USDA Forest Service
Resource Bulletin PNW-81

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1976 WASHINGTON TIMBER HARVEST

by

J. D. Lloyd, Jr., *Supervisory Forester*

The 1976 Washington timber harvest of 6.97 billion board feet was up 12.7 percent from the 8-year low experienced in 1975. Harvest increased about the same percentage in both eastern and western Washington. Production from all owner groups rose except non-industrial private and other Federal (see table headings on page 2).

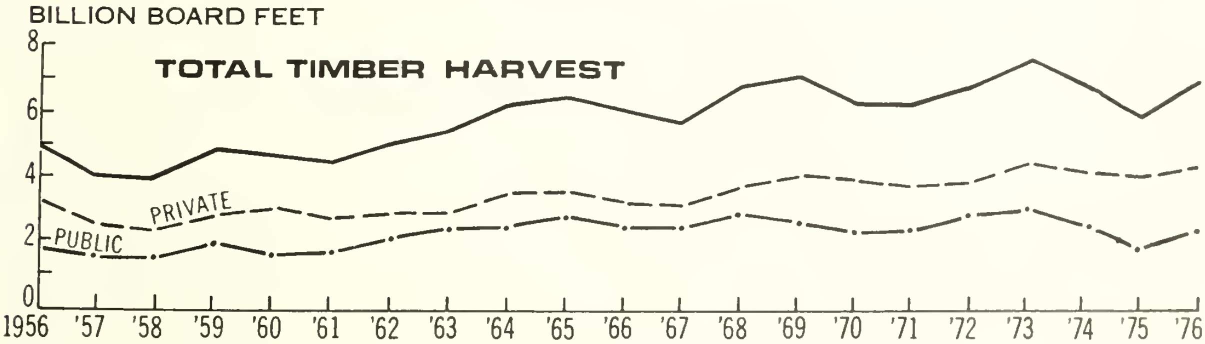
Harvest on public lands jumped 20.4 percent above 1975 to 2.56 billion board feet. National Forest output increased 116 million board feet (11 percent), State lands increased 226 million board feet (42 percent), and Indian lands increased 97 million board feet (23 percent). All remaining public lands combined showed a loss of 7 million board feet.

Private log production was up 275 million board feet (7 percent) in western Washington and 77 million board feet (23 percent) in the eastern half-State. Forest industry reported 3.7 billion board feet, 465 million more than 1975. This was partly offset by a 113 million board-foot reduction from other private lands.

In 1976, Cowlitz was the leading log producing county in the State, a position it has held for 7 of the last 16 years. From 1935 until present, Lewis County was in the lead position 35 years and number two for 7 years. For the previous 10 years (the beginning of our records), Grays Harbor was number one. Over the past 30 years, these three counties combined have consistently provided 27 to 34 percent of the State total.

Compared with 1975, average stumpage prices on National Forest, Indian, and State lands rose an average of 16 percent (to $122) in western Washington and 56 percent (to $68) in eastern Washington. The volume sold on these lands decreased 9 percent (to 2.28 billion board feet), even though harvest was up.

WASHINGTON TIMBER HARVEST 1956-76



PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION

Forest Service
U.S. Department of Agriculture

P.O. Box 3141
Portland, Oregon 97208

Timber harvest by ownership in the State of Washington, 1976

(In thousand board feet, Scribner log scale)

Half-State and county	Private[2]						State[2]		Bureau of Land Management[4]		National Forests[4]		Indian lands[4]		Other public[2]		Other Federal[5]		Total production
	Industrial		Other		Total private														
	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	Live	Dead[3]	
Western Washington:																			
Clallam	197,027	3,844	53,217	2,063	250,244	5,907	93,122	982	--	--	65,544	178	11,479	270	--	--	--	--	427,726
Clark	10,291	18	17,277	183	27,568	201	7,493	304	--	--	2,783	146	--	--	--	--	--	--	38,495
Cowlitz	750,020	140	25,275	46	775,295	186	56,830	1,094	--	--	262	85	--	--	--	--	--	--	833,752
Grays Harbor	227,825	8,283	29,316	995	257,141	9,278	10,480	--	--	--	85,323	4,061	221,032	4,877	437	--	--	--	592,629
Island	833	--	14,274	--	15,107	--	290	--	--	--	--	--	--	--	--	--	--	--	15,397
Jefferson	164,864	5,623	13,485	1,252	178,349	6,875	322,067	7,603	--	--	29,666	210	--	--	505	--	2,334	--	547,609
King	336,273	41	44,353	1,350	380,626	1,391	17,567	--	--	--	29,366	3,222	--	--	17,718	--	465	--	450,295
Kitsap	15,112	--	24,487	198	39,599	198	4,194	--	--	--	--	--	4,074	--	11	--	995	--	49,071
Lewis	644,930	228	66,593	1,812	711,523	2,040	28,830	222	--	--	61,111	5,480	--	--	111	--	--	--	809,317
Mason	43,640	2,767	27,238	2,896	70,878	5,663	3,697	--	--	--	98,466	12,627	--	--	--	--	--	--	191,331
Pacific	460,535	2,267	13,391	60	473,926	2,327	16,249	106	--	--	--	--	--	--	--	--	--	--	492,608
Pierce	206,213	2	52,637	264	258,850	266	6,734	--	--	--	47,093	4,689	--	--	37	--	13,613	--	331,282
San Juan	--	--	12,476	--	12,476	--	--	--	--	--	--	--	--	--	--	--	--	--	12,476
Skagit	96,721	1,566	24,688	617	121,409	2,183	31,148	352	--	--	53,721	1,928	--	--	2,563	--	--	--	213,304
Skamania	92,719	19	6,440	21	99,159	40	17,077	30	13	--	232,359	18,666	--	--	180	--	--	--	367,524
Snohomish	42,901	637	47,645	88	90,546	725	26,616	81	--	--	58,360	4,625	--	10	--	--	--	--	180,963
Thurston	60,860	--	36,268	907	97,128	907	4,548	35	--	--	--	--	648	--	200	--	585	--	104,051
Wahkiakum	51,741	2,436	3,539	8	55,280	2,444	16,481	10	--	--	--	--	--	--	8	--	--	--	74,223
Whatcom	29,895	3,119	10,033	33	39,928	3,152	31,030	202	--	--	29,128	1,449	10	--	--	--	--	--	104,899
Total	3,432,400	30,990	522,632	12,793	3,955,032	43,783	694,393	11,021	13	--	793,182	57,366	237,243	5,157	21,770	--	17,992	--	5,836,952
Total live and dead	3,463,390		535,425		3,998,815		705,414		13		850,548		242,400		21,770		17,992		5,836,952
Eastern Washington:																			
Adams	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Asotin	--	--	8,753	18	8,753	18	123	--	--	--	4,395	87	--	--	--	--	--	--	13,376
Benton	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chelan	13,803	36	27,585	--	41,388	36	--	--	--	--	38,186	3,246	--	--	1,148	--	--	--	84,004
Columbia	77	--	3,317	--	3,394	--	2,165	--	--	--	9,191	52	--	--	--	--	--	--	14,802
Douglas	--	--	853	--	853	--	--	--	--	--	--	--	--	--	--	--	--	--	853
Ferry	16,235	86	5,479	--	21,714	86	2,580	12	161	--	22,945	1,091	66,270	90	--	--	--	--	114,949
Franklin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Garfield	255	--	4,218	--	4,473	--	--	--	--	--	9,670	197	--	--	--	--	--	--	14,340
Grant	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Kittitas	57,757	58	3,514	--	61,271	58	2,417	--	--	--	52,600	8,641	--	--	9,863	--	--	--	134,850
Klickitat	47,511	4,006	14,271	26	61,782	4,032	12,538	3	--	--	6,453	339	21,764	147	--	--	--	--	107,058
Lincoln	95	--	4,909	--	5,004	--	--	--	--	--	--	--	--	--	--	--	--	--	5,004
Okanogan	6,120	--	14,784	41	20,904	41	14,772	--	--	--	88,338	2,843	45,722	--	--	--	--	--	172,620
Pend Oreille	14,429	48	16,110	286	30,539	334	1,369	--	--	--	23,378	6,847	--	--	866	--	--	--	63,333
Spokane	15,933	--	25,902	55	41,835	55	258	--	--	--	--	--	--	--	1,020	--	--	--	43,168
Stevens	50,124	--	45,354	157	95,478	157	11,457	40	2,891	--	12,736	664	17,582	--	58	--	2,630	--	143,693
Walla Walla	--	--	470	--	470	--	--	--	--	--	--	--	--	--	--	--	--	--	470
Whitman	--	--	755	--	755	--	--	--	--	--	--	--	--	--	--	--	--	--	755
Yakima	9,795	2,357	--	--	9,795	2,357	13,319	--	--	--	52,218	19,779	120,853	1,178	--	--	--	--	219,499
Total	232,134	6,591	176,274	583	408,408	7,174	60,998	55	3,052	--	320,110	43,786	272,191	1,415	12,955	--	2,630	--	1,132,774
Total live and dead	238,725		176,857		415,582		61,053		3,052		363,896		273,606		12,955		2,630		1,132,774
Total Washington	3,664,534	37,581	698,906	13,376	4,363,440	50,957	755,391	11,076	3,065	--	1,113,292	101,152	509,434	6,572	34,725	--	20,622	--	6,969,726
Total live and dead	3,702,115		712,282		4,414,397		766,467		3,065		1,214,444		516,006		34,725		20,622		6,969,726

[1] Includes volume in logs, poles, piling, shingles, bolts, etc.

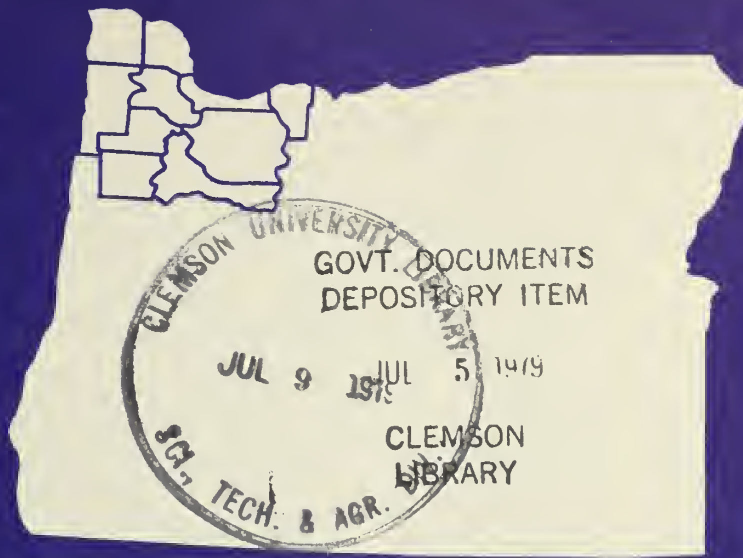
[2] Compiled by Washington State Department of Natural Resources.

[3] Includes snags and down material existing prior to initial logging.

[4] Compiled by respective agencies, U.S. Bureau of Land Management, U.S. Forest Service, U.S. Bureau of Indian Affairs.

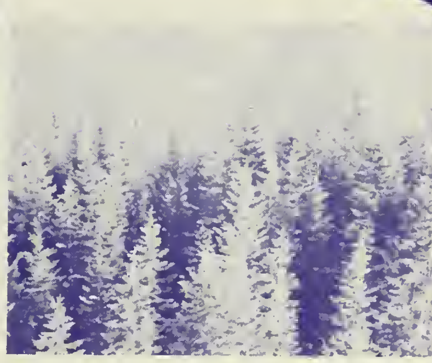
[5] Includes lands logged under jurisdiction of U.S. Department of Interior--Bonneville Power Administration, National Park Service, Bureau of Sport Fisheries and Wildlife, and Department of the Army.

Prepared by Renewable Resources Evaluation Work Unit, Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Portland, Oregon.



MBER RESOURCES OF NORTHWEST OREGON



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. DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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Acknowledgment is made of the cooperation and assistance of many public agencies and private timber companies.

The USDA Forest Service supplied forest resource data for National Forests. The Bureau of Land Management, U.S. Department of the Interior, supplied resource data for Bureau of Land Management lands.

The county assessors and several private timber companies furnished ownership information. The U.S. Forest Service, Bureau of Land Management, and several private timber companies provided maps and information on access to forest lands, as well as general information related to forest management practices in Oregon.

METRIC EQUIVALENTS

1,000 acres	= 404.7 hectares
1,000 cubic feet	= 28.3 cubic meters
1 cubic foot per acre	= 0.07 cubic meter per hectare
1 square foot of basal area per acre	= 0.23 square meter per hectare
1 foot	= 30.48 centimeters
1 inch	= 2.54 centimeters
1 mile	= 1 609.3 meters

TIMBER RESOURCES OF NORTHWEST OREGON

Reference Abstract

Mei, Mary A.
1979. Timber resources of northwest Oregon. USDA For. Serv. Resour. Bull. PNW-82, 29 p. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This report presents statistics from a 1976 timber resource inventory of 10 counties in northwest Oregon: Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill. Tables presented are of forest area, timber volume, growth, mortality, and harvest.

KEYWORDS: Forest surveys, statistics (forest), timber resources, resources (forest), Oregon (northwest), northwest Oregon.

RESEARCH SUMMARY

Resource Bulletin PNW-82

1979

The northwest Oregon resource area (Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties) totals 5,587,000 acres, of which an estimated 3,760,000 acres are forested; an estimated 3,546,000 acres are in commercial forest land. The area has approximately 53 billion board feet (Scribner rule) of standing sawtimber; 62 percent of this volume is in Federal ownership.

PREFACE

This report presents statistics from the latest inventory of the timber resources of 10 counties in northwest Oregon: Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill.

Field data for all lands except National Forests and lands administered by the Bureau of Land Management were collected by the Renewable Resources Evaluation Work Unit of the Pacific Northwest Forest and Range Experiment Station. Resources Evaluation (formerly Forest Survey) is a nationwide project of the Forest Service authorized by the McSweeney-McNary Forest Research Act of 1928 and amended by the Forest and Rangeland Renewable Resources Planning Act of 1974.

Resource evaluations are conducted through the 50 States by the USDA Forest Service Experiment Stations. The Pacific Northwest Forest and Range Experiment Station at Portland, Oregon, is responsible for resource evaluations in the States of Alaska, California, Hawaii, Oregon, and Washington.

The inventory data for lands administered by the Bureau of Land Management (BLM) were collected by that agency in 1968. Current (1976) data were furnished by the agency on all field plots silviculturally treated or cutover since inventory, including the status of all plantations. National Forest inventory data were collected by personnel at each National Forest.

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HIGHLIGHTS

IN 1975:

Commercial forest land--

- ° Covered 3,546,000 acres, 94 percent of the forest land area and 63 percent of the total land area.
- ° Had 70 percent of the area in site classes capable of producing more than 120 cubic-foot annual growth per acre per year.
- ° Was 61 percent in sawtimber stands.
- ° Was 57 percent in Douglas-fir type, 20 percent in other softwoods, 20 percent in hardwoods, and 3 percent in unclassified types.

Growing stock volume--

- ° Totaled 14,022 million cubic feet.
- ° Was comprised of 88-percent softwoods.
- ° Was 89-percent sawtimber-size trees.

Sawtimber volume--

- ° Totaled 53,485 million board feet, Scribner rule.
- ° Was 62 percent in Federal ownership.
- ° Was 57-percent Douglas-fir species.
- ° Was 92-percent softwood.
- ° Was 61 percent in trees over 21 inches.

Ownership distribution--

Ownership	Commercial forest land area	Growing-stock volume	Sawtimber volume
		Percent	
National Forest	26	46	50
Bureau of Land Management	6	8	11
Other public	16	10	9
Forest industry	33	24	20
Other private	19	12	10

Net annual growth--

- ° Totaled 362,022,000 cubic feet (1,948,844,000 board feet, International 1/4-inch rule).

Average annual mortality--

- ° Totaled 52,479,000 cubic feet (228,594,000 board feet, International 1/4-inch rule).

BETWEEN 1963 AND 1976:

Commercial forest land--

- ° Decreased by 408,000 acres, or 10 percent.

Growing stock volume--

- Decreased by 1,750,000 cubic feet, or 11 percent.

Sawtimber volume--

- Decreased by 12,082 million board feet, Scribner rule, or 18 percent.

Net annual growth of growing stock--

- Increased by 138,343,000 cubic feet, or 62 percent.

Net annual sawtimber growth--

- Increased by 1,088,375,000 board feet, International 1/4-inch rule, or 126 percent.

AVERAGE ANNUAL TIMBER HARVEST (1971-75):

- Was 1.31 billion board feet, Scribner scale, 15 percent of the State total.
- Was 53 percent from private lands and 47 percent from public lands.

TABLES FOR NORTHWEST OREGON,

JANUARY 1, 1977

Table 1--*Area by land class and county, northwest Oregon, January 1, 1977*

(In thousand acres)

Land class	All counties	Clackamas	Clatsop	Columbia	Hood River	Marion	Multnomah	Polk	Tillamook	Washington	Yamhill
Forest land:											
Commercial	3,546	845	415	306	223	314	110	254	606	234	239
Deferred	--	--	--	--	--	--	--	--	--	--	--
Productive reserved	43	2	5	1	6	14	8	1	5	1	1/
Unproductive	171	50	13	3	41	38	15	3	5	2	1
Total	3,760	897	433	310	270	366	133	258	616	237	240
Nonforest land 2/	1,827	309	82	99	65	380	138	213	98	228	215
Total area 3/	5,587	1,206	515	409	335	746	271	471	714	465	455

1/ Less than 500 acres.

2/ Includes cropland, pasture and range, swampland, industrial and urban areas, powerline clearings, railroads, all improved roads and highways, and 7,706 acres classified as water by Renewable Resources Evaluation standards, but defined by the Bureau of the Census as land.

3/ Source: United States Bureau of the Census, Land and Water Area of the United States, 1970.

Table 2--*Area of commercial forest land by ownership class and county, northwest Oregon, January 1, 1977*

(In thousand acres)

Ownership class	All counties[1/]	Clackamas	Clatsop	Columbia	Hood River	Marion	Multnomah	Polk	Tillamook	Washington	Yamhill
National Forest	936	473	--	--	151	156	53	[2/]	78	--	25
Bureau of Land Management	227	55	--	10	--	19	5	37	46	12	43
Other public	575	27	136	12	26	22	6	6	282	52	6
Total public[1/]	1,738	555	136	22	177	197	64	43	406	64	74
Private:											
Forest industry	1,144	131	241	215	31	53	11	144	162	85	71
Other private:											
Farmer owned	318	52	15	28	5	22	9	48	17	53	69
Miscellaneous	347	107	24	40	10	42	26	18	22	33	25
Total private[1/]	1,809	290	280	283	46	117	46	210	201	171	165
All ownerships[1/]	3,546	845	415	306	223	314	110	254	606	234	239

[1/] Totals may be off because of rounding.

[2/] Less than 500 acres.

Table 3--*Area of commercial forest land by cubic-foot site and ownership classes, northwest Oregon, January 1, 1977*

Site class[1]	All ownerships[2]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Cubic feet	Thousand acres					
225 or more	180	20	4	46	85	25
165 to 224	456	91	25	64	229	47
120 to 164	1,845	271	143	352	698	381
85 to 119	599	209	42	88	97	163
50 to 84	453	339	13	25	34	42
20 to 49	13	6	--	--	--	7
All classes[2]	3,546	936	227	575	1,144	665

[1]A classification in terms of capacity for cubic-foot annual growth per acre at culmination of mean annual growth in fully stocked stands.

[2]Totals may be off because of rounding.

Table 4--*Area of commercial forest land by stand-size and ownership classes, northwest Oregon, January 1, 1977*

(In thousand acres)

Stand-size class	All ownerships[1]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Sawtimber stands:						
Large sawtimber[2]	646	378	63	47	67	91
Small sawtimber[3]	1,507	300	73	239	607	288
Total[1]	2,154	678	137	286	674	379
Poletimber stands	508	113	17	134	139	105
Sapling and seedling stands	678	111	63	137	291	76
Nonstocked areas	206	34	10	17	40	105
All classes[1]	3,546	936	227	575	1,144	665

[1]Totals may be off because of rounding.

[2]Large sawtimber includes trees 21.0-inch d.b.h. and larger.

[3]Small sawtimber includes softwood trees 9.0- to 20.9-inch d.b.h. and hardwood trees 11.0- to 20.9-inch d.b.h.

Table 5--*Area of commercial forest land by forest type and ownership class, northwest Oregon, January 1, 1977*

(In thousand acres)

Forest type	All ownerships[1/]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Douglas-fir	2,008	443	171	412	737	245
Grand fir	53	19	--	--	27	7
Pacific silver fir	104	100	--	--	4	--
Noble fir	23	13	--	--	10	--
Ponderosa pine	6	6	--	--	--	--
Lodgepole pine	38	30	--	8	--	--
Whitebark pine	2	2	--	--	--	--
Engelmann spruce	2	2	--	--	--	--
Sitka spruce	160	5	--	25	109	21
Mountain hemlock	34	34	--	--	--	--
Western hemlock	215	197	18	--	--	--
Western redcedar	60	12	2	3	12	31
Red alder	554	39	22	110	206	177
Cottonwood	8	--	--	--	--	8
Maple	67	--	3	--	9	55
Oregon white oak	54	--	--	--	1	53
Other hardwoods	21	--	--	--	--	21
Noncommercial hardwoods	22	--	1	--	7	14
Unclassified[2/]	118	34	10	17	24	33
All types[1/]	3,546	936	227	575	1,144	665

[1/]Totals may be off because of rounding.

