United States
Department of
Agriculture

Forest Service

Pacific Northwest
Research Station

Resource Bulletin
PNW-RB-153
August 1988

Potential for Forest Products in Interior Alaska

George R. Sampson, Willem W.S. van Hees, Theodore S. Setzer, and Richard C. Smith

This file was created by scanning the printed publication. Text errors identified by the software have been corrected; however, some errors may remain.

Authors

GEORGE **R.** SAMPSON is a research forester, Pacific Northwest Research Station, Institute of Northern Forestry, 308 Tanana Drive, Fairbanks, Alaska 99775-5500. WILLEM W.S. VAN HEES and THEODORE **S.** SEVER are research foresters, Pacific Northwest Research Station, Forestry Sciences Laboratory, 201 East 9th Avenue, Anchorage, Alaska 99501. RICHARD C. SMITH is retired; he was formerly assistant director, School of Forestry, Fisheries, and Wildlife, University of Missouri-Columbia.

Abstract

Sampson, George R.; van Hees, Willem W.S.; Setzer, Theodore S.; Smlth, Richard C. 1988. Potential for forest products in interior Alaska. Resour. Bull. PNW-RB-153. Portland, OR: **U.S.** Department of Agriculture, Forest Service, Pacific Northwest Research Station. **28** p.

Future opportunities for producing Alaska forest products were examined from the perspective of timber supply as reported in timber inventory reports and past studies of forest products industry potential. The best prospects for increasing industrial production of forest products in interior Alaska are for softwood lumber. Current softwood lumber production in the interior is less than 20 percent of the average annual softwood lumber consumption in Alaska. The dispersed nature of harvestable timber and the attendant poor access are major obstacles to increasing the interior's softwood lumber production. A long-term alternative is to convert hardwood types and black spruce type to contiguous stands of white spruce.

Keywords: Forest products output, *Picea glauca,* white spruce, interior Alaska, Alaska (interior).

Summary

A study was conducted to determine the potential for increased production of forest products in interior Alaska. Lumber from white spruce *(Picea glauca* (Moench) Voss) offers the best opportunities because of local demand and the size and availability of white spruce sawtimber. Softwood lumber imports to Alaska have averaged 100 million board feet annually in recent years, whereas production in the interior has remained below 20 million board feet. The dispersed nature of harvestable sawtimber and the attendant poor access are two major obstacles to increasing the harvest and utilization of the interior's white spruce. The Tanana Valley offers the best opportunities because of the relative abundance of white spruce and existing primary access by highway and the Alaska Railroad. A long-term alternative is to convert hardwood types and black spruce *(Picea rnariana* (Mill.) B.S.P.) type to contiguous stands of white spruce. Use of removed biomass as fuel in local electric generating plants would help defray the cost of type conversion.

Contents

Purpose

More than **75** percent of Alaska's population lives in the interior. An estimated **80** percent of the softwood lumber consumed annually in the Interior is imported from the Pacific Northwest and Canada (Lindh **1979).** Only minor amounts of hardwood timber are used locally for products other than fuehvood. In this paper, we identify major obstacles to increasing the use of the interior's timber resource for local products and examine alternatives for overcoming these obstacles.

For this paper, interior Alaska is defined as the forested part of Alaska from Anchorage north, plus the western half of the Kenai Peninsula (fig. **1).** This area has more than **105** million acres of forest land, more than 22 million acres of it classed as timberland' (Hutchison **1967).**

We focus on the potential for increasing production of softwood lumber. Supply data for hardwood timber is included in the discussion of geographic supply areas; past and present use of hardwoods is included where appropriate. Two studies in recent years have investigated the potential for particleboard production in interior Alaska (Columbia Engineering International, Ltd. **1982,** Harpole and others **1977).** Both *of* these studies concluded that particleboard production is infeasible unless markets develop in Pacific Rim countries. Plywood and pulp production in the interior have not appeared sufficiently promising to justify a study.

Two studies investigating the potential for forest management and development in interior Alaska have been done in the last decade. Hyde and Krutilla **(1979)** examined the potential for a profitable forest industry in the interior as a basis for determining the feasibility of National Forest designation of land set aside under Sec. **17(d)(2)** of the Alaska Native Claims Settlement Act of **1971.** They concluded that neither timber-based regional development nor multiple-use development including timber was feasible. None of the (d)(2) lands were designated for National Forest when the Alaska National Interest Lands Conservation Act was passed in **1980.**

Smith **(1980)** studied forest resources and the existing forest industry in interior Alaska and made recommendations for research and development. He concluded that forest development in the most accessible parts of the railbelt and Tanana Valley could be expanded if demand for export products continues to rise, major land-base problems are resolved, and timber harvesting and manufacturing costs can be lowered.

Potential Demand for Interior Alaska Timber

The future demand for forest products from interior Alaska will depend on local population and economic growth and the competitive position of wood products from interior Alaska compared with those produced in westem Canada, western Oregon, and western Washington. Alaska's population is concentrated in the railbelt area (the general area that can be accessed from the Alaska Railroad running from Seward to North Pole, Alaska).

---

[1] In this paper "forest land' is land at least 16.7 percent stocked by forest trees of any size, or land formerly having such tree cover, and not currently developed for nonforest use; "timberland" is used to define forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. Areas qualifying as timberland could produce more than 20 cubic feet per acfe per year of industrial wood under management.

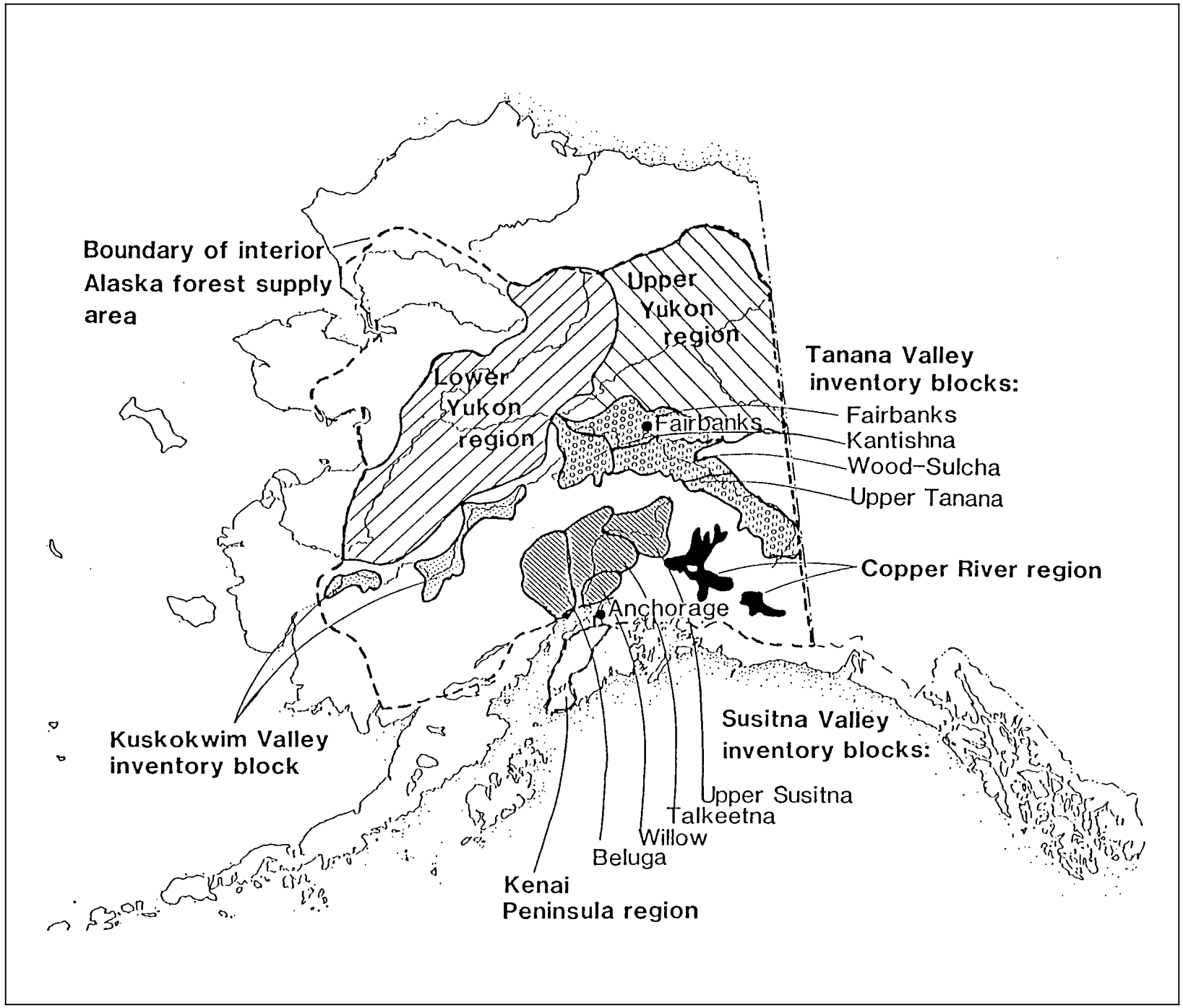

Figure 1—Boundaries of interior Alaska and timber regions and location of inventory blocks in the Kuskokwim, Susitna, and Tanana valleys.

Based on a population projection of 550,000 and consumption rates associated with medium national projections (USDA Forest Service 1982), estimated annual use of major types of wood products in Alaska in 1990 are as follows:

Type product	Volume
Hardwood lumber	22.8 million board feet
Softwood lumber	107.8 million board feet
Softwood plywood	53.4 million square feet (3/8-inch basis)
Particleboard[2]	34.4 million square feet (3/8-inch basis)
Fuelwood	2.5 million cubic feet

Consumption of hardwood lumber in Alaska will probably remain well below the volume predicted above. Nationally, much of the hardwood lumber is used in furniture manufacturing and floors. Only two small manufacturers of cabinets, paneling, and flooring, and a few artisans are using interior Alaska's hardwood timber for purposes other than fuelwood. Because Alaska does not have major manufacturing plants that use hardwood lumber, the volume of hardwood lumber used within the State is very low. Most wood furniture, flooring, paneling, and cabinets are shipped to Alaska in finished form.

Softwood lumber is the major wood product market in Alaska. Consumption level depends directly on new construction, remodeling and repairs, and industrial activity.

Use of particleboard in Alaska is well below the consumption predicted above. Alaska lacks major industrial wood users such as furniture and mobile home manufacturers who use large quantities of particleboard. Structural particleboard can be interchanged with plywood for uses such as roof and wall sheathing and subflooring. Some customer resistance to this change, however, is likely (Columbia Engineering International, Ltd. 1982).

