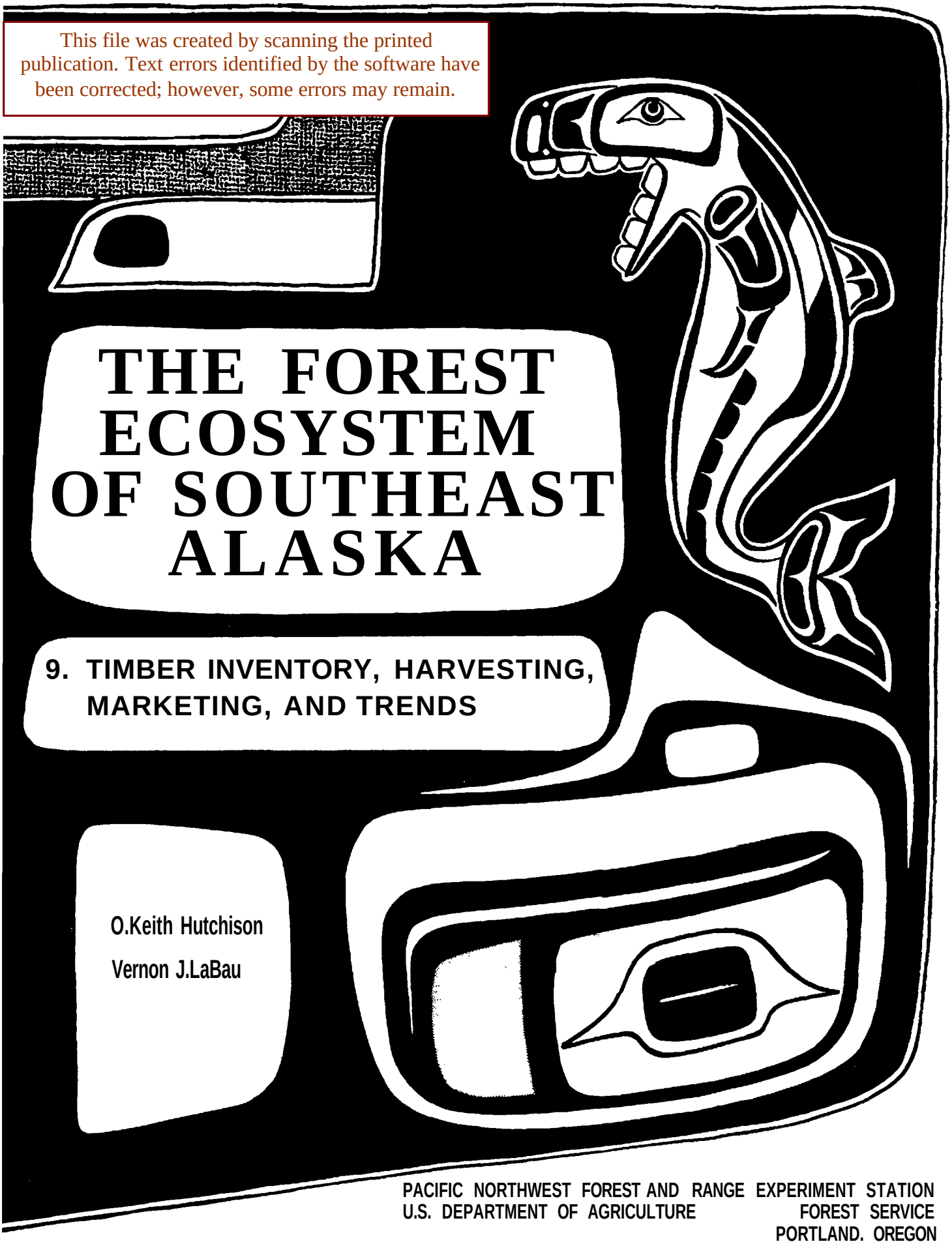
USDA FOREST SERVICE GENERAL TECHNICAL REPORT PNW-34



THE FOREST ECOSYSTEM OF SOUTHEAST ALASKA

9. TIMBER INVENTORY, HARVESTING, MARKETING, AND TRENDS

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ABSTRACT

Southeast Alaska has 11.2 million acres of forest land, of which 4.9 million acres are considered commercial. This commercial acreage supports 166 billion board feet of sawtimber. These primarily old-growth stands of Sitka spruce and western hemlock are supporting a growing wood products industry that ranks first in the southeast economy and third in the State.

This report summarizes current knowledge of the timber resource (areas, volumes, growth, mortality, quality, productivity, and trends) from the initial inventory, a partial remeasurement, and a second inventory now in progress. Historical data of wood products use, output, value, and markets are given and discussed.

The report gives sources for much published and unpublished information for those who need to pursue these subjects more completely.

Keywords: Resources (forest), timber operations (general), timber marketing.

PREFACE

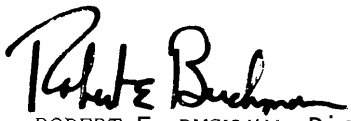
This is the ninth in a series of publications summarizing knowledge about the forest resources of southeast Alaska.

Our intent in presenting the information in these publications is to provide managers and users of southeast Alaska's forest resources with the most complete information available for estimating the consequences of various management alternatives.

In this series of papers, we will summarize published and unpublished reports and data as well as the observations of resource scientists and managers developed over years of experience in southeast Alaska. These compilations will be valuable in planning future research on forest management in southeast Alaska. The extensive lists of references will serve as a bibliography on forest resources and their utilization for this part of the United States.

Previous publications in this series include:

1. The Setting
2. Forest Insects
3. Fish Habitats
4. Wildlife Habitats
5. Soil Mass Movement
6. Forest Diseases
7. Forest Ecology and Timber Management
8. Water



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INTRODUCTION

Forests are a dynamic biological phenomenon requiring constant monitoring in order to determine, understand, and update our knowledge of the resources for regional, State, and national management planning. Forest inventory is such a monitoring system. It concentrates, first of all, on estimating the magnitude of the timber resource, and then on describing the stands in terms of conditions and changes due to natural and manmade causes.

Forest inventory work began in southeast Alaska in 1954.[1] One of the first tasks was to determine the land area of the mainland, the various islands, and the working circles used by Region 10 of the U.S. Forest Service in managing forests. This was done using 1:250,000 scale maps.[2] Inventory is done by sampling; a double sampling technique has been followed in southeast Alaska. The first sample consists of classifying a large number of point locations on aerial photos. A sample of these are then randomly selected and field checked for land classification accuracy and measured for tree and volume data.[3]

By 1962, all field and office work had been completed for the initial southeast Alaska inventory and the results included in a report titled "Alaska's Forest Resource" (Hutchison 1967).

INITIAL INVENTORY

The forested area of southeast Alaska is estimated to be 11,201,000 acres,[4] or about 46 percent of the total land area. This area includes all land now at least 10 percent stocked with trees and land that formerly had tree cover and is not being used for any nonforest purpose.[5]

The area defined as commercial forest land has a minimum of 8,000 board feet (International 1/4-inch rule) of sawtimber per acre, or is capable of producing this amount, and a minimum area of 10 acres. The commercial forest area was estimated to be 4,884,000 acres (does not include 194,000 acres that are productive but reserved from harvesting).

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[1] Authorized by the &Sweeney-&Nary Forest Research Act of May 22, 1928, as amended by the 83d Congress.

[2] H. E. Andersen. April 9, 1954, memorandum on file at Forestry Sciences Laboratory, Juneau, Alaska.

[3] Specific procedures are in "Plan for Forest Survey of Southeast Alaska, April 14, 1954" and in revisions of November 1954, April 1956, and February 1957, on file at Forestry Sciences Laboratory, Juneau, Alaska.

[4] See appendix for metric equivalents of area and volume.

[5] See appendix for more exact definitions of terms.

FOREST OWNERSHIP AND MANAGEMENT UNITS

National Forests encompass 92 percent of the commercial forest land. Because townsites, homesteads, and mining claims account for so little area, they have only very local influence on overall forest management problems and objectives, The State has an important management unit north and west of Haines, and other lands are being selected for State ownership in the vicinity of existing towns. Glacier Bay National Monument contains about 179,000 acres of commercial forest land. This land is withheld from timber harvesting activities in order to thoroughly preserve outstanding scenic values. The ultimate settlement of the Native land claims will affect as much as 400,000 acres of coastal Alaska National Forest land. More forest area than nonforest area will be selected. Likely as much as 200,000 acres or about 4 percent of the commercial forest land of southeast Alaska will change ownership.

For management purposes the forests were divided into units as shown in figure 1, and the forest inventory program conforms to these same boundaries.[6]

FOREST AREA BY STAND TYPES

Western hemlock *(Tsuga heterophylla* (Raf.) Sarg.) and Sitka spruce *(Picea sitchensis* (Bong.) Carr.) forest types together account for 89 percent of the commercial forest area. These two species are by far the most important in the State by volume, value, and use. They account for at least 99 percent of the present log production.

Western hemlock is dominant on about 2.7 million acres. On 636,000 acres, Sitka spruce comprises 50 percent or more of the stand volume. On 1 million acres, hemlock and spruce are mixed, with spruce making up 30 to 49 percent of the stand (Hutchison 1967).

Most of the cedar found in Alaska is in the southeast forests. The area in cedar is about equally divided between western redcedar *(Thuja plicata* Donn) and Alaska-cedar (*Chamaecyparis nootkatensis* (D. Don) Spach).

Hardwoods are found mostly along the drainages. Commercial stands of black cottonwood (*Populus trichocarpa* Torr. & Gray) are found in several localized areas. The Stikine, Taku, Haines, and Yakutat areas are the more important.

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[6] Statistical summary tables for the initial forest inventory of the Juneau unit (1957), the Sitka unit (1958), the Petersburg unit (1959), the Yakutat unit (1959), and the Ketchikan unit (1962) have been processed and are available at Forestry Sciences Laboratory, Juneau, Alaska.

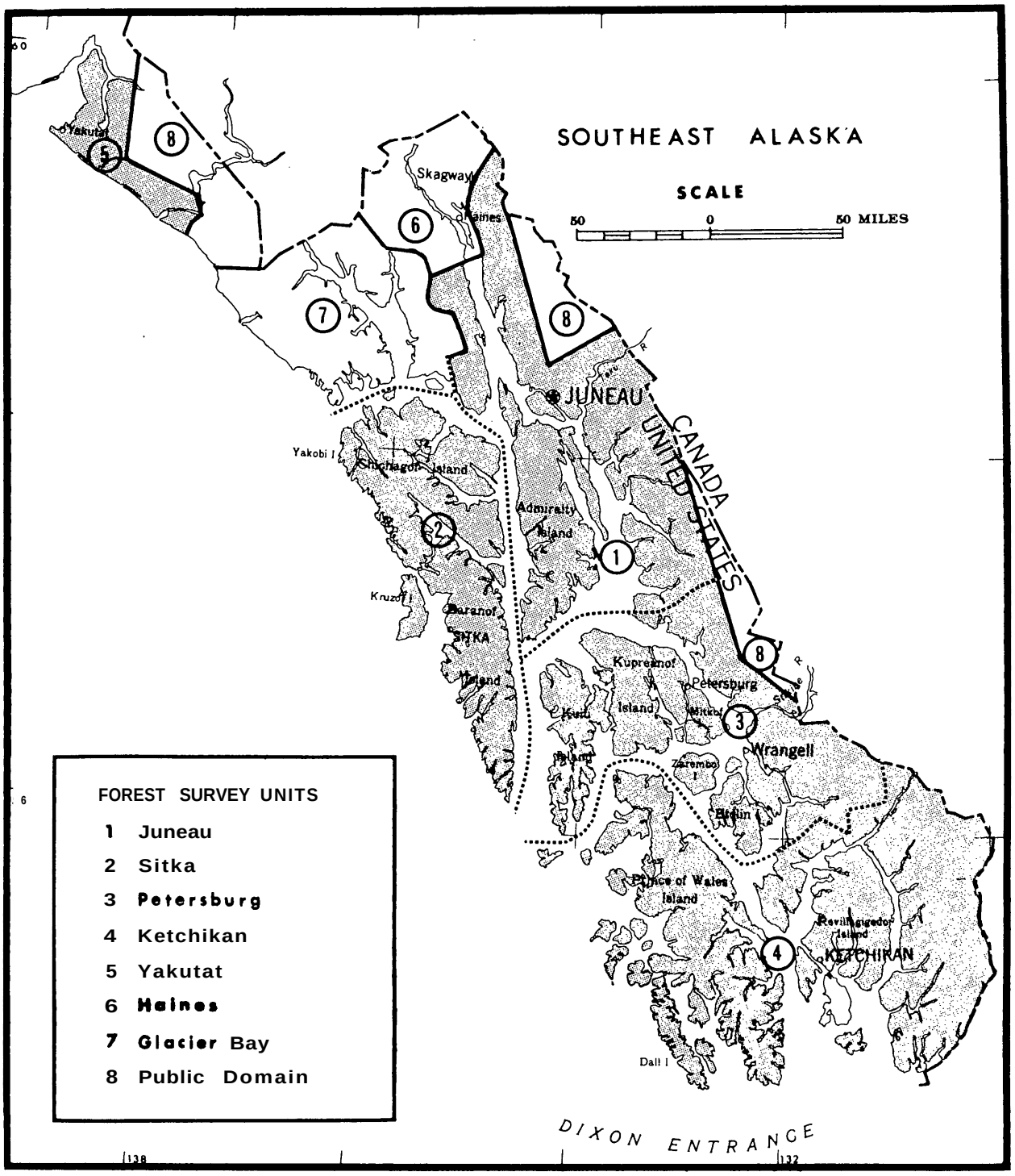

Figure 1.--Southeast Alaska showing Forest Survey units. The shaded areas are management units **of** *the Tongass National Forest.*

FOREST AREA BY STAND-SIZE CLASSES

Forest land was separated into commercial and noncommercial classes (table 1). In a further classification of commercial forest land, five stand conditions were recognized: (1) old-growth sawtimber, (2) young-growth sawtimber, (3) poletimber, (4) seedling and sapling, and (5) nonstocked.