[2/]Unclassified type has less than 10 percent stocked with live trees.

Table 6--*Area of noncommercial forest land by forest type and land class and by ownership class, northwest Oregon, January 1, 1977*

(In thousand acres)

Forest type and land class	All ownerships[1]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
RESERVED						
Productive:						
Douglas-fir	23	1	--	22	--	--
Pacific silver fir	8	8	--	--	--	--
True firs	2/	--	--	2/	--	--
Ponderosa pine	2/	--	--	2/	--	--
Lodgepole pine	1	1	--	2/	--	--
Sitka spruce	4	--	--	4	--	2/
Hemlock	4	--	--	4	--	--
Red alder	2/	--	--	2/	--	--
Cottonwood and aspen	2/	--	--	2/	--	--
Oaks	2/	--	--	2/	--	--
Other hardwoods	3	--	--	3	--	--
Total[1]	43	10	--	33	--	2/
Unproductive:						
Rocky[3]	1	--	--	1	--	--
Willow	2/	--	--	2/	--	--
Unknown	18	17	--	1	--	--
Total[1]	19	17	--	2	--	--
Total reserved[1]	62	27	--	35	--	2/
UNRESERVED						
Unproductive:						
Rocky[3]	7	--	7	--	--	--
Low site[3]	2/	--	2/	--	--	--
Adverse location[3]	2/	--	2/	--	--	--
Unclassified:[4]						
Douglas-fir	65	65	--	--	--	--
Pacific silver fir	8	8	--	--	--	--
Subalpine fir	2	2	--	--	--	--
Noble fir	11	11	--	--	--	--
Lodgepole pine	1	1	--	--	--	--
Mountain hemlock	12	12	--	--	--	--
Western hemlock	5	5	--	--	--	--
Alaska-cedar	1	1	--	--	--	--
Hardwoods	2	2	--	--	--	--
Total[1]	114	107	7	--	--	--
Unknown	4	--	--	--	--	4
Oak-madrone	15	--	--	7	--	8
Willow	19	--	--	9	3	7
Total unreserved[1]	152	107	7	16	3	20

1/ Totals may be off because of rounding.

2/ Less than 500 acres.

3/ Cannot be broken down by forest type.

4/ Cannot be broken down by land class.

Table 7--*Volume of timber on commercial forest land by class of timber and by softwoods and hardwoods, northwest Oregon, January 1, 1977*

(In million cubic feet)

Class of timber	All species[1/]	Softwoods	Hardwoods
Sawtimber trees:			
Saw-log portion	10,557	9,691	866
Upper-stem portion	1,869	1,727	142
Total[1/]	12,426	11,419	1,007
Poletimber trees	1,596	993	603
All growing-stock trees[1/]	14,022	12,411	1,611
Sound cull trees	132	46	86
Rotten cull trees	234	182	52
Salvable dead trees	155	146	10
All timber[1/]	14,543	12,786	1,758

[1/] Totals may be off because of rounding.

Table 8--*Volume of growing stock and sawtimber on commercial forest land by ownership class and by softwoods and hardwoods, northwest Oregon, January 1, 1977*

Ownership class	Average volume per acre	Total volume		
		All species[1]	Softwoods	Hardwoods
	Cubic feet	- - - - - Million cubic feet - - - - -		
Growing stock:[2]				
National Forest	6,724	6,294	6,158	136
Bureau of Land Management	5,004	1,136	1,053	83
Other public	2,546	1,464	1,193	271
Forest industry	2,990	3,421	2,901	520
Other private	2,567	1,707	1,106	601
All ownerships[1]	3,954	14,022	12,411	1,611
	Board feet	- - - - - Million board feet - - - - -		
Sawtimber (International 1/4-inch rule):[3]				
National Forest	37,194	34,814	34,234	580
Bureau of Land Management	30,066	6,825	6,471	354
Other public	12,012	6,907	6,263	644
Forest industry	14,438	16,517	14,869	1,648
Other private	11,469	7,627	5,777	1,850
All ownerships[1]	20,499	72,690	67,614	5,076
Sawtimber (Scribner rule):[4]				
National Forest	29,046	27,187	26,796	391
Bureau of Land Management	25,881	5,875	5,527	348
Other public	8,042	4,624	4,117	507
Forest industry	9,194	10,518	9,211	1,307
Other private	7,941	5,281	3,770	1,511
All ownerships[1]	15,083	53,485	49,421	4,064

[1]Totals may be off because of rounding.

[2]Includes trees 5.0-inch d.b.h. and larger.

[3]Includes softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

[4]Includes trees 11.0-inch d.b.h. and larger.

Table 9--*Volume of growing stock and sawtimber on commercial forest land by county and ownership class, northwest Oregon, January 1, 1977*

County	Total[1/]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
			Million cubic feet			
Growing stock:[2/]						
Clackamas	4,235	3,153	348	78	226	430
Clatsop	1,272	--	--	471	713	88
Columbia	1,147	--	29	82	834	202
Hood River	1,120	919	--	83	62	56
Marion	1,556	1,161	93	51	103	148
Multnomah	522	369	23	10	23	97
Polk	793	--	163	15	477	138
Tillamook	1,874	501	251	511	491	120
Washington	625	--	15	147	235	228
Yamhill	875	191	214	15	256	199
Total[1/]	14,022	6,294	1,136	1,464	3,421	1,707
			Million board feet			
Sawtimber (International 1/4-inch rule):[3/]						
Clackamas	22,835	17,381	2,051	377	1,014	2,013
Clatsop	6,026	--	--	2,273	3,333	420
Columbia	5,814	--	128	511	4,179	996
Hood River	5,875	4,907	--	390	292	286
Marion	8,550	6,610	585	247	463	645
Multnomah	2,802	2,065	123	53	103	458
Polk	4,031	--	1,033	78	2,410	510
Tillamook	9,535	2,790	1,544	2,245	2,336	620
Washington	2,745	--	61	655	1,082	947
Yamhill	4,478	1,061	1,300	78	1,306	733
Total[1/]	72,690	34,814	6,825	6,907	16,517	7,627
			Million board feet			
Sawtimber (Scribner rule):[4/]						
Clackamas	17,486	13,523	1,727	241	586	1,409
Clatsop	4,013	--	--	1,584	2,110	318
Columbia	3,910	--	89	384	2,717	720
Hood River	4,443	3,820	--	245	176	202
Marion	6,560	5,187	506	160	269	438
Multnomah	2,243	1,719	102	35	59	328
Polk	2,870	--	913	52	1,575	330
Tillamook	6,949	2,166	1,362	1,479	1,481	461
Washington	1,719	--	42	392	685	600
Yamhill	3,290	772	1,134	52	858	474
Total[1/]	53,485	27,187	5,875	4,624	10,518	5,281

[1/] Totals may be off because of rounding.

[2/] Includes trees 5.0-inch d.b.h. and larger.

[3/] Includes softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

[4/] Includes trees 11.0-inch d.b.h. and larger.

Table 10--*Volume of growing stock on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In million cubic feet)

Species	All ownerships[1/]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	7,336	3,220	902	555	1,837	821
White fir	1	1	--	--	--	--
Grand fir	176	109	1	26	4	36
Subalpine fir	7	7	--	--	--	--
Pacific silver fir	531	511	8	--	12	--
Noble fir	275	233	19	2	21	--
Ponderosa pine	26	22	--	--	2	2
Lodgepole pine	77	69	--	8	--	--
Western white pine	37	37	[2/]	--	--	--
Engelmann spruce	24	24	--	--	--	--
Sitka spruce	305	87	4	20	119	75
Mountain hemlock	190	185	5	--	--	--
Western hemlock	2,984	1,405	107	551	854	68
Incense-cedar	1	1	--	--	--	--
Alaska-cedar	17	17	--	--	--	--
Western redcedar	390	196	7	31	52	104
Western larch	34	34	--	--	--	--
Total[1/]	12,411	6,158	1,053	1,193	2,901	1,106
Hardwoods:						
Red alder	1,113	129	68	234	429	253
Oregon ash	21	--	--	--	--	21
Black cottonwood	47	--	1	--	--	46
Bigleaf maple	304	6	14	37	88	158
Oregon white oak	124	--	--	--	2	122
Golden chinkapin	1	1	--	--	--	--
Total[1/]	1,611	136	83	271	520	601
All species[1/]	14,022	6,294	1,136	1,464	3,421	1,707

[1/]Totals may be off because of rounding.

[2/]Less than 500,000 cubic feet.

Table 11--*Volume of sawtimber, International 1/4-inch rule, on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In million board feet)

Species	All ownerships[1/]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	41,502	19,183	5,633	2,732	9,806	4,148
White fir	3	3	--	--	--	--
Grand fir	809	539	5	76	16	173
Subalpine fir	36	36	--	--	--	--
Pacific silver fir	2,480	2,411	43	--	26	--
Noble fir	1,580	1,366	124	8	82	--
Ponderosa pine	170	146	--	--	14	10
Lodgepole pine	196	176	--	20	--	--
Western white pine	205	204	1	--	--	--
Engelmann spruce	118	118	--	--	--	--
Sitka spruce	1,876	579	25	123	618	531
Mountain hemlock	938	917	21	--	--	--
Western hemlock	15,323	7,163	589	3,143	4,061	367
Incense-cedar	5	5	--	--	--	--
Alaska-cedar	78	78	--	--	--	--
Western redcedar	2,110	1,122	31	162	247	548
Western larch	188	188	--	--	--	--
Total[1/]	67,614	34,234	6,471	6,263	14,869	5,777
Hardwoods:						
Red alder	3,536	560	290	515	1,373	798
Oregon ash	70	--	--	--	--	70
Black cottonwood	272	--	3	--	--	269
Bigleaf maple	960	20	60	129	264	487
Oregon white oak	238	--	--	--	11	227
Total[1/]	5,076	580	354	644	1,648	1,850
All species[1/]	72,690	34,814	6,825	6,907	16,517	7,627

[1/] Totals may be off because of rounding.

Table 12--*Volume of sawtimber, Scribner rule, on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In million board feet)

Species	All ownerships[1/]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	30,710	15,268	4,837	1,701	6,242	2,662
White fir	2	2	--	--	--	--
Grand fir	536	380	5	37	10	103
Subalpine fir	30	30	--	--	--	--
Pacific silver fir	1,780	1,727	36	--	17	--
Noble fir	1,249	1,096	109	4	40	--
Ponderosa pine	144	128	--	--	10	6
Lodgepole pine	91	90	--	2	--	--
Western white pine	153	152	1	--	--	--
Engelmann spruce	87	87	--	--	--	--
Sitka spruce	1,419	489	22	90	393	425
Mountain hemlock	689	675	14	--	--	--
Western hemlock	10,814	5,578	479	2,170	2,342	245
Incense-cedar	3	3	--	--	--	--
Alaska-cedar	52	52	--	--	--	--
Western redcedar	1,522	898	26	113	157	328
Western larch	141	141	--	--	--	--
Total[1/]	49,421	26,796	5,527	4,117	9,211	3,770
Hardwoods:						
Red alder	2,780	377	285	404	1,081	633
Oregon ash	61	--	--	--	--	61
Black cottonwood	250	--	3	--	--	247
Bigleaf maple	784	14	59	103	217	391
Oregon white oak	189	--	--	--	9	180
Total[1/]	4,064	391	348	507	1,307	1,511
All species[1/]	53,485	27,187	5,875	4,624	10,518	5,281

[1/] Totals may be off because of rounding.

Table 13--*Volume of growing stock on commercial forest land by species and diameter class, northwest Oregon, January 1, 1977*

(In million cubic feet)

Species	Diameter class (inches at breast height)										
	All classes[1/]	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger
Softwoods:												
Douglas-fir	7,336	167	290	378	561	536	566	576	525	1,607	1,143	987
White fir	1	--	2/	--	--	1	--	--	--	--	--	--
Grand fir	176	17	20	19	24	14	20	18	8	23	11	2
Subalpine fir	7	1	1	--	2/	1	2/	1	1	2	--	--
Pacific silver fir	531	29	49	47	47	62	57	55	39	101	40	7
Noble fir	275	3	20	14	26	14	18	15	12	59	61	34
Ponderosa pine	26	2/	2/	1	2	--	2/	2	2/	13	7	1
Lodgepole pine	77	14	21	16	11	8	4	1	2/	2	2/	--
Western white pine	37	1	2	3	3	1	2	2	4	8	6	5
Engelmann spruce	24	1	2	1	6	2	4	1	2	2	3	--
Sitka spruce	305	6	10	11	20	7	11	18	8	37	59	115
Mountain hemlock	190	5	8	11	16	19	19	22	29	48	11	1
Western hemlock	2,984	128	169	241	225	246	236	205	204	683	425	226
Incense-cedar	1	--	2/	2/	--	1	2/	--	--	2/	--	--
Alaska-cedar	17	2/	2	2	3	3	1	2/	1	2	2	1
Western redcedar	390	10	16	25	17	21	18	33	26	71	62	93
Western larch	34	1	2	3	1	3	4	5	3	7	4	1
Total[1/]	12,411	382	612	771	960	940	960	955	862	2,664	1,833	1,472
Hardwoods:												
Red alder	1,113	81	141	190	176	165	116	98	46	90	8	2/
Oregon ash	21	--	2	7	4	1	2	2	--	3	--	--
Black cottonwood	47	--	--	--	--	2	3	4	6	8	11	12
Bigleaf maple	304	26	49	34	50	43	17	22	14	28	18	3
Oregon white oak	124	17	14	42	25	10	6	--	3	7	2/	--
Golden chinkapin	1	1	--	--	--	--	--	--	--	--	--	--
Total[1/]	1,611	125	205	274	254	221	144	128	70	138	37	15
All species[1/]	14,022	507	817	1,045	1,214	1,161	1,104	1,083	932	2,802	1,870	1,487

[1/] Totals may be off because of rounding.

[2/] Less than 500,000 cubic feet.

Table 14--*Volume of sawtimber, International 1/4-inch rule, on commercial forest land by species and diameter class, northwest Oregon, January 1, 1977*

(In million board feet)

Species	Diameter class (inches at breast height)									
	All classes[1/]	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger
Softwoods:										
Douglas-fir	41,502	1,684	2,776	2,919	3,287	3,478	3,241	10,291	7,390	6,438
White fir	3	--	--	3	--	--	--	--	--	--
Grand fir	809	90	123	82	117	106	50	157	69	15
Subalpine fir	36	--	3	6	3	5	6	13	--	--
Pacific silver fir	2,480	200	228	325	311	302	222	590	258	46
Noble fir	1,580	66	124	82	106	91	74	387	416	234
Ponderosa pine	170	3	7	--	2	9	2	83	53	11
Lodgepole pine	196	72	45	42	22	4	3	6	2	--
Western white pine	205	16	13	8	10	11	29	48	39	31
Engelmann spruce	118	8	24	9	20	8	10	19	20	--
Sitka spruce	1,876	52	102	37	64	110	49	243	400	819
Mountain hemlock	938	49	78	97	102	115	155	269	67	6
Western hemlock	15,323	1,128	1,151	1,372	1,350	1,192	1,161	4,000	2,547	1,423
Incense-cedar	5	1	--	1	1	--	--	2	--	--
Alaska-cedar	78	7	12	15	5	2	6	13	13	5
Western redcedar	2,110	104	78	104	96	188	144	425	384	588
Western larch	188	14	5	16	23	34	18	44	27	7
Total[1/]	67,614	3,492	4,770	5,116	5,520	5,655	5,168	16,589	11,685	9,620
Hardwoods:										
Red alder	3,536	--	755	818	614	537	254	508	49	3
Oregon ash	70	--	21	4	12	13	--	20	--	--
Black cottonwood	272	--	--	12	15	25	32	45	69	73
Bigleaf maple	960	--	203	204	81	116	78	154	109	14
Oregon white oak	238	--	97	48	31	--	19	38	3	--
Total[1/]	5,076	--	1,076	1,086	753	692	384	766	229	90
All species[1/]	72,690	3,492	5,846	6,202	6,273	6,347	5,552	17,355	11,914	9,710

[1/] Totals may be off because of rounding.

Table 15--*Volume of sawtimber, Scribner rule, on commercial forest land by species and diameter class, northwest Oregon, January 1, 1977*

(In million board feet)

Species	Diameter class (inches at breast height)									
	All classes[1/]	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger
Softwoods:										
Douglas-fir	30,710	--	1,558	1,850	2,214	2,457	2,387	8,182	6,292	5,771
White fir	2	--	--	2	--	--	--	--	--	--
Grand fir	536	--	77	58	83	78	37	128	60	14
Subalpine fir	30	--	2	5	1	4	6	12	--	--
Pacific silver fir	1,780	--	152	234	228	228	175	495	228	41
Noble fir	1,249	--	76	58	81	72	58	323	369	209
Ponderosa pine	144	--	4	--	1	7	2	70	49	11
Lodgepole pine	91	--	31	31	17	3	2	5	2	--
Western white pine	153	--	9	5	8	9	22	39	34	27
Engelmann spruce	87	--	17	7	16	7	8	16	16	--
Sitka spruce	1,419	--	56	22	40	70	35	180	321	696
Mountain hemlock	689	--	53	69	75	86	120	223	59	5
Western hemlock	10,814	--	686	909	917	865	871	3,185	2,147	1,235
Incense-cedar	3	--	--	1	1	--	--	1	--	--
Alaska-cedar	52	--	8	10	4	1	4	10	11	4
Western redcedar	1,522	--	45	63	63	122	98	314	307	510
Western larch	141	--	3	13	17	25	14	38	24	7
Total[1/]	49,421	--	2,776	3,337	3,764	4,033	3,839	13,222	9,920	8,529
Hardwoods:										
Red alder	2,780	--	554	621	478	433	212	436	45	3
Oregon ash	61	--	18	3	10	11	--	18	--	--
Black cottonwood	250	--	--	10	13	23	29	41	64	69
Bigleaf maple	784	--	153	159	65	96	66	135	98	12
Oregon white oak	189	--	75	37	25	--	16	33	2	--
Total[1/]	4,064	--	799	830	591	563	323	664	209	85
All species[1/]	53,485	--	3,575	4,167	4,355	4,596	4,162	13,886	10,129	8,614

[1/] Totals may be off because of rounding.

Table 16--*Net annual growth of growing stock and sawtimber on commercial forest land by ownership class and by softwoods and hardwoods, northwest Oregon, January 1, 1977*

Ownership class	Average volume per acre	All species[1/]	Softwoods	Hardwoods
	Cubic feet	- - - - - -	Thousand cubic feet	- - - - - -
Growing stock:[2/]				
National Forest	55	51,519	49,850	1,669
Bureau of Land Management	100	22,810	20,108	2,702
Other public	116	66,816	49,673	17,143
Forest industry	135	154,295	131,508	22,787
Other private	100	66,583	45,461	21,122
All ownerships[1/]	102	362,022	296,599	65,423
	Board feet	- - - - - -	Thousand board feet	- - - - - -
Sawtimber (International 1/4-inch rule):[3/]				
National Forest	331	309,809	289,935	19,874
Bureau of Land Management	610	138,504	124,519	13,985
Other public	534	307,088	265,877	41,211
Forest industry	749	857,379	775,712	81,667
Other private	505	336,064	260,660	75,404
All ownerships[1/]	550	1,948,844	1,716,703	232,141

[1/]Totals may be off because of rounding.

[2/]Includes trees 5.0-inch d.b.h. and larger.

[3/]Includes softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

Table 17--*Net annual growth of growing stock on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In thousand cubic feet)

Species	All ownerships[1]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	187,924	24,089	16,711	29,589	81,732	35,803
White fir	36	36	--	--	--	--
Grand fir	4,546	1,631	8	1,009	180	1,718
Subalpine fir	[2]-109	[2]-109	--	--	--	--
Pacific silver fir	8,731	7,643	113	--	975	--
Noble fir	4,509	2,743	357	101	1,308	--
Ponderosa pine	135	89	--	--	19	27
Lodgepole pine	2,126	1,427	--	699	--	--
Western white pine	[2]-2,233	[2]-2,190	[2]-43	--	--	--
Engelmann spruce	354	354	--	--	--	--
Sitka spruce	8,538	1,112	46	526	5,452	1,402
Mountain hemlock	1,873	1,836	37	--	--	--
Western hemlock	72,329	9,469	2,481	17,119	40,314	2,946
Incense-cedar	21	21	--	--	--	--
Alaska-cedar	330	330	--	--	--	--
Western redcedar	7,551	1,431	398	629	1,528	3,565
Western larch	[2]-62	[2]-62	--	--	--	--
Total[1]	296,599	49,850	20,108	49,673	131,508	45,461
Hardwoods:						
Red alder	49,970	1,467	2,215	16,054	19,539	10,695
Oregon ash	363	--	--	--	--	363
Black cottonwood	1,454	--	22	--	--	1,432
Bigleaf maple	11,181	177	465	1,089	3,370	6,080
Oregon white oak	2,430	--	--	--	[2]-122	2,552
Golden chinkapin	25	25	--	--	--	--
Total[1]	65,423	1,669	2,702	17,143	22,787	21,122
All species[1]	362,022	51,519	22,810	66,816	154,295	66,583

[1]Totals may be off because of rounding.

[2]Negative net annual growth is the result of net annual mortality exceeding gross annual growth.