Other wood products used in Alaska are timbers, posts, utility poles, piling, railroad ties, and paper products.

Characteristics of Interior Alaska Timber Supply

The important timber species found in interior Alaska are white spruce *(Picea glauca* (Moench) Voss), paper birch *(Betula papyrifera* Marsh.), balsam poplar (*Populus balsamifera* L.), black cottonwood *(Populus trichocarpa* Torr. & Gray), and quaking aspen (*Populus tremuloides* Michx.). Black spruce *(Picea rnariana* (Mill.) B.S.P.) furnishes only small amounts of wood for products, but is important in forest management because much of the forest land is in the black spruce type. These species are also found from northern Maine and eastern Canada across the northern Lake States and central and western Canada.

---

[2] **Indudes composite board, flakeboard, medium-density fiberboard, and waferboard.**

Permafrost soils and extensive bogs of interior Alaska restrict productive forests to particular sites. The mixed forests of white spruce and hardwoods grow best on warm south-, east-, and west-facing slopes and along the valley bottoms. The forests of the Kenai Peninsula and Susitna Valley differ somewhat from the forests north of the Alaska Range; productive forest stands cover a greater proportion of the area and are much less scattered than in the remainder of the interior.

For discussion purposes, we have divided interior Alaska into seven timber supply regions (fig. 1). Three of these, the Kuskokwim Valley, the Susitna Valley, and the Tanana Valley, are thought to have the best potential for long-term timber industry development at this time. The Kuskokwim Valley was inventoried as one unit. The Beluga, Talkeetna, Upper Susitna, and Willow inventory blocks make up the Susitna Valley data. The Fairbanks, Kantishna, Upper Tanana, and Wood-Salcha inventory blocks make up the Tanana Valley data. Locations of interior Alaska inventory blocks for these three supply regions are shown **by** figure 1. The Tanana Valley and Kuskokwim Valley areas include only the contiguous forest land on either side of the river, which is 12 to 50 miles wide along the Tanana River, but only a few miles wide along the Kuskokwim River. The Susitna Valley areas are not restricted *to* the river and include all lands within the general boundary including those between river valleys. Timber inventory data about the three regions are shown in table 1.

Operability factors for these regions are shown in table **2.** Operability as used here means economic operability and includes factors that have a major impact on the delivered *cost* (per unit of volume) of timber at the processing plant. The operability factors give an estimate of the cost of harvesting. The higher the ratio of timberland to total land, the lower the roadbuilding cost per unit of volume harvested. The same is true for the ratio of timberland to forest land within the inventory unit. The greater the volume of timber per unit of area, the lower will be roadbuilding costs and the lower will be yarding costs.

The proportion of softwood growing stock to hardwood growing stock is also important. For interior Alaska, a ready outlet exists for softwood timber but not for hardwoods. Taken together, these operability factors provide a general comparison of harvesting costs per unit of volume among different areas.

Following is a brief summary for each of the timber supply regions identified in figure 1. Timber inventory data and information from past studies, reports, and articles are summarized for each region.

Tanana Valley

The area of the Tanana Valley inventoried has a total of 2.3 billion cubic feet of growing stock on timberland; 1.4 billion cubic feet of this is softwood timber (van Hees 1984). The larger volumes per acre and greater proportion of softwoods are in the Upper Tanana inventory block. Net volume of growing stock in the Fairbanks inventory block is almost evenly divided between softwoods and hardwoods. In the Kantishna and Wood-Salcha inventory blocks, softwoods make up 54 percent of the growing-stock volume on timberland.

Table 1—Area and growing-stock volume on timberland for selected timber supply areas In Interlor Alaska

Inventory block	Area			Growing-stock volume on timberland	
	Forest land	Timberland	Total area	Hardwood	Softwood
	Thousand acres			*Million cubic feet*	
Tanana Valley:					
Upper Tanana	2,802.9	396.2	3,602.8	103.8	424.9
Wood Salcha	3,408.9	626.3	4,090.9	364.1	435.3
Fairbanks	2,566.9	748.0	3,101.0	283.5	294.3
Kantishna	2,546.0	424.2	2,944.2	168.8	198.5
Total	11,324.7	2,194.7	13,738.9	920.2	1,353.0
Kuskokwim	874.3	52.5	1,168.2	95.4	247.6
Susitna Valley:					
Beluga	648.4	131.7	3,739.7	35.8	63.6
Talkeetna	1,799.3	562.1	5,622.9	449.4	125.3
Upper Susitna	1,141.7	112.1	5,667.5	173.3	11.3
Willow	621.3	230.2	978.5	177.5	54.4
Total	4,210.7	1,036.1	16,008.6	836.0	254.6

Source: Carroll and others (1985), Hegg (1975b, 1982, 1983), Hegg and Sieverding (1979), Mead and others (1985), Setzer and others (1984a, 1984b), Winterberger (1983).

Table 2—Operability factors for selected areas in Alaska

Supply area	Ratio of timberland to total area	Ratio of timberland to forest land	Growing stock on timberland			Ratio to total area
			Net volume per acre			
			Softwoods	Hardwoods	Annual growth	
			Cubic feet			
Tanana Valley:						
Upper Tanana	0.11	0.14	1,072	262	28	147
Wood Salcha	.15	.18	695	581	32	191
Fairbanks	.25	.29	393	379	27	193
Kantishna	.14	.17	468	398	23	121
Kuskokwim	.21	.29	981	378	18	285
Susitna Valley:						
Beluga	.04	.20	483	272	11	30
Talkeetna	.10	.31	70	952	24	102
Upper Susitna	.02	.10	101	1,546	12	33
Willow	.24	.37	236	771	32	242

Source: Carroll and others (1985), Hegg (1975b, 1982, 1983), Hegg and Sieverding (1979). Mead and others (1985), Setzer and others (1984a, 1984b), Winterberger (1983).

Several major roads transect the Tanana Valley. These include the Alaska, Elliott, Glenn, Parks, and Steese Highways. The Alaska Railroad links Fairbanks with the ports of Anchorage, Seward, and Whittier. The Tanana River flows the length of the valley, and most of the softwood growing stock is close to the Tanana River and its tributaries. Since the 1940's, the only commercial barge traffic on the river has been between Nenana and the Yukon River. Above Nenana, the Tanana River is swift and in many areas has multiple, shallow channels. The U.S. Army Corps of Engineers suggests that the Tanana River is navigable by shallow draft (4-foot), flat-bottom vessels and barges from the mouth to Nenana and by smaller rivercraft to the Chena River and up the Chena to the University Avenue Bridge in Fairbanks (Gray 1980).

Most of early-day Fairbanks was built with local timber. In 1910, Kellogg reported two mills with a combined production of 40,000 board feet daily operating in the Fairbanks area with local white spruce timber. Much of this timber was floated down the Chena and Salcha rivers (Lutz 1963). The majority of the softwood timber currently being harvested is coming from the Fairbanks area. Full-time sawmills are operating, however, in the Delta Junction, Nenana, and Tok areas.

Plans for a mill complex capable of cutting and kiln drying 10 million board feet annually were developed for Faitbanks in the early 1960's. A report on the proposed mill cautioned that success of the operation hinged on continued high freight costs on shipped-in lumber (Hallock 1962a). This proposed mill was never built.

Susitna Valley

The Beluga, Talkeetna, Upper Susitna, and Willow inventory blocks make up the portion of the Susitna timbershed covered in this report. Area and volume statistics for these blocks are shown in table 1. Only 6 percent of the total area in these blocks is classified as timberland. Hardwood growing stock on timberland amounts to five times the volume of softwood growing stock on timberland.

An inventory of the Susitna Valley conducted in 1964-65 included only 5.6 million acres or 35 percent of the most recent inventory (Hegg 1970). This early inventory, however, reported more timberland than the most recent inventory, although it contained only 35 percent as much total area. This may be a result of different sampling methods or the nature of the timber resource in this inventory unit and throughout interior Alaska. Potential tree growth on much of the timberland in interior Alaska is close to the minimum growth rate of 20 cubic feet per acre per year for classification as timberland. Different samples can result in substantial differences in the quantity of timberland reported even though differences in annual growth rates are small.

The hardwood resource has been considered for development many times since settlement began in the early 1900's. One study suggested that annual cuts of 9 million board feet of paper birch and 6 million board feet of cottonwood could be harvested from accessible stands in the Susitna Valley (Massie 1966). In the early 1960's, a sawmill with a capacity for processing 20,000 board feet of hardwoods per day was operating (Hallock 1962b). This mill, however, closed after a short time. Small amounts of hardwoods and spruce are currently harvested for local use. The most recent Alaska forest industry directory lists more than *two* dozen sawmills operating in the Susitna Valley (Alaska Department of Natural Resources, Division of Forestry 1983). These mills are all very small.

This region is close to the major markets for lumber in Alaska and is transected by the Glenn and Parks Highways and the Alaska Railroad. Access to timber other than that which is close to these transportation routes remains difficult.

Kuskokwim Valley

The 1967 comprehensive inventory of all the land in the Kuskokwim region reported 2.6 million acres of timberland (Hutchison 1967). Fieldwork for a more intensive inventory of the productive forest areas close to the river was completed in 1967. This inventory reported 252,500 acres of timberland containing a net growing-stock volume of 343 million cubic feet (Hegg and Sieverding 1979). Most of the timberland and timber volume are in the Upper Kuskokwim Valley (above Sleetmute). Most residents of the Kuskokwim Valley live in the Lower Kuskokwim rather than the Upper (10,252 versus 2,740 in 1984). The five western coastal census divisions north of the Aleutian Chain are expected to grow from a population of 33,683 in 1983 to 41,382 by the year 2000 (Reeder and others 1983). These areas could potentially be supplied by forest products produced in the Kuskokwim Valley.

The Kuskokwim Valley has been under repeated study for forest product industry development since 1969. The Federal Field Committee, which coordinated construction of some 200 homes in Bethel, requested the Kuskokwim Forest Resource Committee to explore the possibility of linking the forest products industry of the Kuskokwim to the Bethel Housing Project (Clapp and others 1969). Among factors that apparently stymied efforts to use more local timber in the housing project were: (1) the land freeze in connection with the then pending Alaska Native Claims Settlement Act of 1971, (2) inadequate river transportation, and (3) failure to incorporate product specifications that Kuskokwim timber suppliers could meet (Clapp and others 1970).

The Kuskokwim Forest Resource Committee requested a study of local market demand for timber products. The study was completed in 1970 (Koweluk 1970). The study found an annual consumption of 2 million board feet of lumber in the Kuskokwim area, but only 400,000 board feet of this was produced locally (these data excluded lumber consumption by the military and other government agencies).