Table 1.--Forest areas and timber volume estimates with associated sampling errors, southeast Alaska, 1954-58

Forest Survey unit	Commercial forest		Noncommercial forest		Total volume		Sampling error of total		Sampling error per million ft3
	Area	Sampling error	Area	Sampling error			Fbm	Ft3	
Juneau	815.0	2.5	832.0	2.5	26,764	5,194.9	4.9	4.6	2.0
Sitka	540.7	3.3	1,199.5	1.8	19,470	3,704.5	5.5	5.6	2.9
Petersburg	1,029.2	2.3	1,327.4	1.9	36,584	7,021.9	5.1	5.9	2.2
Ketchikan	1,951.0	1.4	2,297.3	1.3	71,155	13,595.8	4.2	3.5	.9
Yakutat	276.6	4.6	38.6	14.8	5,731	1,055.6	10.1	7.9	7.7
Other	271.5	--	428.2	--	6,196	1,222.0	--	--	--
Total	[2] 4,884.0	--	6,123.0	--	165,900	31,794.7	--	--	--

[1] International 1/4-inch rule.
[2] Does not include 194,000 acres that are productive but reserved from harvesting.

These classes are important to the forest manager as well as to those interested in timber harvesting. Many old-growth sawtimber stands, for example, are recognized as having reached or passed physiological maturity. Such stands are no longer growing vigorously,. Young-growth sawtimber, poletimber, and seedling-sapling stands, on the other hand, are characterized as vigorous, healthy stands which under management could contribute a maximum amount of wood annually through net growth (fig. 2). The overmature, old-growth stands are those the forest manager must harvest first in order to increase the overall productivity of the forest. Many old-growth stands are also wanted by timber buyers and operators because they contain the best quality logs.

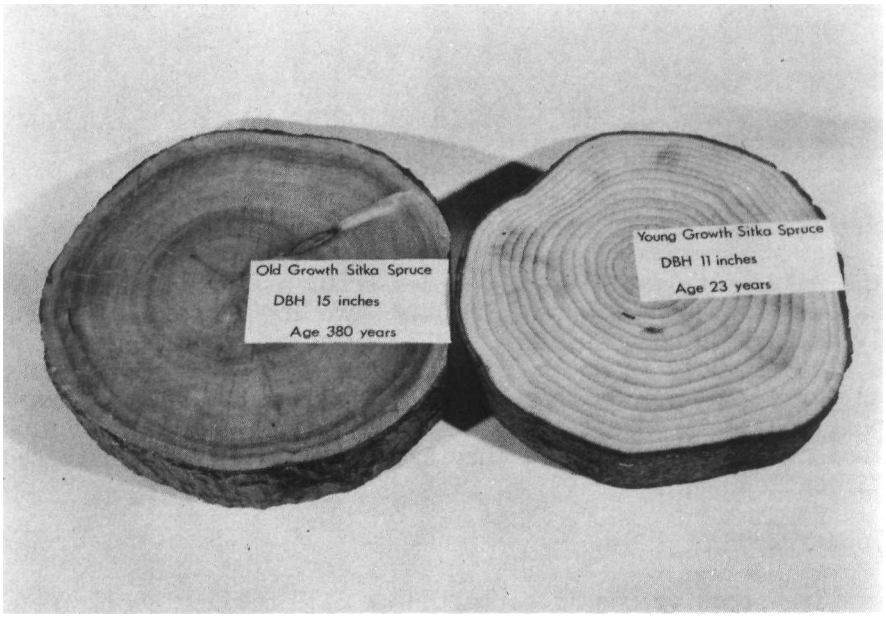

Figure 2.--Cross section on the left came from an uneven-aged, old-growth stand. The section on the right, showing much faster growth, came from an even-aged, young-growth stand.

The commercial forest area of southeast Alaska is 87 percent old-growth sawtimber (fig. 3). Thus, we have 4.2 million acres of forest land which may be considered beyond the optimum age for harvesting. Currently, about 20,000 acres are being cut annually. Because of the unbalanced conditions of the total forest from a timber management viewpoint, the annual volume harvested can exceed the amount being grown for many years before sufficient young stands will be obtained to bring growth and cut into balance. This occurs because there is almost no net growth on areas of old growth, and therefore a static condition exists on 87 percent of the area. Growth will equal harvest, at allowable sustained yield rates, at some time in the future when most of the area is in thrifty young-growth stands.

Figure 3.--Sawtimber stands with trees averaging 150 years or older are classified as old growth. This stand on the southwest side of Tuxekan Island is 160 years old.

For the most part, younger stand sizes occur as scattered, small patches near tidewater. Many of these small tracts were logged earlier because they were easily accessible and possessed high volumes of quality timber. Young stands are also commonly found on areas of windthrow, glacial retreat, land uplift, old burns, and stream channel changes. Many landslides occur on the steep slopes, and these usually restock with forest growth. If these areas have not restocked satisfactorily, they are included in the nonstocked stand-size classification.

GROWING-STOCK VOLUME

The growing-stock volume is estimated at 31.8 billion cubic feet of sound wood in southeast Alaska. By species the volume is distributed as follows:

Species	Percent
Western hemlock	63.9
Sitka spruce	28.1
Western redcedar	3.2
Alaska-cedar	3.7
Cottonwood	.7
All, other	.4
	100.0

The distribution of western hemlock and Sitka spruce volume is about the same in the Juneau, Sitka, Petersburg, and Ketchikan units, with western hemlock predominating. In the other units, however, Sitka spruce dominates.

All of the western redcedar is found on the Petersburg and Ketchikan units. The Sitka,, Petersburg, and Ketchikan units have most of the Alaska-cedar, although scattered trees and stands are also located on the Juneau unit.

SAWTIMBER VOLUME

The commercial forests contain a total net volume of 166 billion board feet (International 1/4-inch rule) of sawtimber, or 90.5 percent of the growing-stock volume. The importance of this figure depends upon the distribution of volume. Areas supporting high volumes per acre are usually more operable, economically, than those supporting low volumes per acre.

These southeast Alaska forests, with 77 percent of the commercial sawtimber volume in Alaska, average more than 30,000 board feet (net) per acre. The range per acre is from 8,000 to more than 100,000 board feet. These stands are attractive for industrial development, but some competing regions offer as much or more in quantity, quality, and preferred species. The forests of western Oregon and Washington have half the total sawtimber on the Pacific coast; and Douglas-fir, which is the preferred industrial species; comprises most of the volume. However, the average volume per acre of sawtimber stands in southeast Alaska compares favorably with hemlock and spruce stands in Oregon and Washington. This region has nearly 80 percent of the Nation's total supply of Sitka spruce.

Soils and drainage are so complex and variable that the better stands are not always found on the benches and valley bottoms where they might ordinarily be expected. Muskegs (fig. 4), with the inherent characteristic of poor drainage, often occur on locations that otherwise would produce good timber. Most of the good stands of timber are, however, within a few miles of tidewater (fig. 5). According to one estimate (Heintzleman 1949, p. 366) for coastal Alaska, "Three fourths of the commercial forest timber is within 2-1/2 miles of the coast line."

Figure 4.--Muskeg areas, such as this, are common throughout southeast Alaska forests.

Figure 5.--The Alexander Archipelago in southeast Alaska contains many arms and inlets with timber extending from tidewater to timberline at 2,500 to 3,000 feet.

The Ketchikan unit, with nearly twice as much sawtimber as any other unit, has a greater total land area and a higher proportion of commercial forest land. The character of the commercial forests changes northward and westward from the Ketchikan unit. Volumes per acre tend to decline, trees are generally of poorer quality, and the stands become less extensive.

Hemlock and Sitka spruce together account for 94 percent of the board-foot volume--101 and 54 billion board feet, respectively. Alaska-cedar and western redcedar account for about 4 billion board feet each. Most of the 1 billion board feet of hardwood is black cottonwood. The remaining 2 billion board feet consist of other softwoods, mostly true fir and lodgepole pine (*Pinus contorta* Dougl,). Although western hemlock and mountain hemlock *(Tsuga mertensiana* (Bong.) Carr.) comprise most of the volume, the largest and best quality trees available are Sitka spruce. Sitka spruce is rather evenly distributed, accounting for about one-third of the volume. The proportion increases to 80 percent in the Yakutat unit.

Most of the volume is in the 21- to 30-inch class. More than one-third of the volume is in trees with diameters greater than 30 inches b.h. In general, the spruce is larger than the hemlock. More than 50 percent of the spruce volume is in diameters greater than 30 inches. These trees produce high-quality spruce logs. Such trees are more common on the units south of Yakutat. Although the Yakutat unit has smaller trees, the average net volume per acre is slightly higher than that for the balance of southeast Alaska. This likely is accounted for by a lower incidence of defect at Yakutat associated with younger stands and a higher predominance of spruce.

LOG QUALITY AND TREE DIAMETERS

In the past, coastal stands have often been described as mature or overmature, of declining quality, and suitable primarily for the manufacture of pulp. Much of this is true, but intermixed in these predominantly pulpwood stands is a good supply of the finest quality Sitka spruce and western hemlock to be found anywhere. To attain full utilization, more attention must be given to determining the supply and value of the high-quality logs and to diverting them to their highest use.

For many years, southeast Alaska has produced logs and cants for manufacture of high-quality specialty products. During World War I (USDA Forest Service 1954), and especiallv during World War 11, this region supplied much of the high-quality spruce used in aircraft. In this region, 14 billion board feet of the spruce and hemlock are in Select, Peeler, and No. 1 grade logs. These logs are desirable for the manufacture of veneer, plywood, and high-quality lumber products. The high-auality volume in the stands amounts to about 5 percent of the total hemlock and 16 percent of the spruce sawtimber volume. In the early 1960's most of the harvested volume went for the production of dissolving pulp, worth about $170 a ton in 1972-73. Now most of the high-quality spruce logs are diverted to sawmills to be cut into cants for the Japanese market. Some high-quality hemlock and spruce still go into dissolving pulp, along with all low-quality logs. Whether the yield of pulp is greater from these high-auality logs than from lower quality logs is not known. But it is hown that the supply of high-quality logs has diminished in other regions, causing veneer, plywood, and other producers there to use relatively low-grade logs.

Log quality is, of course, closely related to tree diameter. Among the larger trees, more high-quality logs can be expected. Select grade Sitka spruce logs must be at least 30 inches in diameter, measured inside the bark at the small end. Peeler and No. 1 grade hemlock logs must measure at least 24 inches.

More than 58 percent of the Sitka spruce sawtimber volume is in trees with 31-inch or larger d.b.h. Twenty-five percent of the volume in these trees is in either Select or No. 1 grade logs. Thirty-nine percent of the hemlock sawtimber volume is in the 21- to 30-inch diameter class and another 30 percent is in diameters of 31 inches or larger.

If stand quality were evenly distributed throughout the commercial forest land in the region, logging operators could expect to obtain about 2,800 board feet per acre in No. 1 or better grade logs. Since the stands are not uniform in quality, only the better stands are in demand for harvesting. Some of the better stands, now bypassed because the cost of reaching them is too great, occur as small, isolated pockets, behind muskegs, on steep slopes, in side drainages, and in other hard-to-reach places. These stands are likely to remain unharvested until more versatile logging methods and favorable economic conditions appear.

There appears to be an opportunity to develop a much more integrated wood-using industry than now exists. Some of the high-quality logs, particularly Sitka spruce, are now sorted from the pulpwood rafts and sold to sawmills; but very few are processed to a finished product. Most are cut into cants for export to Japan. Per capita use of plywood and veneer in the United States is expected to increase from 87 square feet in 1970 to 125 to 139 square feet in 2000. About 78 percent of this demand is expected to be for softwood plywood and veneer (USDA Forest Service 1974). Some other areas producing softwood plywood and veneer are facing raw material supply problems (Cowlin and Forster 1965). Southeast Alaska has 79 percent of the Sitka spruce and 40 percent of the western hemlock sawtimber in the United States (USDA Forest Service 1974). With so much of the total raw material, this region can supply many industries using these species.

ALLOWABLE HARVEST (PRESCRIBED CUT)

Allowable cut, or yield determination, is defined as "The calculation, more directly by volume regulation, less directly by area regulation, of the amount of forest produce that may be harvested, annually or periodically, from a specified area over a stated period, in accordance with the objects of management" (Society of American Foresters 1971). Each forest manager, whether managing public, industry-owned, or private land, computes the allowable harvest based on given or chosen factors that guide his management objectives such as amount of money to be invested in management, timber merchantability, accessibility, utilization standards, markets, and operating conditions. In southeast Alaska, accessibility (fig. 6) has been an important consideration and limiting factor in allowable harvest determination. Guides used in the past would not necessarily apply today because logging, milling, and road-building values, methods, and policies have changed and will continue to change. An entirely different and legitimate allowable harvest for the same forest can easily be computed by using different definitions for these factors.