Table 18--*Net annual growth of sawtimber, International 1/4-inch rule, on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In thousand board feet)

Species	All ownerships[1]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	1,125,691	152,898	107,282	153,183	512,593	199,735
White fir	70	70	--	--	--	--
Grand fir	21,858	7,747	79	3,538	1,005	9,489
Subalpine fir	[2]-690	[2]-690	--	--	--	--
Pacific silver fir	37,350	34,638	598	--	2,114	--
Noble fir	29,455	19,332	2,591	857	6,675	--
Ponderosa pine	1,163	494	--	--	140	529
Lodgepole pine	9,315	6,754	--	2,561	--	--
Western white pine	[2]-12,930	[2]-12,677	[2]-253	--	--	--
Engelmann spruce	1,990	1,990	--	--	--	--
Sitka spruce	51,538	7,152	366	2,831	30,868	10,321
Mountain hemlock	11,499	11,293	206	--	--	--
Western hemlock	395,130	52,432	11,991	99,361	213,922	17,424
Incense-cedar	41	41	--	--	--	--
Alaska-cedar	1,068	1,068	--	--	--	--
Western redcedar	44,903	8,141	1,659	3,546	8,395	23,162
Western larch	[2]-748	[2]-748	--	--	--	--
Total[1]	1,716,703	289,935	124,519	265,877	775,712	260,660
Hardwoods:						
Red alder	172,876	18,455	11,474	35,866	74,987	32,094
Oregon ash	1,630	--	--	--	--	1,630
Black cottonwood	10,664	--	127	--	--	10,537
Bigleaf maple	37,716	1,419	2,384	5,345	6,504	22,064
Oregon white oak	9,255	--	--	--	176	9,079
Total[1]	232,141	19,874	13,985	41,211	81,667	75,404
All species[1]	1,948,844	309,809	138,504	307,088	857,379	336,064

[1] Totals may be off because of rounding.

[2] Negative net annual growth is the result of net annual mortality exceeding gross annual growth.

Table 19--*Average annual mortality of growing stock on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In thousand cubic feet)

Species	All ownerships[1]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	18,654	8,448	3,531	1,105	3,822	1,748
Grand fir	1,542	1,076	--	466	--	--
Subalpine fir	238	238	--	--	--	--
Pacific silver fir	1,850	1,850	--	--	--	--
Noble fir	872	872	--	--	--	--
Ponderosa pine	85	43	--	--	--	42
Lodgepole pine	445	445	--	--	--	--
Western white pine	2,574	2,554	20	--	--	--
Engelmann spruce	53	53	--	--	--	--
Sitka spruce	1,127	143	--	120	864	--
Mountain hemlock	217	217	--	--	--	--
Western hemlock	10,618	5,328	317	1,112	3,719	142
Incense-cedar	2	2	--	--	--	--
Alaska-cedar	55	55	--	--	--	--
Western redcedar	1,490	551	--	198	399	342
Western larch	512	512	--	--	--	--
Total[1]	40,332	22,387	3,868	3,001	8,803	2,273
Hardwoods:						
Red alder	8,618	1,692	--	1,140	3,168	2,618
Oregon ash	292	--	--	--	--	292
Black cottonwood	707	--	--	--	--	707
Bigleaf maple	1,667	18	--	286	329	1,034
Oregon white oak	863	--	--	--	155	708
Total[1]	12,147	1,710	--	1,426	3,652	5,359
All species[1]	52,479	24,097	3,868	4,427	12,455	7,632

[1] Totals may be off because of rounding.

Table 20--*Average annual mortality of sawtimber, International 1/4-inch rule, on commercial forest land by species and ownership class, northwest Oregon, January 1, 1977*

(In thousand board feet)

Species	All ownerships[1/]	National Forest	Bureau of Land Management	Other public	Forest industry	Other private
Softwoods:						
Douglas-fir	88,818	46,025	20,092	3,592	13,684	5,425
Grand fir	6,491	5,302	--	1,189	--	--
Subalpine fir	1,251	1,251	--	--	--	--
Pacific silver fir	8,292	8,292	--	--	--	--
Noble fir	4,960	4,960	--	--	--	--
Ponderosa pine	286	286	--	--	--	--
Lodgepole pine	1,142	1,142	--	--	--	--
Western white pine	14,257	14,147	110	--	--	--
Engelmann spruce	255	255	--	--	--	--
Sitka spruce	5,212	148	--	630	4,434	--
Mountain hemlock	1,068	1,068	--	--	--	--
Western hemlock	52,340	23,545	2,017	4,468	21,400	910
Incense-cedar	8	8	--	--	--	--
Alaska-cedar	245	245	--	--	--	--
Western redcedar	7,165	2,706	--	615	2,030	1,814
Western larch	2,791	2,791	--	--	--	--
Total[1/]	194,581	112,171	22,219	10,493	41,548	8,148
Hardwoods:						
Red alder	23,273	3,978	--	1,858	8,354	9,083
Oregon ash	1,395	--	--	--	--	1,395
Black cottonwood	3,524	--	--	--	--	3,524
Bigleaf maple	5,153	44	--	1,543	1,640	1,926
Oregon white oak	670	--	--	--	--	670
Total[1/]	34,015	4,022	--	3,401	9,994	16,598
All species[1/]	228,594	116,193	22,219	13,894	51,542	24,746

[1/] Totals may be off because of rounding.

Table 21--*Timber harvest by ownership class, northwest Oregon, 1950-75*

(In thousand board feet, Scribner scale)

Year	All ownerships	Private			State	National Forest	Bureau of Land Management	Other public
		Total private	Forest industry	Other				
1950	1,820,569	1/			1,652,269	167,300	--	1,000
1951	1,860,799	1/			1,687,999	172,800	--	--
1952	1,908,200	1/			1,711,900	196,300	--	--
1953	1,651,879	1/			1,374,192	277,600	--	87
1954	1,504,386	1/			1,283,086	221,300	--	--
1955	1,628,234	1/			1,370,985	257,249	--	--
1956	1,863,444	1/			1,555,380	260,300	47,764	--
1957	1,270,422	1/			987,668	206,700	76,054	--
1958	1,339,235	865,279	2/	2/	89,102	308,198	76,656	--
1959	1,517,907	863,803	2/	2/	99,840	448,409	105,855	--
1960	1,329,708	780,908	2/	2/	121,579	334,748	92,473	--
1961	1,063,687	518,316	2/	2/	108,917	339,030	97,424	--
1962	1,216,622	593,205	510,861	82,344	98,180	390,900	134,337	--
1963	1,321,967	660,941	557,349	103,592	138,316	412,900	109,810	--
1964	1,389,370	705,875	587,184	118,691	123,532	422,100	137,863	--
1965	1,453,284	754,899	631,098	123,801	99,892	480,100	115,578	2,815
1966	1,375,667	712,167	624,284	87,883	79,543	421,800	137,187	24,970
1967	1,214,950	637,594	566,775	70,819	64,644	375,100	127,742	9,870
1968	1,601,193	851,398	760,104	91,294	102,306	472,784	163,434	11,271
1969	1,470,278	810,336	677,225	133,111	85,243	446,991	108,573	19,135
1970	1,280,586	723,979	664,563	59,416	64,528	360,446	130,213	1,420
1971	1,389,183	848,997	780,814	68,183	73,756	318,842	137,768	9,820
1972	1,422,204	666,540	590,382	76,158	119,823	464,717	157,236	13,888
1973	1,519,491	675,907	513,249	162,658	146,192	494,720	176,597	26,075
1974	1,156,344	617,685	557,871	59,814	77,554	358,458	99,054	3,593
1975	1,065,190	641,572	593,414	48,158	75,942	283,323	53,861	10,492

1/ Private and State lands are added together.

2/ No breakdown available.

INVENTORY PROCEDURES

This report of northwest Oregon's forest resources combines data from three sources: (1) a 1976 inventory of private, State, county, and municipal lands conducted by the Renewable Resources Evaluation Work Unit; (2) three National Forest inventories--two completed in 1971 and one in 1974; and (3) a 1968 Bureau of Land Management (BLM) inventory. The BLM inventory has been updated to 1976 to account for cutting, reforestation, growth, and mortality since 1968.

Inventory Design

National Forest and Bureau of Land Management Inventories.--The National Forest inventories relied on a systematic sample of field plots arranged in a 1.7-mile-square grid; the BLM used an 0.85-mile grid interval. On the National Forests, nonforest, noncommercial forest, and clearcut areas were mapped and excluded from the sample. The Bureau of Land Management sampled all land, regardless of status--all volume, area, and growth data were expanded from field plots; each plot was given equal weight. National Forest statistics for the sampled area were developed in the same way, but information about clearcuts came from forest records of plantation and compartment examinations.

The field plots used in both inventories were clusters of 10 variable-radius points distributed over approximately an acre. Seedlings and saplings were sampled on 1/300th-acre fixed-radius plots located at each of the 10 points.

Estimates of volume, growth, and mortality obtained from the BLM inventory were updated by stand projection (Larson and Goforth 1970). In addition, all plots cut since the inventory were identified and assigned new area classifications based on data furnished by the BLM.

Renewable Resources Evaluation inventory.--The sampling design used was double sampling for stratification (Cochran 1963). About 8,912 photo points were classified by (1) owner group; (2) major land class (commercial forest, noncommercial forest, and nonforest); and (3) stand volume class.

The 10-point field plot design that had been used on the National Forest and Bureau of Land Management inventories was used in this inventory. Unlike those inventories, however, most of these field plots were established in 1961 and were remeasured for this inventory. Growth and mortality were estimated on the remeasured plots by comparing old and new tallies. A few new plots were established--either because of ownership change or failure to relocate the old plot. On these new plots, growth was estimated from increment cores and mortality was backdated from current observations.

A summary of the three inventory designs follows:

Inventory	Number of photo plots	Number of field plots	Field grid intensity	Inventory date	Updated to
			Miles		
Private, State, County, and municipal	8,912	571	3.4	1976	--
Siuslaw National Forest	--	108	1.7	1974	--
Willamette National Forest	--	53	1.7	1971	--
Mount Hood National Forest	--	351	1.7	1971	--
Salem District of BLM	--	502	.85	1968	1976

RELIABILITY OF CURRENT INVENTORY DATA

Forest Land Area and Timber Volume

The area of commercial forest land on National Forests in northwest Oregon was determined by mapping. All other forest land area and timber volume estimates are based on sampling and consequently have sampling errors. These sampling errors and their associated confidence intervals have been computed for all estimates except BLM volume. Since BLM volume estimates were updated with a stand projection model (Larson and Goforth 1970), I was unable to compute legitimate sampling errors for those estimates.

The confidence intervals shown in tables 22-27 are a quantitative expression of the reliability of the forest area and volume estimates. Table 22, for example, indicates that there is a 68-percent probability that the true area of commercial forest land on private and other public holdings is within 1.9 percent of the inventory estimate of 2,383,000 acres and 95-percent probability that the true area is within 3.7 percent of the inventory estimate. There is a 2-in-3 chance that the commercial forest area on private and other public lands lies between 2,428,000 and 2,338,000 acres and a 19-in-20 chance that the area lies between 2,471,000 acres and 2,295,000 acres.

Table 22--*Confidence intervals for estimates of forest area and timber volume on private and other public lands, northwest Oregon, January 1, 1977*

Item	Estimated total	Confidence interval	
		68-percent probability	95-percent probability
		Percent	
Commercial forest land	2,383,000 acres	±1.9	±3.7
Noncommercial forest land	39,000 acres	±38.6	±75.7
Volume:			
Growing stock	6,592 million cubic feet	±4.4	±8.6
Sawtimber (International 1/4-inch rule)	31,051 million board feet	±5.3	±10.4

Table 23--*Approximate confidence intervals*[1] *for area and volume estimates on various sizes of private and other public lands, northwest Oregon, January 1, 1977*

Commercial forest land			Growing stock		Sawtimber	
Area	Confidence intervals at the 68-percent probability level for: Tables 1 and 2[2]	Confidence intervals at the 68-percent probability level for: Tables 3, 4, and 5[3]	Volume	Confidence interval at the 68-percent probability level	Volume	Confidence interval at the 68-percent probability level
Thousand acres	- - - Percent (±)	- -	Million cubic feet	Percent (±)	Million board feet[4]	Percent (±)
			6,000	4.6	30,000	5.4
2,000	2.1	3.0	4,000	5.6	28,000	5.6
1,000	2.9	6.6	2,000	8.0	26,000	5.8
800	3.3	7.8	1,000	11.3	24,000	6.0
600	3.8	9.5	800	12.6	22,000	6.3
400	4.6	12.1	600	14.6	20,000	6.6
200	6.6	17.9	400	17.9	18,000	7.0
100	9.3	25.8	200	25.3	16,000	7.4
50	13.1	36.8	100	35.7	14,000	7.9
25	18.6	52.3	50	50.5	12,000	8.5
15	23.9	67.7	25	71.4	10,000	9.3
10	29.3	83.0	15	92.2	5,000	13.2
					1,000	29.5
					800	33.0
					400	46.7
					200	66.0
					100	93.4

[1] Constant variance is assumed.

[2] Applies to the estimated total of commercial forest land which is based on double sampling.

[3] Applies to any breakdown of the total estimate of commercial forest land; e.g., site class, stand-size class, forest type, etc.

[4] International 1/4-inch rule.

Table 24--*Confidence intervals for estimates of areas and timber volume, on National Forest forest lands, northwest Oregon, January 1, 1977*

Item	Estimated total	Confidence interval	
		68-percent probability	95-percent probability
		Percent	
Commercial forest land	936,000 acres	1/	1/
Noncommercial forest land	107,000 acres	1/	1/
Volume:			
Growing stock	6,293 million cubic feet	±2.9	±5.7
Sawtimber (International 1/4-inch rule)	34,814 million board feet	2/	2/

1/ The commercial forest land and the noncommercial forest land were classified by type-mapping procedures and have no associated sampling error.

2/ Not available.

Table 25--*Approximate confidence interval*[1] *for volume estimates on various areas of National Forests, northwest Oregon, January 1, 1977*

Commercial forest land[2]		Growing stock	
Area	Confidence interval, 68-percent probability	Volume	Confidence interval, 68-percent probability
Thousand acres	Percent (±)	Million cubic feet	Percent (±)
900	0.88	6,000	3.0
800	1.8	4,000	3.6
600	3.3	2,000	5.1
400	5.1	1,000	7.3
200	8.5	800	8.1
100	13.5	600	9.4
50	18.6	400	11.5
25	26.7	200	16.3
15	34.7	100	23.0
10	42.6	50	32.5
		25	46.0
		15	59.4

1/ Constant variance is assumed.

2/ Total commercial forest land area is without error, but breakdowns are based on field plot proportions and are subject to sampling error.

Table 26--*Confidence interval for estimates of area on Bureau of Land Management forest lands, northwest Oregon, January 1, 1977*

Item	Estimated total	Confidence interval	
		68-percent probability	95-percent probability
	Acres	- - - - - Percent - - - - - -	
Commercial forest land	227,000	±1.3	±2.5
Noncommercial forest land	7,000	±24.6	±48.2
Volume		1/	1/

1/ Unable to compute because volume statistics were updated.

Table 27--*Approximate confidence intervals*[1/] *for estimates of various areas of Bureau of Land Management commercial forest land, northwest Oregon, January 1, 1977*

Area	Confidence interval, 68-percent probability
Thousand acres	Percent (±)
200	1.6
100	5.0
50	8.4
25	12.7
15	16.8
10	20.8

1/ Constant variance is assumed.

The confidence intervals associated with any of the breakdowns of forest area and volume will be substantially wider than those shown in tables 22, 24, and 26; generally, the smaller the breakdown, the wider the confidence interval. An approximation of the width of the confidence intervals associated with subtotals and breakdowns of forest area and volume can be obtained from tables 23, 25, and 27.

In addition to measurable sampling errors, there may be errors caused by mistakes in judgment and by measurement and compilation errors. The magnitude of such errors cannot be determined; but they are minimized by training and supervising personnel, by checking for errors in the field, and by careful editing of data.

DEFINITION OF TERMS

Land Area

Total land area is that reported by the Bureau of the Census. Total land area includes dry land and land temporarily or partially covered by water, such as marshes, swamps, and river flood plains; streams, sloughs, and canals less than one-eighth mile wide; and lakes, reservoirs, and ponds less than 40 acres in area.

Forest land is at least 10 percent stocked by live trees or formerly having such tree cover and not currently developed for nonforest use. Minimum area of forest land recognized is 1 acre.

Nonforest land has never supported forests or was formerly forested and is currently developed for nonforest uses. Included are lands used for agricultural crops, improved pasture, residential areas, city parks, improved roads, operating railroads and their right-of-way clearings, powerline and pipeline clearings, streams over 30 feet wide, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and other nonforest strips must be more than 120 feet wide and clearings, etc., more than 1 acre in size to qualify as nonforest land.

Forest-Land Classes

Commercial forest land is capable of producing 20 cubic feet per acre per year of industrial wood and is not withdrawn from timber utilization.

Noncommercial forest land is incapable of yielding crops of industrial wood because of adverse site conditions, or it is productive public forest land withdrawn from commercial timber use through statute or administrative regulation.

Productive-reserved forest land is public land withdrawn from timber utilization through statute, ordinance, or administrative order but which otherwise qualifies as commercial forest land.

Unproductive forest land is land incapable of yielding crops of industrial wood products because of adverse site conditions, such as sterile soils, poor drainage, high elevation, steepness, and rockiness.

Forest Types

Stands with 50-percent or more stocking in live conifer trees are called softwood types. Stands with a majority of stocking in live hardwood trees are classed as hardwood types. Within these two groups, the individual forest type is determined by plurality of stocking by species of live softwood or hardwood trees.

Tree Classes

Growing Stock

Growing stock trees are all live trees with the exception of noncommercial species and cull trees which are nongrowing stock.

Sawtimber growing stock trees are at least 9.0 inches in d.b.h. if they are softwoods and at least 11.0 inches in d.b.h. if they are hardwoods. At least 25 percent of board-foot volume in a sawtimber tree must be free from defect. Softwood trees must contain at least one 12-foot saw log with a top diameter of not less than 6 inches inside the bark; hardwood trees must contain at least one 8-foot saw log with a top diameter of not less than 8 inches inside the bark.

Poletimber growing stock trees are 5.0 to 8.9 inches in d.b.h. if they are softwoods and 5.0 to 10.9 inches in d.b.h. if they are hardwoods, with a cubic-foot volume of wood at least 25 percent free from defect. They are free from any disease, defect, or deformity likely to prevent their becoming sawtimber trees.

Sapling and seedling growing stock trees are less than 5.0 inches in d.b.h. and have no disease, defects, or deformities likely to prevent their becoming growing stock poletimber trees.

Nongrowing Stock

Cull trees are noncommercial species or commercial species which are too defective or unlikely to become growing stock trees because of deformity, disease, low vigor, etc.

Sound cull trees are noncommercial species or commercial species with excessive defect caused by form, roughness, etc.

Rotten cull trees have excessive defect primarily caused by rot.

Salvable dead trees are standing or down trees of commercial species, 9.0 inches or more in diameter for softwoods and 11.0 inches or more in diameter for hardwoods, containing 25 percent or more of sound volume and at least one merchantable 12-foot log if softwood or one merchantable 8-foot log if hardwood.

Mortality Trees

Commercial species that died from natural causes within a specified period and were growing stock trees at the time of death.

Stand-Size Classes

Sawtimber stands are at least 10 percent stocked wih growing stock conifer, red alder, and black cottonwood trees; half or more of this stocking is in sawtimber and poletimber trees, and sawtimber stocking is equal to or greater than poletimber stocking. In *large sawtimber stands*, the majority of the sawtimber stocking is in trees 21.0 inches and larger at breast height. In *small sawtimber stands*, the majority of the sawtimber stocking is in trees from 9.0 to 20.9 inches at breast height.

Poletimber stands are at least 10 percent stocked with growing stock conifer, red alder, and black cottonwood trees; half or more of this stocking is in sawtimber and poletimber trees, and poletimber stocking exceeds sawtimber stocking.

Sapling and seedling stands are at least 10 percent stocked with growing stock conifer, red alder, and black cottonwood trees; more than half of this stocking is in saplings, seedlings, or both.

Nonstocked areas of commercial forest land are less than 10 percent stocked with growing stock conifer, red alder, and black cottonwood trees.

Timber Volume

Live Sawtimber

Net volume of live sawtimber trees of commercial species is measured in board feet. Net volume equals gross volume less deduction for rot, sweep, crook, and other defects that affect use for lumber.

Scribner rule is the common board-foot log rule used locally in determining volume of sawtimber before harvest. Scribner volume was measured in terms of 32-foot logs for all owners except BLM which uses 16-foot logs.

Scribner scale is the common board-foot log scale used locally in determining volume of harvested sawtimber.

International 1/4-inch rule is the standard board-foot log rule adopted nationally by the USDA Forest Service for the presentation of Renewable Resources Evaluation volume statistics before harvest.

Saw-log portion is the bole of sawtimber trees between the stump and the saw-log top.

Upper-stem portion includes the bole of sawtimber trees above the saw-log top of 7.0 inches outside bark for softwoods and 8.0 inches outside bark for hardwoods to a minimum top diameter of 4.0 inches outside bark, or to the point where the central stem breaks into limbs.

Growing Stock

Net volume of growing stock is measured in cubic feet of live sawtimber trees and live poletimber trees from stump to a minimum 4.0-inch top (of central stem) outside bark. Net volume equals gross volume less deduction for rot and missing bole sections.

All Timber

All timber includes the net volume in cubic feet of live growing stock poletimber and sawtimber trees and salvable dead sawtimber trees of commercial species and the gross volume in cubic feet of cull trees of all species. Volume is measured from stump to a minimum 4.0-inch top outside bark.