A study of forest products industry potential of the Yukon-Kuskokwim River area was requested by the USDA Forest Service, Alaska Planning Team, in the mid-1970's. The study compared interior Alaska with northern Minnesota and drew the general conclusion that interior Alaska has the potential for a sizable forest industry that could supply local needs as well as export products (Zasada 1976).

In 1980, a consulting firm investigated the business potential of the forest resource in the middle Kuskokwim area. This study considered three business options: (1) log export; (2) a sawmill in Bethel exporting rough, green material; and (3) a small sawmill cutting rough lumber for the local market. The study concluded that none of the three options was economically viable at that time, but an export operation could be viable within 10 years (Hammons 1981). A followup study concluded that a small sawmill (600 thousand board foot measure) operating near the timber supply and selling products to the Bethel market would be profitable (Kilborn and others 1981).

In spite of the interest and past studies, very little lumber is produced in the Kuskokwim Valley. Only one mill has consistently operated in recent years, and it produces less than a half million board feet per year.

White spruce accounts for 72 percent of the net growing-stock volume and 88 percent of the net sawtimber volume on timberland. Net annual growth of white spruce on timberland amounts to 3.1 million cubic feet of growing stock and includes 19.7 million board feet of sawtimber. Balsam poplar is the predominant hardwood of sawtimber size with a net volume of 6.8 million board feet on timberland. Paper birch has a net volume of 563.5 million cubic feet of growing stock on timberland. Transportation is a major obstacle to forest products industry. Roads exist only in the immediate vicinity of villages.

Kenal Peninsula

This region includes only the western part of the Kenai Peninsula and amounts to 5.7 million acres. Of this, 2.1 million acres are in forest land, and 1.5 million acres, or 26 percent of the total land area, is timberland (Hutchison 1967). A subsequent study estimated less than 500,000 acres of timberland (Ryan 1982). The eastern half of the Kenai Peninsula includes the Chugach National Forest, which is managed under its own management plan and is not included in this study (USDA Forest Service 1984).

The Kenai National Wildlife Refuge occupies more than 1.9 million acres of the remaining area, including more than 166,000 acres of timberland (Ryan 1982). The selected management plan for the refuge would allow timber and firewood harvest on an area of 263,000 acres (U.S. Department of the Interior, Fish and Wildlife Service 1985a). The final plan and record of decision (U.S. Department of the Interior, Fish and Wildlife Service 1985b) recognize the usefulness of timber harvest as a means of manipulating vegetation for moose management but include no suggested or planned harvest levels.

The Alaska Department of Natural Resources has more than 89,000 acres of timberland not withdrawn from timber harvest (Ryan 1982). Projected timber harvest from this land is 2 million board feet per year with current road access. The University Trust Lands and Kenai Peninsula Borough add another 28,000 acres of timberland (Taiga Resource Consultants 1986).

The land holdings of four Native corporations total more than 90,000 acres of timberland on the Peninsula. The timberland holdings of three additional Native corporations on the Peninsula have not yet been determined. The Native corporation lands on the west side of the Kenai Peninsula contain more than 1 billion board feet of sawtimber (Ryan 1982). A mill capable of sawing 35,000 board feet per day in the Anchor Point area ceased operation in 1984, partly because of inexpensive Canadian construction lumber. The remaining operating sawmills are small (under 5,000 board feet per day).

Copper River

The field inventory for the Copper River unit was done in 1968 (Hegg 1975a). This inventory covered only the areas close to the Chistochina, Chitna, Copper, Gakona, Gulkana, Klutina, Tazlina, and Tonsina Rivers. About 600,000 acres of the original inventory unit were set aside as the Wrangell-St. Elias National Park and Preserve by the Alaska National Interest Lands Conservation Act (ANILCA) of 1980. The remaining portion has 154,600 acres of timberland with a net volume of about

134.1 million cubic feet of growing stock that includes 482.6 million board feet of sawtimber. Most of the sawtimber is white spruce. The Edgerton, Glenn, and Richardson Highways and the Tok Cut-Off provide general road access.

Upper **Yukon**

The Upper Yukon area encompasses a total land area of almost 37 million acres. This includes 22.6 million acres of forest land, of which 4.9 million acres are timberland (Hutchison 1967). A timber resource inventory of 8.9 million acres of the Black River, Porcupine River, and Sheenjek River timbersheds was completed in 1977 and 1978 (Setzer 1987). A similar inventory covered 8.2 million acres including parts of the Charley, Kandic, and Yukon River timbersheds in 1980 (van Hees, in press). Together, these inventories estimated that more than 2 million acres of timberland exist in the Upper Yukon. This timberland averages only 1,200 board feet of sawtimber per acre.

Much of this land is now in National Wildlife Refuge, National Park, and National Preserve status. More than 22 million acres of land in this area was set aside by ANILCA in 1980 for these special conservation uses. Management plans are still being developed, but apparently only a small area will be available for timber harvest. The Venetie Indian Reserve contains 1.8 million acres. Seven other Native villages have land entitlements of 668,160 acres (U.S. Department of the Interior, Bureau of Indian Affairs 1978). Doyon, Ltd. (a Native regional corporation) land selections total more than 1 million acres (U.S. Department of the Interior, Fish and Wildlife Service 1987). Most of these owners do not know how much forest land and timber they own. A forest inventory was completed for lands of Fort Yukon village within one-half mile of the Yukon and Porcupine Rivers (Zufelt 1984). The inventory included 85,155 acres, but almost 32,000 acres of this was water and more than 13,000 acres were nonforest land. The annual allowable harvest for forest land was estimated to be 185,000 cubic feet or 835,000 board feet.

Lower **Yukon**

The lower Yukon region delineated by Hutchison (1967) contains a total land area of nearly 45 million acres. More than 30 million acres of this qualified as forest land, but only 4.2 million acres as timberland. About 16.7 million acres within this region was set aside **by** ANILCA as National Parks and National Wildlife Refuges. Native village holdings total more than **1.5** million acres. Twelve small sawmills are reported to be within this area (Alaska Department of Natural Resources, Division of Forestry 1983).

In 1971, a forest inventory was conducted on 741,710 acres of the Upper Koyukuk River, which lies within the Lower Yukon region. The 34,839 acres of commercial forest land in this inventory unit averaged only 2,500 board feet per acre (Hegg 1974).

Investigation of markets for lumber from the lower Yukon was done in conjunction with the Kuskokwim Valley (Koweluk 1970). In a report on the lumber potential of the middle Yukon, Brady (1971) concluded that harvesting and milling of timbers and dimension lumber could be conducted at costs equal to or slightly higher than costs of importing these products.

Limiting Factors

Factors that affect the current and future availability of timber from interior Alaska are the ownership patterns and the cost competitiveness of locally produced products.

Ownership and Dedicated Use

As was already mentioned in the discussion of individual timber supply areas, current ownership and use designation eliminate timber harvest as a major activity on many areas. For example, designation as National Park or Preserve or National Wildlife Refuge generally precludes any future timber harvest. Before **1958,** almost 300 million acres of Federal land in Alaska were not reserved for special purpose. Through legislation passed in **1958, 1971,** and **1980** that figure will ultimately be reduced to **45** million. The land transfers from Federal to State and Natives are still in process. The **1958** Alaska Statehood Act granted the State **104** million acres. The **1971** Alaska Native Claims Settlement Act awarded Alaska Natives **44** million acres. The **1980** Alaska National Interest Lands Conservation Act added **104** million acres to national parks, wildlife refuges, and monuments (fig. 2).

With the exception of remote lands perceived to have high resource value, State-owned lands are concentrated along the transportation network (fig. 3). Because of selection requirements, Native-land selections are concentrated around existing villages, and most are far from the existing road and railroad network. Ownership and use designation in relation to forestry and potential timber harvest in interior Alaska are summarized below.

Federal–Most of the **45** million acres of Federal public-domain land that will remain after completion of State and Native selection are located far from existing land-transportation networks. The State did not select these lands because the State perceived other lands to have higher value. Neither the area of these lands that is forested nor the timber volumes on these lands are known. At this time, no areas have been planned for timber harvest or forest management. Some of the Federal lands close to Native or other villages may furnish firewood and saw logs for local use under agreement with the U.S. Department of the Interior, Bureau of Land Management.

State–Most of the lands selected by the State are along the transportation network or were perceived to have high potential value for oil or mineral development (fig. 3). The State is transferring about **770,000** acres to municipal and borough governments (Leask **1985).** The State has some legislatively designated land-use categories such as State parks, forests, game refuges, sanctuaries, and critical habitat areas. For areas not in these special categories, the Alaska Department of Natural Resources classifies land under a system that designates primary uses but does not prohibit other uses. These classifications are reviewed annually and can be changed. Because of possible changes in classification, little incentive exists for the Alaska Division of Forestry to make forestry investments in land that has not been legislatively designated for forestry.

In the Tanana Valley, virtually all efforts of the Division of Forestry, except fire protection, are on the legislatively designated Tanana Valley State Forest. In the Copper River Valley, the Kuskokwim Valley, and the Susitna Valley, and on the Kenai Peninsula, the Division has a timber-sale program, but no long-range plans, harvest schedules, or road access plans. Sales for fuel, house logs, and saw logs are in response to local requests.

