsam Poplar	48	10.1%	30,167
Subtotal:	**48**	**10.1%**	**30,167**
TOTAL:	**475**	**100.0**	**298,527**

Stratum Acreage in this Subunit: 655

Table B-14. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum CWP3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
Balsam Poplar	172	20.7%	46,338
Subtotal:	**172**	**20.7%**	**46,338**
Poletimber			
Balsam Poplar	489	58.8%	131,741
Subtotal:	**489**	**58.8%**	**131,741**
Seed / sap			
Balsam Poplar	138	16.6%	37,179
Subtotal:	**138**	**16.6%**	**37,179**
Dead			
Balsam Poplar	33	4.0%	8,891
Subtotal:	**33**	**4.0%**	**8,891**
TOTAL:	**832**	**100.0**	**224,149**

Stratum Acreage in this Subunit: 322

Table B-15. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSP1.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	35	34.3%	19,970
Subtotal:	**35**	**34.3%**	**19,970**
Poletimber			
White Spruce	36	35.3%	20,541
Subtotal:	**36**	**35.3%**	**20,541**
Seed / sap			
White Spruce	17	16.7%	9,700
Balsam Poplar	14	13.7%	7,988
Subtotal:	**31**	**30.4%**	**17,688**
TOTAL:	**102**	**100.0**	**58,199**

Stratum Acreage in this Subunit: 571

Table B-16. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSP2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	26	9.1%	26,960
Subtotal:	**26**	**9.1%**	**26,960**
Poletimber			
White Spruce	121	42.2%	125,467
Subtotal:	**121**	**42.2%**	**125,467**
Seed / sap			
White Spruce	109	38.0%	113,024
Subtotal:	**109**	**38.0%**	**113,024**
Dead			
White Spruce	31	10.8%	32,144
Subtotal:	**31**	**10.8%**	**32,144**
TOTAL:	**287**	**100.0**	**297,594**

Stratum Acreage in this Subunit: 1,037

Table B-17. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSP3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	295	35.1%	211,884
Subtotal:	**295**	**35.1%**	**211,884**
Poletimber			
White Spruce	331	39.4%	237,741
Balsam Poplar	32	3.8%	22,984
Subtotal:	**363**	**43.2%**	**260,725**
Seed / sap			
White Spruce	146	17.4%	104,865
Balsam Poplar	10	1.2%	7,183
Subtotal:	**156**	**18.6%**	**112,047**
Dead			
White Spruce	22	2.6%	15,802
Balsam Poplar	4	0.5%	2,873
Subtotal:	**26**	**3.1%**	**18,675**
TOTAL:	**840**	**100.0**	**603,330**

Stratum Acreage in this Subunit: 718

Table B-18. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSS1.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	336	72.9%	76,247
Subtotal:	**336**	**72.9%**	**76,247**
Poletimber			
Balsam Poplar	125	27.1%	28,366
Subtotal:	**125**	**27.1%**	**28,366**
TOTAL:	**461**	**100.0**	**104,613**

Stratum Acreage in this Subunit: 227

Table B-19. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSS2.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	379	48.7%	338,049
Subtotal:	**379**	**48.7%**	**338,049**
Poletimber			
White Spruce	350	45.0%	312,182
Subtotal:	**350**	**45.0%**	**312,182**
Seed / sap			
White Spruce	49	6.3%	43,706
Subtotal:	**49**	**6.3%**	**43,706**
TOTAL:	**778**	**100.0**	**693,937**

Stratum Acreage in this Subunit: 892

Table B-20. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSS3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	436	36.2%	731,088
Balsam Poplar	5	0.4%	8,384
Subtotal:	**441**	**36.7%**	**739,473**
Poletimber			
White Spruce	606	50.4%	1,016,146
Balsam Poplar	2	0.2%	3,354
Subtotal:	**608**	**50.5%**	**1,019,500**
Seed / sap			
White Spruce	68	5.7%	114,023
Balsam Poplar	2	0.2%	3,354
Subtotal:	**70**	**5.8%**	**117,377**
Dead			
White Spruce	84	7.0%	140,852
Subtotal:	**84**	**7.0%**	**140,852**
TOTAL:	**1,203**	**100.0**	**2,017,201**

Stratum Acreage in this Subunit: 1,677

Table B-21. Net Timber Volume by Species and Size Class for Noatak Subunit, Stratum WSS/CWP3.