Net Annual Growth

Components of net annual growth are: (a) the increment in net volume of trees at the beginning of the specified year surviving to the year's end plus (b) the net volume of trees reaching the size class during the year minus (c) the net volume of trees that died during the year minus (d) the net volume of trees that became culls during the year.

Net Annual Mortality

Mortality data are reported as periodic annual mortality. In northwest Oregon, the periods are as follows:

BLM, 5 years	1963 to 1968
Siuslaw National Forest, 10-11 years	1963 to 1973-74
Willamette National Forest, 10-11 years	1961 to 1970-71
Mount Hood National Forest, 11 years	1961 to 1972
Private and other public, 15 years	1961 to 1976

Ownership Classes

National Forest lands are Federal lands which have been designated by Executive order or statute as National Forest or purchase units and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones title III lands.

Other public lands are Federal lands other than National Forests or lands administered by the Bureau of Land Management and lands owned by States, counties, and local public agencies or leased by these governmental units for more than 50 years.

Forest industry lands are lands owned by companies or individuals operating wood-using plants.

Other private lands include all private lands except those classed as forest industry lands.

Miscellaneous Definitions

A short log is a standard 16-foot log.

A long log is a standard 32-foot log.

Plantation examination is the examination of an artificially reforested area established by planting or direct seeding.

Compartment examination is the examination of a small subdividion of forest area defined by permanent boundaries and used for orientation, administration, and silvicultural operations.

PLANT SPECIES

This list includes tree species occurring in northwest Oregon. The source for scientific name is Little (1953).

Scientific name	Common name
Softwood trees:	
Abies amabilis (Dougl.) Forbes	Pacific silver fir
Abies concolor (Gord. & Glend.) Lindl.	white fir
Abies grandis (Dougl.) Lindl.	grand fir
Abies lasiocarpa (Hook.) Nutt.	subalpine fir
Abies procera Rehd.	noble fir
Chamaecyparis nootkatensis (D. Don) Spach	Alaska-cedar
Larix occidentalis Nutt.	western larch
Libocedrus decurrens Torr.	incense-cedar
Picea engelmannii Parry	Engelmann spruce
Picea sitchensis (Bong.) Carr.	Sitka spruce
Pinus contorta Dougl.	lodgepole pine
Pinus monticola Dougl.	western white pine
Pinus ponderosa Laws.	ponderosa pine
Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
Thuja plicata Donn	western redcedar
Tsuga heterophylla (Raf.) Sarg.	western hemlock
Tsuga mertensiana (Bong.) Carr.	mountain hemlock
Hardwood trees:	
Acer macrophyllum Pursh	bigleaf maple
Alnus rubra Bong.	red alder
Arbutus menziesii Pursh	Pacific madrone
Castanopsis chrysophylla Dougl. A. DC.	golden chinkapin
Fraxinus latifolia Benth.	Oregon ash
Populus trichocarpa Torr. & Gray	black cottonwood
Quercus garryana Dougl.	Oregon white oak

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1979. Timber resources of northwest Oregon. USDA For. Serv. Resour. Bull. PNW-82, 29 p. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This report presents statistics from a 1976 timber resource inventory of 10 counties in northwest Oregon: Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill. Tables presented are of forest area, timber volume, growth, mortality, and harvest.

KEYWORDS: Forest surveys, statistics (forest), timber resources, resources (forest), Oregon (northwest), northwest Oregon.

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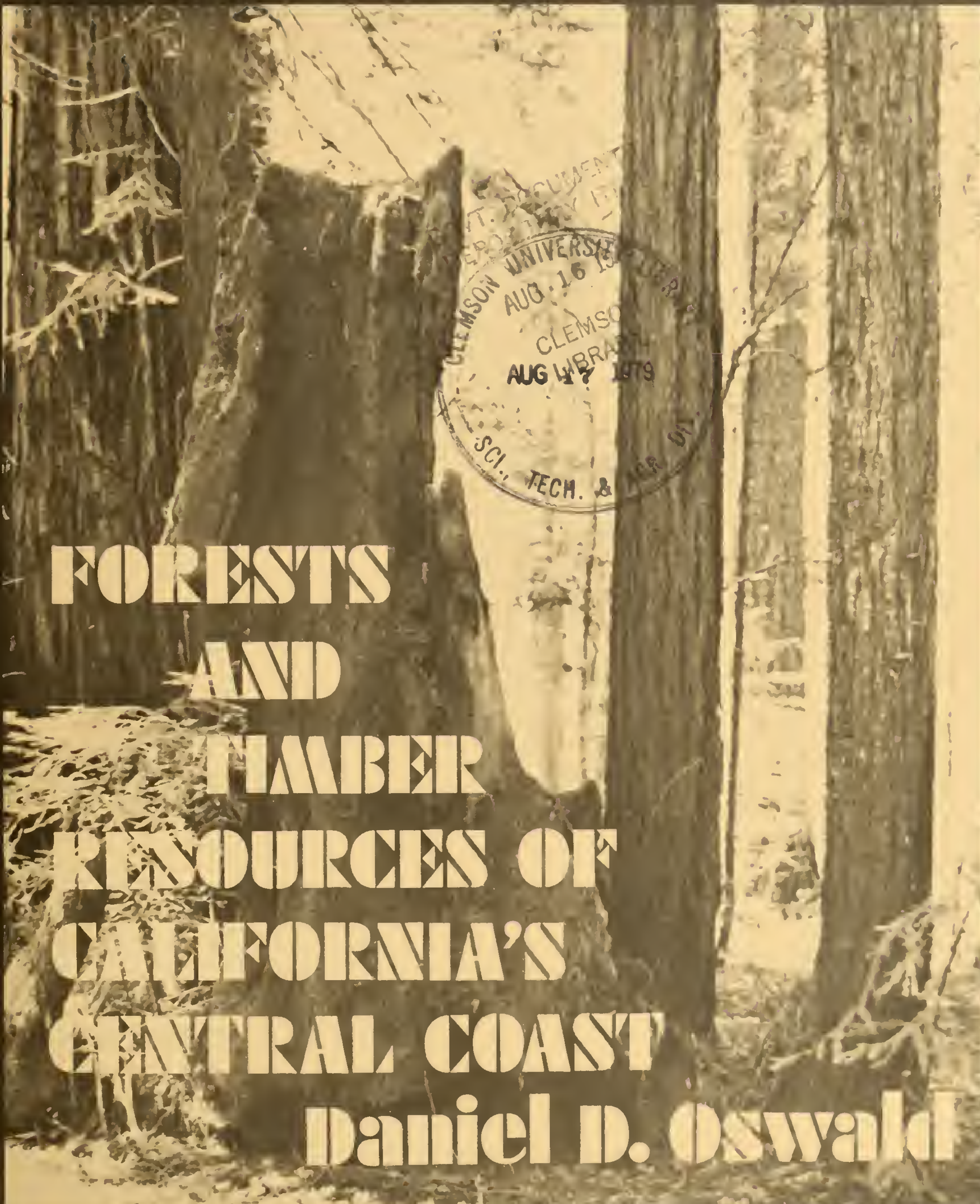

FORESTS AND TIMBER RESOURCES OF CALIFORNIA'S CENTRAL COAST

Daniel D. Oswald

PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
U.S. DEPARTMENT OF AGRICULTURE FOREST SERVICE

METRIC EQUIVALENTS

1,000 acres	= 404.69 hectares
1,000 cubic feet	= 28.3 cubic meters
1 cubic foot per acre	= 0.070 0 cubic meter per hectare
1 square foot basal area per acre	= 0.229 6 square meter per hectare
1 foot	= 30.48 centimeters
1 inch	= 2.540 centimeters

FORESTS AND TIMBER RESOURCES OF CALIFORNIA'S CENTRAL COAST

REFERENCE ABSTRACT

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This report summarizes the findings of a 1972 inventory of the forest land area and timber resources of a 10-county area on California's central coast. Included are detailed tables of area, timber volume, timber growth and harvest, and mortality. The report includes a discussion of the current timber resources and some potential limitations on their availability.

KEYWORDS: Forest surveys, timber resources, resources (forest), California (coastal).

Research Summary

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1979

California's central coast is a mountainous region with forests covering 2.3 million acres, more than one-third of the area. Only 339,000 acres of the forested area are capable of producing commercial crops of timber; of this total, 79,000 acres have been reserved from commercial timber operations.

The 260,000-acre total of unreserved commercial forest land is concentrated in 5 of the area's 10 counties. Commercial timber operations center on 193,000 acres of unreserved commercial forests in the Santa Cruz Mountains of San Mateo, Santa Clara, and Santa Cruz Counties.

An estimated 6.1 billion board feet (Scribner rule) of sawtimber, 93 percent of it in softwood species, is contained within the central coast's 260,000 acres of unreserved commercial forests. Redwood and Douglas-fir account for most of the softwood volume. Current annual growth in the region's forests totals 128 million board feet (26 million cubic feet).

Most (207,000 acres) of the commercial timberland is held by miscellaneous private owners. Forest industries own approximately 10,000 acres of timberlands in the region. Public timberlands total 43,000 acres, three-fourths of which are in the Los Padres National Forest in Monterey County.

Potential productivity of the central coast's commercial forests is high. Of 221,000 acres for which data are available, 89 percent is capable of producing 120 cubic feet or more of industrial wood per acre each year. The average potential for this area exceeds 175 cubic feet per acre per year.

There are two forest types of commercial importance in the region. Redwood predominates on 127,000 acres which contain 4.3 billion board feet of sawtimber and which are accruing 82 million board feet of growth annually. Douglas-fir is predominant on 27,000 acres, accounting for almost 1 billion board feet of sawtimber. Hardwoods are the predominant vegetation on 68,000 acres.

Three-fourths of the current forest is less than 100 years old. These young forests contain almost half the region's sawtimber. The older forests (100 years plus) cover only one-fourth of the area.

Production from the central coast's commercial timberlands is limited in a number of ways. Perhaps the most important limitations are those placed by miscellaneous private owners, many of whom have primary objectives for their landholdings other than timber production.

Forest practice regulations can affect potential output from current timber stocks. The central coast has the most stringent set of forest practice regulations in the State. On the average, 40 percent of the standing softwood sawtimber volume in a stand would likely be reserved from cutting at any one time under these regulations.

PREFACE

This report presents the findings of inventories of forests and timber resources conducted in a 10-county area on California's central coast: Alameda, Contra Costa, Marin, Monterey, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, and Solano. The forests of this region had been inventoried in the late 1940's (USDA Forest Service 1953, 1954; Baker and Poli 1953, 1954).

The inventory summarized herein was conducted in most of the forested area of the region in 1972. The lands of the Los Padres National Forest in Monterey County were inventoried in 1974.

Most of the forested area in this region has changed little since these inventories. In Monterey County, however, the catastrophic Marble Cone fire in the summer of 1977 burned 178,000 acres of wildlands--much of the area of the Los Padres National Forest, including most of the Ventana Wilderness.

A preliminary appraisal by Los Padres National Forest personnel of the effects of that fire indicates little impact on commercial timber stands; heavy damage is likely only on 2,000 acres of Coulter pine. But in the Wilderness Area, 6,000 acres of ponderosa pine sustained heavy damage. The greatest loss was the temporary removal of protective vegetation on tens of thousands of acres of Monterey County's watershed lands.

As a consequence of the fire, the inventory findings pertaining to vegetative cover in Monterey County and on National Forest land no longer reflect the current status of those resources.

In addition to vegetative changes resulting from fire, a major land use status change--not reflected in this report--occurred in 1978. About 61,000 acres of formerly unreserved National Forest land has been added to the Ventana Wilderness.

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INTRODUCTION

California's central coast is a unique forested region which stretches from Marin County southward across San Francisco Bay to Monterey County (fig. 1), a length of 200 miles. This 10-county area, like California's major forest regions, is mostly mountainous; and 37 percent of its 6.24 million acres is forested. The uniqueness of its forests lies in their isolation from the State's major forested regions, the complexity of their makeup, and their proximity to the Region's 5 million residents.

Because most of the Region's commercial timberlands are situated near San Francisco Bay and its surrounding communities, their virgin timber was rapidly exploited and depleted; as old forests fell to the saw and ax, they were reborn in the structures of early San Francisco, Oakland, and San Jose. Logging activities in those early years and the fires that followed did much to shape the central coast's current forests.

Figure 1.--The counties of California's central coast.

Today, the region's populace has different needs and desires for the forests. Watershed protection has become paramount, and the recreational value of the central coast's forests affects decisions about their allocation and use.

Yet, little noticed by many of the region's residents and visitors, timber harvesting continues on a commercial scale on some of the timberlands (fig. 2). This commercial timber enterprise is much scaled down from its heyday, but it supports local sawmills as it has for more than 125 years. Planners in the two most important timber counties in the region--San Mateo and Santa Cruz--believe that commercial timber operations will continue in those counties at levels compatible with other forest resource uses.

The forest inventory reported on herein provides a glimpse of the region's forests as they exist today, different in many respects from what they were in the past. Some of the important trends evident in these forests have

Figure 2.--Saw logs from partial harvest of young-growth redwood stands are the mainstay of the central coast's timber industry.

been identified and will be discussed. Detailed tables, which summarize the findings of the inventories, immediately follow the text. Although most of the tables contain data for the entire central coast, tables 24-27 are for Santa Cruz County, the most important timber producing county in the region.

THE FORESTS CHARACTERIZED

California's 10 central coast counties contain an estimated 2.3 million acres of forest land.[1] Though the region is 37 percent forested, the extent of the forests varies widely from county to county. At one extreme are San Francisco, the only county of the group that has no forest land, and Solano County, with only 7 percent of its area forested; at the other is Santa Cruz which is two-thirds forested.

Though much of the region is forested, areas supporting commercially valuable stands of timber, or with the potential to do so, are limited. Only 339,000 acres of forested land fall in this class; of that area, almost one-fourth has been formally reserved from commercial timber operations. Unreserved commercial forest land totals 260,000 acres and is found in only 5 of the Region's 10 counties:

County	Commercial forest area (Acres)
Marin	7,000
Monterey	60,000
San Mateo	44,000
Santa Clara	14,000
Santa Cruz	135,000
Total	260,000

The unreserved commercial forests of Marin County are only a fraction of the county's 30,000 acres of productive forests. The Marin forests are an isolated "island" of redwood and Douglas-fir,[2] separated by many miles from the

[1] The terms used in this report are defined in "Definition of Terms," page 50.

[2] See last page of appendix for scientific names of trees and plants according to Little (1953) and Munz and Keck (1970).

redwood forests of Sonoma County to the north and those of San Mateo to the south. In recent years, most of this county's productive forests have been reserved from commercial timber operations by inclusion in the Point Reyes National Seashore, the Golden Gate National Recreation Area, and the county's protected watersheds. The remaining unreserved commercial forests are too small to produce significant quantities of timber.

Monterey, the central coast's largest county, has vast areas of mountainous forested land. But the areas containing commercially valuable conifers, located in the Santa Lucia Mountains, are scattered and small. Consequently, commercial timber operations are infrequent in Monterey's coniferous forests.

These forests are unique in several respects. The redwood forests, which account for most of the commercial forest area, are found in the canyon bottoms of many small coastal streams. Redwood reaches its southernmost point on the south coast of this county.

Monterey pine, which occurs naturally in only three isolated locations on California's coast, is most abundant on the Monterey Peninsula. Coulter pine and ponderosa pine occur in many areas of the county; sugar pine and bishop pine are rare and isolated.

The USDA Forest Service, which manages over half of Monterey County's commercial forest area (as part of the Los Padres National Forest), has classed those lands as "unregulated"; i.e., lands not suited or desirable for sustained timber production. These lands are managed to retain vegetation and for recreation. Redwood, ponderosa pine, and Coulter pine are harvested only to recover dead timber or to maintain the health of stands. Sugar pine is protected because its occurrence here is disjunct from the main concentrations of sugar pine in California.

The most significant commercial stands of timber in the region are the redwood and Douglas-fir forests of the Santa Cruz Mountains. These forests, intermingled with stands of hardwoods, occupy a mostly contiguous area of 234,000 acres in San Mateo, Santa Clara, and Santa Cruz Counties. Within this area are 193,000 acres of commercial forest land not formally reserved from timber production; the remainder has been set aside, primarily in parks. The redwood and Douglas-fir forests of the Santa Cruz Mountains, sites of some of California's earliest commercial timber operations, are the only areas within the central coast where logging is likely to continue on a commercial scale.

Most of the central coast's forest area is unproductive from the standpoint of timber production. These noncommercial forest lands are covered by trees or woody shrubs, but because of soils, topography, climate, or a combination of these factors, they are not suitable for management for the production of timber crops. The trees that do grow on much of this area are typically crooked and limby and do not yield industrial roundwood products (fig. 3). The

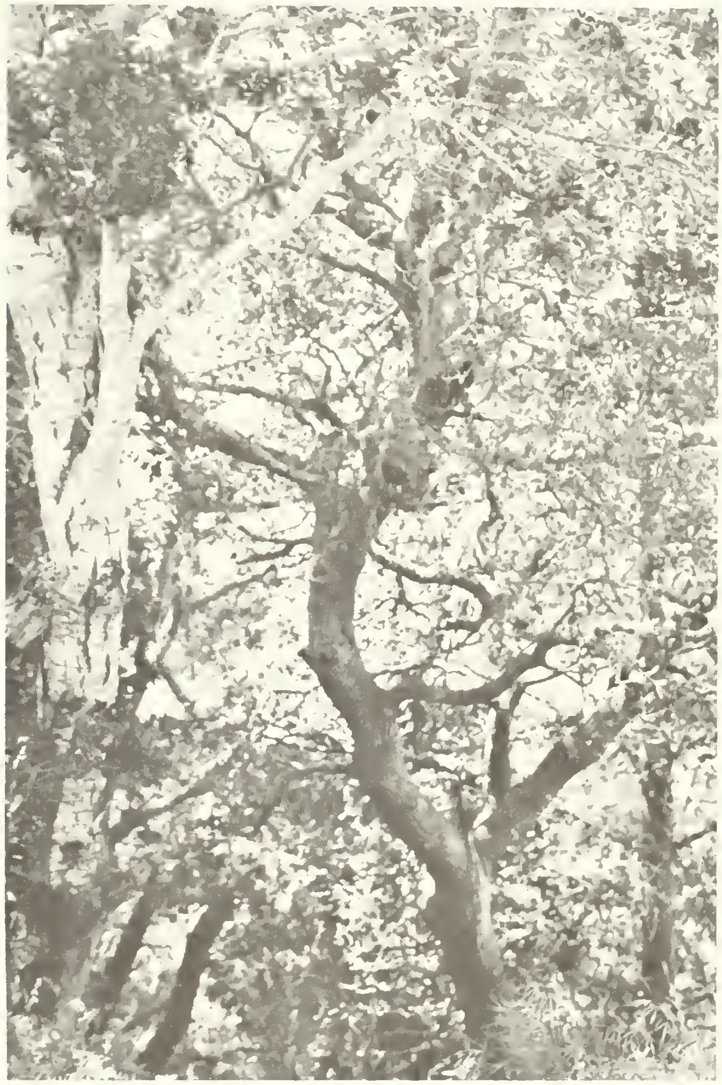

Figure 3.--Live oak trees are the major component of the central coast's evergreen broad-leaved forests. They are usually crooked and limby and not suited for use as industrial roundwood.

noncommercial forest lands total 1.95 million acres, and are found in every county in the region except San Francisco. Three counties--Monterey, Santa Clara, and San Benito--account for 80 percent of this area.

The noncommercial forest land of this region has a variety of vegetative covers. But the cover types fall into two major vegetative associations. About one-third of this area is inhabited by associations of woody shrubs commonly known as chaparral. Common species found in the chaparral association include chamise, manzanita, scrub oak, and *Ceanothus* spp. Although the chaparral cover provides wildlife habitat and stabilizes watersheds, it is highly susceptible to periodic loss through wildfire.

Approximately two-thirds of the unproductive forest land is covered by mixed evergreen forests comprised of broad-leaved trees (including coast live oak, canyon live oak, interior live oak, Pacific madrone, and California-laurel), or by forests of deciduous oaks (blue oak, California black oak, California white oak). In some locations the broad-leaved forests include scattered Coulter pine and Digger pine. Although these hardwood forests do not produce industrial roundwood, in aggregate they contain a large volume of dense wood well suited for use as fuel.

RECENT CHANGES IN FOREST AREA

The forests of the central coast were previously inventoried in 1948 and updated to 1953 (USDA Forest Service 1954). The current inventory is independent of that earlier effort, so sampling errors and design and definitional differences complicate use of direct comparisons to determine the magnitude of area change. But aided by type maps from the earlier inventory and information from sources other than the inventories, we have identified elements of change in forest area that confirm the direction of change indicated by such comparisons.

	1953	1973
	(Thousand acres)	
Forest land:	2,598	2,293
Unproductive	2,321	1,954
Productive	277	339

The apparent 12-percent decrease in forest land area is due to the decreased estimate of unproductive forest land. Change in land use and vegetative cover has been considerable. From 1953 through 1972, 122,000 acres of brush covered forest was burned under permit for range improvement in the central coast (California Division of Forestry 1954-74). This program centered on Monterey, Santa Clara, and San Benito Counties. An additional 164,000 acres of noncommercial forest burned in wildfires on State-protected lands in the central coast from 1953 through 1972; some of this area has most likely been converted from forest to rangeland by grazing after the fires (California Division of Forestry 1953-72).

Besides actual changes in forest area by intent or catastrophe, some of the apparent shift in acreage comes from changes in classification. For example, some woodland grass areas that were classed in 1953 as noncommercial forest became "nonforest" in the recent inventory by a change in the minimum size of the classification area. Then too, sampling error associated with estimates of area could account for some of the apparent differences in the region's total forest acreage.