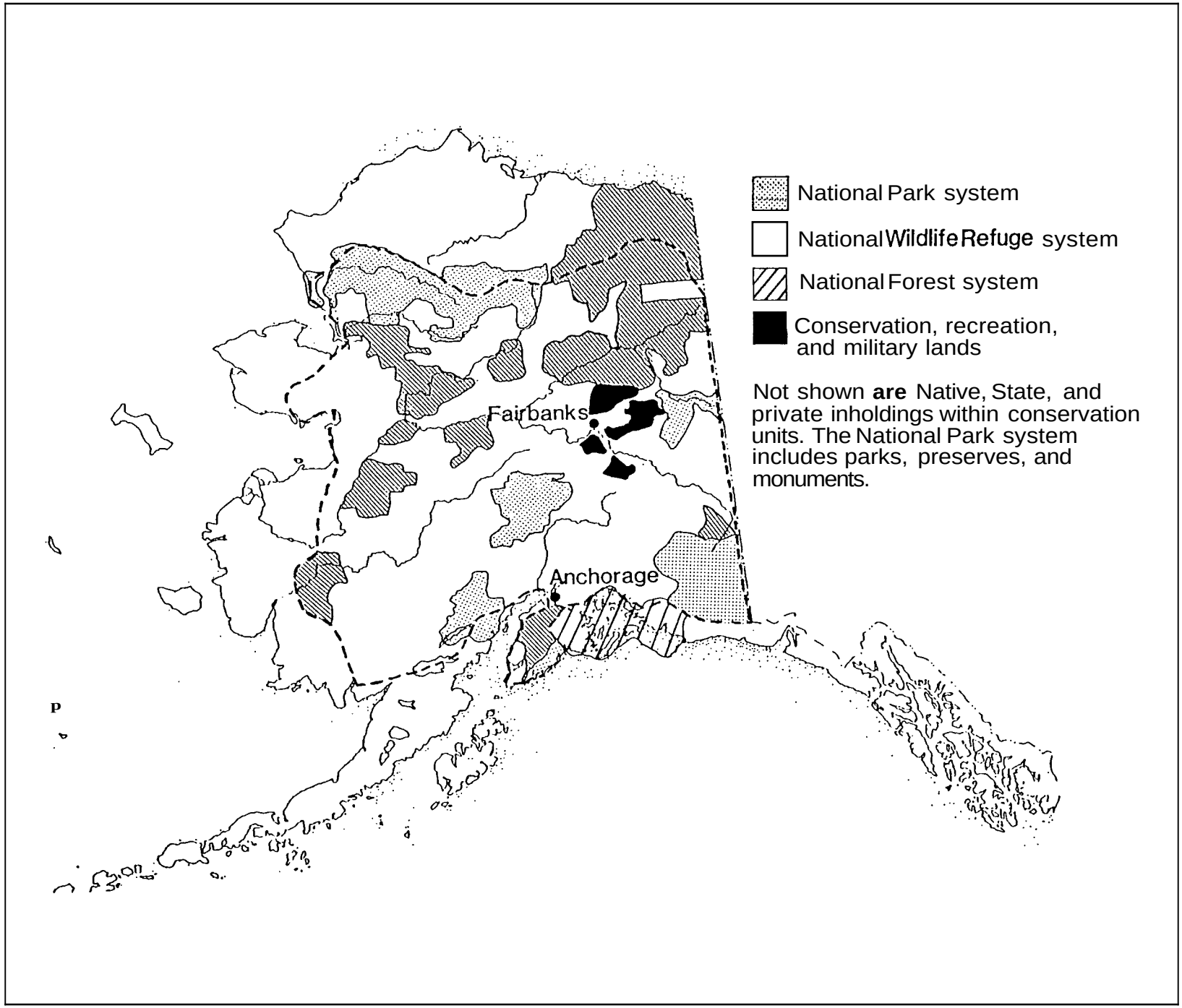

Figure 2—National conservation, recreation, and military lands in interior Alaska.

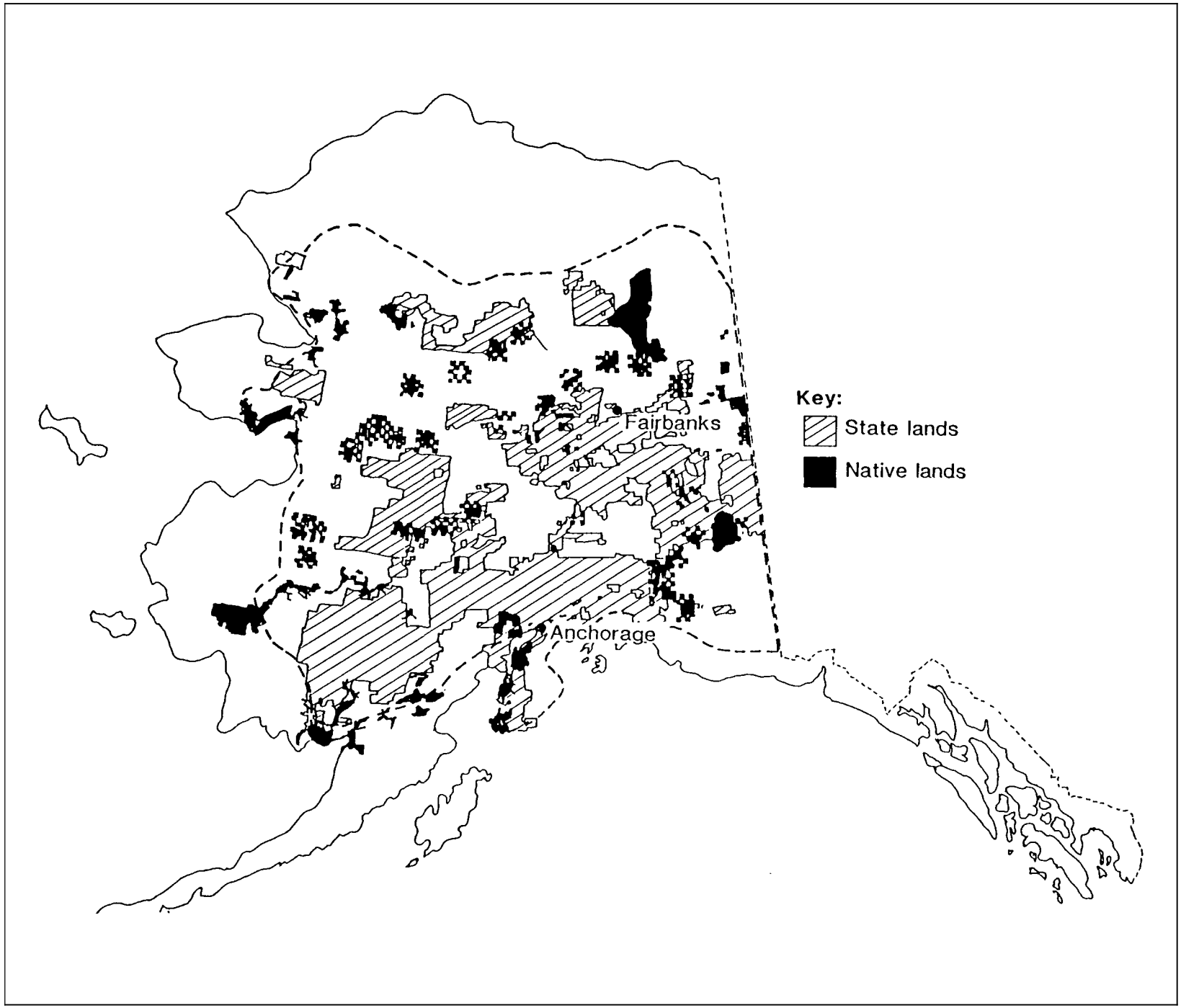

Figure 3—State government and Native corporation lands, 1985.

Native--Alaska Native Claims Settlement Act of **1971** (ANCSA) provided that Native villages receive three to seven townships depending on population (U.S. Department of the Interior, Bureau of Land Management **1980).** The Native regional corporations were also given land entitlement by ANCSA. The Ahtna, Cook Inlet, and Doyon Regional Corporations lie wholly within interior Alaska. These three corporations will eventually hold title to about **11** million surface acres. (The regional corporations also have the subsurface rights to Native village-owned lands within their respective regions.) Native-village holdings within the boundaries of the three corporations will total about **4.8** million acres. No estimates exist of the proportion of these lands that are forested or of timber volumes present. Individual Alaska Natives can claim up to **160** acres of land under the Native Allot- ment Act ***of*** **1906** in instances in which they can show use prior to **1971.** Alaska Natives could receive title to as much as **1.2** million acres under the allotment program (Leask **1985).** In addition to the above lands, there are two Indian reserves: the Venetie Reserve, which covers **1.8** million acres; and the Tetlin Reserve, which covers **743,000** acres. Approximate locations ***of*** Native lands within interior Alaska are shown in figure **3.**

Many Native villages have small sawmills. None of these are known to be operating full time; most operate occasionally to provide lumber or house logs for local use. None are known to be producing sawn lumber or logs for export. In the past, logs from the Toghotthele Corporation (Native) were exported from Nenana via the Alaska Railroad to Seward.

Native lands have the scattered sawtimber stands and low volumes per acre typical of interior Alaska (Hanson **1984, 1985;** Maisch **1984;** Zufelt **1984).** The low volumes limit opportunities for road construction to harvest and manage timber; and for most Native lands, export opportunities are limited because transporting logs or sawn products away from the immediate environs is difficult (Hammons **1981).** The best immediate opportunities for timber harvest and forest management may be on the west side of the Kenai Peninsula where there are large contiguous tracts of timber (Sampson and others **1983).**

Other Private–Private-landownership, other than Native villages or corporations or individual Native allotments, in interior Alaska is less than **1** percent of total land area. In **1985,** an estimated **1.35** million acres in private holdings existed in the entire State (Leask **1985).** Before Alaska became a State in **1959,** all except **65** million acres were open to homesteading, mining, and other uses. An estimated one-half million acres were privately owned in all of Alaska in **1958.** Additions to private holdings since then have come from land-disposal programs by the Bureau of Land Management, the State, and boroughs. State land-disposal programs, mainly for homesteads and agriculture, still occur. These disposal programs will not result in much change in forestry potential on private lands. The largest areas are for agriculture, and clearing of a portion of such land within a prescribed time is required for most disposals.

Production Costs

A number of factors affect economic productivity of softwood products in interior Alaska and their ability to compete with the Pacific Northwest and western Canada firms for local and export markets. Interior Alaska timber has not consistently competed in export markets. Pulp chip exports endured for only a few years as did white spruce log exports from Nenana.

For rough softwood lumber consumed in interior or northern Alaska, Interior producers have had an advantage over an equivalent imported product (or imported dry, surfaced lumber). Some Alaska mills also produce dry, surfaced lumber for local sale. Some local retailers, who also operate sawmills, recognized an advantage in importing dry, surfaced lumber instead of producing it themselves in about **1983.** This change was in part because of a steady gain in strength of the U.S. dollar against the Canadian dollar and the resulting advantage to Canadian lumber exports. The exchange rate of Canadian dollars to U.S. dollars increased from **$1.14** in **1978** to **$1.37** in January **1987.**

Direct cost comparisons between softwood lumber produced in interior Alaska and lumber of comparable quality produced in the lower **48** States and Canada are not possible. Adequate cost data for harvesting, milling, drying, and planing are not available for interior Alaska. Sawmills in the lower **48** States and Canada typically produce a wider range of products, and the prices for dimension lumber and rough timber, the typical Alaska sawmill products, are not comparable to Alaska prices.

Some general inferences can be made about the price competitiveness of softwood lumber from interior Alaska. Lumber price is based on the sum of stumpage, harvesting, log hauling, log storage, milling, lumber drying and planing, marketing, lumber transport, and overhead costs less value of by-products. Only two cost components potentially provide interior Alaska producers an advantage over the lower 48 States and Canadian producers: stumpage costs and lumber transport costs.