GUIDES TO ACCESSIBILITY

Forest Survey
Juneau, Alaska
11/23/55

A. Basic Assumptions
1. Market exists (on present economic and operability standards).
2. Minimum net volume yarding tree can support = 500 MBM.
3. Minimum of 16 M/A average net required immediately behind area that can be directly yarded to protected beach or truck road.
   a. Minimum set volume cold deck tree can support = 750 MBM.
   b. Maximum of one (1) cable swing from cold deck to yarding tree.
      thence (1) Directly to beach
      or (2) Truck to beach
      or (3) Cat swing to beach
   c. Well-spaced cold deck beach 100' x 150', or easily built.

B. Controlling Factors

SHOW	LOGGING METHOD	ROAD BUILDING FACTORS	MAXIMUM REACH[1] Horiz. (Photo) Dist. Level	50%	100%	RATIO Slope Dist. /Horiz. 33'/ch. (50%)	66'/ch. (100%)	NOTES[2]
Large Valley	Road, with High Lead	Refer to Table below	Yarding 1000'	900'	700'	1.1	1.4	
			Swinging 1200'	1090'	860'			
Gentle slope, beach front	Cat, or Donkey yard & cat swing	--	1000' 3/4 mi	900' Maximum	700'	1.1	1.4	Cat, 30% (20'/ch.) Max. Oper.
Beach Front	"A" Frame	--	2000'	1800'	1400'	1.1	1.4	
Steep Slope Beach Front	Skidder	--	2600'	2360'	1860'	1.1	1.4	40 MBM per show; protected H_2

[1]Steep gullies, cliffs cause loss of deflection, cable wear, excessive breakage.
[2]Muskeg-nonpaying distance; shallow soil limits road bldg., spar trees, cats.

ROAD BUILDING ACCESSIBILITY FACTORS

Av. vol. per acre MBF	[1]Acres timber required at these road distances (miles) 1/2	1	2	3	4	5	6	7	8	9	10
10	375	750	1500	2250	3000	3750	4500	5250	6000	6750	7500
20	187	375	750	1125	1500	1875	2250	2625	3000	3375	3750
30	125	250	500	751	1001	1251	1501	1751	2002	2252	2502
40	94	187	375	562	749	936	1123	1310	1498	1685	1872
50	75	150	300	450	600	750	900	1050	1200	1350	1500
60	62	125	250	174	499	624	749	874	998	1123	1248

'Average cost logging road $30,000/mile; $4/MBF allocated for roadbuilding purposes. Weigh all factors--terrain, available gravel, muskegs, number spur roads, etc.

360" - Tree Maximum Reach Horiz. (Photo) Dist. feet	Theoretical acreage1	Ave. Net. Vol./Acre	ficult road construction Acreage Encompassed 500M[1] per yard. tree	750M per cold deck tree
600	26	16	31	47
800	46	20	25	38
1000	72	30	17	25
1200	104	40	12	19
1600	185	50	10	15
2000	288	60	8	12
2400	415	70	7	11

[1]Reduce accordingly for fractions of tree, arc of reach of floating A-frames,

Figure 6.--During the initial inventory, each photo and field location was classified according to accessibility by the above guides.

A precise allowable harvest cannot be computed for southeast Alaska as a whole since this would require knowledge of management objectives for all areas and ownerships. However, because 92 percent of the commercial forest land is in National Forests, the allowable harvest computed for these forests determines, for practical purposes, the potential commercial development of this region.

The Tongass National Forest contains about 4-1/2 million acres of commercial forest land. The allowable annual harvest is currently placed at 820.3 million board feet (Scribner log scale). However, only 3.2 million acres (65 percent of the commercial forest land) were classified in the initial inventory as accessible. Allowable harvest was computed for this land. As cheaper and more efficient logging methods are developed, as markets improve, as demand for stumpage increases, and as timber becomes scarcer, more and more of the 1-1/2 million acres initially classified as inaccessible commercial forest land will become economically operable and be brought into the allowable harvest computation. It is estimated that this inaccessible commercial forest land could eventually support an annual harvest of about 400 million board feet. An offsetting factor, however, will be demands on management to set aside commercial forest land for other uses, thereby limiting timber harvest. On the other hand, more intensive timber management could ultimately increase yields.

Improved markets for Alaskan timber may increase the allowable harvest in future years. At the time the initial allowable harvest was determined, there was no active market for western redcedar and Alaska-cedar (fig. 7). Therefore 7.8 billion board feet in these two species was not included in the initial allowable harvest computation. Since then some cedar logs have been exported, small amounts have been sawn into lumber for local use, and most recently a shingle mill has begun to operate. As cedar markets improve, these species should be included in the allowable harvest.

Figure 7.--An Alaska-cedar tree, 42 inches in diameter and 87 feet tall, growing on a poor site at Cape Fanshaw.

In computation of allowable harvest the difference between inventory Scribner volume and the scaled log volume as utilized is recognized. Scaled log volume is only about 73.6 percent of inventory volume. The difference between inventory and scaled volume is caused by (1) losses from breakage and other residues during logging, (2) use of the 16-foot-log volume table for inventory when average scaled length is about 32 feet, and (3) scaling diameters rounded to the last full inch, whereas inventory volumes are based on rounding diameters to the nearest inch. The allowance for these factors reduces the inventory volume estimate by about 26.4 percent. As utilization practices improve, more of the inventory volume will end up in products.

In 1973, the timber cut from the Tongass National Forest amounted to 588.5 million board feet (Scribner Bureau scale), about 72 percent of the allowable harvest. If the planned installation of one more large pulpmill, some green veneer production, and some increased sawmill capacity are accomplished, the total present allowable harvest on National Forest lands will be utilized,

REMEASUREMENT OF GROWTH, MORTALITY, AND VOLUME

Since the initial inventory, about 31 percent of the original field plots have been remeasured on the five major southeast Alaska inventory units; and the Yakutat, Juneau, Sitka, and Petersburg units have been completely reinventoried. All of coastal Alaska is scheduled for remeasurement and reinventory.

Data were collected to provide estimates of forest change and trends based on the remeasurement of 269 forest survey field locations over a 7-year period. Of these 269 locations, 215 were systematically selected from the initial forest inventory of southeast Alaska. To improve estimates of growth and mortality trends in young-growth stands, 44 additional locations were measured in young-growth stands of southeast Alaska. Also, 10 additional locations were measured in old-growth stands on the Yakutat unit to improve the reliability of estimates for that unit.

GROWTH

Table 2 summarizes annual gross and net growth and mortality as a percent of total inventory for the period between 1954 and 1968. Yet growth and mortality are influenced by catastrophic losses during this period and, therefore, are not always valid as estimates from the long-range viewpoint. Until reliable long-term mortality rates can be determined, gross growth may give a better comparative measure of forest growth.

In initial inventory work, it was assumed that growth of old-growth stands was offset by mortality. In table 2 it can be seen that this was a reasonable assumption.

Unmanaged young-growth stands are producing gross annual cubic-foot growth at a rate 3.36 times that of old-growth stands (table 2). Partly, this is because the annual cubic-foot mortality rate in old-growth stands is three tines that of the unmanaged young-growth stands. The gross growth rate is relatively uniform for young-growth stands throughout southeast Alaska. The Ketchikan unit has the highest rate, and the lowest rate is in the Petersburg unit. More knowledge of soils and site distribution and other factors is needed to account

Table 2.--Summary of annual growth rates, southeast Alaska, 1954-68

Unit	Old-growth stands			Young-growth stands			Combined stands		
	Annual net growth	Annual mortality	Annual gross growth	Annual net growth	Annual mortality	Annual gross growth	Annual net growth	Annual mortality	Annual gross growth
Sitka:									
Cubic feet	.11	.25	.36	1.35	.20	1.55	.13	.25	.38
Board feet[1]	.06	.25	.31	1.45	.17	1.62	.08	.25	.35
Petersburg:									
Cubic feet	.01	.51	.52	.91	.16	1.07	.03	.51	.54
Board feet[1]	.05	.48	.53	1.01	.08	1.09	.07	.47	.54
Ketchikan:									
Cubic feet	-.16	.63	.47	2.12	.13	2.25	-.13	.63	.50
Board feet[1]	-.10	.61	.51	1.82	.06	1.88	-.08	.60	.52
Southeast Alaska except Yakutat:									
Cubic feet	-.02	.51	.49	1.57	.17	1.74	.02	.50	.52
Board feet[1]	.02	.49	.51	1.41	.09	1.50	.05	.48	.53
Yakutat:									
Cubic feet	.34	.25	.59	1.46	.11	1.57	.66	.21	.87
Board feet[1]	.41	.26	.67	1.49	.07	1.56	.64	.23	.87
Total, all southeast Alaska:									
Cubic feet,	0	.50	.50	1.53	.15	1.68	.04	.49	.53
Board feet[1]	.03	.48	.51	1.43	.09	1.52	.07	.47	.54

[1] Scribner rule.

for these differences. The average site index at Yakutat has been estimated at 80 (80 feet at 100 years of age) compared to an average of 103-108 for the balance of southeast Alaska.[2]

MORTALITY

While the remeasurement study provided the first reasonably reliable look at tree mortality rates and the causes (table 3), there is much need for improvement in the estimates. Studies covering different periods might well produce different estimates, largely because of the incidence of catastrophes.

[2] Region 10 Timber Management Plans, USDA Forest Service, Division of Timber Management, Juneau, Alaska.

Table 3.--Summary of annual mortality by cause of death, southeast Alaska, 1954-68

Unit	Insects	Disease	Windthrow	Animal	Other, including landslides	Total
Juneau:						
Cubic feet	7.0	66.9	20.8	0	5.3	100.0
Board feet[1]	6.8	67.4	21.2	0	4.6	100.0
Sitka:						
Cubic feet	19.6	54.9	25.3	0	.2	100.0
Board feet[1]	21.0	54.3	24.7	0	0	100.0
Petersburg:						
Cubic feet	1.0	39.5	21.5	.3	37.7	100.0
Board feet[1]	.7	38.1	21.2	.2	39.8	100.0
Ketchikan:						
Cubic feet	.4	19.5	29.0	1.1	50.0	100.0
Board feet[1]	.3	19.1	28.7	.9	51.0	100.0
Southeast Alaska except Yakutat:						
Cubic feet	2.5	31.3	26.3	.7	39.2	100.0
Board feet'	2.3	30.1	26.2	.6	40.8	100.0
Yakutat:						
Cubic feet,	2.1	16.9	71.5	0	9.5	100.0
Board feet'	1.0	15.5	79.4	0	4.1	100.0
Total, all southeast Alaska:						
Cubic feet,	2.5	31.0	27.1	.7	38.7	100.0
Board feet'	2.3	29.8	27.2	.6	40.1	100.0

[1] Scribner rule.

Mortality due to disease in natural forests tends to be greatest in the Juneau unit and decreases in the Sitka, Petersburg, Ketchikan, and Yakutat units.[8] Windthrow mortality (fig. 8) is reasonably consistent across all units in southeast Alaska. Although when shown as a percent of total mortality (table 3), Yakutat appears to have 300 percent more windtkrow, it has only 20 percent more on a per-acre basis. Tree mortality due to animal causes is a relatively minor factor in this region.

[8] A cull study in progress at Forestry Sciences Laboratory, Juneau, Alaska, shows this same pattern of losses due to disease.

Figure 8.--One storm in November 1968 blew down millions of board feet in stands as shown here. Also note the landslide in the center of the picture.

In the category, "Other mortality," one of the greatest contributing causes is natural landslides (fig. 9) in forest stands (Swanston 1969). This was especially evident in the Ketchikan Working Circle, where mortality due to a landslide was by far the predominating factor.

VOLUME

The remeasurement gave a highly significant difference in volume estimates for the Juneau and Yakutat units but no significant difference for the other units or for all units combined (table 4).

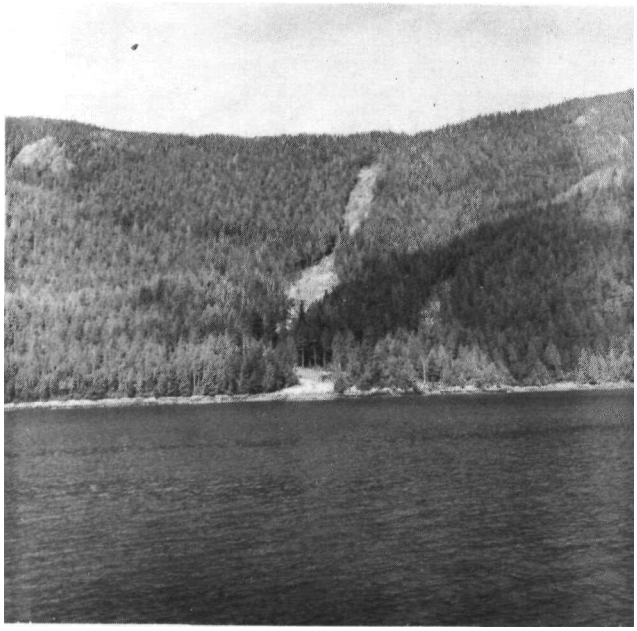

Figure 9.--Many landslides similar to the one pictured here at Walker Cove occur throughout southeast Alaska.

Table 4.--Comparison between initial and remeasurement average cubic-foot volumes. southeast Alaska

Unit	Number of locations used in analysis	Initial inventory	Remeasurement	Difference
		Mean net cubic feet acre		
Juneau	35	5,782	6,176	394**
Sitka	23	7,247	7,071	176ns
Petersburg	36	5,947	5,908	39ns
Ketchikan	59	7,716	7,638	78ns
Southeast Alaska except Yakutat	153	6,787	6,811	24ns
Yakutat	45	6,449	5,862	587**
Total, all southeast Alaska	198	6,711	6,596	115ns

NOTE.--** = Significant at 1-percent probability level.
ns = Nonsignificant at 5-percent probability level.