Size Class / Species	Net Volume Per Acre Cubic Feet		Total Net Volume Cubic Feet
Sawtimber			
White Spruce	375	37.5%	162,519
Balsam Poplar	29	2.9%	12,568
Subtotal:	**404**	**40.4%**	**175,087**
Poletimber			
White Spruce	380	38.0%	164,686
Balsam Poplar	120	12.0%	52,006
Subtotal:	**500**	**50.0%**	**216,692**
Seed / sap			
White Spruce	31	3.1%	13,435
Balsam Poplar	15	1.5%	6,501
Misc. Hardwoods	3	0.3%	1,300
Subtotal:	**49**	**4.9%**	**21,236**
Dead			
White Spruce	48	4.8%	20,802
Subtotal:	**48**	**4.8%**	**20,802**
TOTAL:	**1,001**	**100.0**	**433,817**

Stratum Acreage in this Subunit: 354

Appendix C: Timber Volumes by Allotment Parcel

Table C-1. Timber volumes and parcel acreages by Native allotment parcel, Kobuk Subunit.

Parcel	Parcel Acres	Total Net Cubic Feet		Parcel	Parcel Acres	Total Net Cubic Feet
AKAA 084052	159.98	100,851		AKFF 014211	159.98	44,095
AKF 009169	160.05	75,261		AKFF 014408B	79.99	33,470
AKF 009172	159.85	67,603		AKFF 015625A	35.97	8,426
AKF 017323	160.03	28,102		AKFF 015625B	40.00	2,659
AKF 019643A	79.99	4,062		AKFF 015625C	40.00	636
AKF 019643B	39.99	9,662		AKFF 015631	80.00	28,118
AKF 022652	160.02	72,451		AKFF 015632	159.98	19,140
AKF 022747	159.98	53,466		AKFF 015633	159.99	36,417
AKF 023433	160.00	55,714		AKFF 015634A	32.98	23,529
AKF 024287	159.97	7,687		AKFF 015634B	40.00	16,885
AKF 024292A	4.99	267		AKFF 015635A	40.00	0
AKF 024292B	154.97	13,585		AKFF 015635B	39.94	19,648
AKF 026204	160.02	86,525		AKFF 015635C	40.00	40,123
AKF 026389A	159.42	182,298		AKFF 015635D	40.00	5,488
AKF 026389B	0.57	0		AKFF 015638A	24.98	8,779
AKF 031389	34.99	911		AKFF 015638B	39.99	23,075
AKF 035179A	0.54	0		AKFF 015638C	40.08	12,295
AKF 035179B	0.88	0		AKFF 015638D	40.00	203
AKFF 000047A	0.73	0		AKFF 015639A	37.00	14,868
AKFF 000047B	40.00	19,843		AKFF 015639B	120.00	39,398
AKFF 000047C	39.98	0		AKFF 015640	160.03	41,026
AKFF 000047D	39.00	36,377		AKFF 015648	154.93	13,255
AKFF 000047E	40.00	4,539		AKFF 015649A	39.99	26,899
AKFF 000048	0.64	0		AKFF 015649B	74.99	20,446
AKFF 000503A	0.57	0		AKFF 015649C	26.96	16,735
AKFF 000503B	159.42	3,995		AKFF 015664A	40.00	14,974
AKFF 000593A	26.00	8,798		AKFF 015664B	39.34	36,297
AKFF 000593D	94.07	76,973		AKFF 015664C	40.40	5,629
AKFF 009545A	19.96	0		AKFF 015664D	39.98	20,485
AKFF 009545B	19.97	12,440		AKFF 015695	160.00	31,436
AKFF 011926A	39.99	2,202		AKFF 015696	134.98	23,388
AKFF 011926B	79.98	6,195		AKFF 015700	159.92	91,828
AKFF 011926C	39.98	55,822		AKFF 015707A	39.98	6,752
AKFF 011982	160.00	47,612		AKFF 015707B	40.00	20,181
AKFF 012120	160.03	81,375		AKFF 015707C	39.85	22,613
AKFF 013023	159.99	0		AKFF 015708A	39.98	49,279
AKFF 013024	159.97	12,032		AKFF 015708B	39.96	27,738
AKFF 013027	159.97	20,324		AKFF 015708C	39.99	1,438
AKFF 013127B	79.96	25,156		AKFF 015708D	40.01	3,167
AKFF 013264	160.05	80,724		AKFF 015729	160.01	23,216
AKFF 013265	90.01	0		AKFF 015754	159.96	0
AKFF 013266	159.84	35,745		AKFF 015799A	59.98	149
AKFF 013267	159.87	44,821		AKFF 015799B	80.00	19,963
AKFF 013268A	80.00	44,471		AKFF 015849A	79.99	13,657
AKFF 013318A	154.82	16,347		AKFF 015849B	40.00	3,109
AKFF 013318B	4.99	2,172		AKFF 015849C	40.00	52,262
AKFF 013801A	79.96	96,581		AKFF 015850A	79.98	63,648
AKFF 013801B	80.00	7,977		AKFF 015850B	79.99	2,712
AKFF 013871	160.00	40,184		AKFF 015851A	79.99	22,533
AKFF 014167	160.46	135,104		AKFF 015851B	79.98	81,280
AKFF 014169	159.98	14,692		AKFF 015852	159.99	21,081
AKFF 014185B	40.00	4,833		AKFF 015864	159.94	9,976
AKFF 014185C	40.00	0		AKFF 015865	49.79	392
AKFF 014209	159.99	14,577		AKFF 015866B	62.29	0