Stumpage prices in interior Alaska are lower on a volume basis because stumpage price is typically derived by subtracting all costs from product value. Harvesting and milling costs are a function of technology used in conjunction with timber and terrain characteristics, as well as labor and energy costs. Interior Alaska's timber and terrain have a disadvantage relative to other softwood-timber-producing areas. The individual trees are small and not of high quality. Volumes harvested per acre are small, and harvestable stands are widely scattered. Access roads are generally lacking; and when permafrost soils and boggy areas must be crossed, roadbuilding costs are high.

Unit costs for labor and energy in interior Alaska are generally higher than in all areas in the lower **48** States. Canada has higher energy costs in some areas than Alaska, but labor costs are lower.

Use of high technology allows substitution of fixed-equipment costs for labor (and sometimes energy) to lower total per unit cost. Invariably, the most efficient technology is associated with high levels of production; therefore, the largest producers are the most efficient. In Oregon, for example, sawmills capable of producing **120,000** board feet or more per shift increased their share of the total log volume sawn from **48** percent in **1968** to **89** percent in **1982** (Howard **1984).** Individual interior Alaska mills cannot get long-term commitment of a sufficient volume of timber to justify investment in higher technology, and this is one reason they are less efficient.

Lumber produced in interior Alaska has a cost advantage for shipping to Alaska railbelt markets and a potential (but unrealized) advantage for shipping to China, Japan, Korea, and Taiwan. Instate shipments by truck or rail to the railbelt from within the Interior cost $10 to $50 per thousand, whereas out-of-state shipments cost $60 to $120 per thousand, depending on product and species (Knapp and Foster 1986). The potential advantage for shipping from interior Alaska to the northern Pacific Rim countries has not been developed because the volume is insufficient to justify full ship loads directly from Alaska. Instead, small amounts are shipped via Seattle which adds extra handling as well as extra shipping distance.

Interior Alaska mills are competitive with out-of-state mills for small timbers (less than 12 inches) and rough lumber for local use. Dry, planed and graded lumber consumed in Alaska, however, is provided almost entirely from outside Alaska. Production of dry, planed and graded softwood lumber from the interior will probably require the addition of dry kilns which, in turn, require larger annual production for individual mills and, hence, greater timber supplies.

The problems of establishing economically viable forestry operations in interior Alaska are demonstrated by recent efforts to expand the operable timber base in the Tanana Valley. In 1983, the Alaska legislature designated 1.8 million acres in the Tanana Valley as the Tanana Valley State Forest. This forest includes State lands previously designated for forest management and stretches the entire length of the Tanana Valley, about 280 air miles in length.

A management plan for the Tanana Valley State Forest is now being prepared by the Alaska Department of Natural Resources. Preliminary planning indicates that harvested areas would have to return $257 per acre for white spruce types and $153 per acre for hardwood types to cover the costs of secondary roads and reforestation (Alaska Department of Natural Resources, Division of Forestry 1987). The cost of all-season secondary roads is estimated to be $115 per acre and reforestation cost at $142 per acre for spruce stands and $38 per acre for hardwood stands. With assumed stumpage returns of $36.87 per thousand board feet for spruce sawtimber and $10.95 per hundred cubic feet for mixed-species fuelwood, only 254,000 acres (or 14 percent of the Forest area) are potentially harvestable if spruce sawtimber is the product sought. If only spruce and spruce-hardwood types are considered, 20 percent of the area is operable, given the cost and return parameters above.

Future Cost Competitiveness of the Interior

The major question affecting the feasibility of increased production of softwood lumber in interior Alaska for local use is whether it can be cost competitive with lumber from the Pacific Northwest and British Columbia. The current Canadian advantage, caused by a favorable exchange rate, may disappear in the future because of changes in the exchange rate or changes in the cost of production factors in Canada. Lumber from the Pacific Northwest continues to be imported to the railbelt area. Interior Alaska cannot significantly increase production under the current mode of operation.

Processing Alternatives

The physical nature of interior Alaska timber stands results in high road and harvest costs per unit of volume. High volume (more than 15,000 board feet per acre) sawtimber stands are widely scattered and each stand occupies a small area (Hegg 1975b). If 800 cubic feet or more of growing stock per acre is used as a prerequisite for identifying harvestable forest land, only a small proportion of inventory units in the Kuskokwim, Susitna, and Tanana Valleys are harvestable (fig. 4). Spruce timber constitutes the majority of the growing-stock volume on timberland in the Kuskokwim and Tanana Valleys. Hardwoods make up most of the growing stock volume in the Susitna Valley (fig. 5).

The hardwood growing stock is relatively small in the Kuskokwim and Tanana Valley inventory units, and spruce makes up nearly all of the sawtimber volume on timberland (fig. 6). In the Susitna Valley units, most of the sawtimber volume on timberland is cottonwood (including balsam poplar) and paper birch.

Industry expansion alternatives--One alternative for increasing production of softwood lumber in the interior Alaska is to increase the number of small sawmills. For example, 500 small sawmills each producing 4,000 board feet per week would produce 100 million board feet in a year if each were operated 50 weeks. The other extreme would be five sawmills each producing 400,000 board feet per week. Production of 400,000 board feet per week is not exceptionally large for sawmills in the Pacific Northwest, British Columbia, or southeast Alaska. In southeast Alaska where nearly all output is exported, combined production of the two largest sawmills averaged more than 2 million board feet per week in 1984 (USDA Forest Service 1986). Problems inherent with either of the two extremes described above are discussed in the following sections.

Expansion of current system of small sawmills--If 500 sawmills each produced 4,000 board feet per week, 167 timber sales averaging 600,000 board feet would be required per year to supply them. The Alaska Division of Forestry had 26 commercial saw-log sales in the interior in 1984. These sales included 8.9 million board feet of saw logs (Scribner scale) or less than one-tenth of softwood lumber consumption in Alaska in high-use years.

Drying, planing, and grading are major problems if a large volume of lumber is produced by many small sawmills. Nearly all the softwood lumber imported to Alaska is planed and graded. If locally produced lumber is to be substituted for these imports, it will also have to be planed and graded. Some of interior Alaska's small mills have planers; most do not have dry kilns. Mills with low production cannot economically have kiln drying and lumber grading capabilities. Both fixed costs and operating costs decrease per unit of volume from the smallest kilns to the largest kilns (Rosen 1980, Shottafer and Shuler 1974). Each mill that is a member of an existing lumber-grading agency must pay a periodic cost of certifying their grader(s) as well as an assessment based on volume graded.

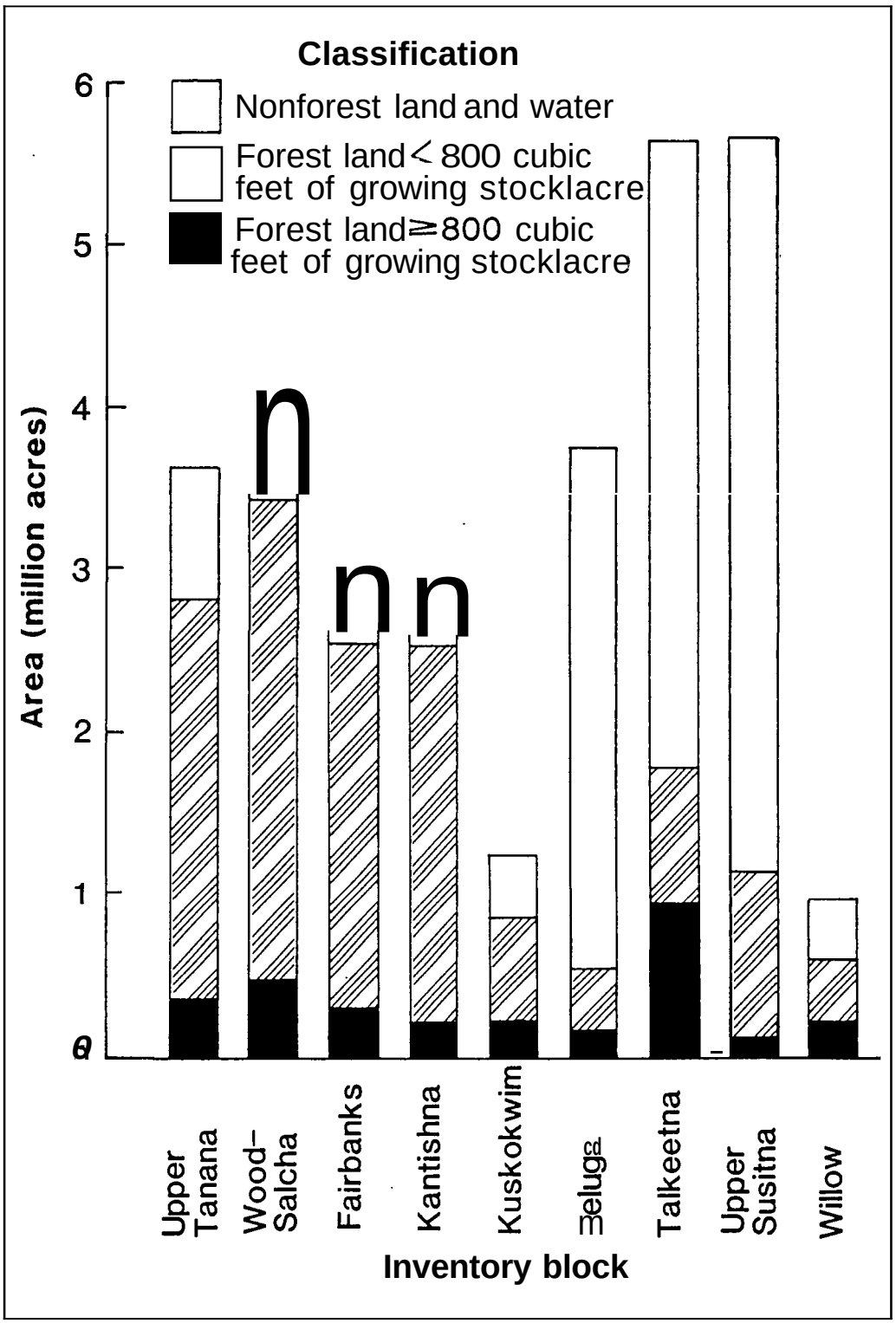

Figure 4—Land area by land class for inventory blocks in the Kuskokwim, Susitna, and Tanana Valleys.