REINVENTORY

THE YAKUTAT UNIT

The Yakutat unit was initially inventoried in 1957 and totally remeasured in 1967. The volume and area estimates resulting from the 1967 remeasurement are summarized in Forest Survey Report No. 7, "Forest Inventory Statistics for the Yakutat Area of Alaska, 1967,"[2] compiled by Robert B. Mattson. Basically, the initial inventory sampling designs and standards were followed. The highlights of the two studies are summarized in table 5.

Table 5.--Comparative summary of *two* Yakutat forest inventory estimates

Item	inventory	remeasurement
1. Total photo points	872	2,310
2. Total ground locations on commercial forest land	57	77
3. Total area (acres)	795,900	767,000
4. Estimated area of commercial forest land (acres)	276,600	208,000
5. Sampling error for item 4 (percent)	±4.6	±3.8
6. Estimated area of operable commercial forest land (acres)	[1]230,750	[2]110,100
7. Estimated total net volume (Scribner M bm)	5,231,751	5,600,000
8. Sampling error for item 7 (percent)	±10.1	±8.9
9. Estimated total operable net volume (Scribner M bm)	5,103,672	4,611,000
10. Average net volume per acre all commercial forest (Scribner M bm)	18.2	26.9
11. Average operable net volume per acre commercial forest (Scribner M bm)	2201	41.9

[1] Includes 88,300 acres in stands less than sawtimber size.
[2] Includes only sawtimber stands. Operability criteria used for the remeasurement were more restrictive than those used for initial inventory work (fig. 6).

[2] Report on file with U.S. Forest Service, Regional Forester's office, Division of Timber Management, Juneau, Alaska.

Some of the differences in estimates between the two inventories can be attributed to a change of area boundaries in 1967. Some differences are attributed to more reliable measurements in 1967 and to growth during the 10-year interval. Estimates of area and volume that are operable or accessible according to the two surveys are not strictly comparable. Operability criteria used for the remeasurement were more restrictive than those used for the initial inventory work. Because economic conditions and harvesting methods change, operability criteria that might be used today would not necessarily agree with criteria used in the past surveys.

THE JUNEAU AND SITKA UNITS

A complete reinventory program was started in 1970 to reevaluate the southeast Alaska forest area and volume. Several new categories of information were collected, including data to evaluate level of stocking, volume strata classes, soil classifications, multiple use classifications, degree of slope, revised operability guides, and revised quality guides. Further, more detailed data were collected on the individual trees to better determine the management potential, such as risk class and soil microsite. In all, 185 variables are on file for each tree tallied. Table 6 gives preliminary comparison of basic information.

The Juneau and Sitka units show an increase in commercial forest volume of about 30 percent and 20 percent, respectively, when compared with the original inventory estimates (table 6). The increase is largely the result of an increase in the commercial forest land base of the units.

Table 6.--Comparison of two inventories, Juneau and Sitka units

Item	Juneau unit		Sitka unit	
	1954	1970 [1]	1957	1971 [1]
Sampling:				
Photo locations (number)	5,830	14,404	3,314	11,771
Field locations (number)	485	475	328	567
Field locations on commercial forest land (number)	164	192	129	180
Area:				
Total (acres)	3,832,800	4,090,200	2,433,300	2,571,800
Commercial forest land (acres)	817,500	1,321,635	540,700	821,675
Sampling error, commercial forest land (percent)	2.5	2.2	3.3	2.4
Volume:				
Commercial forest land (M bm net Scribner)	[2] 23,383,000	[3] 33,539,919	[4] 17,828,984	[3] 20,915,321
Sampling error (percent)	4.9	3.2	5.5	3.6
Average per acre (M bm net Scribner)	28.6	25.4	33.0	25.3

[1] Preliminary data.
[2] Reduced by 8.2 percent to allow for breakage in harvesting.
[3] Not reduced to allow for breakage in harvesting but reduced for volume cut between inventories.
[4] Reduced by 1.8 percent to allow for breakage in harvesting.

In the reinventory, the minimum area criterion for commercial forest land was reduced to 1 acre, whereas the original inventory minimum area was 10 acres. It was expected that this change would result in an increase in the commercial forest area estimate. However, an analysis of all 16,500 commercial forest photo points in the Juneau, Sitka, and Petersburg[10] reinventory units showed that the change in criteria caused only a minimal increase in commercial forest land area. Slightly more than 1 percent of the commercial forest area was in tracts less than 10 acres in size (table 7).

Table 7.--A summary of commercial forest point occurrence by size of forest

Unit	Commercial forest		Percent of total
	≥10 acres	<10 acres	<10 acres
		6,170	
		16,303	

Reinventory results indicate that the Juneau and Sitka units have about 217,000 and 95,000 acres with 5.5 and 2.1 billion board feet, respectively, on slopes over 37° (75 percent), Preliminary results for the Petersburg unit show about 143,000 acres with 3.7 billion board feet on these slopes (table 8). The risk of landslides is high where the range of slope angle is 34" to 37° or more (Swanston 1969).

Approximately 47,000 and 27,000 acres in the Juneau and Sitka units, respectively, have stands averaging over 50,000 net board feet Scribner per acre.

.In the reinventory, we made the first general attempt to measure area and volume by soil classification units (table 9). All survey units yielded about the same average volumes per acre by soil class. The soil classes had been assigned site indices in previous studies, and this now provides a tool for obtaining a realistic evaluation of site and productivity in old-,growth sawtimber stands where height-age relationships are not meaningful. There appears to be an important relationship between soil class site index and average volume of the site. Further study is needed to evaluate how significant this relationship is.

The F3 soil class indicates either ash soil, coarse .gravelly outwash soils, or a cobblestone uplifted beach soil. The Juneau study showed no F3 soils in sawtimber stands. The Sitka unit has about 94,000 acres and 2.7 billion board feet, primarily on ash soil.

The F3 ash soil class was of particular interest because the type is hown to be unstable on slopes over 35 percent or if exposed on gentler slopes, and this study gave the first estimate of the extent of F3 ash soils. It should be noted, however, that although the bulk of the ash soils will fall in the F3 class, there are also small amounts of ash soil in the F1 and F4 classes.

[10] Not fully reported in this section because the inventory was only partially compiled as of the time of this report.

Table 8.--Preliminary estimates of area and volume of sawtimber stands by slope percent for the Juneau, Sitka, and Petersburg survey units. Alaska. 1973

Unit and slope (percent)	Area	Volume	volume per acre
Juneau?			
0-5	117	2,719	23.2
5-15	129	2,757	21.4
15-25	183	4,463	24.4
25-35	142	3,962	27.9
35-45	174	4,179	24.0
45-55	135	3,981	29.5
55-65	156	4,379	28.1
65-75	41	766	18.7
75-85	68	1,677	24.7
85+	149	3,839	25.8
Total or average	1,294	32,722	25.3
Sitka:			
0-5	143	4,079	28.5
5-15	93	2,131	22.9
15-25	90	2,317	25.7
25-35	85	2,269	26.7
35-45	103	2,962	28.7
45-55	68	1,799	26.4
55-65	68	1,760	25.9
65-75	36	921	25.6
75-85	41	949	23.1
85+	54	1,162	21.5
Total or average	781	20,349	26.0
Petersburg:			
0-5	217	5,277	24.3
5-15	156	3,551	22.8
15-25	129	2,703	21.0
25-35	169	4,281	25.3
35-45	169	3,997	23.6
45-55	122	2,709	22.2
55-65	74	2,160	29.2
65-75	47	1,153	24.5
75-85	102	2,884	28.3
85+	41	812	19.8
Total or average	1,226	29,527	24.1

[1] National Forest ownership only.

NOTE.--13.8 percent of the combined unit areas of commercial forest land (455,000 acres) and 13.7 percent of the combined Scribner volumes (11.3 billion f bm) are on slopes over 75 percent and therefore over 37°.

From the site index information by soil class, estimates of average site indices for the Juneau, Sitka, and Petersburg units were determined with a reasonable degree of confidence. Table 9 presents these averages, which increase slightly in magnitude from north to south. This is to be expected.

Table 9.--Preliminary estimates of area and volume of sawtimber stands by soil class for the Juneau, Sitka, and Petersburg survey units. Alaska. 1973

Unit and soil class	Tree site index	Area	Volume	Volume per acre
Juneau:[1]				
F5	70	136	1,975	14.5
F2R	80	291	6,474	22.2
F2,4,6	100	596	15,907	26.7
F3	110	8	1	.7
F1	130	263	8,365	31.8
Total or average	98.8	1,294	52,722	25.3
Sitka:				
F5	70	63	989	15.7
F2R	80	59	1,155	19.6
F2,4,6	100	360	8,665	24.1
F3	110	94	2,717	28.9
F1	130	205	6,823	33.3
Total or average	104.3	781	20,549	26.0
Petersburg:				
F5	70	88	1,374	15.6
F2R	80	102	2,398	23.5
F2,4,6	100	677	14,089	20.8
F3	110	34	643	18.9
F1	130	325	10,985	33.8
Total or average	104.5	1,226	29,489	24.1

[1] National Forest ownership only.

INVENTORY PROJECTIONS--ONE EXAMPLE

With TRAS (Timber Resource Analysis System) as a tool and the remeasurement data as input, it was possible to make several projections to estimate what might happen if certain cutting rates and management alternatives were followed. The background, assumptions, and highlights of one projection are given here as an example of one trend analysis. Many other combinations of assumptions are possible.

In 1971, a nationwide evaluation was made whereby current stands were projected to the year 2020, using three different sets of basic assumptions. As a part of this study, coastal forests[1] were projected 50 years into the future using current management techniques and assuming no change in stumpage prices.

[1] The term coastal Alaska forests includes the Chugach National Forest. Discussion has been confined to southeast Alaska forests, primarily the Tongass National Forest region, as much as possible.

· It was necessary to make this projection for coastal Alaska in three parts: one projection for coastal Alaska old-growth stands, one for coastal Alaska young-growth stands, and one for Yakutat stands. In addition, it was necessary to project cutover stands by a bookkeeping system and finally to merge these four projections. International 1/4-inch board-foot volume was used; and it was assumed that the annual allowable harvest (1,244.5 million board feet, International 1/4-inch scale) would come only from old-growth stands, would be obtained in the year 1975, and would hold at that level through the remainder of the projection. It was assumed that 2,000,000 acres of land, including 400,000 acres of commercial forest land, would be withdrawn from forest production between 1970 and 1980 for other uses. No allowance was made for Native Land Claim withdrawals.

Given the above assumptions, basal area per acre dropped from 193 square feet per acre in 1970 to 189 square feet per acre in about 1990 and climbed back to 198 square feet per acre by 2020. Total International 1/4-inch board-foot volume begins at 185 billion board feet in 1957 and drops to 130 billion board feet in 2020.

In approximately year 2025, net board-foot growth will overtake and surpass the annual cut (fig. 10). This projection indicates that inventory will never drop below 125 billion board feet (International 1/4-inch scale). This means that, based on the above projection and assumptions, at no point in the sustained yield plan will the timber supply drop below 67-1/2 percent of the original inventory volume. Net annual growth will overtake annual cut before the original stand drops below that level.

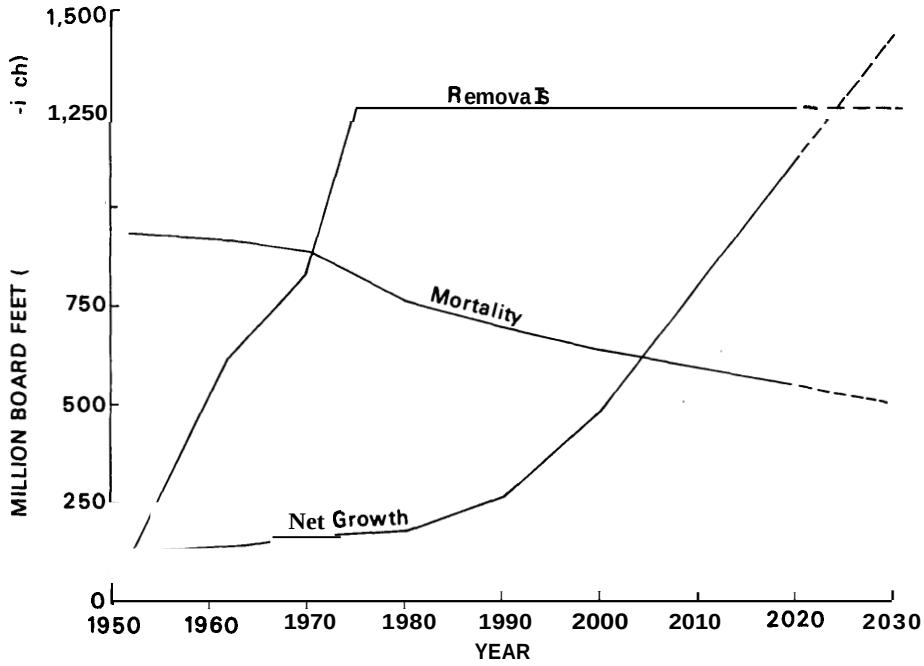

Figure 10.--Projection of removals, net growth, and mortality for coastal Alaska commercial forest land to 2020. Assumes present allowable harvest and no change in stumpage prices.