There has been considerable shifting of acreage within the area that was called forest land in both inventories. These shifts have resulted from classification changes; none derived from physical changes. Productive forest land--both commercial and reserved--increased 62,000 acres from 1953 to 1973, mainly because of classification changes that have resulted in current inclusion in the productive forest base of isolated timber patches, narrow timbered stringers, and minor conifers, which were previously classed as nonproductive from the timber standpoint. Although these areas meet our current definition of productive forest land, in many instances their value for producing timber as a crop is marginal.

Productive forest land in reserved status has increased from an estimated 20,000 acres in 1953 to 79,000 acres in 1973. Most of this increase can be accounted for by the dedication of formerly unreserved lands to uses that preclude timber production. If we consider the limited size of the timbered forest resource area in the central coast, the estimated increase is substantial. It indicates, as detail and discussion will show, the trend in priorities for the use of the region's timberlands:

Productive forest land reserved from timber production

County	1953	1973
	(Thousand acres)	
Marin	1	23
Monterey	4	10
San Mateo	3	16
Santa Clara	2	6
Santa Cruz	9	19
Other counties	1	5
Total	20	79

In Marin County, municipal watershed lands have been set aside from commercial timber operations. Beyond that, the creation of Point Reyes National Seashore and the Golden Gate National Recreation Area have brought about withdrawal of most of the remaining productive forests in this county.

San Mateo County's increased reserve of productive forest land resulted from expansion of State parks, new county parks, and the dedication of the city of San Francisco's San Mateo watershed lands as an open space and recreation preserve.

The increase in productive reserved land in Santa Cruz County is due to creation of the Santa Cruz campus of the University of California and to expansion of State parks (fig. 4). In the other counties as well, increases in productive reserved land resulted largely from park expansion.

These increases in reserved forest land document a continuing effort in this region to reserve timbered forests for uses other than timber production, an effort that started in 1902 with the establishment of the State's first redwood park.

The area of commercial timberlands potentially available for timber production appears to be essentially unchanged from the earlier estimate; but, in fact, a substantial acreage has since been dedicated to noncommodity uses. What has happened is that in Santa Cruz and Monterey Counties some areas classed in the earlier inventory as noncommercial have now been designated potentially productive. These areas are of three types: (1) small isolated patches or stringers of timber, (2) areas presently without commercially valuable tree cover because of fires, and (3) areas with minor conifers of marginal commercial value, primarily Coulter and knobcone pines. Although these areas meet the

Figure 4.--This stand of young-growth redwood is a recent addition to the State Park system in Santa Cruz County.

current definitions of commercial forest land, their prospects for commercial timber operations and management are poor. So, although they appear to have offset the productive acres that have been dedicated to parks, they do not. It is more likely that the manageable commercial forest base has decreased.

Estimated unreserved commercial forest area

County	1953	1973
	(Thousand acres)	
Marin	31	7
Monterey	16	60
San Mateo	59	44
Santa Clara	25	14
Santa Cruz	125	135
Total	256	260

THE REGION'S TIMBERLANDS AND TIMBER RESOURCES

This section of the report discusses the central coast's unreserved commercial forest land and timber resources. Detailed statistics are given in the tables following the text.

A caution is in order here: In the following discussions of timber resource characteristics, some descriptive elements were not available for the entire resource. For example, information on site class, stand age, and species volume was not available for the 33,000 acres of commercial forests on the Los Padres National Forest nor for a 6,000-acre area of privately owned Monterey pine on the Monterey Peninsula. Timber values in both these areas are of secondary concern, so the lack of details for these resources is not vital. And in the following discussion of area, volume, and growth, the base for comparisons and proportions varies, depending on availability of data for these two areas. Missing data in the tables are indicated by footnotes.

The central coast's 260,000 acres of unreserved commercial forests contain an estimated 6.1 billion board feet (Scribner rule) of sawtimber. Coniferous species account for 93 percent (5.7 billion board feet) of all sawtimber volume; 71 percent of the conifer sawtimber volume is redwood, 24 percent Douglas-fir. The cubic-foot volume of all growing stock trees totals 1.3 billion.

Tanoak and madrone are the most abundant hardwoods in the region's commercial forests, accounting for about three-fourths of the hardwood volume on commercial forest land. The hardwood volume estimates reported herein, however, do not indicate the total extent of hardwoods in the central coast. This region has 1.2 million acres of noncommercial forest land occupied by hardwood forests. Since these forests were not inventoried for timber volumes, no estimates of the hardwood volume on this large forested area are available.

Current net annual growth on the region's commercial forests is estimated at 26 million cubic feet. Sawtimber growth amounts to 128 million board feet, 95 percent of which is conifer species--mostly redwood and Douglas-fir.

The average acre in the central coast has 24,000 board feet of sawtimber and is growing 550 board feet per year. These averages indicate that the central coast's forests have relatively high sawtimber volume and high annual growth compared with California's other timbered regions.

Ownership

The timberlands of the central coast are essentially a privately owned resource. This region's many private owners control 217,000 acres, or 83 percent of the region's timberlands and 83 percent of the sawtimber volume. Of this area, forest industry owns only about 10,000 acres. Two-thirds of the privately owned timberlands are controlled by farmers and other individual owners of small tracts, and 29 percent is owned by corporate owners not involved in the manufacture of wood products. Most of the private timberland in the region is controlled by owners who apparently are not holding their land primarily for its timber production. An indicator that many of the owners are not interested in producing and marketing timber is that the region's per-acre timber output is 115 board feet per year, low compared with the average sawtimber volume and growth on the central coast's timberlands.

Public ownerships account for 17 percent of the region's commercial forests and sawtimber volume. The portion of the Los Padres National Forest in Monterey County contains an estimated 33,000 acres classed as commercial forests. These lands, however, are marginal in potential timber production; over half the area is in isolated stands of redwood in canyon bottoms, and 30 percent is in mostly open stands of Coulter pine--a species with little commercial use.

Public timberlands other than National Forest total 10,000 acres, mostly in county or municipal ownership. The municipal watersheds of Santa Cruz County are managed for timber production as well as water.

Productivity of the Forest Land

The central coast timberlands vary in potential for wood production. They have been placed in cubic-foot site classes based on potential mean annual growth (per acre) in fully stocked natural timber stands. Although neither the yield of existing stands is reflected nor what might be produced in managed stands, the classes provide a relative measure to rate timberlands.

Of the central coast's 221,000 acres rated for productivity, 89 percent is capable of producing 120 cubic feet or more per acre per year. The average site class for this region exceeds 175 cubic-feet, making it potentially the most productive timber region--on a per-acre basis--in California. Other regions in the State have high-site timberlands, but they also have large areas of low productivity. Except for Monterey County, most of which was not classed as to productivity, the central coast has essentially no timberland of low productivity.

The 221,000-acre area rated for productivity has an average net annual growth of 115 cubic feet per acre, about two-thirds of the rated potential for the area. Considering the voluntary origins of the stands, varied stocking, and uneven distribution of age classes, a high proportion of the estimated potential of the region's forests has been realized in the existing stands.

Forest Types

The commercial forests of the central coast include many tree species. But one conifer, coastal redwood, is most evident in the commercial forests of the region. This species supported early development of the forest industries and continues to be the primary commercial resource. The

Figure 5.--Most forests in the central coast have several tree species. This redwood stand has numerous Douglas-firs and hardwoods.

redwood forest type totals 127,000 acres and accounts for 70 percent (4.3 billion board feet) of the region's sawtimber volume and for 64 percent (82 million board feet) of the current sawtimber growth. Although the volume in this type is mostly redwood, Douglas-fir and hardwoods are also found on much of this area (fig. 5).

The other important commercial conifer in the region, Douglas-fir, predominates on 27,000 acres. This forest type contains almost 1 billion board feet of sawtimber and has a current annual growth of 17 million board feet.

Pines--Coulter, knobcone, ponderosa, or Monterey--predominate on a total of 38,000 acres in the central coast (fig. 6). These pine forests, which are scattered and not in large concentrations, hold 292 million board feet of sawtimber and account for 11 percent (14 million board feet) of the region's sawtimber growth.

Tanoak, Pacific madrone, and several other hardwoods, singly or in combination, are the predominant tree species on about one-quarter (68,000 acres) of the region's commercial timberlands. These hardwood forests contain almost 600 million board feet of sawtimber, of which more than three-fourths is

Figure 6.--A sparse stand of knobcone pine on shallow soil in Santa Cruz County. Pine stands in the central coast are of little importance for timber value.

softwoods. This apparent anomaly--hardwood forest type with sawtimber mostly in softwoods--results because forest type is determined by trees of all sizes. These hardwood stands often are characterized by a scattering of large conifers and many small hardwoods, the latter accounting for a greater total of stocking but providing little sawtimber volume. The hardwood forests account for 14 million board feet of current growth, most of it on the conifers within the stands.

Stocking

Stocking is a measure of the degree to which the existing stand is utilizing the capability of the site to grow trees (a measure of how effectively the land is being used from the standpoint of producing timber). In the central coast, stocking was separated into two components: (1) softwood growing stock which, with respect to timber values, is considered the desirable component; and (2) hardwoods and cull softwoods, which could be considered an impediment to timber production though not to watershed protection, wildlife habitat, recreation, or other nontimber values.

No commercial forest lands in the central coast were found unstocked with trees. The areas that were lightly stocked or nonstocked with softwood growing stock were at least moderately stocked with hardwoods. Conversely, areas with few hardwoods were moderately to fully stocked with softwood growing stock.

Of the 221,000-acre area for which we have stocking information, 71 percent is moderately to fully stocked with growing stock softwoods; 24 percent lightly stocked; 5 percent nonstocked. The impressive stocking condition of the central coast's commercial forests comes from a combination of factors. The region's forest lands are of high productivity. Redwood, the predominant coniferous species, readily sprouts after cutting, and the region's hardwoods are aggressive in occupying areas where vegetation has been removed (fig. 7). In most years, moisture is not a limiting factor in stand establishment.

Since the first harvests in the region and the fires that followed, the young forests have developed relatively undisturbed. The industry that has depended on the young timber resource in recent decades has been small so the acreage annually harvested has been small. Also, the harvest methods used in recent years usually have left a residual stand. Our inventory indicated that 77,000 acres had undergone partial harvest in the present stands; about 14,000 acres underwent partial harvest in the 5 years before inventory. This is a modest amount for partial harvest if we consider the region's entire inventory of unreserved forests.

Of the area partially harvested, only one-fourth is predominantly stocked with hardwoods, and all these areas have some softwoods as well. The practice of partial harvest in the central coast does not appear to have resulted in conversion of softwood stands to hardwoods.

Figure 7.--Redwood stumps sprout vigorously at the root collar shortly after trees are cut. These sprouts provide almost immediate restocking of harvested redwood areas.

Stand Age

As a consequence of the extensive harvests of virgin timber and the massive fires that were characteristic of this region in the latter part of the 19th century and the early years of this century, young forests predominate in the central coast. Three-fourths of the region's timberland has forest stands less than 100 years old; 92,000 acres with stands less than 50 years old; and 71,000 acres with stands 50 to 100 years old.

Collectively, these young stands contain 2.5 billion board feet of sawtimber and account for two-thirds (84 million board feet) of the region's sawtimber growth and almost three-fourths of its cubic-foot growing stock growth. Within the young forests, two-thirds of the sawtimber volume is concentrated in the 50- to 100-year-old stands.

The stands more than 100 years old total 58,000 acres and are of several origins. Some are only slightly over 100 years old and probably originated after the earliest logging. Others show no evidence of past harvest; and yet others (22,000 acres) are partially harvested stands of mature timber. Even though they occupy only one-fourth of the commercial forest area, these old stands, because of their higher volume concentrations, account for more than half (2.8 billion board feet) of the region's sawtimber.

In contrast with the young stands, which average about 15,000 board feet of sawtimber per acre, the old stands average 48,000 board feet; and some exceed 90,000 board feet. The current annual growth is 768 board feet per acre in these old stands compared with 512 in the young stands.

In summary, the central coast's commercial forests can be characterized as rapidly growing, mostly young forests. They are of mixed species, but redwood or hardwoods (Pacific madrone and tanoak) most often predominate. Across almost the entire commercial forest area, both hardwoods and conifers are present (fig. 8). The impression from flying over or traveling through the region's forests is that the tree cover is almost unbroken. The clearcutting and massive fires of decades ago left in their wake extensive areas that now are vegetated with mixed forests of hardwoods and conifers. The fire protection of recent decades and the practice of partial harvests, now mandated by forest practices regulations, have fostered the continuous forest cover characteristic of the central coast today.

Figure 8.--A mixed stand of tanoak and redwood. Both hardwoods and softwoods are usually present on productive forest land in the central coast.

THE POTENTIAL IMPACTS OF HARVEST LIMITATIONS

A number of limitations may affect the availability of timber in the central coast. The first category of limitations is economic and includes species of low value, concentrations of low volumes, inaccessibility, and lack of processing facilities. Much of the scattered timber in Monterey County has one or more of these limitations.

Another limitation, perhaps more important than any other in this region, is the pattern of timberland ownership and owners' objectives. The central coast's timberlands are held primarily by many owners, in small woodland tracts (Baker and Poli 1953, 1954). Although no survey of owner intent has been made, the ownership pattern suggests that much--perhaps most--of the forested area is owned for reasons other than the production of timber. Although many of these owners do sell timber at one time or another, at any given time much of the timber probably is not available regardless of market conditions (demand). Moreover, investments in timber growing are likely minimal in most cases. The ownership pattern in this region, then, is probably the most significant reason for the small scale of the resident forest industry. As one consequence of the ownership pattern, owner objectives, and small scale of industry, timber stocks in the central coast have built up until this region has the highest average per-acre concentration of sawtimber of all timber-producing regions in California.

Local government zoning regulations, restricting the uses on lands within well-defined geographic boundaries, can also affect timber availability. The impacts of such zoning limitations were not investigated in this inventory, but the intensified land-use planning efforts that can be anticipated with expanding population in this region likely will result in zoning impacts on some of the commercial forest land.

Another important set of limitations on the availability of timber is local and State forest practice regulations, which affect the availability of timber on almost all the region's timberlands. These regulations vary somewhat from county to county in the central coast, but all have specific requirements about conditions of forest lands subsequent to harvest operations.

The forest practice regulations that apply to the central coast counties are more stringent than those of other timbered regions in California; they require that a significant residual stand of trees be left after harvest (fig. 9). So only part of the timber stand is available for harvest at any time, and stands cannot be reentered for subsequent harvest until they meet specified minimal stocking standards, which means that residual volume might not be available for extended periods.

Impact of Forest Practice Regulations

Most of the limitations on timber availability affect only one portion or another of the region's timber resource. But forest practice regulations affect availability of the entire

Figure 9.--The appearance of this open stand of redwood was little changed by recent partial harvest in accordance with forest practice regulations. Some trees were left in each cluster of trees, which originated from sprouts. After harvest, logging slash was removed and the area was seeded to annual grasses, an indication that the owner places high value on the restoration of the appearance of the forest.

timber base and deserve a brief discussion here as a potential limitation on availability of the region's current timber stocks.

Forest practice regulations in the central coast vary among counties; but they all require that a well-distributed residual stand of thrifty, vigorous, coniferous trees with full crowns--40 to 50 percent of the original stand--be left after harvest. To approximate the impact of these regulations on current availability of the region's sawtimber resource, I screened each forest inventory sample plot. Tree distribution, crown position, tree diameter, and numbers of trees were considered in an attempt to estimate the minimum residual stand that would be required by the appropriate set of regulations.3/

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[3] For San Mateo County, the county's 1972 harvest regulations were used. For Monterey County, the Southern Forest District high-use subdistrict rules were used (California Administrative Code, Title 14, Division 2, Chapter 2, subchapter 2, Article 3 (953.8)). For Marin, Santa Clara, and Santa Cruz Counties, the Coast Forest District, southern area rules were used (California Administrative Code, Title 14, Division 2, Chapter 2, subchapter 1, Article 3 (913.9a)).

The trees on each plot not needed to meet the minimum requirements for the residual stand were considered "available" for harvest; the volumes of these trees were then summed to provide estimate of available softwood sawtimber volume for each plot.

The following tabulation shows estimated acres and volume of softwood sawtimber in each of five broad volume classes, before and after volume data were adjusted for estimated impacts of the regulations on timber availability:

Volume class	Thousand acres	Total volume	Thousand acres	Available volume
(M bd ft)		(MM bd ft)		(MM bd ft)
0-5	55	126	94	104
5-10	38	284	34	286
10-25	42	669	55	894
25-50	62	2,082	25	889
50+	24	1,801	13	803
Total	221	4,962	221	2,976

Analysis of the data (after screening and adjustment of volume) indicates the following:

1. On the average, the central coast's timber stands can be expected to yield approximately 60 percent of their total sawtimber volume when harvested in compliance with forest practice regulations pertaining to minimum residual stocking levels.

2. An estimated 93,000 acres--43 percent of the timbered area for which sample plots were analyzed--has less than 5,000 board feet per acre of available sawtimber.

3. The percentage of total stand volume that is available is quite variable and is not predictable on the basis of total stand volume. Some stands have as much as 80 percent of their total sawtimber volume available.

It is important to recognize that the sawtimber trees left standing after harvest can, in most cases, be harvested at a later date when the stands have restocked sufficiently to meet minimum stocking standards specified by the regulations.

The forest practice regulations governing logging in the central coast were drafted to insure maintenance of a sawtimber conifer component in the region's forests, in recognition of the multiple resource values associated with the forests and their use. Through deferral of harvest of some of the conifer sawtimber in each stand, the continuous forest cover that characterizes most of this region's forested area can be maintained.

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APPENDIX

Table 1--Area by land class and county, California's central coast, January 1, 1973

(In thousand acres)

Land class	Alameda	Contra Costa	Marin	Monterey	San Benito	San Francisco	San Mateo	Santa Clara	Santa Cruz	Solano	All counties
Forest land:											
Commercial	--	--	7	60	--	--	44	14	135	--	260
Productive reserved	3	2	23	10	--	--	16	6	19	--	79
Unproductive	95	67	94	892	324	--	60	357	28	37	1,954
Total	98	69	124	962	324	--	120	377	182	37	2,293
Nonforest land	370	399	209	1,160	569	29	166	455	99	492	3,948
Total area	468	468	333	2,122	893	29	286	832	281	529	6,241

Source: United States Bureau of the Census, Land and Water Area of the United States, 1971.

Table 2--Area of commercial forest land by ownership and county,

California's central coast, January 1, 1973

(In thousand acres)

Ownership	Marin	Monterey	San Mateo	Santa Clara	Santa Cruz	All counties
National Forest		33				33
Other public:						
Miscellaneous Federal		1/				1/
State		1/			1/	1
County and municipal			1	2	6	9
Total other public		1	1	2	6	10
Private:						
Forest industry			8		2	10
Farmer-owned	3	13	2	1/	7	25
Miscellaneous private--corporate	1	5	7	3	47	63
Miscellaneous private--noncorporate	3	8	26	9	73	119
Total private	7	26	43	12	129	217
All ownerships	7	60	44	14	135	260

1/ Less than 500 acres.

Table 3--Area of noncommercial forest land by land class and forest type and by ownership, California's central coast, January 1, 1973

(In thousand acres)

Land class and forest type	National Forest	Other public	Private	All ownerships
	RESERVED			
Productive forest land:				
Douglas-fir		6		6
Ponderosa pine	7	3		10
Monterey pine		1		1
Redwood	2	36		38
Black oak		1		1
Pacific madrone		1		1
Other hardwoods		7		7
Noncommercial conifers		2		2
Unclassified		11	2	13
Total	9	68	2	79
Unproductive forest land:				
Oaks		36		36
Chaparral		88		88
Unclassified	86			86
Total	86	124		210
Total reserved	95	192	2	289
	UNRESERVED			
Unproductive forest land:				
Douglas-fir			2	2
Noncommercial conifers			5	5
Oaks	30	131	1,036	1,197
Chaparral	28	187	292	507
Pinyon-juniper	1			1
Unclassified	32			32
Total unreserved	91	318	1,335	1,744

Table 4--Area of commercial forest land by site class and ownership, California's central coast, January 1, 1973

Site class[1/]	Public	Private	All ownerships
Cubic feet		In thousand acres	
225 or more	2	62	64
165 to 224	3	47	50
120 to 164	1	81	82
85 to 119	2	18	20
50 to 84	2	--	2
20 to 49	--	3	3
Unclassified	33	6	39
All classes	43	217	260

[1/] A classification in terms of capacity for cubic-foot annual growth per acre at culmination of mean annual growth in fully stocked stands.

Table 5--Area of commercial forest land by stand-size class and ownership, California's central coast, January 1, 1973

(In thousand acres)

Stand-size class	Public	Private	All ownerships
Sawtimber stands:			
Large sawtimber[1/]	4	93	97
Small sawtimber[2/]	4	80	84
Total	8	173	181
Poletimber	2	13	15
Sapling and seedling stands	--	25	25
Nonstocked areas	--	--	--
Unclassified	33	6	39
All classes	43	217	260

[1/] Large sawtimber includes trees 21.0-inch d.b.h. and larger.

[2/] Small sawtimber includes softwood trees 9.0- to 20.9-inch d.b.h. and hardwood trees 11.0- to 20.9-inch d.b.h.