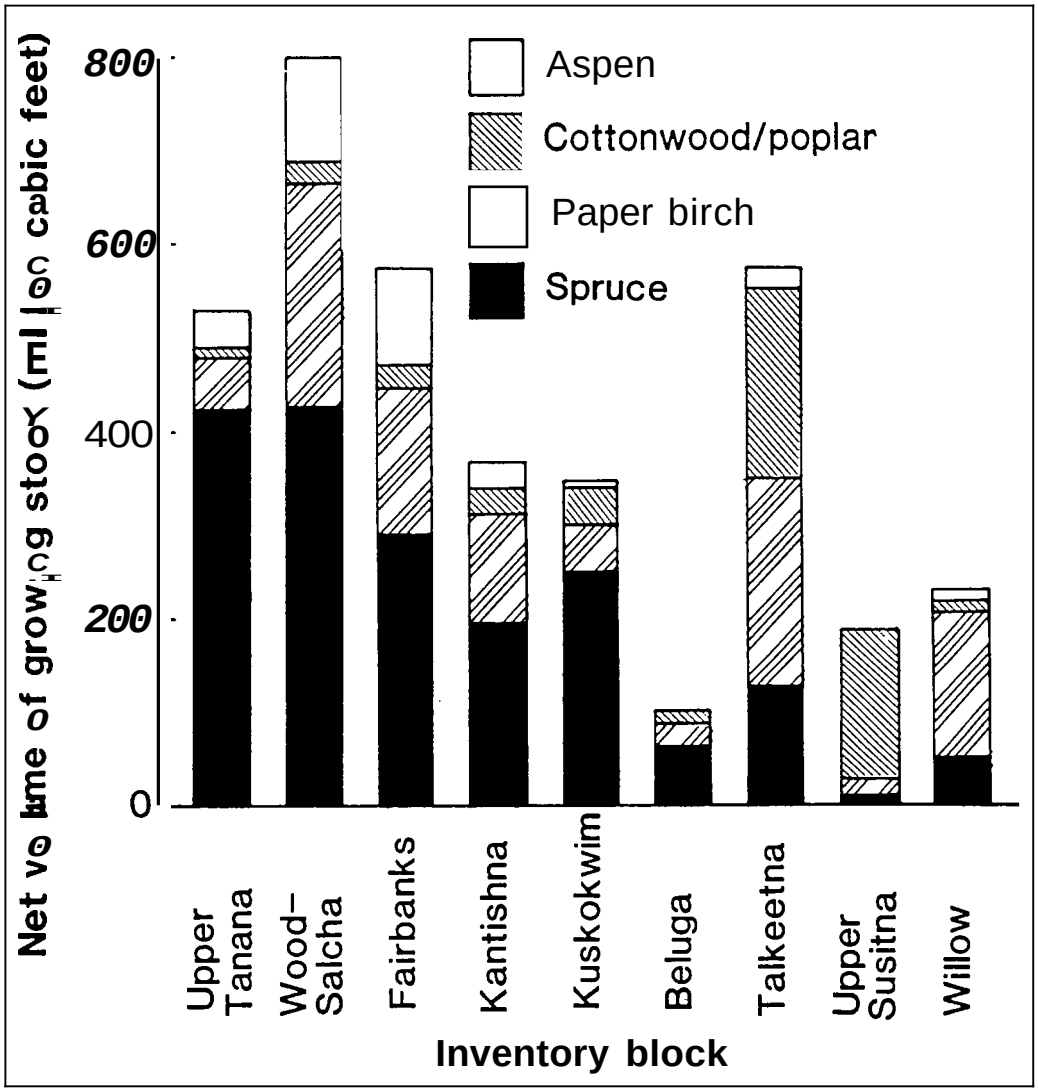

Figure 5—Growing stock on timberland by species for inventory blocks in the Kuskokwim, Susitna, and Tanana Valleys.

The output from individual sawmills could be pooled at a concentration yard where lumber could be dried, planed, graded, and marketed. This would permit economies of scale in drying, planing, grading and marketing, but additional handling costs would be incurred. The lumber concentration yard could be independent or could be a co-operative effort. In either case, the individual sawmills would have to be able to sell their rough production to the concentration yard at an advantage over the open market.

Access to timber is a problem regardless of whether future lumber production is by many small mills or a few large ones. The option of the timber buyer building roads is essentially eliminated for small volume buyers. During the 1980's, virtually all commercial timber harvesting in interior Alaska has been done from the existing road system. The only roadbuilding that has been required on State timber sales has been onsite, although these roads often provide access to a future timber sale. The 5-year harvest plan submitted in May 1985 for the northern region of the Alaska Department

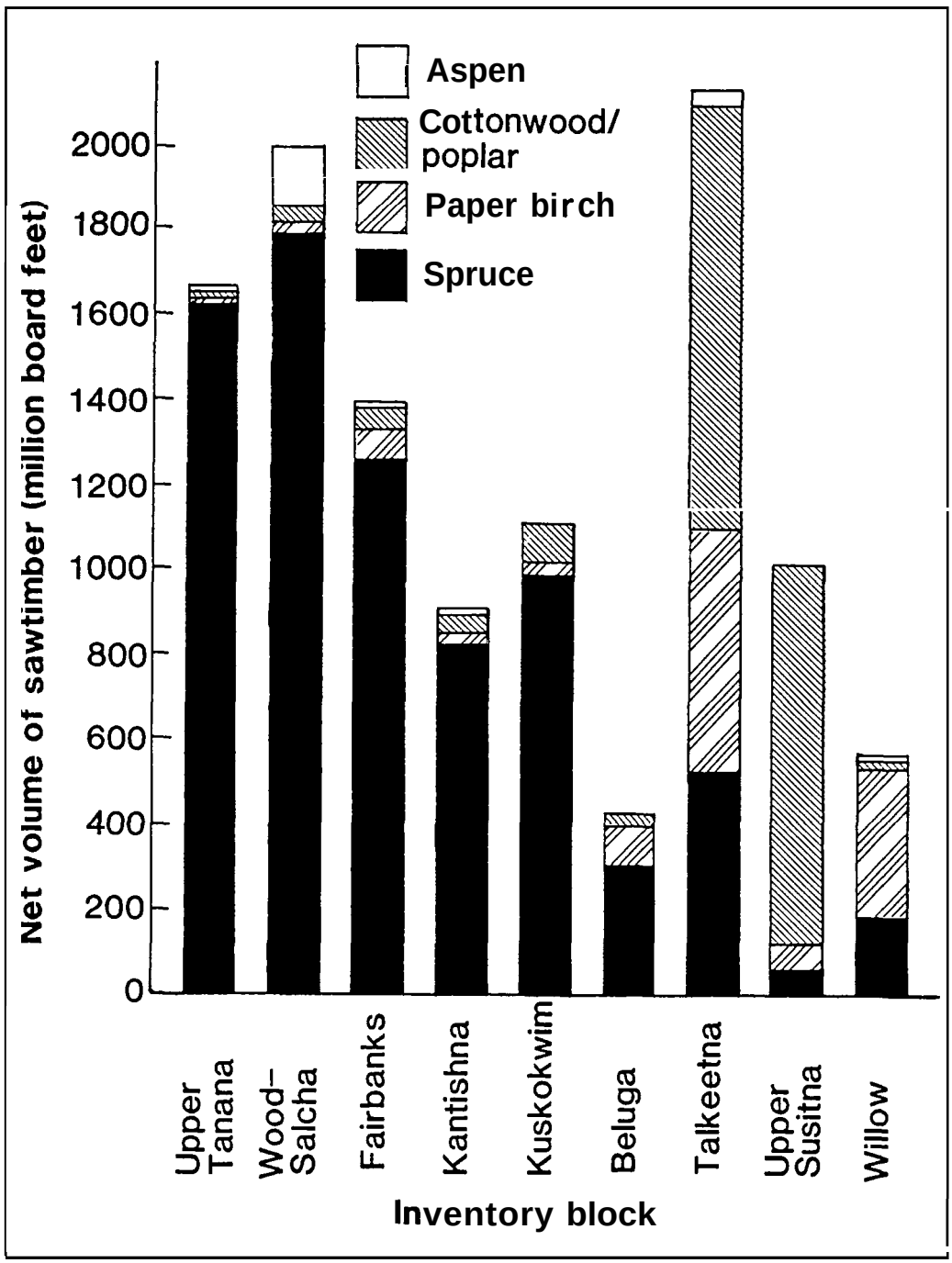

Figure 6—Sawtimber on timberland by species for inventory blocks in the Kuskokwim, Susitna, and Tanana Valleys.

Department of Natural Resources, Division of Forestry required building 16.5 miles of new road. This small amount of roadbuilding indicates that the lands now designated for forest management are close to the existing road system.

Large sawmill **alternative--**If most of the future softwood lumber consumed in Alaska were to be produced by a few large mills (400,000 board feet per week or 20 million board feet per year), major modifications would probably have to be made in the size of timber sales offered. Thirty-three sales of 600,000 board feet each would be required to meet the annual timber needs of one of these mills. A large mill would have to devote major effort to evaluating timber sales and bidding on them if the policy of small volume sales were continued. Given the existing road system, a large mill would have to get much of its annual supply of timber from nonroaded areas.

The area formerly designated as the Fairbanks Working Circle includes all State lands classified as forest management and resource management lands within about a 60-mile radius of Fairbanks. Of the 700,000 acres of State-owned land within this working circle, 242,500 acres, or 35 percent, were classified as commercial forest land (timberland). The determined annual allowable harvest of white spruce sawtimber for the Fairbanks Working Circle is 4.1 million board feet (Wieczorek 1980). Allowable harvests from State-owned lands in the Delta Junction and Tok areas (both within the Tanana Valley) have not been established, but planned annual harvests are about 1.5 million board feet and 500,000 board feet, respectively.[3] The Fairbanks Working Circle and previously managed land near Delta Junction and Tok are included in the Tanana Valley State Forest created in 1983. The management plan for this forest has not been finalized, but preliminary planning indicates an average annual harvest of 9.6 million board feet of spruce sawtimber--far below annual requirements of a "large sawmill."

Harvesting Alternatives

The net annual growth of the Tanana Valley's softwood sawtimber is about 50 percent greater than the State's annual consumption of softwood lumber. Road access to this timber, however, is generally lacking. One possibility is to take advantage of roads that may be built for mineral development to access harvestable timber where possible. Near-future road development is not likely to be swift or extensive (for example, see Louis Berger and Associates 1982). If timber harvesting is to proceed at a faster rate than road development, special methods will have to be used to move timber from the stump to the existing road system or to industrial sites. Possible ways of doing this include: (1) winter roads and (2) log rafts or barges on rivers.

Winter roads--Winter roads and ice bridges could be used for access to timber. A winter road is essentially a cleared path where vehicles are supported by the frozen condition of the substrate rather than by compaction (Lotspeich and Helmers 1974). The period when such roads are usable varies from year to year and by location. In the Fairbanks area, normal daily high temperatures drop below freezing around October 20 and do not rise to the melting point until the end of March. Generally, mid-November to the end of March is the possible period for travel on winter roads. Logs can be hauled by truck over such roads, but large loads hauled by rubber-tired skidders at speeds of 5 to 10 miles per hour might work better. In the "horse-hauling" days, two-horse teams hauled sled loads containing as much as 4 cords into Fairbanks for fuel (Alaska Geographic Society 1985).