HARVESTING

CUT

Timber harvesting and processing ranks third, after oil and fisheries, as the most important industry in Alaska (table 10), but ranks first in southeast Alaska (table 11). Southeast Alaska with eight large sawmills and two pulpmills clearly dominates the State's wood processing industry (Clapp 1972). The annual harvest of Alaska timber has always come predominantly from the National Forests of the southeast coastal region. This, of course, is because the high volume per acre stands of western hemlock and Sitka spruce are in the southeast and because 92 percent of the commercial forest land of the region is in National Forests.

Table 10.--Total value of major resource production, Alaska, 1960 and 1967-72

Industry	1960	1967	1968	1969	1970	1971	1972
Fisheries	96,689	126,696	191,686	144,200	213,932	198,660	202,951
Oil and gas	1,260	95,455	191,083	227,129	279,132	286,507	267,270
Minerals	20,600	41,692	30,617	30,514	59,139	46,341	49,890
Forest products	47,300	77,700	89,300	100,900	112,700	118,100	109,800
Total	165,849	341,543	502,686	502,743	664,903	649,608	629,911

Sources: Alaska Department of Economic Development (1972, 1974) and Alaska Department of Fish and Game (1972).

Estimates of the amount of timber cut annually from the National Forests and other forests of southeast Alaska have been difficult to obtain and are subject to reporting and accounting errors. Timber cut from private land, for example, is not reported, Since private lands comprise such a small percent of the total southeast Alaska forest land (less than 1 percent), any error involved in the estimate of timber cut from this sector is insignificant. The public agencies vary in methods of accounting for the amount of timber cut. Some timber is sold on the basis of the estimated amount of standing timber available on a given area, and no measure is made of the amount actually removed. The U.S. Forest Service scales the volume of logs removed, but the relationship of that volume to the estimated inventory volume prior to harvesting is not always known. In 1961-62, a study of 21 logging operations in southeast Alaska showed that 60 of every 1,000 board feet of inventory was left in the woods as residue. [12]

[12] James T. Bones. Relating products output to inventory estimates on the Tongass Forest. Unpublished report on file at Forestry Sciences Laboratory, Juneau, 38 p., illus., undated.

Table 11.--Total value of major resource production and processing, southeast Alaska

Industry	1950	1955	1960	1965	1970	1971	1972	1973
Fish products	[1]38.2	[1]25.8	[1]19.5	[1]39.0	[2]43.1	[2]38.2	[2]60.1	[2]75.8
Stumpage[3]	.1	.5	.9	.8	4.4	4.9	3.6	4.1
Wood products[3]	6.7	27.0	46.2	53.9	93.7	103.5	99.1	122.0
Minerals[4]	.2	.2	.9	4.2	5.5	--	5.4	--

Sources: [1] U.S. Bureau of Commercial Fisheries (1953-73).
[2] Alaska Department of Fish and Game (1970-73).
[3] U.S. Forest Service, Region 10. Unpublished preliminary estimates for National Forest production only. Available at Juneau.
[4] U.S. Bureau of Mines (1953-74).

Table 12.--Sawtimber volume and acres removed from inventory by cutting, coastal Alaska. 1950-73

Year	National Forests	All other	Total	Percent from National Forests	Estimated acres cut from National Forests
1950	83,736	17,371	101,107	82.8	--
1951	81,970	16,483	98,453	83.3	--
1952	92,890	29,025	121,915	76.2	--
1953	89,182	27,845	117,027	76.2	--
1954	155,028	14,646	169,674	91.4	--
1955	305,507	17,224	322,731	94.7	--
1956	324,294	34,607	358,901	90.4	5,783
1957	321,657	47,158	368,815	87.2	6,772
1958	245,426	11,172	256,598	95.6	5,217
1959	382,919	12,988	395,907	96.7	5,789
1960	490,340	14,950	505,290	97.0	8,962
1961	482,265	17,342	499,607	96.5	9,921
1962	521,521	20,110	541,631	96.3	9,649
1963	558,759	22,194	580,953	96.2	11,300
1964	623,225	31,902	655,127	95.1	12,330
1965	566,708	38,911	605,619	93.6	11,040
1966	665,400	48,508	713,908	93.2	11,658
1967	665,902	82,297	748,199	89.0	11,931
1968	744,758	94,406	839,164	88.8	13,589
1969	730,846	95,248	826,094	88.5	13,666
1970	783,402	102,098	885,500	88.5	12,413
1971	739,342	106,785	846,127	87.4	15,460
1972	768,802	120,933	889,735	86.4	23,000
1973	825,874	--	--	--	--

Table 12 shows the annual removal of timber (International 1/4-inch scale) from the inventory since 1950 for coastal Alaska. More than 99 percent of the total coastal Alaska harvest comes from southeast Alaska. The log volume utilized is usually reported in Scribner Bureau scale which is familiar to the industry and logging operators. The volume of logs reaching the mill in Scribner Bureau scale is about 73.6 percent of the timber inventory (Scribner rule). Harvesting of logs for lumber, piling, fish traps, and other local uses has been going on since earliest settlement; but quantities harvested annually have been small, Also the source of logs has been from the best stands and those easily logged from a protected beach (fig. 11).

Figure 11.--A-frame skidders, such as this one operating in Traitors Cove in 1957, are used to log direct to a protected beach. Such operations are less common today, accounting for about 2 percent of the total log production.

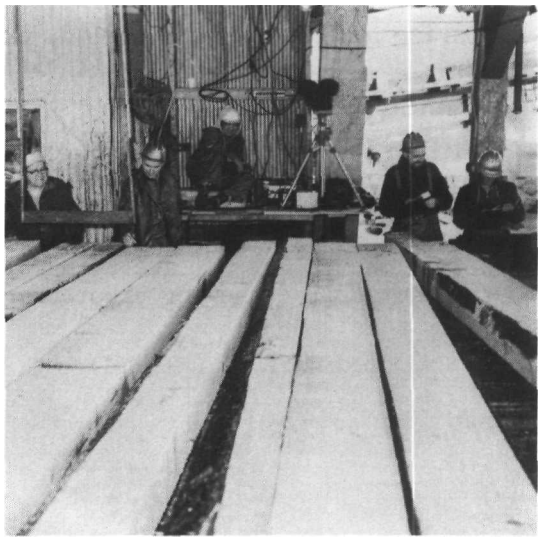

Figure 12.--Today the better grades of logs are cut into export squares, as shown here at a southeast Alaska mill.

The Forest Service and other public land managers have required that logs produced from Alaska public forests be processed through the primary stage in Alaska. Lumber produced in Alaska has not been able to compete in price on other than local markets. However, sawn cants have found a ready outlet on the Japanese market in recent years (fig. 12). The market for pulp provided the needed breakthrough, and early in the 1950's a pulpmill began operating at Ketchikan. The sizable increase in timber cut from National Forests in 1954 and 1955 reflects this new market. Another large increase in timber cut took place in 1960. This reflects the beginning operation of a pulpmill at Sitka. Southeast Alaska now has the two pulpmills and eight major sawmills. These eight sawmills each produce from 3 to over 100 million board feet annually, mostly in cants for a Japanese market.

For coastal Alaska, the Forest Service has set an allowable annual harvest of 1.2 billion board feet (International 1/4-inch scale) that can be drawn from the accessible commercial forest land. The sale of timber to supply a third

pulpmill and sawmill complex about meets the allowable harvest. The sale, however, has been challenged by a lawsuit, with the outcome still in question as this goes to press.

Most of the lumber and cants produced in southeast Alaska are exported. Table 13 shows that in recent years 79 to 94 percent of the total Alaska lumber production is exported and of that, 99 percent goes to Japan. In 1973 nine southeast Alaska sawmills produced 440 million board feet of lumber and cants (Forest Industries 1974). Seven of these mills accounted for most of the export.

During a recent 5-year period, pulp production from southeast Alaska timber averaged 386,000 tons annually (table 14). All of the pulp is exported from Alaska, but as much as 40 to 45 percent goes to domestic "lower 48" markets.

With only a few exceptions, round log exports must come from private land. For lack of any other market, the Forest Service allows the export of cedar logs from the National Forest that otherwise would be surplus in logging for spruce and hemlock (fig. 13). In the past 5 years, log exports have totaled 266.6 million board feet--averaging 53.3 million board feet annually (table 13). About 95 percent of the log exports are to Japan.

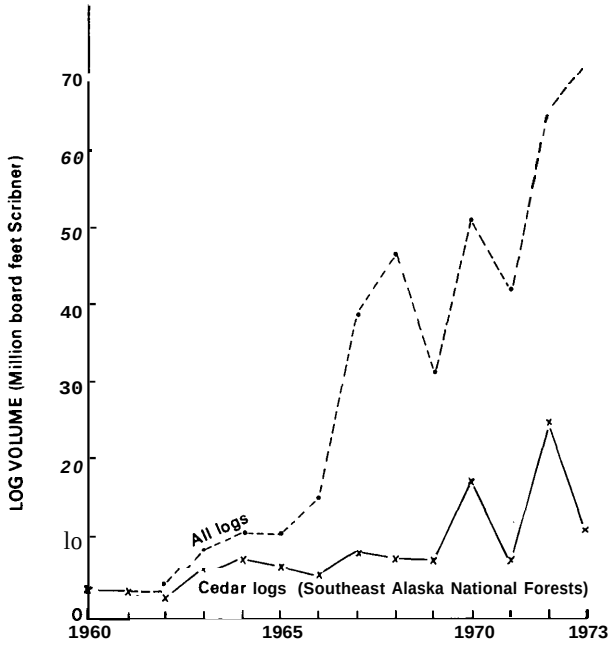

Figure 13.--Log exports from Alaska and export of cedar logs from southeast Alaska's National Forests, 1960-73.

Wood products exports are an important part of Alaska's economy. Without including the value of pulp shipped to the "lower 48," the value of wood products exported to foreign countries exceeds the value of Alaska imports (table 15).

Table 13.--Softwood log and lumber (cants) exports from Alaska,1/ total lumber and cant production for southeast Alaska, and total Alaska lumber and cant production, 1967-73

Year	Alaska exports to Japan				Total Alaska exports		Total southeast Alaska lumber and cant production2/	Total Alaska lumber and cant production2/	Percent of total Alaska lumber production exported
	Logs	Percent of total shipped	Lumber (cants)	Percent of total shipped	Logs	Lumber (cants)			
	M bm		M bm		M bm				
1967	37,404	94.7	203,860	99.9	39,512	203,905	226,000	228,000	89
1968	46,371	98.4	243,599	99.1	47,098	245,633	257,000	262,000	94
1969	30,889	96.8	285,432	99.8	31,889	285,894	286,000	336,000	85
1970	47,583	92.3	315,386	99.9	51,531	315,586	305,000	349,000	90
1971	38,948	91.4	245,974	99.4	42,600	247,414	274,000	302,000	82
1972	61,882	94.0	336,798	99.0	65,837	340,196	359,000	411,000	87
1973	71,705	100.0	403,938	99.8	71,719	404,849	440,000	510,000	79
3/1974	29,088	83.2	361,691	99.8	34,949	362,412	--	--	--

Sources: 1/ Holt (1974).
2/ Forest Industries (1968-74).
3/ U.S. Forest Service, Report on softwood log and lumber exports from the Pacific coast (February 18, 1975).

Table 14.--Log, lumber, and pulp production, 1960-73

Year	Coastal Alaska			Southeast Alaska	
	Log production from National Forests[1]	Total log production	Lumber and cant production	Logs converted to pulp	Pulp production
1960	351.1	361.8	--	--	--
1961	345.3	357.7	[2]70	--	[2]266,500
1962	373.4	387.8	--	--	--
1963	399.0	414.9	--	--	369,175
1964	432.8	468.0	--	289	385,431
1965	404.5	432.4	--	293	378,783
1966	475.5	510.2	[3]158	379	401,640
1967	476.8	535.7	228	384	394,953
1968	533.3	600.9	262	379	393,600
1969	523.3	591.5	334	[4]354	394,200
1970	561.0	634.1	346	[4]306	350,500
1971	529.4	605.9	300	[4]300	403,290
1972	550.5	631.3	407	[4]372	394,500
1973	591.6	708.9	505	[4]396	453,825

[1] The Tongass and Chugach National Forests.
[2] Banes (1963).
[3] Massie (1967).
[4] Includes chips from sawmill residues.

Table 15.--Value of Alaska imports and exports, value of wood products from Alaska National Forests, and value of wood products shipped to Japan, 1958-73

Year	Alaska		End product value of wood products from Alaska National Forests		Value of southeast Alaska exports to Japan		
	All imports	All exports[1]	Total				
1958	2.0	6.3	24.6	--			--
1959	3.1	6.5	34.1	--	--	--	--
1960	5.7	19.5	46.2	--	--	--	--
1961	6.4	25.2	45.9	--	--	--	--
1962	8.1	24.4	49.7	--	--	--	--
1963	8.1	32.1	51.4	--	--	--	--
1964	6.9	36.0	57.9	--	22.7	5.0	.3
1965	7.9	36.7	53.9	--	21.0	5.1	.6
1966	10.1	43.3	70.6	61.3	24.4	9.0	.9
1967	11.7	47.4	76.0	67.5	22.7	12.6	2.8
1968	23.7	55.3	89.2	68.9	19.3	17.4	3.3
1969	52.5	92.8	100.6	71.0	22.2	24.6	3.8
1970	78.4	129.9	93.7	64.8	22.8	30.0	6.5
1971	41.3	126.1	103.5	74.6	23.3	25.2	5.0
1972	49.0	180.7	99.1	63.8	26.6	37.8	8.1
1973	39.9	170.2	122.0	62.7	21.2	--	--

A Does not include the value of products shipped to "lower 48" markets.
Sources: U.S. Bureau of the Census (1964-73).
Alaska Department of Economic Development (1969, 1971, 1972).