Table C-1. Timber volumes and parcel acreages by Native allotment parcel, Kobuk Subunit (continued).

Parcel	Parcel Acres	Total Net Cubic Feet		Parcel	Parcel Acres	Total Net Cubic Feet
AKFF 015866C	17.67	0		AKFF 016371B	79.93	1,684
AKFF 015867	159.49	12,328		AKFF 016372A	80.00	28,363
AKFF 015868	79.94	16,505		AKFF 016372B	73.00	56,789
AKFF 015869	159.97	1,856		AKFF 016373A	79.51	69,446
AKFF 015870	159.53	6,015		AKFF 016373B	80.01	68,864
AKFF 015871A	79.99	11,190		AKFF 016464	159.93	0
AKFF 015871B	40.00	331		AKFF 016569	160.01	10,464
AKFF 015871C	40.00	3,023		AKFF 016570A	79.99	52,608
AKFF 015872	159.97	25,660		AKFF 016570B	40.00	1,172
AKFF 015873	159.97	38,225		AKFF 016570C	39.95	3,365
AKFF 015874	160.03	56,055		AKFF 016572	160.02	12,020
AKFF 015875A	40.00	8,448		AKFF 016573	159.98	51,108
AKFF 015875B	40.00	11,112		AKFF 016574	160.01	9,449
AKFF 015876	160.00	6,949		AKFF 016575	160.00	9,420
AKFF 015877	159.98	5,526		AKFF 016576A	80.00	62,596
AKFF 015878	160.21	0		AKFF 016576B	40.01	15,127
AKFF 015880	159.79	50,887		AKFF 016576C	39.96	11,444
AKFF 015881	159.82	0		AKFF 016578	160.04	37,080
AKFF 015882	160.03	13,912		AKFF 016579	159.94	8,866
AKFF 015883	159.97	24,509		AKFF 016580A	79.97	19,522
AKFF 015884A	80.01	1,013		AKFF 016580B	79.94	1,754
AKFF 015884B	79.99	1,975		AKFF 016581A	80.00	7,194
AKFF 015885	159.97	2,160		AKFF 016581B	79.97	8,584
AKFF 015886A	79.97	9,921		AKFF 016583	159.95	23,986
AKFF 015886B	79.94	215		AKFF 016590	99.96	0
AKFF 015887	160.01	161,280		AKFF 016591	160.01	41,895
AKFF 015888B	80.02	6,434		AKFF 016792A	80.01	10,660
AKFF 015890	159.98	7,378		AKFF 016792B	80.00	22,881
AKFF 015891	160.03	35,286		AKFF 016793A	79.97	43,003
AKFF 015892	89.96	62,933		AKFF 016793B	79.99	4,571
AKFF 015893	159.98	19,239		AKFF 016794	160.01	0
AKFF 015894	160.00	30,738		AKFF 016795	160.01	95,577
AKFF 015895	80.01	40,276		AKFF 016797B	80.00	51,511
AKFF 015896	158.92	70,126		AKFF 016798	160.02	68,104
AKFF 015897	79.98	2,408		AKFF 016799A	79.97	3,342
AKFF 016116A	39.97	2,402		AKFF 016799B	79.98	17,025
AKFF 016116B	119.99	27,557		AKFF 016800	159.97	17,034
AKFF 016117C	79.93	5,958		AKFF 016880	160.00	25,470
AKFF 016208	159.98	15,219		AKFF 016881A	80.00	45,208
AKFF 016218A	79.84	48,270		AKFF 016885	159.96	12,341
AKFF 016218B	79.97	14,649		AKFF 016886	160.03	24,619
AKFF 016366A	79.99	81,675		AKFF 016887	159.98	13,873
AKFF 016366B	39.97	0		AKFF 016888	159.96	39,169
AKFF 016367A	79.98	22,462		AKFF 016889A	80.01	24,514
AKFF 016367B	79.71	0		AKFF 016889B	40.00	28,301
AKFF 016368A	39.99	1,683		AKFF 016890A	39.98	3,790
AKFF 016368C	40.00	23,255		AKFF 016890B	119.99	26,944
AKFF 016368D	40.00	1,586		AKFF 016891A	119.99	89,201
AKFF 016369A	79.96	19,351		AKFF 017028A	79.99	926
AKFF 016369B	79.96	51,879		AKFF 017028B	79.99	6,898
AKFF 016370A	39.99	5,414		AKFF 017462A	79.96	41,822
AKFF 016370C	39.98	9,758		AKFF 017543	159.98	37,732
AKFF 016370D	40.00	2,308		AKFF 017719	159.97	25,829
AKFF 016371A	79.99	9,456		AKFF 017720	159.99	7,536