[3] From Alaska Division of Forestry's northern region five-year harvest plan, May 1985.

An interior Alaska transportation study used a figure of **$13,000** per mile for winter roads **26** to **40** miles long (Louis Berger and Associates, Inc. **1982).** Each road segment carried an annual cost of $4,000 or $100 to **$160** per mile for maintenance. The Division of Forestry (Alaska Department of Natural Resources **1987)** estimates that **costs** for secondary roads could be reduced from **$1 15** to **$41** per acre if temporary winter roads were used.

Log **rafts** and barges--An alternate to roads for hauling timber to the sawmill is water, by use of log rafts or barges. Logs were floated downstream on the Chena and Salcha Rivers to early sawmills in the Fairbanks area. This practice is still used occasionally on the Kuskokwim and Yukon Rivers. Such future operations on a larger scale have also been proposed (Hammons **1981,** Marshall **1981).** Barges operate seasonally on the Kuskokwim River from Bethel to McGrath and on the Tanana and Yukon Rivers from Nenana downstream to Galena and upstream to Fort Yukon.

Drawbacks ***of*** nonroadbulldlng alternatives-Use of winter roads or river barging or rafting eliminates costly road construction and maintenance but also presents unique problems. Although winter roads and ice bridges cost considerably less than standard project roads buitt across similar terrain, winter roads can be traveled only when they are frozen; traveling on these roads and ice bridges too early or late in the season can have expensive and dangerous consequences. The short hauling season for winter roads, at best, requires careful planning to efficiently use harvesting and hauling equipment on both winter roads and roads that provide access for summer logging. Likewise, the rafting and barging season is short in interior Alaska, generally running from late May through August. Only shallow draft barges can be used because of water depths. The absence of conventional access roads makes timber-sale layout and administration more difficult and expensive and complicates harvesting and postharvest silvicultural activity.

Creating an accessible forest--Natural succession with continuing fire protection may result in a slow increase in area of spruce sawtimber over time as some hardwood stands are replaced by white spruce as suggested by Van Cleve and Viereck **(1981). The** existing timber stand conditions and wood product markets in interior Alaska, however, tend to foster adoption of silvicultural systems that will perpetuate the fragmented spruce stands existing today. The only major markets besides those for fuelwood are for softwood lumber and spruce house logs. A very small proportion of the existing area is occupied by white spruce timber with a high enough volume to be harvested economically.

Planting of harvested white spruce areas or scarification to allow natural regeneration from nearby spruce seed sources may lead to spruce reforestation. Hardwood timber stands that are harvested are most easily regenerated to hardwoods. Regenerating harvested areas with the least expensive methods will limit the area of future white spruce sawtimber to little more than the small amount that currently exists. For example, white spruce sawtimber occupies only **407,169** acres in the Tanana Valley, or **3** percent of the **13.6** million acres inventoried in this unit (van Hees **1984).**

Reforestation with white spruce on large contiguous blocks close to the road system would result in a future forest much more economically accessible than the scattered fragments that exist now. At this time and presumably until a white spruce stand established now would mature (80 to 120 years), white spruce on large contiguous blocks close to the road system would be much more valuable than the vegetation that would be replaced. Forest-type conversion to achieve large contiguous blocks of white spruce close to the road system, however, seems unlikely unless the existing biomass can be processed into a salable product.

Electric power generation plants north of the Alaska Range in the Interior consumed an average 710,000 tons of coal per year from 1972 to 1980 (Fairbanks North Star Borough 1980). If green wood could be substituted for 10 percent of the coal at the rate of **2** tons of green wood for 1 ton of coal, an annual market for 142,000 tons of wood would be created. This would provide an outlet for biomass of 3,000 to 4,000 acres annually. Research is in progress on burning wood chips mixed with coal at Fort Wainwright, near Fairbanks. In October 1986, successful burning tests were made with wood chips amounting to 24 percent of the fuel mix. More test burning is planned for 1987, including effects on stack emissions from adding wood to the coal fuel.

Summary and Conclusions

Interior Alaska presents an enigma to those interested in expanding forest industry production. Total annual growth of white spruce sawtimber is more than tenfold current harvest. Alaska's consumption of softwood lumber is more than five times the softwood timber harvest in all the interior. Volumes of 15,000 board feet per acre can be found (Hegg 1975b); however, most of the white spruce sawtimber volume is in widely scattered stands. The existing sawmills have difficulty acquiring sufficient volumes *of* sawtimber stumpage to maintain their current level of production. Little can be done to improve interior Alaska's competitive position in softwood lumber in the short-run.

In 1977, Zivnuska suggested a possible strategy for the management and use of interior forests.

> Here, then, is one scenario for the role of high-latitude forests of Alaska: a planned continuance of current subsistence uses, with the development, in more favorable situations, of a commercial industry serving primarily Alaskan markets. With this would go the maintenance of options to respond in the future to the much more remote and conjectural possibility of a world demand for timber from interior Alaska.

Little has apparently changed in the intervening 10 years, and the scenario also serves well today. At least a dozen full-time commercial mills operate in interior Alaska, providing employment and valuable products for the economy. Most are constrained from investment for major expansion or efficiency improvement by the lack *of* an assured future timber supply. Entrepreneurs continue to show interest in exporting interior Alaska hardwoods and white spruce to Pacific Rim countries. So far, these apparent "demand" and "timber supply alternatives" have not meshed to provide a sustained operation.

In the long run (80 years or more), major improvements can be made in the timber supply by developing larger contiguous areas of harvestable timber. Conversion of some hardwood and black spruce types to white spruce or lodgepole pine could increase the area and volume in contiguous harvestable stands adjacent to the existing road system. The use of biomass for fuel in existing powerplants could result in enough value recovered to make the conversions economically feasible. Land managers, however, must consider the net benefits before implementing a plan of site conversion.

Metric Equivalents

1 inch = 25.4 millimeters
1 inch = 0.0254 meter
1 foot = 0.3048 meter
1 cubic foot = 0.0283 cubic meter
1 cubic foot per acre = 0.06997 cubic meter per hectare
1 square foot (3/8-inch basis) = 0.0929 square meter (9.525-millimeter basis)

References

Alaska Department of Natural Resources, Division of Forestry. 1983. Alaska 1983-1984 forest industry directory. Anchorage, AK. 48 p.

Alaska Department of Natural Resources, Division of Forestry. 1987. Tanana Valley State Forest forest management plan public review draft. Fairbanks, AK. 226 p.

Alaska Geographic Society. 1985. Alaska's forest resources. Alaska Geographic. 12(2): 109 p.

Alaska National Interest Lands Conservation Act of Dec. 2, 1980. 94 Stat. 2371, as amended; 16 U.S.C. 3101-3233.

Alaska Native Claims Settlement Act of Dec. 18, 1971. 85 Stat. 688, as amended; 43 U.S.C. 1601-1629a.

Brady, Terry T. 1971. Special report concerning the lumbering potential of the middle Yukon Valley. Anchorage, AK: Alaska State Office of Economic Opportunity. 20 p.

Carroll, Gary L.; Setzer, Theodore S.; Mead, Bert R. 1985. Timber resource statistics for the Beluga block, Susitna River basin multiresource inventory unit, Alaska, 1980. Resour. Bull. PNW-121. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 48 p.

Clapp, Verner; Homan, Frank; Marsh, Bernard [and others]. 1970. Feasibility of utilizing Kuskokwim forest resources. Second report to the Federal Field Committee for Development Planning in Alaska. [Location of publisher unknown]: Koskokwirn Forest Resource Committee. 12 p.

Clapp, Verner; Sorenson, Robert; Sachek, Wlllam [and others]. 1969. Feasibility of utilizing Kuskokwim forest resources at the Bethel housing project. A report to the Federal Field Committee for Development Planning in Alaska. [Location of publisher unknown]: Koskokwim Forest Resource Committee. 27 p.

Columbia Engineering International, Ltd. 1982. An investigation into land clearing methods and the utilization of salvaged wood fiber from the Nenana agricultural project. Juneau, AK: Alaska Agricultural Action Council. 95 p.

Fairbanks North Star Borough, Communlty lnformatlon Center. 1980. The energy report. 1(3). Fairbanks, AK: Fairbanks North Star Borough, Community Information Center. 33 p.

Gray, John. 1980. Alaska's unique transportation system. Alaska review of social and economic conditions. 17(2). Anchorage, AK: University of Alaska, Institute of Social and Economic Research. 28 p.

Hallock, H. 1962a. Report on several aspects of the proposed Brice lumber company sawmilling enterprise at Fairbanks, Alaska. Unpublished report. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, **WI.** 20 p.

Hallock, Hiram. 1962b. Report and recommendations on the Alaska Hardwoods Company of Wasilla, Alaska. Unpublished report. U.S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, WI. 29 p.

Hammons, John. 1981. Forest development potential in the middle Kuskokwim. Anchorage, AK: Reid, Collins Inc. *156* p.

Hanson, Douglas. 1985. Forest resources Nenana Village lands, Nenana Ridge, and Solider Slough resource areas Alaska, 1985. Fairbanks, AK: Tanana Chiefs Conference, Inc. 24 p., plus appendix.

Hanson, Douglas. 1984. Forest resources Rampart Village/Yukon River watershed Alaska 1984. Fairbanks, AK: Tanana Chiefs Conference, Inc. 23 p., plus appendix.

Harpole, George B.; Guss, Leonard M.; Ganes, Robert C.; Grantham, John B. 1977. Feasibility of structural particleboard manufacture in Alaska. Fairbanks, AK: Fairbanks Industrial Corporation. 128 p., plus appendix.

Hegg, Karl M. 1970. Forest resources of the Susitna Valley, Alaska. Resour. Bull. PNW-32. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 42 p.

Hegg, Karl M. 1974. Forest statistics for the Upper Koyokuk River, Alaska, 1971 Resour. Bull. PNW-54. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 26 p.

Hegg, Karl M. 1975a. Timber resource statistics for the Copper River inventory unit, Alaska, 1968. Resour. Bull. PNW-62. Portland, OR: U.S. Department of Agricutture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 55 p.

Hegg, Karl M. 1975b. Timber resource statistics for the Fairbanks block, Tanana inventory unit, Alaska, 1970. Resour. Bull. PNW-59. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 36 p.

Hegg, Karl M. 1982. Timber resource statistics for the Kantishna block, Tanana inventory unit, Alaska, 1973. Resour. Bull. PNW-95. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 32 p.