OPERABILITY

For management purposes, the commercial forest land is classified as operable (or accessible) and inoperable (or inaccessible). The inoperable class included stands on unstable soils, slopes too steep to log without doing serious damage to the site, and stands that would not pay the cost of logging, using costs and methods current at the time of inventory. Stands that would require new methods, such as helicopter or balloon logging, were not in the operable class.

In the initial southeast Alaska inventory, 3.2 million acres were classified as accessible commercial forest land and 1.7 million acres were inaccessible. The estimate of annual allowable harvest for the Tongass National Forest is based on the accessible area and sawtimber volume after making deductions for land that is being withheld or is expected to be withheld from timber harvesting. Timber sales are laid out in the accessible stands using the same general guidelines as were used for inventory. Sales of a few million board feet to meet current short-term demand are easily inspected by the buyer and seller to determine operability and value. Long-term sales of several billion board feet to justify construction of plants such as a pulpmill leave agreement on operability to the future. The result has been some controversy over long-term sales between Forest Service foresters and company logging operators regarding the actual amount of land and timber volume that is economically available. To help resolve questions, some units have been reinventoried more intensively. Although some shifting of land between the two classes resulted, the total operable (accessible) areas and volumes remained about the same.

A current National Forest management objective is to map all forest land by multiple use classes and to review economic operability criteria. To help plan the timber harvest, the multiple use classes are being zoned to show standard, special, and marginal harvesting opportunities. For the most part the standard and special zones will include the areas previously classified as operable while the marginal zone will include much that is inoperable.

QUALITY

Log grades are used in timber inventory to determine stand quality and in cruising for timber appraisal purposes. Currently the quality of standing Sitka spruce and western hemlock is estimated by using both U.S. Forest Service and Puget Sound Log Scaling and Grading Bureau specifications applied to 16-foot segments of the standing tree.

Based on the remeasurement inventory, 18.4 percent of the Sitka spruce and 7.9 percent of the western hemlock sawtimber volume is in Grade 1 and better logs (modified application of the Puget Sound Log Scaling and Grading Bureau grading rules). The proportion of the various grades of logs in the timber cut is not hown. Logs sent to the pulpmills have not been graded. However, for one 5-year period, 1964-68, a study (U.S. Forest Service, Region 10) was made of six operators who sorted logs for sawmills. According to this study, the Sitka spruce logs sorted for the sawmill by Puget Sound Log Scaling and Grading Bureau grades averaged 27 percent Grade 1 and better by volume, and hemlock logs sorted for the sawmill averaged 30 percent Grade 1 and better. If we assume that the volume used for pulp contains no Grade 1 or better logs, that is that they have all been sorted for sawmill use, then the quality distribution of the total log production would approximate that found in the inventory.

In 1965, 1967, and 1969, three mill recovery studies were made (two on Sitka spruce and one on western hemlock) to provide updated recovery information on export cants and timber quality data for research on new grades. The study in 1965 was at Wrangell Lumber Company on Sitka spruce. Some sample logs were lost at sea during the tow to the mill, and it was determined that additional samples were needed to complete the study. In 1967, additional trees were selected, logged, and sawed (Lane et al. 1972). The 1969 study was on western hemlock.

The lumber or cants produced for export to Japan are usually graded under at least one of two systems. The most common one is a buyer-seller agreed-upon system using grades designated as Piano, A, B, or C. The other is the Standard R List and graded by the Pacific Lumber Inspection Bureau. The yield of each current log grade in terms of these lumber and cant grades was determined for Sitka spruce in the 1965 and 1967 Wrangell studies (Lane et al. 1972).

Based on 400 trees, the report shows that 98 percent of the lumber volume was produced as cants 3 to 8 inches thick. Tables in the report detail the cant sizes by log grade and lumber grade. A comparison is made of the two lumber grade systems. For example, Piano grade cants are about 77 percent No. 2 and No. 3 Clear grade under rules as applied by the Pacific Lumber Inspection Bureau.

In 1969 a study similar to the Wrangell Sitka spruce study was undertaken on western hemlock.[13] The log grade distribution, log scale, and lumber recovery are summarized in table 16.

Table 16.--Summary of western hemlock logs sawn for export cants

Log grade	Number of logs	Gross scale	Net scale	Defect	Recovery ratio	Lumber tally'
Peeler	3	2,620	2,310	12	1.25	2,878
No. 1	54	48,370	35,260	27	1.26	44,430
No. 2	567	206,270	163,990	20	1.17	192,017
No. 3	541	62,210	55,210	11	1.27	69,862

Recovery in Grade No. 2 and No. 3 Clear cants was 16 percent for hemlock and 13 percent for Sitka spruce.

The percentage of the cubic volume of commercial logs converted to lumber was 48 percent for hemlock and 56 percent for Sitka spruce. In other words, 52 and 44 percent, respectively, of the total log volume became slabs, edgings, and sawdust. Most of the slabs and edgings are now being made into chips for the pulpmills,

[13] Richard O. Woodfin, Jr., and Thomas A. Snellgrove. Lumber yield from western hemlock in southeastern Alaska. Being prepared as a USDA Forest Service Research Note.

The need for an improved grading system for Sitka spruce and western hemlock has been recognized for some time. Based on the mill recovery data, a new grading system for Sitka spruce timber has been developed for determining timber quality by measurement of specific tree characteristics that reflect total value and total lumber tally volume. The coastal Alaska Forest Survey now is recording these quality characteristics for sample trees on inventory plots.

A comparable grading system is being developed for western hemlock.

TIMBER APPRAISAL

The southeast Alaska timber market differs from "lower 48" markets in several ways:

1. There is a limited product market--primarily for pulp and cants.

2. "Arms length'' transactions in logs and lumber are the exception rather than the rule. (An "arms length'' transaction is a commercial transaction within a free market and results in a fair market value.)

3. U.S. Forest Service controls 92 percent or more of the available commercial timber.

4. The *two* pulp producers exercise predominant control over log purchases, logging operations, and the financing of the logging industry.

Region 10 of the U.S. Forest Service is currently developing a procedure for appraising from the end product values of pulp and lumber manufactured in Alaska.

Before the construction and operation of the first pulpmill in Alaska, the principal products produced from Alaska timber were piling, poles, and dimension lumber used for homes, warehouses, docks, fish boxes, and related items. Timber appraisals of National Forest timber before 1958 were based on values and costs collected from local sawmills and loggers. There was no system to recognize stand quality, terrain, difficulty of logging, or other variables ordinarily recognized in timber appraisals.

In 1959 a mill scale study of Sitka spruce lumber was conducted at Ketchikan Spruce Mills. At the time of the study, Ketchikan Spruce Mills was sawing dimension lumber and boards for the Alaska retail market, with a small volume of selected lumber being shipped south to the Puget Sound area. In 1960, the Forest Service began a formal program of cost and value collection in Alaska. Also, a system of recognizing tree quality was devised.[14] This system was applied to the recovery data from Ketchikan Spruce Mills to serve as the basis for selling values of both spruce and hemlock timber. Until 1965, appraisals were made on the value of logs derived from lumber selling values.

The export of cants cut from Sitka spruce to the Japanese market began in late 1950's. The Wrangell Lumber Company at Wrangell, Alaska, pioneered this market.

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[14] Leslie J. Sullivan and John F. Shields. Lumber grade recovery from old-growth Sitka spruce on *the* South Tongass National Forest. Unpublished report on file at U.S. Forest Service, Region 10, Juneau, 8 p., illus., about 1960.

By 1965 the demand for spruce cants in Japan had advanced to the point that the Wrangell Lumber Company output could not meet it. Ketchikan Spruce Mills then began sawing spruce cants along with its usual dimension lumber output.

When the lumber market changed from domestic dimension to foreign cant market in 1968, the base for Forest Service timber appraisals changed with it. Average cant values by species were collected along with average milling costs and overruns. From these data, an average value by net log scale and species was calculated. This average value by log scale and species was distributed to log grade values based on the spread of values traditional to the domestic dimension market which existed in 1966.

Later, as data from the spruce and hemlock cant, mill-scale studies became available, the spread of log values indicated by those studies was substituted for the traditional spread from the domestic dimension market.

MARKETING

Markets for wood products that could be produced in coastal Alaska have been difficult and slow to develop. The small population of Alaska, 302,647 in 1970 (Lin 1971), will not support significant and efficient woodworking plants, even if those plants could capture most of the Alaska market, In the past, small sawmills could produce the lumber needed for fish boxes and local construction. The larger, efficient mills of today must have export markets. In 1962, the per capita consumption of lumber in the Nation was 200 board feet. At this rate of use, Alaska would require about 60 million board feet of lumber annually. Southeast Alaska has seven mills, each with capacity to produce the total needs of the Alaska population. In order to operate as they do, these mills contract their output to a foreign market, and Alaskans obtain their lumber needs through "lower 48" wholesalers.

Export markets have been slow to develop, partly at least because of the high cost of transportation. In the past, specialty items such as spruce for airplane stock could be exported because of the high value. Standard lumber products, however, have not been able to compete in the Pacific Northwest markets. Many people did and still do argue that because the Jones Act restricts shipment of goods between United States ports to United States vessels, it is unfair *to* Alaska (Johnson and Jorgenson 1963). [15] It is claimed that this restriction on shipping adds to the cost of goods delivered to Alaska, thereby adding to the costs of production in Alaska and to the cost of products shipped from Alaska to United States markets.

In a study of the economy of Haines, Alaska, Massie and Haring (1969) concluded that "The isolated location of the Haines community and the existence of unattractive domestic shipping costs have to date limited profitable sales of forest products from Haines to a one buyer market--Japan."

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[15] Robert K. Buchanan. The history, growth, use, and future development of *the timber* industry in southeastern Alaska. Thesis on file at the Pacific Coast Banking School, University of Washington, Seattle, 129 p., illus., 1972.

The development of foreign markets, primarily Japanese, made it possible for Alaska to compete with industries in any other State. Cost of production in Alaska might still be higher, but at least transportation to the market was competitive. Because Alaska was hungry for industrial development, the Japanese markets were welcomed.

Another restriction on market development was the policy that requires primary manufacture of Alaska Forest Service logs in Alaska. It is often, argued that logging of southeast Alaska forests would have increased much earlier if the logs could have been rafted or barged to mills in the Seattle-Tacoma area. How the wood markets of southeast Alaska might have developed under a different policy will, of course, never be hown. However, Alaskans seem to generally favor the current policy. This was apparent during hearings regarding the Foreign Assistance Act of 1968 (U.S. Congress 1968a, 1968b, 1968c). In fact, the State has followed the same policy on timber sold from State lands. Based on limited data, Massie (1969) found that round log export from privately owned timber provided greater gross revenues per unit of wood than cant manufacture.

The wisdom of selling Alaska's wood products to Japan is often questioned. If free enterprise by American investors is to be encouraged, it would seem difficult to do otherwise. To require the marketing of Alaska products to "lower 48" markets would be selective action and inconsistent with the feeling of Alaskans with respect to restrictions such as the Jones Act. In a study of the economic ties between Japan and Alaska, Tussing et al. (1968) found no indication that Japanese investments and markets have preempted domestic enterprise or markets, Furthermore, there are a number of indications that the foreign markets for U.S. wood products end up benefiting the American consumer as well as forest utilization and management practices. For example, many logs that cannot be sold to U.S. markets are being sold to Japan rather than being left in the woods to rot. By selling logs to Japan, U.S. consumers possibly get lumber at a more favorable price from Canada--lumber that otherwise might go to Japan. In the Pacific Northwest, the Japanese market for small logs and chips is making it possible to commercially thin some stands and thereby increase the productivity of the residual stands. Without such markets the thinning would not be done. The Japanese market provides an opportunity to harvest overmature stands in southeast Alaska and thereby convert them to more productive young stands.

In 1961 it was estimated that 93 percent of Alaska's total output of wood products left the State. Of the total production, 57 percent went to foreign markets and 36 percent to U.S. markets (Bones 1963). A 1966 estimate showed little change in the proportion of product output going to a foreign market (Massie 1967).

All pulp is exported from Alaska. In 1973 Japan received about 34 percent (based on value) of the pulp production (table 15), while 2 percent went to other foreign markets and 64 percent to "lower 48."

TRENDS

Except for stands that are being cut, the inventory volume of southeast Alaska forests is rather stable. Of the commercial forest area of southeast Alaska, 87 percent is in old-growth stands in which growth and mortality are offsetting. Thirteen percent of the forest is in young stands that are growing at a reasonable rate.

Cutting has been increasing. Although early records were not kept, it is hown that in the era of 1950 and before, less than 2,000 acres were cut annually. By 1955 the cut increased to about 5,000 acres per year, to 10,000 by 1962, and to 16,000-17,000 acres by 1971. When full allowable harvest is reached, about 30,000 acres will be required annually.

A better record has been kept of the volume of log production. Log production (fig. 14) has, of course, followed basically the same trend as area cut. In 1970 the timber volume harvested was about eight times greater than in 1950. Since 1960, log production has been increasing at a rate of about 6 percent annually.