Table 6--Area of commercial forest land by stand volume and ownership,

California's central coast, January 1, 1973

Stand volumes per acre[1/]	Public	Private	All ownerships
Board feet	- - - - -Thousand acres- - - - -		
Less than 1,500		14	14
1,500 to 4,999		20	20
5,000 to 9,999	4	34	38
10,000 to 19,999	2	38	40
20,000 to 29,999	2	22	24
30,000 to 39,999		41	41
40,000 to 49,999	2	12	14
50,000 to 59,999		3	3
60,000 to 69,999		9	9
70,000 to 79,999		5	5
80,000 to 89,999		9	9
90,000 or more		4	4
Unclassified	33	6	39
Total	43	217	260

[1/] Net volume, International 1/4-inch rule.

Table 7--Area of commercial forest land by forest type and ownership, California's central coast, January 1, 1973

(In thousand acres)

Forest type	National Forest	Other public	Private	All ownerships
Redwood	17	4	106	127
Douglas-fir	--	--	27	27
Coulter pine	10	--	3	13
Knobcone pine	--	--	10	10
Ponderosa pine	6	--	--	6
Monterey pine	--	--	9	9
Pacific madrone	--	1	16	17
Tanoak	--	--	24	24
Other hardwoods	--	5	22	27
All types	33	10	217	260

Table 8--Area of commercial forest land by stocking percent and stand component, California's central coast, January 1, 1973[1/]

Stocking in softwood growing stock	Stocking in hardwoods and cull softwoods (percent)					Total
	0-10	11-35	36-60	61-80	81+	
Percent	- - - - - - - - -Thousand acres- - - - - - - -					
0-10	--	--	--	--	11	11
11-35	--	--	10	3	39	52
36-60	4	4	22	6	30	66
61-80	--	1	4	24	3	32
81+	6	27	20	7	--	60
All stocking levels	10	32	56	40	83	221

[1/] Excludes 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forest, for which data were not available.

Table 9--Volume of timber on commercial forest land by class of timber and by softwoods and hardwoods, California's central coast, January 1, 1973[1/]

(In million cubic feet)

Class of timber	Softwoods	Hardwoods	All species
Sawtimber trees:			
Saw-log portion	882	62	944
Upper-stem portion	121	59	180
Total	1,003	121	1,124
Poletimber trees	31	43	74
All growing stock trees	1,034	164	1,198
Sound cull trees	1	33	34
Rotten cull trees	1	4	5
Salvable dead trees	4	--	4
All timber	1,040	201	1,241

[1/] Excludes volume on 33,000 acres of Los Padres National Forest and on 6,000 acres of privately owned forests, for which data were not available.

Table 10--Volume of growing stock and sawtimber on commercial forest land by stand-size class and by softwoods and hardwoods, California's central coast, January 1, 1973[1/]

Stand-size class	Average volume per acre	Softwoods	Hardwoods	All species
	Cubic feet	- - -Million cubic feet- - -		
Growing stock:[2/]				
Large sawtimber stands	8,371	736	76	812
Small sawtimber stands	3,940	251	80	331
Poletimber stands	2,267	27	7	34
Sapling and seedling stands	840	20	1	21
Nonstocked areas	--	--	--	--
All stands	5,421	1,034	164	1,198
	Board feet	- - -Million board feet- - -		
Sawtimber (International 1/4-inch rule):[3/]				
Large sawtimber stands	44,433	4,133	177	4,310
Small sawtimber stands	16,369	1,243	132	1,375
Poletimber stands	9,000	133	2	135
Sapling and seedling stands	2,800	68	2	70
Nonstocked areas	--	--	--	--
All stands	26,652	5,577	313	5,890
Sawtimber (Scribner rule):[4/]				
Large sawtimber stands	40,732	3,778	173	3,951
Small sawtimber stands	13,750	1,026	129	1,155
Poletimber stands	7,600	112	2	114
Sapling and seedling stands	1,920	46	2	48
Nonstocked areas	--	--	--	--
All stands	23,837	4,962	306	5,268

[1/] Excludes volume on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forest, for which detailed data were not available.

[2/] Includes trees 5.0-inch d.b.h. and larger.

[3/] Includes softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

[4/] Includes trees 11.0-inch d.b.h. and larger.

Table 11--Volume of growing stock and sawtimber on commercial forest land by ownership and by softwoods and hardwoods, California's central coast, January 1, 1973

Ownership	Average volume per acre	Softwoods	Hardwoods	All species
	Cubic feet	- - -Million cubic feet- - -		
Growing stock:[1/]				
National Forest	4,121	117	19	136
Other public	4,500	33	12	45
Private[2/]	5,464	1,001	152	1,153
All ownerships	5,252	1,151	183	1,334
	Board feet	- - -Million board feet- - -		
Sawtimber (International 1/4-inch rule):[3/]				
National forest[4/]	--	--	--	--
Other public	20,800	188	20	208
Private[2/]	26,929	5,389	293	5,682
All ownerships	26,652	5,577	313	5,890
Sawtimber (Scribner rule):[5/]				
National Forest	26,182	741	123	864
Other public	18,400	164	20	184
Private[2/]	24,095	4,798	286	5,084
All ownerships	24,142	5,703	429	6,132

[1/] Includes trees 5.0-inch d.b.h. and larger.

[2/] Excludes 6,000 acres of privately owned forests, for which data were not available.

[3/] Includes softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

[4/] Excludes 33,000 acres of Los Padres National Forest for which data were not available.

[5/] Includes trees 11.0-inch d.b.h. and larger.

Table 12--Volume of growing stock and sawtimber on commercial forest land by county and ownership, California's central coast, January 1, 1973[1/]

County	National Forest	Other public	Private	Total
	- - - - -Million cubic feet- - - - -			
Growing stock:[2/]				
Marin			43	43
Monterey	136	2	131	269
San Mateo		1	281	282
Santa Clara		2	77	79
Santa Cruz		40	621	661
Total	136	45	1,153	1,334
	- - - - -Million board feet- - - - -			
Sawtimber (Scribner rule):[3/]				
Marin			204	204
Monterey	864	7	627	1,498
San Mateo		6	1,325	1,331
Santa Clara		11	357	368
Santa Cruz		160	2,571	2,731
Total	864	184	5,084	6,132

[1/] Excludes volume on 6,000 acres of privately owned forests.

[2/] Includes trees 5.0-inch d.b.h. and larger.

[3/] Includes trees 11.0-inch d.b.h. and larger.

Table 13--Volume of growing stock and sawtimber on commercial forest land by species, California's central coast, January 1, 1973[1/]

Species	Growing stock	Sawtimber
	Million cubic feet	Million board feet, Scribner rule
Softwoods:		
Redwood	772	3,526
Douglas-fir	206	1,196
Coulter pine	10	54
Knobcone pine	21	46
Ponderosa pine	10	60
Monterey pine	15	80
Unclassified	117	741
Total	1,151	5,703
Hardwoods:		
Pacific madrone	48	89
Tanoak	78	132
Other hardwoods	38	85
Unclassified	19	123
Total	183	429
All species	1,334	6,132

[1/] Excludes volume on 6,000 acres of privately owned forests.

Table 14--Volume of growing stock on commercial forest land by species and diameter class, California's central coast, January 1, 1973[1/]

(In million cubic feet)

Species	Diameter class (inches at breast height)										
	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger	All classes
Softwoods:												
Redwoods	6	12	16	17	27	33	42	52	135	135	298	772
Douglas-fir	1	5	--	6	2	5	2	5	35	45	102	206
Pines	4	3	5	5	2	3	1	4	14	10	5	56
Total[2/]	11	20	21	28	31	41	45	61	181	190	405	1,034
Hardwoods:												
Pacific madrone	1	2	5	10	5	6	5	1	9	4	--	48
Tanoak	4	8	11	10	9	7	6	6	14	3	--	78
Other hardwoods	3	4	4	5	4	2	4	2	9	1	--	38
Total[2/]	8	14	20	25	18	15	15	9	32	8	--	164
All species[2/]	19	34	41	53	49	56	60	70	213	198	405	1,198

[1/] Excludes volume on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests, for which detailed data were not available.

[2/] Totals may be off because of rounding.

Table 15--Volume of sawtimber on commercial forest land by species and diameter class, California's central coast, January 1, 1973[1]

(In million board feet, Scribner rule)

Species	Diameter class (inches at breast height)								
	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0-38.9	39.0 and larger	All classes
Softwoods:									
Redwood	41	80	129	185	242	644	615	1,590	3,526
Douglas-fir	21	9	18	8	25	175	266	673	1,196
Pines	14	9	13	6	21	74	64	40	240
Total[2]	76	99	160	198	286	893	947	2,303	4,962
Hardwoods:									
Pacific madrone	20	10	14	11	3	23	9	--	89
Tanoak	16	18	16	16	16	38	10	--	132
Other hardwoods	12	13	6	11	5	36	3	--	85
Total[2]	48	41	36	38	24	97	22	--	306
All species[2]	124	140	196	236	310	990	969	2,303	5,268

[1] Excludes volume on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests, for which detailed data were not available.

[2] Totals may be off because of rounding.

Table 16--Area of commercial forest land and volume and net growth of growing stock and sawtimber by forest type, California's central coast, January 1, 1973

Forest type	Area	Volume		Net growth	
		Growing stock	Saw-timber	Growing stock	Saw-timber
	Thousand acres	Million cubic feet	Million board feet[1/]	Thousand cubic feet	Thousand board feet[1/]
Redwood	127	921	4,304	15,992	82,345
Douglas-fir	27	177	952	2,998	17,195
Coulter pine	13	19	105	438	2,375
Knobcone pine	10	14	16	693	589
Ponderosa pine	6	9	57	51	0
Monterey pine[2/]	3	22	114	1,716	11,341
Pacific madrone	17	33	108	407	619
Tanoak	24	87	269	2,429	7,888
Other hardwoods	27	52	207	1,240	5,718
All types	[2/]254	[2/]1.334	[2/]6,132	[2/]25,964	[2/] [3/]128,070

[1/]Scribner rule.

[2/]Excludes area, volume, and growth on 6,000 acres of privately owned forest.

[3/]Excludes sawtimber growth on 33,000 acres of Los Padres National Forest.

Table 17--Area of commercial forest land and volume and net growth of growing stock and sawtimber by stand age, California's central coast, January 1, 1973[1/]

Stand age class	Area	Volume		Net growth	
		Growing stock	Saw-timber	Growing stock	Saw-timber
Years	Thousand acres	Million cubic feet	Million board feet[2/]	Thousand cubic feet	Thousand board feet[2/]
Nonstocked areas:					
0-9	12	8	24	711	4,282
10-19	3	2	--	208	--
20-29	6	9	22	313	1,019
30-39	14	56	199	2,431	13,425
40-49	20	76	249	3,391	12,734
50-59	6	16	50	607	2,326
60-69	6	41	172	1,057	5,773
70-79	7	37	149	600	2,666
80-89	--	--	--	--	--
90-99	--	--	--	--	--
100-119	--	--	--	--	--
120-139	3	33	204	847	5,719
140-159	--	--	--	--	--
160-179	--	--	--	--	--
180-199	--	--	--	--	--
200 and over	10	114	582	598	3,000
Uneven-aged stands:					
Less than 50	37	94	350	2,334	9,881
50-99	52	305	1,285	6,591	31,424
100 and over	45	409	1,981	5,792	35,821
All classes[2/]	221	1,198	5,268	25,480	128,070

[1/] Excludes 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests, for which detailed data were not available.

[2/] Scribner rule.

Table 18--Net annual growth of growing stock and sawtimber on commercial forest land by ownership and by softwoods and hardwoods, California'a central coast, 1972

Ownership	Average volume per acre	Softwoods	Hardwoods	All species
	Cubic feet	- - -Thousand cubic feet- - -		
Growing stock:[1]				
National Forest	15	484	[2]	484
Other public	95	232	721	953
Private[3]	111	21,085	3,442	24,527
All ownerships	102	21,801	4,163	25,964
	Board feet	- - -Thousand board feet- - -		
Sawtimber (International 1/4-inch rule):[4]				
National Forest[2]	--	--	--	--
Other public	266	1,679	979	2,658
Private[3]	614	130,305	5,470	135,775
All ownerships	599	131,984	6,449	138,433
Sawtimber (Scribner rule):[5]				
National Forest[2]	--	--	--	--
Other public	258	1,630	955	2,585
Private[3]	568	120,090	5,395	125,485
All ownerships	554	121,720	6,350	128,070

[1] Includes trees 5.0-inch d.b.h. and larger.

[2] Not available.

[3] Excludes 6,000 acres of privately owned forests, for which growth data were not available.

[4] Includes softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger

[5] Includes trees 11.0-inch d.b.h. and larger.

Table 19--Net annual growth of growing stock and sawtimber on commercial forest land by species, California's central coast, 1972

Species	Growing stock	Sawtimber
	Thousand cubic feet	Thousand board feet[1]
Softwoods:		
Redwood	14,547	80,186
Douglas-fir	3,612	21,495
Coulter pine	358	2,375
Knobcone pine	1,163	6,827
Ponderosa pine	[2] -79	[2] -504
Monterey pine	1,716	11,341
Unclassified	484	--
Total	21,801	121,720
Hardwoods:		
Pacific madrone	1,046	1,430
Tanoak	2,269	3,231
Other hardwoods	848	1,689
Total	[3] 4,163	[3] 6,350
All species	[3][4] 25,964	[5] 128,070

[1] Scribner rule.

[2] Negative growth is the result of mortality in excess of gross growth.

[3] Does not include growth of hardwoods on National Forest lands.

[4] Excludes growth on 6,000 acres of privately owned forests.

[5] Excludes growth on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests.

Table 20--Average annual mortality of growing stock and sawtimber on commercial forest land by species, California's central coast, 1968-72[1/]

Species	Growing stock	Sawtimber	
		International 1/4-inch rule	Scribner rule
	Thousand cubic feet	- -Thousand board feet- -	
Softwoods:			
Redwood	48	175	--
Douglas-fir	320	2,077	1,855
Knobcone pine	150	963	850
Ponderosa pine	112	776	738
Total	630	3,991	3,443
Hardwoods:			
Pacific madrone	125	--	--
Tanoak	123	--	--
Total	258	--	--
All species	888	3,991	3,443

[1/] Excludes mortality on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests.

Table 21--Average annual mortality of growing stock and sawtimber on commercial forest land by cause of death and by softwoods and hardwoods, California's central coast, 1968-72[1/]

Cause of death	Growing stock			Sawtimber		
	Softwoods	Hardwoods	All species	Softwoods	Hardwoods	All species
	- - -Thousand cubic feet- - -			- -Thousand board feet[2/]- -		
Fire	112	--	112	738	--	738
Insects	192	--	192	1,204	--	1,204
Disease	--	--	--	--	--	--
Weather	150	90	240	850	--	850
Suppression	47	--	47	--	--	--
Animal	--	45	45	--	--	--
Unknown	129	123	252	651	--	651
Other	--	--	--	--	--	--
All causes	630	258	888	3,443	--	3,443

[1/]Excludes mortality on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests.

[2/]Scribner rule.

Table 22--Net volume of salvable dead sawtimber on commercial forest land by volume per acre class, California's central coast, January 1, 1973[1/]

Volume per acre class	Sawtimber	
	International 1/4-inch rule	Scribner rule
Board feet	- - - -Thousand board feet- - - -	
1- 499	1,148	846
500- 999	--	--
1,000-2,499	19,106	17,628
2,500-4,999	7,855	7,153
Total	28,109	25,628

[1/] Excludes salvable dead sawtimber on 33,000 acres of Los Padres National Forest and 6,000 acres of privately owned forests.

Table 23--Reported timber production in California's central coast counties, 1947-76

(In thousand board feet)[1/]

Year	Marin[2/]	Monterey[3/]	San Mateo	Santa Clara[4/]	Santa Cruz	Total
1947	--	4,332	20,477	10	1,821	26,640
1948	--	1,918	17,762	--	8,452	28,132
1949	--	1,493	16,500	--	4,911	22,904
1950	180	2,355	17,520	--	2,959	23,014
1951	--	1,987	19,795	--	5,692	27,474
1952	620	950	20,371	--	4,684	26,625
1953	--	650	21,803	75	4,073	26,601
1954	719	221	20,081	--	8,018	29,039
1955	10,010	535	24,644	500	20,127	55,816
1956	5,256	2,075	20,811	1,750	19,072	48,964
1957	2,595	4,525	17,013	1,555	14,877	40,565
1958	8,643	7,212	19,213	632	28,668	64,368
1959	25,906	4,195	24,256	1,309	21,964	77,630
1960	9,165	4,579	19,046	3,035	22,778	58,603
1961	3,890	4,637	19,698	2,110	23,686	54,021
1962	1,575	6,331	21,058	1,504	26,850	57,318
1963	9,076	6,103	37,016	3,656	12,518	68,369
1964	2,095	3,461	32,642	1,732	20,596	60,526
1965	4,021	3,782	25,791	1,866	20,763	56,223
1966	948	6,821	24,322	10	18,483	50,584
1967	2	8,559	15,849	35	20,570	45,015
1968	117	4,292	22,160	125	19,989	46,683
1969	8	718	21,778	3,790	34,900	61,194
1970	341	2,870	14,689	30	19,418	37,348
1971	690	2,920	21,659	34	13,489	38,792
1972	105	1,808	6,381	757	21,245	30,296
1973	--	612	5,292	4,344	19,692	29,940
1974	12	3,192	5,583	60	21,737	30,584
1975	--	20	6,671	200	10,335	17,226
1976	523	155	5,843	903	12,619	20,043

[1/] Log rule unspecified--primarily short log Scribner scale.

[2/] Includes Napa and Solano.

[3/] Includes San Luis Obispo.

[4/] Includes Alameda, Contra Costa, San Benito, and Stanislaus.

Source: California Division of Forestry (1948-77).

Table 24--Area of commercial forest land by stand-size class and ownership, Santa Cruz County, California, January 1, 1973

(In thousand acres)

Stand-size class	Public	Private	All ownerships
Sawtimber stands:			
Large sawtimber[1/]	2	38	40
Small sawtimber[2/]	4	56	60
Total	6	94	100
Poletimber stands	--	14	14
Sapling and seedling stands	--	21	21
Nonstocked areas	--	--	--
All classes	6	129	135

1/ Large sawtimber includes trees 21.0-inch d.b.h. and larger.

2/ Small sawtimber includes softwood trees 9.0- to 20.9-inch d.b.h. and hardwood trees 11.0- to 20.9-inch d.b.h.

Table 25--Area of commercial forest land by site class and ownership, Santa Cruz County, California, January 1, 1973

Site class[1/]	Public	Private	All ownerships
Cubic feet	- - - - Thousand acres - - - -		
225 or more	2	51	53
165 to 224	3	28	31
120 to 164	1	32	33
85 to 119	--	18	18
50 to 84	--	--	--
20 to 49	--	--	--
All classes	6	129	135

[1/] A classification in terms of capacity for cubic-foot annual growth per acre at culmination of mean annual growth in fully stocked stands.

Table 26--Area of commercial forest land and volume and net growth of growing stock and sawtimber by forest type, Santa Cruz County, California, January 1, 1973

Forest type	Area	Volume		Net growth	
		Growing stock	Saw-timber	Growing stock	Saw-timber
	Thousand acres	Million cubic feet	Million board feet[1]	Thousand cubic feet	Thousand board feet[1]
Redwood	68	462	1,968	11,946	61,502
Douglas-fir	13	65	325	997	4,286
Knobcone pine	10	14	16	693	589
Monterey pine	3	22	114	1,716	11,341
Pacific madrone	12	22	67	329	939
Tanoak	14	48	143	1,711	6,309
Other hardwoods	15	28	98	790	3,688
All types	135	661	2,731	18,182	88,654

[1] Scribner rule.

Table 27--Volume and net annual growth of growing stock and sawtimber on commercial forest land by species, Santa Cruz County, California, January 1, 1973

Species	Volume		Growth[1]	
	Growing stock	Saw-timber	Growing stock	Saw-timber
	Million cubic feet	Million board feet[2]	Thousand cubic feet	Thousand board feet[2]
Softwoods:				
Redwood	435	1,932	10,841	61,889
Douglas-fir	89	469	1,771	9,659
Knobcone pine	15	31	802	1,315
Ponderosa pine	7	46	20	141
Monterey pine	15	80	1,716	11,341
Total	561	2,558	15,150	84,345
Hardwoods:				
Pacific madrone	35	64	735	1,089
Tanoak	37	48	1,526	1,746
Other hardwoods	28	61	771	1,474
Total	100	173	3,032	4,309
All species	661	2,731	18,182	88,654

[1] Growth is for 1972.

[2] Scribner rule.

Inventory Procedures

The statistics for forest lands outside National Forests were collected in 1972 by Renewable Resources Evaluation Work Unit personnel of the Pacific Northwest Forest and Range Experiment Station. The procedures used for these lands were designed specifically to obtain the kinds of data shown in this report. The forest statistics for the Los Padres National Forest were collected in 1974 by National Forest personnel.

For *lands outside National Forest*, a double sampling for stratification inventory design was used. First, aerial photo sample plots 1 acre in size were distributed systematically across the area and classified as commercial forest, noncommercial forest, or nonforest. Commercial forest plots were further classified into several stand volume strata. In addition, plots were stratified by kind of owner from county tax assessor records. A random sample of field plots was selected from the aerial photo plots, proportional to the number of aerial photo plots in each land class, volume class, and ownership class. The sample on lands outside National Forests consisted of over 9,000 aerial photo plots in all land classes, from which were selected 77 commercial forest field plots and 109 noncommercial forest field plots.