Hegg, Karl M. 1983. Timber resource statistics for the upper Tanana block, Tanana inventory units, Alaska, 1974. Resour. Bull. PNW-100. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 34 p.

Hegg, Karl M.; Sleverding, Harold. 1979. Timber resources of the Kuskokwim flood plain and adjacent upland. Resour. Bull. PNW-87. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 40 p.

Howard, James O. 1984. Oregon's forest products industry: 1982. Resour. Bull. PNW-118. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 79 p.

Hutchison, O. Keith. 1967. Alaska's forest resources. Resour. Bull. PNW-19. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 74 p.

Hyde, William F.; Krutlla, John V. 1979. The question of development or restricted use of Alaska's interior forests. The Annals of Regional Science. 13(1): 1-10.

Keliogg, R.S. 1910. The forests of Alaska. Bull. 81. Washington, DC: U.S. Department of Agriculture, Forest Service. 24 p.

Kllborn, Kenneth A.; Ruppert, Forrest A.; Nelson, Garry S. 1981. A small sawmill venture to supply wood products needs for the Kuskokwim River market area. Unpublished report, The Kuskokwim Corporation. 22 p.

Knapp, Gunnar; Foster, Karen. 1986. Alaska railbelt markets: volumes and prices. Anchorage, AK: Alaska Department of Commerce and Economic Development. 16 p., plus appendix.

Koweluk, Kay. 1970. Local market demand for timber products in the middle Yukon and upper Kuskokwim Rivers. Unpublished report. Community Enterprise Development Corporation. 67 p.

Leask, Linda. 1985. Changing ownership and management of Alaska lands. Alaska review of social and economic conditions. 22(2). Anchorage, AK: University of Alaska, Institute of Social and Economic Research. 32 p.

Lindh, Craig J. 1979. An excellent assessment of the domestic market for Alaska wood products. Juneau, AK: Division of Economic Enterprise, Department of Commerce and Economic Development. 32 p.

Lotspelch, Frederick B.; Helmers, Austin E. 1974. Environmental guidelines for development roads in the subarctic. EPA-660/3-74-009. Corvallis, OR: U.S. Environmental Protection Agency, Office of Research and Development, Arctic Environmental Research Laboratory. 63 p.

Louis Berger and Associates, Inc. 1982. Interior Alaska transportation study: project identification and evaluation. Fairbanks, AK: State of Alaska Department of Transportation and Public Facilities. 198 p. Vol. **4.**

Lutz, H.J. 1963. Early forest conditions in the interior: an historical account with original sources. Juneau, AK: U.S. Department of Agriculture, Forest Service, Northern Forest Experiment Station. 74 p.

Maisch, John C. 1984. Forest resources of Doyon, Ltd. pre-selection lands Kantishna River watershed Alaska, 1983. Fairbanks, AK: Tanana Chiefs Conference, Inc. 30 p., plus appendix.

Marshall, H.G.W. 1981. Forest resource development for interior Alaska. Anchorage, AK: Reid, Collins Inc. 71 p.

Massle, Michael R.C. 1966. Marketing hardwoods from Alaska's Susitna Valley. SEG Rep. 9. College (Fairbanks), AK: University of Alaska, Institute of Social, Economic and Government Research. 162 p.

Mead, Bert R.; Setzer, Theodore, S.; Carroll, Gary L. 1985. Timber resource statistics for the Upper Susitna block, Susitna River Basin multiresource inventory unit, Alaska, 1980. Resour. Bull. PNW-122. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 47 p.

Reeder, Brian; Goldsmith, Scott; White, Karen; Knapp, Gunnar. 1983. Map model regional base case projections 1980-2010 for use in OCS lease sale 87 (Diapir Field) impact analysis. Anchorage, AK: University of Alaska, Institute of Social and Economic Research. 28 p.

Rosen, Howard N. **1980.** Kiln size affects energy required to dry lumber. Res. Note NC-256. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 2 p.

Ryan, Richard J. 1982. Kenai Peninsula timber supply and marketing opportunities. Anchorage, AK: Reid, Collins Alaska, Inc. 50 p. plus appendix.

Sampson, George R.; Gasbarro, Anthony F.; Ruppert, Forrest A. [and others]. 1983. Chapter 13 forestry in Alaska. In: Alaska's agriculture and forestry. Alaska Rural Development Counc. Publ. 3. Fairbanks: Cooperative Extension Service, University of Alaska and U.S. Department of Agriculture: 177-199.

Setzer, Theodore S. 1987. Timber resource statistics for the Porcupine inventory unit, Alaska, 1978. Resour. Bull. PNW-RB-141. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 32 p.

Setzer, Theodore S.; Carroll, Gary L.; Mead, Bert R. 1984a. Timber resource statistics for the Talkeetna block, Susitna River basin multiresource inventory unit, Alaska, 1979. Resour. Bull. PNW-115. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest. Forest and Range Experiment Station. 47 p.

Setzer, Theodore S.; Mead, Bert R.; Carroll, Gary L. 1984b. Timber resource statistics for the Willow block, Susitna River basin multiresource inventory unit, Alaska, 1978. Resour. Bull. PNW-114. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 45 p.

Shottafer, James E.; Shuler, Craig E. 1974. Estimating heat consumption in kilndrying lumber. Tech. Bull. 73. Orono, ME: University of Maine. 25 p.

Smith, RIchard C. 1980. Potential economic development of forest resources in interior Alaska. Columbia, MO: University of Missouri, School of Forestry, Fisheries and Wildlife. 57 **p.**

Taiga Resource Consultants. 1986. Kenai Peninsula Borough forest resources management plan. Girdwood, AK. 37 p., plus appendix.

U.S. Department of Agriculture, Forest Service. 1982. An analysis of the timber situation in the United States 1952-2030. For. Resour. Rep. 23. Washington, DC. 499 p.

U.S. Department of Agriculture, Forest Service. 1984. Chugach National Forest land and resource and management plan. Admin. Doc. 1278. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 320 p.

U.S. Department of Agriculture, Forest Service. 1986. Timber supply and demand 1985. Alaska National Interest Lands Conservation Act Section 706 (a). Rep. 5. Juneau, AK: U.S. Department of Agriculture, Forest Service, Alaska Region. 35 p.

U.S. Department of the interior, Bureau of Indian Affairs. 1978. Alaska natives regional profiles. Rep. 269. Billings, MT: U.S. Department of the Interior, Bureau of Indian Affairs, Planning Support Group: 1-1 to 12-8.

U.S. Department of the Interior, Bureau of Land Management. 1980. Alaska Native Claims Settlement Act of 1971 and Amendments of 1973-1979. Anchorage, AK: U.S. Department of the Interior, Bureau of Land Management. 52 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1985a. Kenai National Wildlife Refuge final comprehensive conservation plan, environmental impact statement and wilderness review. Anchorage, AK. 195 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1985b. Record of decision Kenai National Wildlife Refuge comprehensive conservation plan, environmental impact statement and wilderness review. Anchorage, AK. 11 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1987. Yukon Flats National Wildlife Refuge comprehensive conservation plan, environmental impact statement, and wilderness review final. Anchorage, AK. 422 p.

Van Cleve, K.; Viereck, L.A. 1981. Forest succession in relation to nutrient cycling in the boreal forest of Alaska. In: West, D.; Shugart, H.; Botkin, D., eds. Forest succession: Concepts and applications. New York: Springer Advanced Texts in Life Sciences: 185-211.

van Hees, Willem W.S. 1984. Timber resource statistics for the Tanana inventory unit, Alaska, 1971-75. Resour. Bull. PNW-109. Portland, **OR:** U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 36 **p.**

van Hees, Willem W.S. 1987. Timber resource statistics for the Upper Yukon inventory unit, Alaska, 1980. Resour. Bull. PNW-RB-146. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 60 p.

Wieczorek, Daniel H. 1980. Forest resource and allowable cut Fairbanks working circle. Fairbanks, AK: State of Alaska, Department of Natural Resources, Division of Forest, Land, and Water Management. 98 p., plus appendix.

Winterberger, Kenneth C. 1983. Timber resource statistics for the Wood-Salcha block, Tanana inventory unit, Alaska, 1975. Resour. Bull. PNW-107. Portland, **OR:** U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 34 p.

Zasada, Zigmond A. 1976. Forest products potential of the Yukon-Kuskokwim River areas in interior Alaska. Unpublished report. U.S. Department of Agriculture, Forest Service Alaska Planning Team, Alaska Region, Juneau, AK. 15 p.

Zivnuska, John A. 1977. The role of high-latitude forests in meeting human expectations. In: North American forest lands at latitudes north of 60 degrees: Proceedings of a symposium; 1977 September 19-22; Fairbanks, **AK.** Fairbanks, AK: University of Alaska: 3-17.

Zufelt, William J. 1984. Forest resources Fort Yukon Village Yukon/Porcupine corridor Fort Yukon vicinity Alaska, 1984. Fairbanks, AK: Tanana Chiefs Conference, Inc. 20 p., plus appendix.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1988- 591-132182020

Sampson, George R.; van **Hees, Willem** W.S.; **Setzer, Theodore S.; Smlth,** RIchard C. 1988. Potential for forest products in interior Alaska. Resour. Bull. PNW-RB-153. Portland, OR: U.S. Department of Agriculture, Forest Service, Paafic Northwest Research Station. 28 p.

Future opportunities for producing Alaska forest products were examined from the perspective of timber supply as reported in timber inventory reports and past studies of forest products industry potential. The best prospects for increasing industrial production of forest products in interior Alaska are for softwood lumber. Current softwood lumber production in the Interior is less than 20 percent of the average annual softwood lumber consumption in Alaska. The dispersed nature of harvestable timber and the attendant poor access are major obstacles to increasing the interior's softwood lumber production. A long-term alternative is to convert hardwood types and black spruce type to contiguous stands of white spruce.

Keywords: Forest products output, *Picea glauca*, white spruce, interior Alaska, Alaska (interior).

The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — **as** directed **by** Congress — to provide increasingly greater service to a growing Nation.

The U.S. Department of Agriculture is an Equal Opportunity Employer. Applicants for all Department programs will be given equal consideration without regard to age, race, color, sex, religion, or national origin.

Pacific Northwest Research Station
319 S.W. Pine St.
P.O. Box 3890
Portland, Oregon **97208**

U.S. Department of Agriculture
Pacific Northwest Research Station
319 S.W. Pine Street
P.O. Box 3890
Portland, Oregon 97208

BULK RATE
POSTAGE +
FEES PAID
USDA-FS
PERMIT No. G-40

Official Business
Penalty for Private Use, $300

do NOT detach label