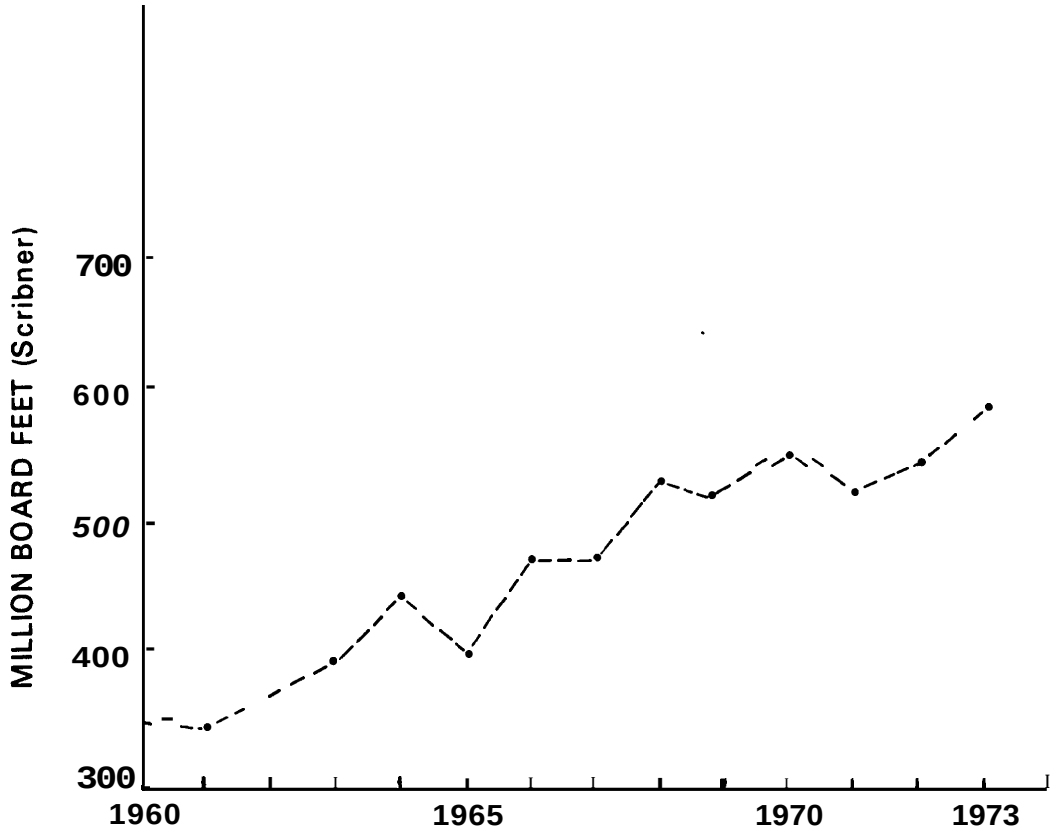

Figure 14.--Log production from Alaska National Forests, 1960-73.

Pulp production has increased from less than 300,000 tons in 1960 to roughly 400,000 tons in 1971. However, pulp production has tended to level off since 1963 when the mills nearly reached capacity. The next large increase in pulp production should take place with the building of a new mill to process timber sold to the Champion International Corporation. Building this third plant could increase total pulp production to 600,000 tons.

Lumber production has been increasing, but here again, good records are not available. Bones estimated lumber and cant production at 70 million board feet for 1961. Massie estimated 158 million for 1966 and Snyder, 296 million for 1968. Beginning with its May 1963 issue, ***Forest Industries*** has been reporting the production of major mills. Response to the ***Forest Industries*** questionnaire from Alaska was not good in the beginning but has been good in recent years. The indicated total production for southeast Alaska sawmills in 1973 is 440 million board feet. From 1967 to 1973, lumber and cant production in southeast Alaska increased an average of about 16 percent per year.

Under present Forest Service projections, the harvest will increase until about 1980 and then level off at the accessible annual allowable harvest. The inventory volume will steadily decline until about 2020, at which time the inventory volume will amount to about 70 percent of the current inventory. With removal of the old-growth stands, mortality will gradually decline. Cutover areas will begin producing measurable board-foot volume within 30 years after cutting, and by 2025 net growth will exceed the amount being cut (fig. 10).

If demand for timber should increase to the level that currently inoperable commercial forest land can be harvested, an alternate cutting plan might be adopted. One such schedule would reduce the current inventory to about 52 percent of the initial volume base by 2020. The cut would increase gradually each year, but growth would increase at a faster rate. However, because by 2020 nearly 50 percent of the inventory would still be in old-growth sawtimber stands that contribute very little net growth, the net annual growth of the total forest at that time would equal about 55 percent of the annual volume removed. Growth and removals would equate in later years as more of the old-growth stands are converted to vigorous young-growth stands.

NEEDED INVENTORY, ECONOMICS, and MARKETING RESEARCH

INVENTORY

Thus far Forest Survey work has generally been based on the need for timber resource information useful in regional and national planning. A two-phased system of sampling information observable on aerial photos and measured on field plots has been used. The system gives good information for a forest and its major planning units. Information gathered is used to describe the timber production opportunity, to determine the allowable annual harvest, and to prepare long-range plans.

The current inventory program has not satisfied the land manager's need for bookkeeping records of forest conditions and management actions on land units. Past inventories have not related timber resource data to the many basic land strata employed by the manager in his multiple use plan. To do this requires a more intensive inventory system that can be tied to specified mapped areas or coordinates and is capable of being recorded, recalled, and summarized quickly by computer methods.

As demonstrated in other regions there certainly is a need for intensive inventories at the management unit level. Such inventories are expensive and take much time. They cannot be repeated on a short enough time interval to provide total change data for regional and State planning. It appears that inventories at two intensity levels are needed, one for the local land manager and one for regional, State, and national planning.

Much progress has been made in the techniques of timber inventory, but much room for improvement remains. More use of high altitude photography, photo interpretation, and computer methods might greatly reduce the cost. Methods of projecting change in the total forest without total remeasurement of field plots should be researched. A better tie to land productivity classes is needed. Relating timber inventory to major soil types may be part of the answer. However, such a system will not work until reliable soil type maps are available for the region. Some success has been achieved in mapping major soil types from aerial photos.

Total resource inventories are needed to aid in multiple use planning. Some progress has been made in developing techniques to gather timber inventory and other resource data at the same time, but more effort and time need to be given to this problem. In an agency such as the Forest Service, where multiple use planning requires knowledge of water, recreation, soils, insects, disease, timber, wildlife, fish, minerals, and other resource factors, much of the information needed could be gathered in one well-planned multiresource inventory. Systems for doing this need to be developed. Public Law 93-378, the Forest and Rangeland Renewable Resources Planning Act of 1974 enacted by the 93d Congress, now authorizes and directs the Forest Service to undertake this work. The first assessment of all renewable forest and rangeland renewable resources is to be completed in 1975.

Definition and identification of criteria for land and stand condition classes used in forest inventory are a continual problem. Classes that are based on economic criteria are especially troublesome because such factors are continually changing and because people motivated by different objectives cannot agree on application of the economic criteria. One clear example is the classification of operable and inoperable commercial forest land. Many factors enter into the determination of these two classes. The logging operator strives to maximize profits, so naturally wants the best quality timber on the easiest logging situation that is obtainable. The forest manager is concerned with harvesting the highest risk stands first and with protecting water, land, and esthetic values. Seldom will the logging operator and forest manager agree. They are continually bargaining.

To the extent that it can be done, inventory personnel have classified forest land into commercial operable and commercial inoperable classes based on current logging methods and costs. The operable commercial forest land becomes the base for determining allowable annual harvest from the forest. Because the criteria are intended to be current, the logging operator's immediate costs and profit margin become related to the allowable harvest of the forest. In bargaining situations between the operators and forest managers regarding timber sale boundaries, logging costs and operability limits immediately become limiting factors and disagreement can be expected.

Forest management decisions aimed at long rotations, such as 100 years in southeast Alaska, will always carry uncertainties. However, in such a long period there will be many opportunities for management adjustments. Perhaps

the operability classification should be projected to some future time, such as a fourth or half of the rotation period. The forest manager and logging operators would still have the problem of determining currently operable sales. But the manager would not be faced with immediate adjustments in his rotation plan. These could be made periodically, based on study of historical information. This and other possible solutions to the problem of operability classification should be studied.

ECONOMICS AND MARKETING

A large and growing tourist industry is attracted to Alaska partly because of the unequaled scenic grandeur of southeast Alaska's forests, water, and associated animal and aquatic life.

Many conflicts have developed in recent years between those bent on industrial use of natural resources and those interested in preserving the intangible values. That both are needed is beyond question. The policymaker needs estimates of the values involved and how restrictions on one may affect the other. As a State, Alaska must have income from a stable tax base. Many tourism activities are seasonal, and investments are based outside the State. Income to the State must come from taxing home businesses that cater to the tourists. Research is needed to tell policymakers how this compares with the tax base provided by year-round industries.

Based on value, 50 to 70 percent of the pulp and lumber production of southeast Alaska is exported, mostly to Japan. Alaska imports its lumber needs from the "lower 48." Because stumpage purchases are dominated by two pulpmills, a truly competitive market for stumpage does not exist. Because of the peculiar interlocked markets, it is difficult to obtain end product values that can be carried back to log values for stumpage appraisal purposes.

The economy of Alaska is developing under restrictions--some aimed at helping Alaska, others not. Examples are the Jones Act which restricts shipping without Alaska interests in mind and the primary timber processing policy aimed at promoting industrial development in Alaska. Some of these policies may outlive their usefulness. The State could benefit from an objective study of the marketing and utilization alternatives and the probable long-range effects of following the various alternatives. Would log export, at least on a limited basis, help southeast Alaska's timber markets and help establish competitive stumpage values? Should wood chips from stumpage sales qualify for export? Would such policy changes encourage more complete utilization? In the past an exception has been made to allow the export of cedar logs harvested during clearcutting operations to obtain western hemlock and Sitka spruce. Without this exception, the cedar logs would not have been utilized. Now western redcedar, as well as Alaska-cedar, has become a valuable tree in high demand. Should the export of cedar logs continue? Because markets and the economy are dynamic, we need to continually study the alternative policies and determine when changes should be made. Better utilization of the resource might result from less restriction on trade. On the other hand, less restriction might result in diseconomies to the State or the Nation.

Transportation economics is critical to southeast Alaska development. Systems are changing--and improving. Goods that once arrived in Alaska by ship are now containerized and delivered by tug and barge. The freight ship once familiar in Alaska's coastal waters has been retired or transferred to other service. But like the ships, the barges arrive loaded and generally return

empty. Backhaul products could greatly reduce freight rates. The Alaska Marine Highway or ferry system, developed in recent years, has changed southeast Alaska's transportation pattern. Highways to communities of southeast Alaska and to British Columbia are either under construction or being planned. Our knowledge of the implications of this growth and change in transportation for policy decisions has not kept pace. It would appear that some new market opportunities should become available. Included in transportation economics are the methods of moving logs from the woods to the mills. The present log rafting system results in heavy losses of logs at times, which may be difficult to justify on strictly a transportation cost basis. If water transportation of logs should shift to barging, then an entirely different logging road system would be required. Based on cost, however, a recent study shows that in most cases rafting is the most economical means of transporting logs in southeast. Alaska.[16]

Factors of efficiency and world markets require study and better understanding. The two subjects are related to the extent that world markets usually require high production plants, whereas home markets might be small by comparison. Southeast Alaska presently depends on export markets for its timber industry. Clearcutting to supply timber for the southeast Alaska industry is the preferred forestry practice. The size of areas clearcut can be varied, and here economics of scale apply. The costs, both real and social, are different for 1,000 acres cut in 20-acre tracts than for 1,000 acres cut in one block. Understanding these and other costs will help improve policy decisions with respect to harvesting and other use practices.

How much timber per acre and what size are needed for a commercial operation? How much can be invested periodically to grow timber over various rotations? The economics of growing timber in southeast Alaska have not been studied. The base for commercial forest land classification is 20 cubic feet of mean annual increment, Although the Forest Service does not agree, currently some logging operators claim that any acre with less than 20,000 board feet is not economically operable. These bases change over time and presently are not derived from sound economic studies. Fertilization, thinning, and other cultural treatments to improve growth rates or quality are being considered without knowing the cost-benefit relationship. These questions are important both to the land manager who must decide how to invest money and to the Nation in forecasting supply.

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[16] Kenneth E. Beil. The economics of rafting vs. barging as a means of transporting logs in southeast Alaska waters. Unpublished report to Pacific Northwest Forest and Range Experiment Station under contract No. 19-200, 53 p., 1974.

EPILOG

Alaska is still in the category of a new area for settlement. The magnitude of the new industries, recreational opportunities, wilderness experiences, and other uses that Alaska's forests can support is still unknown. How many citizens of the United States can benefit from development of these forest resources depends upon policies as well as upon inventory and evaluation of the resources and research to direct their use.

Because the amount of money allotted to forest research is limited, there must, of course, be a priority for its use. Forest inventory and economics research in Alaska should carry a high priority because:

1. Forests of Alaska, and southeast Alaska forests in particular, are a major key to the potential development and growth of the State.

2. The number of people employed in forest industries of Alaska depends upon markets obtainable, harvesting methods used, products produced, and the extent of secondary manufacture done locally.

3. The manner in which Alaska's forest land is to be used has national interest, and the outcome may affect the jobs and interests of people along the Pacific coast and elsewhere.

4. Forest inventory and economics research should and can provide the needed look ahead and thereby play a major role in allocations of Alaska's forest resources to meet the often conflicting environmental, social, and industrial demands of the people. That opportunity is present now.

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APPENDIX

DEFINITION OF TERMS

Land Use Classes

Forest land. --Includes (a) lands that are at least 10 percent stocked by trees of any size and capable of producing timber or other wood products, or of exerting influence on the climate or on the water regime; (b) land from which trees have been removed to less than 10-percent stocking, and which has not been developed for other use. (Forested tracts and islands of less than 10 acres and isolated strips of timber less than 120 feet wide are excluded.)