The field sample was used to adjust the aerial photo sample for photo interpretation errors and changes since date of photography; it also provided detailed stand data such as stocking by species, volume by size class, etc. Field plots consisted of 10 sample points distributed over an acre. The variable radius plot sampling principle was used to select trees 5.0-inch d.b.h. and larger to be tallied. Trees smaller than 5-inch d.b.h. were tallied on a circular fixed radius plot. Where no trees were tallied, a ground cover class was recorded. Information on past disturbance or treatment and nontimber uses was also recorded. Increment cores were taken from all trees 5.0-inch d.b.h. and larger on 3 of the 10 points to determine radial growth. These radial growth data were used to estimate basal area and volume growth in the current forest stand. Mortality was estimated over a 5-year period by postdating *all* dead trees tallied.

On the Los Padres National Forest, commercial, noncommercial, and nonforest land classes were delineated on aerial photos, and type maps were constructed. Commercial forest areas were further divided into condition classes and major types. Mapped areas of noncommercial forest and nonforest land were accepted without ground checking. The commercial forest area was sampled with field plots proportionally distributed to area by condition class and major type. Field plots consisted of five sample points 132 feet apart in an L-shape. At each point, the variable radius plot sampling principle was used to select tally trees 1-

inch d.b.h. and larger. Trees smaller than 1-inch d.b.h. were tallied on a circular fixed radius plot. Growth and mortality estimates were developed from 10-year increment borings and 5-year postdating of dead trees.

Reliability of Forest Resource Estimates

FOREST LAND AREA AND TIMBER VOLUME

The estimates of forest land area and timber volume outside National Forests in the central coast region were derived by sampling and thus have predictable errors associated with sampling. Confidence intervals have been computed for the estimate of commercial forest land area, noncommercial forest land area, net cubic-foot volume of growing stock, and net board-foot volume (International 1/4-inch rule) of sawtimber. These confidence intervals are presented in table 28 as a percent of the estimated total at

Table 28--Confidence intervals for estimates of forest area and timber volume, California's central coast, January 1, 1973

Item	Estimaged total	Confidence interval: 68-percent probability	Confidence interval: 95-percent probability
		- - -Percent- - -	
Commercial forest land	227,000 acres[1/]	±5.0	±9.8
Noncommercial forest land	1,653,000 acres[2/]	±1.6	±3.1
Volume:			
Growing stock	1,198 million cubic feet[3/]	±9.1	±17.8
Sawtimber (International 1/4-inch rule)	5,890 million board feet[3/]	±10.4	±20.4

[1/]Excludes area on the Los Padres National Forest.

[2/]Includes only the forest area determined by sampling methods. Forest area in the Los Padres National Forest and within parks and other reservations was determined by type-mapping procedures not subject to sampling error.

[3/]Excludes volume on the Los Padres National Forest and on 6,000 acres of privately owned forests.

the 68-percent and 95-percent probability levels. They may be interpreted as meaning that the odds are two out of three for 68-percent probability or 19 out of 20 for 95-percent probability that the ranges shown include the true value (i.e., the results of a 100-percent inventory). For example, we can expect, with 95-percent confidence, that the estimate of commercial forest land area--227,000 acres ± 9.8 percent (22,246 acres)--includes the true value.

The confidence interval for any breakdown of these totals will be substantially greater than for the totals. An approximation of confidence intervals associated with estimates smaller than the totals is shown in table 29.

In addition to measurable sampling errors, there may be nonsampling errors caused by mistakes in judgment, measurement, and compilation. The magnitude of errors of this nature cannot be determined. Such errors are kept to a minimum through training and supervising personnel, checking for errors in the field, and careful editing and machine verification of the data.

Definition of Terms

LAND AREA

Total land area is that reported by the Bureau of the Census and includes dry land and land temporarily or partially covered by water (such as marshes, swamps, and river flood plains), streams, sloughs, and canals less than 1/8-mile wide, and lakes, reservoirs, and ponds less than 40 acres in size.

Forest land is at least 10 percent stocked by trees of any size or is land that formerly had such tree cover and is not currently developed for nonforest use. Minimum area of forest land recognized is 1 acre.

Table 29--Approximate confidence interval by size of estimate, California's central coast, January 1, 1973[1/]

Commercial forest land		Noncommercial forest land		Growing stock		Sawtimber	
Area	Confidence interval[2/] [3/]	Area	Confidence interval[3/]	Volume	Confidence interval[3/]	Volume	Confidence interval[3/]
Thousand acres	Percent (±)	Thousand acres	Percent(±)	Million cubic feet	Percent (±)	Million board feet[4/]	Percent (±)
260	4.7	1,700	1.6	1,200	9.1	6,000	10.3
100	7.5	1,000	2.1	1,000	10.1	4,000	12.6
50	10.6	500	2.9	500	14.1	2,000	17.8
25	15.0	250	4.1	250	19.9	1,000	25.2
10	23.8	100	6.5	100	31.5	500	35.7
5	33.7	50	9.3	50	44.5	250	50.5
3	43.4	25	13.1	25	63.0	100	79.8
--	--	10	20.7	--	--	--	--
--	--	5	29.3	--	--	--	--
--	--	3	37.8	--	--	--	--

1/ Excludes area and volume on Los Padres National Forest.

2/ Applies only to estimates in tables 1 and 2, which are based on double sampling. Confidence intervals for area breakdowns that are based only on field plots (such as area of forest type, area by age class, etc.) might be considerably larger.

3/ By random sampling formula: 68-percent probability.

4/ International 1/4-inch rule.

Nonforest land has never supported forests or was formerly forested and is currently developed for nonforest uses. Included are areas used for agricultural crops, improved pasture, residential areas, city parks, improved roads of any width and their right-of-way clearings, power-line clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and other nonforest strips must be more than 120 feet wide, and clearings, etc., more than 1 acre in size, to qualify as nonforest land.

FOREST LAND CLASSES

Commercial forest land is capable of producing 20 cubic feet per acre per year of industrial wood and is not withdrawn from timber utilization.

Noncommercial forest land consists of unproductive forest land and productive reserved forest land.

Productive reserved forest land is withdrawn from timber utilization through statute, ordinance, or administrative order but otherwise qualifies as commercial forest land.

Unproductive forest land is incapable of yielding crops of industrial wood products because of adverse site conditions, such as sterile soil, poor drainage, high elevation, steepness, and rockiness.

FOREST TYPES

Forest types are determined on the basis of species plurality of all live trees that contribute to stocking; both size and spacing are considered.

TREE CLASSES

Growing Stock

Sawtimber trees, poletimber trees, saplings, and seedlings are considered growing stock (all live trees except cull trees).

Sawtimber trees are growing-stock trees at least 9.0-inch d.b.h. if they are softwoods, and at least 11.0-inch d.b.h. if they are hardwoods. At least 25 percent of the board-foot volume in any sawtimber tree must be free from defect. Softwood trees must contain at least one 12-foot saw log with a top diameter of not less than 6 inches inside the bark; hardwood trees must contain at least one 8-foot saw log with a top diameter of not less than 8 inches inside the bark.

Poletimber trees are 5.0- to 8.9-inch d.b.h., live commercial species, not less than 25 percent sound on a cubic-foot basis; they have no disease, defects, or deformities likely to prevent them from becoming growing stock sawtimber trees.

Sapling and seedling trees are less than 5.0-inch d.b.h., live commercial species and have no disease, defects, or deformities likely to prevent them from becoming growing stock poletimber trees.

Nongrowing Stock

Cull trees are noncommercial species or commercial species which are too defective or which are unlikely to become growing stock trees because of deformity, disease, low vigor, etc.

Sound cull trees are noncommercial species or commercial species with excessive defect because of form, roughness, etc.

Rotten cull trees have excessive defect, primarily from rot.

Mortality trees are commercial species which have died from natural causes within a specified period and which were not cull trees at the time of death.

Salvable dead trees are standing or down commercial species, 11.0 inches or more in diameter, containing 25 percent or more of sound volume and at least one merchantable 16-foot log for softwoods or one merchantable 8-foot log for hardwoods.

STAND SIZE CLASSES

Sawtimber stands are at least 10.0 percent stocked with growing stock trees; half or more of this stocking is in sawtimber and poletimber trees and sawtimber stocking is equal to or greater than poletimber stocking. In *large sawtimber stands*, the majority of the sawtimber stocking is in trees 21.0 inches and larger at breast height. In *small sawtimber stands*, the majority of the sawtimber stocking is in softwood trees from 9.0- to 20.9-inch d.b.h. and hardwood trees 11.0- to 20.9-inch d.b.h.

Poletimber stands are at least 10.0 percent stocked with growing stock trees; half or more of this stocking is in sawtimber and poletimber trees, and poletimber stocking exceeds sawtimber stocking.

Sapling and seedling stands are at least 10.0 percent stocked with growing stock trees; more than half of this stocking is in saplings and seedlings.

Nonstocked areas of commercial forest land are less than 10.0 percent stocked with growing stock trees.

STOCKING

Stocking is a measure of how well the productive potential of the site is utilized by trees. For stands with a mean d.b.h. of at least 8 inches, the measure of stocking is relative density expressed as a percentage of normal stocking; i.e., the current number of trees per acre expressed as a percentage of the normal number indicated for a stand of the same mean diameter and species. For stands with a mean diameter of less than 8 inches, stocking does not indicate the current level of site utilization but rather is an estimate of the degree of site utilization expected when the stand reaches 8 inches in mean diameter. For such stands, the stocking standard is the normal number of trees for an 8-inch stand, adjusted for expected mortality. In stands of mixed size and species, the density standard is a weighted average for the various species and sizes of trees present.

In general, stocking standards are based on normal yield tables. But full normal stocking (100 percent in this report) requires far more trees than are needed to fully occupy the site. Stands in excess of 60-percent stocking are often considered as fully occupying their sites.

TIMBER VOLUME

Live Sawtimber

Net volume of live sawtimber trees of commercial species is estimated in board feet. Net volume equals gross volume less deduction for rot, sweep, crook, and other defects that affect use for lumber.

Scribner rule is the common board-foot log rule used locally in determining volume of sawtimber. Scribner volume was computed on a 16-foot log basis to a utilized top for trees 11.0-inch d.b.h. and larger.

International 1/4-inch rule is the standard board-foot log rule adopted nationally by the Forest Service for the presentation of Forest Survey volume statistics. For International 1/4-inch board-foot volume, the minimum diameter for softwood trees is 9.0 inches b.h.; the minimum log length, 12 feet; and the small end diameter, 7.0-inch outside bark. The minimum diameter for hardwoods is 11.0 inches b.h.; the minimum log length, 8 feet; and the small end diameter, 9.0-inch outside bark.

Growing Stock

Net volume in cubic feet of live sawtimber trees and live poletimber trees from stump to a minimum 4.0-inch top (of central stem) outside bark is measured. Net volume equals gross volume less deduction for rot and missing bole sections.

Industrial Wood

All roundwood products, except fuelwood, are included.

Net Annual Growth

Net annual growth is the net increase in volume of trees during a specified year. Components of net annual growth are: (a) the increment in net volume of trees at the beginning of the specified year surviving to the year's end plus (b) the net volume of trees reaching minimum poletimber or sawtimber diameter during the year minus (c) the net volume of trees that died during the year minus (d) the net volume of trees that become culls during the year.

OWNERSHIP CLASSES

National Forest lands are Federal lands which have been designated by Executive Order or statute as National Forests or purchase units and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other public lands are Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies; and lands owned by States, counties, and local public agencies or lands leased by these governmental units for more than 50 years.

Forest industry lands are owned by companies or individuals operating wood-using plants.

Farmer-owned lands are lands owned by operators of farms.

Miscellaneous private-corporate lands are owned by companies or corporations that do not operate wood-using plants. Included are corporate farms, some railroad lands, oil company lands, real estate and land-holding company lands, and lands held by banks and other financial institutions and various other companies and corporations.

Miscellaneous private-noncorporate lands are privately owned lands other than forest industry, farmer-owned, or corporate lands.

Scientific and Common Names of Plants Mentioned in This Report

Adenostoma fasciculatum	chamise
Arbutus menziesii Pursh	Pacific madrone
Arctostaphylos spp.	manzanita
Ceanothus spp.	ceanothus
Juniperus californica Carr.	California juniper
Lithocarpus densiflorus (Hook. & Arn.) Rehd.	tanoak
Pinus attenuata Lemm.	knobcone pine
Pinus coulteri D. Don	Coulter pine
Pinus lambertiana Dougl.	sugar pine
Pinus muricata D. Don	bishop pine
Pinus ponderosa Laws.	ponderosa pine
Pinus radiata D. Don	Monterey pine
Pinus sabiniana Dougl.	Digger pine
Pseudotsuga mensiesii (Mirb) Franco	Douglas-fir
Quercus agrifolia Nee	coast live oak
Quercus chrysolepis Liebm.	canyon live oak
Quercus dumosa	scrub oak
Quercus douglasii Hook. & Arn.	blue oak
Quercus kelloggii Newb.	California black oak
Quercus lobata Nee	California white oak
Quercus wislizenii A. DC.	interior live oak
Sequoia sempervirens (D. Don) Endl.	redwood
Umbellularia californica (Hook. & Arn.) Nutt.	California-laurel

GPO 988-335

Oswald, Daniel D.
1979. Forests and timber resources of California's central coast. USDA For. Serv. Resour. Bull. PNW-83, 56 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

This report summarizes the findings of a 1972 inventory of the forest land area and timber resources of a 10-county area on California's central coast. Included are detailed tables of area, timber volume, timber growth and harvest, and mortality. The report includes a discussion of the current timber resources and some potential limitations on their availability.

KEYWORDS: Forest surveys, timber resources, resources (forest), California (coastal).

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1. Providing safe and efficient technology for inventory, protection, and use of resources.

2. Developing and evaluating alternative methods and levels of resource management.

3. Achieving 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 are made available promptly. Project headquarters are at:

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Resource Bulletin PNW-84
May 1979

MASS MOVEMENT RESPONSE TO FOREST MANAGEMENT IN THE CENTRAL OREGON COAST RANGES

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U.S. Department of Agriculture • Forest Service

The Authors

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Metric Equivalents

1 inch	=	2.54 centimeters
1 foot	=	0.3048 meter
1 mile	=	1.609 kilometers
1 acre	=	0.4047 hectare
1 cubic yard	=	0.7646 cubic meter

MASS MOVEMENT RESPONSE TO FOREST MANAGEMENT IN THE CENTRAL OREGON COAST RANGES

REFERENCE ABSTRACT

Gresswell, Stuart, David Heller, and Douglas N. Swanston.
1979. Mass movement response to forest management in the central Oregon coast ranges. USDA For. Serv. Resour. Bull. PNW-84, 26 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Timber management activities have clearly accelerated the number and frequency of soil mass movements on the Mapleton District, Siuslaw National Forest as a result of the November 29-December 1, 1975 storm. Exclusive of roads, clearcutting is the most damaging activity.

KEYWORDS: Landslide (-forest damage, erosion -)forestry methods, logging (-erosion, timber management planning.

Research Summary

RESOURCE BULLETIN PNW-84

1979

Timber management activities have clearly accelerated the number and frequency of soil mass movements on the Mapleton District, Siuslaw National Forest as a result of the November 29-December 1, 1975 storm. The silvicultural practice of clearcutting, unassociated with roads, is the most damaging activity.

Soil resource inventory land type, slope gradient, and aspect exert a strong influence on slope failures. Greater than 95% of all failures inventoried occurred on soil resource inventory units 47, 44 and 41 and on slopes greater than 70 percent. North facing slopes had the largest number of failures (64%) in "in-unit" and "road related" classes. Occurrence of failures within a cutting unit was also strongly influenced by both position on the slope and time since cutting.

CONTENTS

INTRODUCTION

As noted by numerous authors (Swanston 1969 and 1976, Swanston and Dyrness 1973, O'Loughlin 1974, Megahan and Kidd 1972, Rice et al. 1972, Swanson and Dyrness 1975), soil mass movement is probably the dominant erosion process in the steep, mountainous terrain of the Pacific Northwest. The present landforms of much of the Coast Ranges of Oregon are being shaped by active mass movement erosion.

Management-related mass movement erosion has consistently been identified as one of the major environmental impacts associated with forest operations in this naturally unstable terrain.

Following a major storm in November 1975, a field inventory of mass movements, primarily debris avalanches and debris torrents was conducted on the Mapleton Ranger District of the Siuslaw National Forest [1/] (fig. 1). The inventory revealed that more than three-fourths of the 245 failures

[1/] The inventory was performed by Mapleton Ranger District personnel as an extension of a regular Flood Emergency Road Maintenance mobilization.

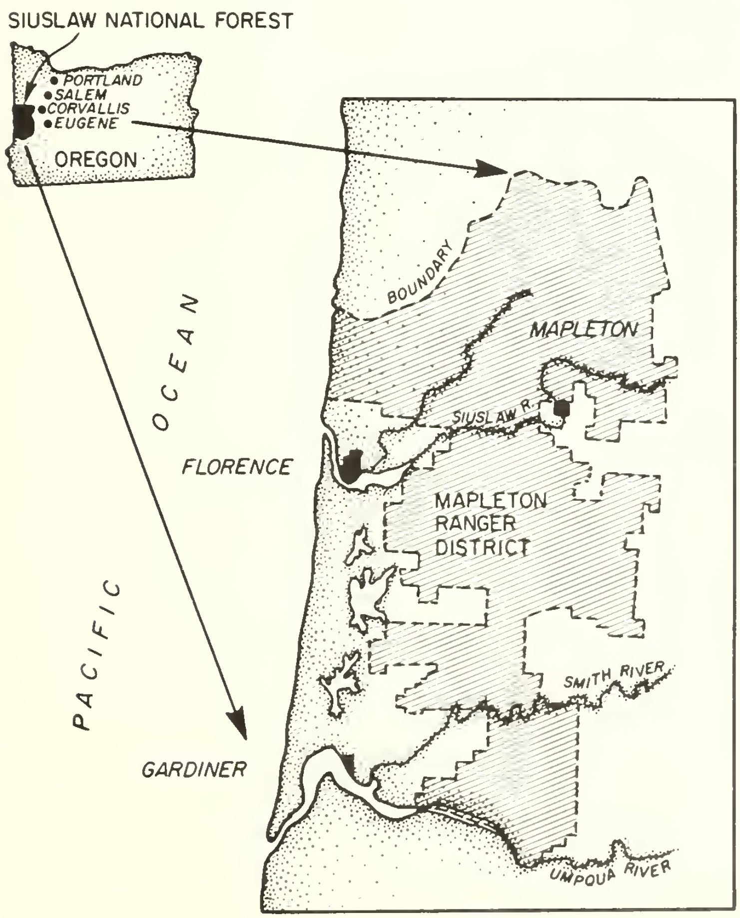

Figure 1.--Location map of the Siuslaw National Forest with an enlargement showing the boundaries of the Mapleton Ranger District.

inventoried occurred within clearcut units with no apparent association to forest road construction. These accounted for more than 60 percent of the total estimated soil volume transported from slopes to stream channels by mass movements in areas influenced by management activities.

Although past research indicates that roadbuilding is the dominant management activity accelerating this type of erosion, results of this inventory suggest that timber harvesting and logging activities, exclusive of roads, produce significant increases in slide frequency and volume of transported soil.

HISTORICAL PERSPECTIVE

Potential soil stability problems related to management activities on the Siuslaw National Forest were first identified in the early 1950's. By 1957, when the timber harvesting volumes began to approach the programed allowable harvest level, multiple use plans for the Smith River and Mapleton Ranger Districts explicitly addressed the critical nature of the soil resource and the potential for accelerated erosion by mass movement activity.[2/]

After the two Districts were combined as the Mapleton District (July 1972), several major storms hit the area in the winter of 1973-1974. Numerous soil mass movements were triggered during these storms. A large portion was related to land management activities. A specific road failure which entered a nearby anadromous fisheries stream focused the concerns of the State fisheries agency on the apparent acceleration of soil mass movement activity and the associated impacts to watershed resources.[3/] Subsequent onsite investigation concluded that inadequate road maintenance was the most likely causal factor for this specific event.[4/]

[2/] A chronological summary of events and efforts related to mass soil movement problems is contained in a joint report, "Mass Soil Movement and Stream Damage from Road Construction Activities on the Siuslaw National Forest," by the Oregon Wildlife Commission and Siuslaw National Forest. On file at Forestry Sciences Laboratory, Corvallis.

[3/] Oregon Wildlife Commission Report, Northwest Regional Office, Salem, Oregon, 1974.

[4/] USDA Forest Service Storm Damage Report on Mapleton Ranger District for the 1973-1974 water period. On file at Mapleton Ranger District Office, Siuslaw National Forest, Mapleton, Oregon.

The continuing concerns over forest-wide soil stability problems and adequate road maintenance resulted in development of a number of innovative management tools. Two major examples are the Region 6 USDA Forest Service Fish Habitat Management Policy (FHMP) and the Flood Emergency Road Maintenance Plan (FERM). The Fish Habitat Management Policy establishes specific goals for managing fish habitat. One of these is to protect the existing habitat from degradation. An interim directive[5/] provided for the identification of high risk mass soil movement areas in terms of potential fisheries habitat damage. The FERM plan stresses various alert levels dependent on rainfall volume and intensity. This plan mobilizes personnel and heavy equipment in order to minimize, control, clean up, and document storm damage along District roads.

During the same time period that the FHMP and FERM plan were being developed, the Siuslaw National Forest initiated a forest-wide resource inventory process in preparation for timber management and land use planning. The Soil Resource Inventory (SRI)[6/], one of these planning level inventory tools, identified and mapped major landform units in the District and provided profile characteristics representing the dominant soil that would be found on that landform unit. A special refinement of the SRI included a landslide inventory and the development of relative stability ratings for most of the mapping units.[7/]

During the winter of 1975-1976, another major storm hit the forest. It started on November 29 and ended on December 1. Approximately 7.75 inches of precipitation were recorded at the office of the Mapleton Ranger District as a result of this storm. The most intense rainfall occurred on Sunday, November 30. During a 6-hour period, 3.0 inches of rainfall were recorded.