Table C-1. Timber volumes and parcel acreages by Native allotment parcel, Kobuk Subunit (continued).

Parcel	Parcel Acres	Total Net Cubic Feet		Parcel	Parcel Acres	Total Net Cubic Feet
AKFF 017721	159.97	132,434		AKFF 018143	159.95	102,817
AKFF 017731A	39.99	6,170		AKFF 018218	160.02	103,151
AKFF 017803	159.96	11,551		AKFF 018439A	39.67	33,871
AKFF 017804	159.96	50,481		AKFF 018439B	40.03	34,504
AKFF 017805	160.00	78,587		AKFF 018567A	80.00	19,099
AKFF 017832A	79.99	3,182		AKFF 018567B	79.99	91,665
AKFF 017832B	39.96	7,909		AKFF 018590A	79.98	3,863
AKFF 017832C	39.98	9,696		AKFF 018590B	80.00	17,312
AKFF 017833A	40.00	6,949		AKFF 018700A	79.99	44,702
AKFF 017833B	79.99	106,862		AKFF 018700B	39.97	2,031
AKFF 017833C	39.97	34,191		AKFF 018701A	79.99	15,109
AKFF 017837B	79.99	0		AKFF 018701B	39.99	3,281
AKFF 017862	159.97	75,921		AKFF 018726D	39.97	16,943
AKFF 017897	159.99	29,658		AKFF 018763A	79.99	47,947
AKFF 017956A	39.98	2,398		AKFF 018768	159.93	85,772
AKFF 017957A	80.01	6,299		AKFF 018822A	120.02	14,010
AKFF 017980A	39.98	29,031		AKFF 018822B	39.99	32,195
AKFF 017982A	79.99	4,815		AKFF 018860B	79.97	38,468
AKFF 017982B	40.03	0		AKFF 018868A	80.20	7,880
AKFF 018001	159.98	0		AKFF 018992B	40.00	6,898
AKFF 018002	159.97	0		AKFF 019018	160.02	37,095
AKFF 018003A	79.99	4,958		AKFF 019030	160.01	50,631
AKFF 018003B	79.99	24,107		AKFF 019180A	39.97	45,761
AKFF 018004A	79.98	18,893		AKFF 019180B	40.00	4,533
AKFF 018005A	80.00	1,614		AKFF 019180C	79.96	22,013
AKFF 018005B	79.95	9,713		AKFF 019197	159.96	33,064
AKFF 018006	159.98	40,161		AKFF 019280	159.94	48,314
AKFF 018007B	79.87	23,480		AKFF 019586	119.98	50,335
AKFF 018007A	79.99	413		AKFF 019587	159.97	41,116
AKFF 018008	159.98	22,713		AKFF 021262B	79.99	1,138
AKFF 018009A	79.97	17,305		AKFF 021295	159.98	0
AKFF 018009B	79.96	22,353		AKFF 082014	160.00	22,895
AKFF 018033A	39.98	0		AKFF 082015	160.14	1,251
AKFF 018095A	79.99	5,542		AKFF 082017	159.96	13,150
AKFF 018095B	79.96	13,617		AKFF 082021	159.96	8,115
AKFF 018107B	39.98	7,239		AKFF 093566B	119.96	42,459
AKFF 018141A	80.02	31,184		AKFF 093567A	82.18	24,245
AKFF 018142	159.97	43,918				

Total: 291 parcels; 27.857 acres; 7,413,611 cubic feet

Table C-2. Timber volumes and parcel acreages by Native allotment parcel, Noatak Subunit.