Commercial: Forest land which is (a) producing or capable of producing usable crops of industrial wood (will net a minimum of 8,000 board feet per acre, International 1/4-inch rule); (b) economically accessible now or in the foreseeable future; and (c) not withdrawn from timber utilization.

Noncommercial: Forest land incapable of producing usable industrial wood because of adverse site conditions or withdrawn for specified purposes.

Unproductive: Noncommercial forest land which does not now support or will not produce a minimum of 8,000 board feet per acre.

Productive: Forest land capable of producing usable crops of industrial wood, but withdrawn for specified purposes through statute, ordinance, or administrative order.

Nonforest land.--All land not qualifying as forest land. Includes land which has never supported forest growth; land from which the forest has been removed to less than 10-percent stocking and has been developed for other use, such as agricultural, residential, or industrial; all land in thickly populated urban and suburban areas; and water areas under 40 acres classified by the Bureau of the Census as land. Glaciers, icefields, marshland above mean high tide, permanent brush fields, muskegs less than 10-percent stocked to trees of any size, and barren mountaintops are examples of lands which have never supported forest growth.

Forest Types

Forest types are classified on the basis of the species or species group that accounts for the major portion of the stand in terms of net board-foot volume for sawtimber, cubic-foot volume for poletimber, and number of trees for seedling-sapling stands.

Sitka spruce: Forests in which Sitka spruce is predominant.

Hemlock-Sitka spruce: Forests in which 50 percent or more of the stand is western hemlock but in which Sitka spruce makes up 30 to 49 percent of the stand.

Hemlock: Forests predominantly western hemlock except when Sitka spruce comprises 30 to 49 percent of the stand.

Hardwood: Forests predominantly cottonwood or red alder, singly or in combination.

Tree and Stand Classes

Sawtimber trees.--Live trees of commercial species, at least 11.0-inch d.b.h., with at least 25 percent of their gross board-foot volume free from rot or other defect and that contain at least one merchantable saw log.

Merchantable saw log: For softwoods, not less than 16 feet long, containing a minimum of 20 board feet, between a stump height equal to d.b.h. but not exceeding 4-1/2 feet and a merchantable top equal to 40 percent of d.b.h., except in the case of small trees where the minim top is 6 inches. For hardwoods, not less than one 8-foot log to a minimum top of 8 inches d.i.b. for small trees and 40 percent of d.b.h. for large trees. After deductions for defect, a saw log must contain a net scale of at least 33-1/3 percent of the gross.

Upper stem: The section of the bole or main stem of a sawtimber tree from the merchantable top to a minimum top diameter of 4.0-inches inside the bark.

Poletimber trees.--Live trees, 5.0-inches to, but not including, 11.0-inch d.b.h. These trees are of sufficiently good form and condition to indicate that they will grow into merchantable sawtimber trees.

Sapling and seedling trees.--Live trees of commercial species, less than 5.0-inch d.b.h., and of sufficiently good form *and* vigor to indicate that they will grow *into* merchantable sawtimber trees.

Growing-stock trees.--All live trees, except cull trees, of commercial species.

Cull trees.--Live trees, 5.0-inch d.b.h. and over, that do not qualify as sawtimber or poletimber trees due to poor form, limbiness, rot, or other defect. Rotten cull trees contain excessive decay, Sound cull trees have excessive crook, sweep, or large limbs.

Salvable dead trees.--Standing, dead, sawtimber-size trees containing at least one merchantable saw log having sound volume equal to at least 50 percent of the gross volume in the tree.

Mortality trees.--Pees, 5.0-inch d.b.h. and larger, which died of natural causes and were not cull trees at the time of death.

Sawtimber stand.--Forest stands in which the minimum volume for coniferous types is 8,000 net board feet per acre in growing-stock trees, 11.0-inch d.b.h. and larger. For hardwood sawtimber stands the minimum volume is 4,000 net board feet per acre.

Old growth: Sawtimber stands in which the majority of volume is in sawtimber trees more than 150 years of age.

Young growth: Sawtimber stands in which the majority of volume is in sawtimber trees less than 150 years of age.

Poletimber stand.--Stands failing to meet the sawtimber stand specification, but at least 10 percent stocked with poletimber and larger growing-stock trees, and with at least half the minimum stocking in poletimber trees.

Sapling and seedling stand.--Stands not qualifying as either sawtimber or poletimber, but having at least 10-percent stocking of trees of commercial species and with at least half the minimum stocking in seedlings and saplings.

Nonstocked and other areas.--Commercial forest land less than 10 percent stocked with growing-stock trees.

Volume Classes

Sawtimber volume.--The net volume in board feet, International 1/4-inch rule, of merchantable saw logs in live sawtimber trees of commercial species.

Growing-stock volume.--The net volume in cubic feet of sound wood in live sawtimber and poletimber trees of commercial species from the stump to a minimum 4.0-inch top inside the bark.

Total volume.--The net volume in cubic feet of sound wood in live and salvable dead sawtimber and poletimber trees and in sound and rotten cull trees of commercial species from the stump to a minimum 4.0-inch top inside the bark. Included is the volume of hardwood limbs on sawtimber trees to a minimum diameter of 4.0 inches inside the bark.

Log Grades

Sample western hemlock and Sitka spruce trees were graded in 16-foot log lengths. However, when any 12- or 14-foot section of a log was better than the entire log, the grade of the shorter section was given to the entire log.

The rules used were from the January 1954 edition of Official Log Scaling and Grading Rules for the Puget Sound, Grays Harbor, Southern Oregon, and Northern California Bureaus.

Abbreviations Used

DBH, d.b.h., or b.h.--Abbreviation for diameter at breast height. This measurement is taken 4-1/2 feet above the ground on the uphill side of the tree.

D.i.b.--Abbreviation for diameter inside the bark. This measurement may be taken at any specified location.

D.o.b.--Abbreviation for diameter outside the bark. This measurement may be taken at any specified location.

Two-inch diameter class.--If the classes are expressed as 6, 8, 10 inches, etc., this means that the diameters included are from 5.0 through 6.9, 7.0 through 8.9, 9.0 through 10.9, etc.

Stocking Classes

Stocking is a measure of how effectively the area is being utilized by growing stock. No stocking measure was assigned to old-growth stands. For young-growth stands, ocular estimates were made of the crown cover of sawtimber trees on the 10 acres surrounding each plot location. The stocking of poletimber, saplings, and seedlings was based on the number of stems per acre. For. poletimber, these were:

	Percent stocked
210 or more stems per acre	70
120 to 210 stems per acre	40
30 to 120 stems per acre	10

For saplings and seedlings, stocking was measured on ten 4-milacre circular plots. Two or more established saplings or seedlings were required to stock a 4-milacre plot. Stocking of the area was determined by the number of 4-milacre locations that were stocked. Thus, if six of the ten 4-milacre locations were stocked, the area was judged to be 60 percent stocked.

Area stocking classes	Percent
Nonstocked	0-10
Poorly stocked	10-39
Medium stocked	40-69
Well stocked	70-100

Volume Measurements

Board foot.--A board 1 foot long, 1 foot wide, and 1 inch thick. The bark is usually eliminated from this measurement. In practice, the working unit is 1,000 board feet and may be abbreviated to M bd. ft., M bm, M.B.M., or MBF.

Cubic foot.--A cube 12 inches on a side. The cubic-foot volume of a log or tree is commonly computed by Smalian's formula (Bruce and Schumacher 1950).

International 1/4-inch log rule.--A rule used to determine the log volume in board feet (Bruce and Schumacher 1950).

Allowable Cut

The volume of wood which can be cut under management for a given period of time.

A number of formulas are available to make this estimate. The Kemp formula is easy to apply with the kind of inventory data available. Usually this formula is applied to areas in which there is a surplus of timber beyond rotation age. The objective is to determine the cut that will achieve an approximately equal distribution of area by age or stand-size classes within a rotation.

The Kemp formula:

$$\text{Annual cut} = \frac{7A + 5A_1 + 3A_2 + A_3}{4R}\,(MA)$$

A = area of sawtimber stands
A_1 = area of poletimber stands
A_2 = area of seedling and sapling stands
A_3 = nonstocked area
$A + A_1 + A_2 + A_3$ = total commercial forest land area
R = rotation in years
MA = average volume per acre of current sawtimber stands, the A stratum.

EQUIVALENTS

English	Metric
Length:	
1 mile	1.609 kilometers
1 rod	5.029 meters
1 foot	30.480 centimeters
1 inch	2,540 centimeters
Area:	
1 square mile	2.590 square kilometers
1 acre	0.4047 hectare
1 square foot	0.093 square meter
1 square inch	6,451 square centimeters
Volume:	
1 cubic foot	0.0283 cubic meter
1 cubic inch	16.3871 cubic centimeters
Weight:	
1 short ton	0.907 metric ton
1 long ton	1.016 metric tons

The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

Within this overall mission, the Station conducts and stimulates research to facilitate and to accelerate progress toward the following goals:

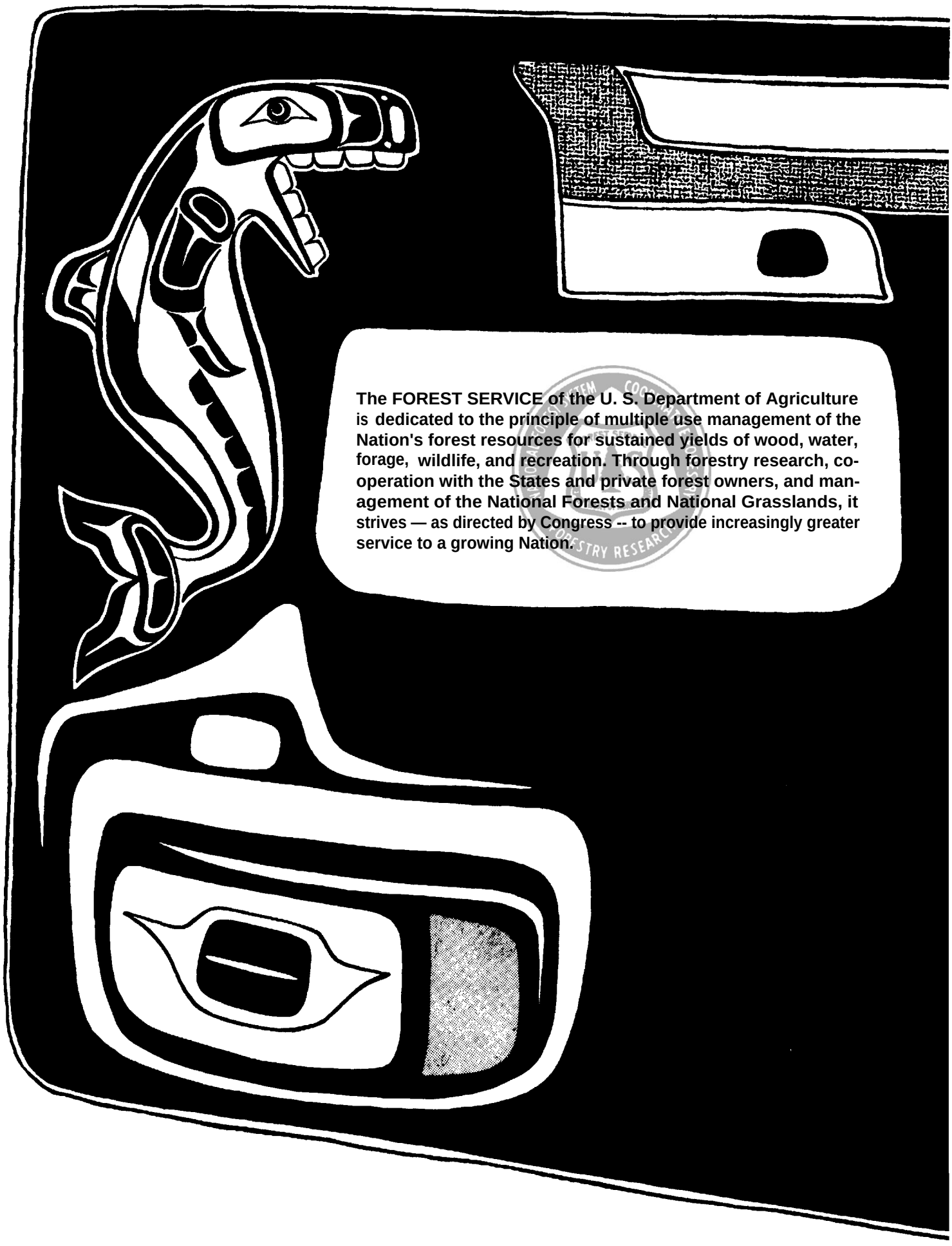
1. Providing safe and efficient technology for inventory, protection, and use of resources.
2. Development and evaluation of alternative methods and levels of resource management.
3. Achievement of optimum sustained resource productivity consistent with maintaining a high quality forest environment.

The area of research encompasses Oregon, Washington, Alaska, and, in some cases, California, Hawaii, the Western States, and the Nation. Results of the research will be made available promptly. Project headquarters are at:

Fairbanks, Alaska	Portland, Oregon
Juneau, Alaska	Olympia, Washington
Bend, Oregon	Seattle, Washington
Corwallis, Oregon	Wenatchee, Washington
La Grande, Oregon	

Mailing Address: Pacific Northwest Forest and Range Experiment Station
P.O. Box 3141
Portland, Oregon 97208

GPO 993-626



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.