Parcel	Parcel Acres	Total Net Cubic Feet		Parcel	Parcel Acres	Total Net Cubic Feet
AKF 032355	159.92	62,816		AKFF 013626	159.94	131,036
AKFF 000476B	159.41	121,840		AKFF 013627	138.93	17,351
AKFF 013439	160.01	54,337		AKFF 013754	159.93	156,233
AKFF 013440	160.02	49,631		AKFF 013756	95.38	14,587
AKFF 013441	159.98	92,056		AKFF 013757A	79.96	74,846
AKFF 013442	159.93	13,591		AKFF 013771A	79.98	35,107
AKFF 013486	159.98	30,614		AKFF 013771B	79.99	61,967
AKFF 013487	159.94	113,445		AKFF 013782B	79.99	70,947
AKFF 013588	159.95	84,312		AKFF 013784	159.96	66,027
AKFF 013589A	160.48	83,554		AKFF 013785	159.95	78,770
AKFF 013594	159.94	142,114		AKFF 013831	160.01	7,293
AKFF 013595	160.03	103,151		AKFF 013876A	79.97	43,590
AKFF 013596A	45.03	4,400		AKFF 013877A	80.00	45,897
AKFF 013596B	80.27	67,416		AKFF 013878	159.96	87,468
AKFF 013597A	80.00	1,658		AKFF 013879	159.98	75,094
AKFF 013597B	79.97	78,157		AKFF 014000A	79.97	32,903
AKFF 013598A	80.00	63,348		AKFF 014164	159.96	88,611
AKFF 013598B	80.00	0		AKFF 014165	160.00	1,301
AKFF 013599	159.95	74,863		AKFF 014172	159.84	122,089
AKFF 013600	159.97	81,498		AKFF 014213A	79.96	52,233
AKFF 013601A	79.96	36,611		AKFF 014213B	79.92	5,673
AKFF 013601B	79.97	55,955		AKFF 014221B	79.99	52,358
AKFF 013602A	79.94	33,358		AKFF 015266	159.98	51,253
AKFF 013602B	79.97	5,243		AKFF 015267	159.96	76,856
AKFF 013603	159.99	71,402		AKFF 015268	160.01	45,428
AKFF 013606A	75.93	35,445		AKFF 015269	160.01	54,803
AKFF 013606B	79.98	15,369		AKFF 015270	159.95	15,412
AKFF 013607	160.00	33,727		AKFF 015798	159.92	55,584
AKFF 013608	159.96	59,922		AKFF 016462	144.10	11,268
AKFF 013609	159.95	99,978		AKFF 016466	159.95	104,475
AKFF 013612	159.96	9,530		AKFF 016467	160.00	54,955
AKFF 013613	159.98	4,775		AKFF 016473	159.97	1,413
AKFF 013615	159.95	60,147		AKFF 016478	159.99	77,110
AKFF 013616	159.98	139,118		AKFF 016505	159.95	1,072
AKFF 013617A	79.98	33,780		AKFF 016506	159.92	392
AKFF 013617B	79.96	52,892		AKFF 016508	160.63	1,860
AKFF 013618A	79.97	57,926		AKFF 016895	159.97	46,724
AKFF 013618B	80.00	103		AKFF 016924	159.95	120,440
AKFF 013619A	79.95	17,878		AKFF 016925	159.92	153,939
AKFF 013619B	79.96	27,077		AKFF 016976B	39.98	2,756
AKFF 013620A	79.97	87,565		AKFF 016976C	39.99	642
AKFF 013620B	79.98	10,691		AKFF 017594	159.98	55,216
AKFF 013623A	79.96	7,623		AKFF 017681	159.99	149,884
AKFF 013623B	80.00	32,720		AKFF 018034A	79.97	16,232
AKFF 013624A	79.97	31,331		AKFF 018429	159.97	715
AKFF 013624B	79.99	56,501		AKFF 019178	159.94	17,875
AKFF 013625	160.26	63,415		AKFF 019345	159.99	15,555

Totals: 94 parcels; 11,858 acres; 4,915,124 cubic feet.