On Sunday evening, the District Ranger implemented the FERM plan to mobilize personnel and equipment as early as possible the next morning. Within 2 days, an accurate overview of the location and relative magnitude of the major road and in-unit soil mass movements was obtained. Recognizing the opportunity to gain valuable information

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5/ This FHMP interim directive is no longer in effect.

6/ Soil Resource Inventory, Siuslaw National Forest, USFS Pacific Northwest Region, 1974, originally performed by Harold Legard, LeRoy Meyer and George Badura and refined by Donald Boyer. A copy is on file at the Siuslaw National Forest, Corvallis, Oregon.

7/ The SRI Landslide Inventory was performed by Laurence Rich and the landslide risk ratings developed by Donald Boyer, Laurence Rich, and George Badura. Siuslaw National Forest, Corvallis, Oregon.

relating soil mass movements to management activity, District watershed management specialists conducted a comprehensive field inventory of the storm damage. The major objective of the inventory was to define and quantify the nature and magnitude of mass movements resulting from this specific storm event.

From this inventory data, comparisons were drawn between the occurrence and magnitude of mass movements and existing SRI debris avalanche risk ratings, as well as other environmental parameters. Such comparisons and the quantitative information obtained during subsequent field and office investigations are the basis of this study.

METHODOLOGY

The field inventory was performed by two District two-man teams. One team was responsible for checking the north half of the District and the other the south half. Each team carried a District fire map, which was used to indicate completed survey areas, and color aerial photographs (scale 1/15,850) on which to mark the location of individual mass movements. Roads were inventoried by vehicle, and most units were partially walked so that all drainages and headwalls were observed.[8] Approximately 70 percent (144,200 acres) of the District's land area was inventoried. Only mass movements which entered a drainageway and whose volume exceeded 10 cubic yards were counted. Road backslope failures were excluded unless they met the requirements above.

Information on an event was recorded on a standard data sheet (fig. 2). Slides were first placed in one of three major categories: natural, road-related, or in-unit. Natural slides were those events which had no apparent relation to management activity (fig. 3). Road-related failures were those failures which occurred within the road prism or had an obvious connection to the road (fig. 4). Typically, those were from a concentration of drainage water by ditchline and culvert outfalls or by ditchline obstruction. Slides occurring at the edge of landings were considered road related. Those which occurred within the boundaries of clearcut units and had no apparent relation to roads or landings were in-unit slides (fig. 5).

Slope angle was measured at the head of each slide using a clinometer. Aspect of the slope at the site was recorded, using a Silvacompass, as one of eight classes--each containing 45° of azimuth (see fig. 2). Other variables included apparent point of origin on the slope, slide dimensions, and estimated length of stream channel scour. Stream scour was determined through visual estimation and measurement from aerial photographs.

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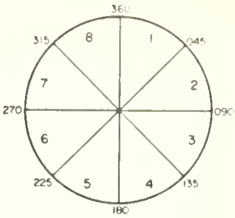
[8] Headwall - the steep, concave slope at the upper end of a drainage formed primarily by debris avalanche processes.

SLIDE DATA SHEET



SLIDE NO.____________________

Type: Debris Slide_________________ Slump/Earthflow____

Soil Type____________________ Slope Angle____________ Aspect__________

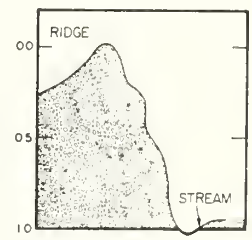
Origin:

Unit Name_________________ Road No.________ Natural

When Cut____________________ When Built_______________ Remarks_____________

Yard Syst.___________________ Sidecast_________ Full Bench_______________

Below Landing____________ Soil Hazard Rating______________



Apparent Point of Origin______________________

Vegetative Cover_____________% Species___________________________________

____

____

Estimated Ft. Channel Scour______________ Jams___________ Remove___________

Likelihood Future Failure____

____

Remarks:____

____

____

____

____

Figure 2.--Landslide data sheet used for slope failure inventory.

Figure 3.--Debris avalanche on an undisturbed slope.

Figure 4.--Debris avalanche resulting from a road prism failure.

Figure 5.--Debris avalanche developed in clearcut units.

Numbers of slope failures and estimated volumes released to the channel by land-use category are shown in figure 6.

Dominant soil at the site where the slide had occurred was determined using Forest Soil Resource Inventory (SRI) descriptions and quadrangle maps. Since the SRI mapping units are not designed to be site-specific in terms of soil type, individual judgment was used to identify the actual soil type at the slide site by comparison with characteristic profiles of the dominant soil type for each mapping unit. These determinations were later field checked by the Siuslaw National Forest soil scientist.

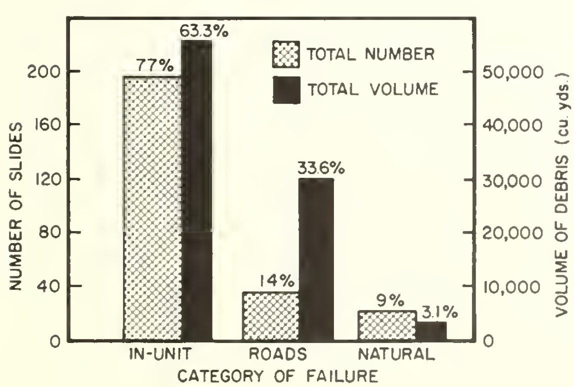


Figure 6.--Graph showing number of slope failures and estimated volumes of debris released by land-use category.

Data Analysis

At completion of the field inventory, data sheets were separated into three categories (natural, road-related, or in-unit landslides) and information transferred to data summary sheets for analysis. The summarized data are reported in tables 1 through 4. Using these data, comparisons were made between number of landslides, category of landslide, and the independent variables:

1. SRI unit
2. Slope steepness
3. Aspect
4. Slope position
5. Time (years since cutting)

Table 1--Characteristics of the 22 inventoried natural failures in terms of Soil Resource Inventory unit, slope and aspect

1. Natural slides as related to site specific SRI mapping units

Unit no.	Number	Percentage
47	6	27
44	7	32
41	9	41

2. Natural slides as related to slope steepness class

Steepness (%)	Number	Percentage
0-59	1	4
60-69	0	0
70-79	4	18
80-89	12	55
90 +	5	23

3. Natural slides as related to slope aspect class

Aspect class	Number	Percentage
NW	5	23
NE	5	23
SW	4	18
SE	8	36

Table 2--Characteristics of the 34 inventoried road-associated failures in terms of Soil Resource Inventory units, slope, aspect, and road drainage

1. Road associated slides as related to SRI unit

Unit no.	Risk class*	Number	Percentage
47	5	13	38
44	4	8	24
41	3	11	32
42	2	1	3
51	4	1	3

*For debris avalanche from road right-of-way.

2. Road associated slides as related to slope steepness

Steepness (%)	Number	Percentage
0-59	1	3
60-69	1	3
70-79	4	12
80-89	19	56
90 +	9	26

3. Road associated slides as related to slope aspect class

Aspect class	Number	Percentage
NW	8	24
NE	14	41
SW	2	6
SE	10	29

4. Road associated slides as related to road drainage (ditchline or culvert outfalls)

Total number of road failures	Drainage related	Percentage
34	16	47

Table 3--Characteristics of the 189 inventoried in-unit failures in terms of Soil Resource Inventory units, slope, clear-cut age, aspect and point of initiation

1. In-unit failures as related to SRI unit

Unit no.	Risk class*	Number	Percentage
47	5	83	44
44	4	54	29
41	4	45	24
42	3	6	3
43	3	1	1

*Risk class for debris avalanches from clearcut harvesting

2. In-unit slides as related to slope steepness class

Steepness (%)	Number	Percentage
0-59	3	1
69-70	5	3
70-79	21	11
80-89	60	32
90 +	101	53

3. In-unit slides as related to time (years) since timber felling

Time (Years)	Number*	Percentage
0-3	120	63
4-10	54	29
11 +	12	1
Age unknown	3	2

*Unit ages for three failures were not found, percentages were based on a total of 189 slides.

4. In-unit failures as related to slope aspect class

Aspect class	Number	Percentage
NW	56	30
NE	65	34
SW	32	17
SE	36	19

5. In-unit slides as related to the upper point of headward slide migration[1]

Upward point class	Number[2]	Percentage
0	40	21
0.5	92	49
1.0	55	29

[1] 0 = ridgetop and 1.0 = bottom of slope

[2] Data for two slides were not obtained.

Table 4--Landslide related impacts[1/] to District streams

1. Stream miles impacted by all categories of soil mass movement

Stream class	Total miles	Impacted miles	Percentage of total
CLASS I	315	240	76
CLASS II	139	23	16
CLASS III	238	14	6

2. Length of stream channel mechanically scoured as related to categories of mass movement

Category	Feet of channel scour	Miles	Percentage
Natural	17,700	3.35	19
Road-associated	26,140	4.95	29
In - unit	47,395	8.98	52
Total	91,236	17.28	

[1/]The impacted segment of a stream is any part of the drainage system which is downstream from the point where material from a mass movement has entered the stream. This is based on the assumption that this material will be transported through the entire downstream drainage. No effort was made to differentiate the degrees of impact throughout individual drainage systems.

This study was not a statistically designed experiment, but simply a case history of the impacts of management-related activites on soil mass movement generation during a single storm event. Within the limitations imposed by access and terrain, all failures occurring as a direct result of the November 29-December 1, 1975 storm were enumerated, thus, we have assumed that the entire population has been measured. The frequencies which are reported are population parameters and any differences which exist in frequencies by class are real differences.

Of the 245 inventoried slope failures resulting from the November 29-December 1, 1975 storms, 22 or approximately 9 percent were natural events with no apparent association with management activity (table 1). In terms of frequency, this is approximately one failure per 6,129 acres (1/6,129) of uncut timber. Thirty-four of the inventoried failures, or approximately 14 percent, were road-associated, occurring within the road prism or directly associated with road drainage (table 2). This is about one failure per 85 acres (1/85) of road right-of-way or one failure per 14 miles of road.[9] The largest number, 189 failures or approximately 77 percent, were in-unit failures having no apparent association with roads or landings (table 3). Most of these occurred within headwall areas or on the mid-slope, in or adjacent to class I streams[10] and incipient drainages loaded with organic debris. The calculated frequency of occurrence for these in-unit failures is one slide per 261 acres (1/261). The differences in frequency between land-use categories are large. There are more failures per given area along road right-of-way than within clearcut units. If, however, the higher frequency for road-related failures is weighted in terms of total area impacted by management (assuming 5 percent of area influenced by road construction and 95 percent of area in clearcut units), the frequency resulting from road impact is reduced to one failure per 1,540 acres (1/1540). This is more than a fivefold increase in failure frequency (5.57) within clearcut units over roads.

A similar analysis by Swanson and Dyrness (1975), based on a 25-year history of landslide activity on the H. J. Andrews Experimental Forest in the western Cascade Range, points out that while roads accelerate debris avalanche erosion to a much greater extent than clearcutting in terms of frequency, rights-of-way cover much less area than do clearcut units. When road and clearcutting are weighted by the area influenced by each activity, the two types of activity contribute about equally to the level of accelerated erosion.

Damage resulting from these mass movement processes was extensive in terms of total stream miles affected, the amount of mechanical scouring occurring within the stream channel, and total volume of soil and debris introduced into the stream (table 4). Of a total of 315 miles of class I stream within the District, 76 percent (240 miles) was

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[9] Road acreage estimates are based on a 50-foot right-of-way width being approximately 6 acres per mile.

[10] Class I - a perennial or intermittent stream or sections thereof having one or more of the following characteristics:

(a) Direct source of water for domestic use (cities, recreation sites)
(b) Used by large numbers of fish for spawning, rearing, or migration
(c) Enough water flow to have a major influence on water quality of a class II stream.

impacted[11] by all categories of slope failure. From the total of 139 miles of class II channel,[12] 16 percent or 23 miles was impacted. Of a total of 238 miles of class III channel,[13] 6 percent or 14 miles was impacted.

Mechanical scouring was the clearest impact to identify and define during the inventory (figure 7). It was possible to correlate scour directly with failure category. Thus, of the total length of channel scour observed (91,236 feet or 17.28 miles), 52 percent (47,395 feet or 8.98 miles) occurred as the result of in-unit failures. Road related failures accounted for 29 percent of about 26,140 feet (4.95 miles) of scour. Natural failures produced 19 percent or 17,700 feet (3.35 miles) of scour. All of these channel scour estimates are conservative.

Differences in volume of debris added to the channel, obtained from estimates of failure dimensions during the inventory, were also large (figure 6), and suggest that in-unit landslides added more debris volume to stream channels than road and natural categories combined. The total estimated volume of all categories was 87,090 cubic yards. Of this total volume, approximately 63.3 percent or 55,100 cubic yards resulted from in-unit failures and 33.6 percent or 29,240 cubic yards from road-related failures. Only a small percentage (3.1 percent or 2,750 cubic yards) was contributed by natural failures, based on a limited sample size.

Of considerable interest is the average volume released per failure in each of the three categories. Natural failures were quite small, averaging only 125 cubic yards per failure. In-unit failures averaged 290 cubic yards per failure or about twice as large as those occurring under natural conditions. Road-related failures, while fewer in number, were by far the largest, averaging 860 cubic yards per failure or about a seven times increase in volume over natural failures.

11/ The impacted segment of a stream is any part of the drainage system which is downstream from the point where material from a mass movement has entered the stream. This is based on the assumption that this material will be transported through the entire downstream drainage. *No effort was made to differentiate the degrees of impact throughout individual drainage systems.*

12/ Class II - a perennial or intermittent stream or sections therefore having one or more of the following characteristics:

(a) Used by moderate though significant numbers of fish for spawning, rearing or migration.

(b) Enough water flow and not clearly identifiable influence on downstream quality of a class I stream, or have a major influence on a class II stream.

13/ Class III - All other perennial streams or segments thereof not meeting higher class criteria.

Figure 7.--Channel scour in a class I stream result from a debris torrent.

It should be pointed out that total slide volume (volume leaving slope + volume entrained in debris torrent) was not estimated. Therefore, these volumes are extremely conservative in describing the total slide erosion volume which occurred.

Natural failures as a result of this storm appear to be of minor importance in terms of numbers of occurrence, frequency, and amount of channel damage. Total numbers, size, and frequency of occurrence were all low compared to management-related events. Caution must be taken in interpreting these data, however, since emphasis was placed on management-related occurrences, all of which can be easily identified and described. All observable natural events were recorded; but an unknown number, occurring at inaccessible sites or too small to see under heavy forest cover, were missed.

The number of road-associated failures is low compared to data reported elsewhere in the Pacific Northwest. Dyrness (1967), investigating accelerated soil mass movements on the west flank of the Cascade Ranges following heavy rains in the winter of 1964-1965, found 65 percent directly associated with roadbuilding. In Idaho, Megahan and Kidd (1972) reported 90 percent of the soil mass movements which occurred along the south fork of the Salmon River during a storm in April 1965, resulted from failures along the logging road right-of-way. Recent studies of accumulated landslide activity related to timber harvesting in the Pacific Northwest over extended periods of time (Fiksdal 1974, Morrison 1975, Swanson and Dyrness 1975) reported 70 percent of all landslides generated were related to road rights-of-way. In all cases, the greatest number of these resulted from road-fill failures. The low frequency of road related events on the Mapleton District may be directly related to the implementation of the District FERM plan and improved road design and construction techniques. The principal intent of the plan was to reduce road failures by having personnel patrol roads and clean culverts to prevent ponding and damming of water during storms.

The greatest amount of landslide activity and resultant watershed damage was produced from failures occurring within clearcut units unassociated with roads. This strongly emphasizes the importance of logging operations, exclusive of associated activities, as a generator of accelerated soil mass movements on steep, forested slopes. Bishop and Stevens (1964) working in southeast Alaska demonstrated a direct correlation between timber harvesting and accelerated soil mass movements following heavy rains in the fall of 1961. They report an increase in landslide frequency of 4-1/2 times following clearcut logging exclusive of roads. Croft and Adams (1950), reporting on landslide increases following timber harvesting in the Wasatch Mountains of Utah, attribute accelerated landslide activity chiefly to timber cutting and burning.

Dominant soil characteristics, slope dissection, slope steepness, and aspect exerted significant control on debris avalanche occurrence during the storm. There is a strong relationship between landslide frequency and SRI units with more than 96 percent of inventoried failures occurring within the group of "high risk" units (units 41, 44, and 47). All three types have dominant soils derived from residuum and colluvium over micaceous sandstone.[14/]

The dominant soils in each category possess surface soils which are characteristically thin, gravelly, sandy loams to loams. Subsoils are thin loams and gravelly loams with a depth to bedrock of less than 3 feet. All occur on slopes between 50 to 90 percent. Unit 41 soils typically contain more clay. Unit 47 soils typically contain more cobbles. All three types are similar in engineering properties, being essentially nonplastic, inorganic silts with some sand and gravel. Maximum bulk densities are low. Such soils possess little cohesion when saturated and a low enough permeability so that they may be susceptible to rapid increases in pore-water pressure during major storms due to the presence of excess water. Under these conditions, the coefficient of friction may be reduced from a range of 27-30° to a range of 20-22°, greatly reducing resistance to shear of the soil (Terzaghi and Peck, p. 86, 1960).

Despite the similarity in physical properties and slope occurrence of dominant soils in the "high risk" category, a large difference is also indicated for the frequency of occurrence of in-unit failures on each of these units (fig. 8). These differences are probably due to degree of dissection of the slope.

Based on SRI unit characteristics, unit 41 slopes are smooth to moderately dissected. Unit 44 slopes are moderately to highly dissected, and unit 47 slopes are highly to extremely dissected. For purposes of this analysis, degree of dissection is defined in table 5.

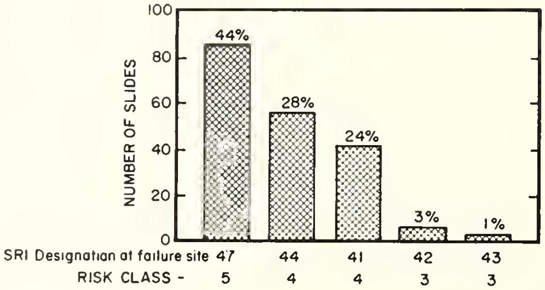

Figure 8.--Number of in-unit slides versus SRI mapping unit. Risk class 4 at 24 percent is considered a 3 on a forest-wide basis, however, Mapleton Ranger District considers it risk class 4.

14/ Soil Resource Inventory, Siuslaw National Forest, basic soil information and interpretive tables. USDA Forest Service Pacific Northwest Region, 1974, copy on file at the Siuslaw National Forest office, Corvallis, Oregon.

Table 5--Table of dissection criteria used by field personnel of the Siuslaw National Forest

Dissection	Centerline spacing between drainages (feet)
Extreme	400
High	400 - 700
Moderate	700

The largest number of failures in clearcut units occurred within SRI unit 47 (83 out of 189 or 44 percent). This is probably because of the larger number of potential failure sites along existing drainages and incipient channels on these highly to extremely dissected slopes. SRI unit 44 accounted for 54 in-unit failures or about 28 percent, and SRI unit 41 produced 46 or about 24 percent. SRI units 41 and 44 exhibit similar degrees of relative landslide activity, probably due to the dominance of moderate dissection for both these units. This suggests that dissection exerts a strong degree of control on landslide occurrence for clearcut slopes.

Slope steepness is also an important factor in landslide generation with 95 percent of all inventoried failures occurring on slopes greater than 70 percent (31.5 degrees). For natural and road-related failures, the greatest number occurred on greater than 80-percent (36 degrees) slopes (77 percent of natural failures and 81 percent of road-related failures). The greatest number of in-unit failures occurred on slopes above 90 percent (40.5 degrees, approximately 53 percent of all failures). This corresponds to about the upper limit of the angle of internal friction for inorganic silts in the absence of water. In the presence of saturated conditions, slopes above this 70-percent gradient can be expected to be in a highly unstable state.

Similar distributions of slope failure gradient have been reported for other areas. Dyrness (1967) reports the greatest number of debris avalanches occurring on slopes above 22.5° (50 percent) following logging and burning on the H. J. Andrews Experimental Forest, western Cascade Range of Oregon. Bishop and Stevens (1964), after measuring and profiling 15 debris avalanches in clearcut units following a major storm in southeast Alaska, report a minimum angle of release of 31° (70 percent) with a mean of all slides of 39° (87 percent). O'Loughlin after a study of 77 debris avalanches in the Coastal Mountains of British Columbia reported a minimum angle of release of 30° (67 percent) with a mean of 36° (80 percent).[15/]

Aspect or exposure was the least important common factor in landslide generation during the November 30 storm. Natural landslides were nearly equally distributed on northerly and southerly slopes, although the small sample size limits the reliability of this observation. For the occurrence of management-generated failures, however, there is a strong relationship to aspect class. Approximately 64 percent of road-related and in-unit failure occurred on northerly aspects. The higher frequency of landslides on north slopes is probably directly correlated with local structure. Parent material and structure have been identified repeatedly in the literature as exerting a controlling influence on the type and frequency of soil mass movements on steep, forested slopes (Swanston 1967 and 1971, Dyrness 1967, Megahan 1975, Fredriksen and Ross 1975, Swanston and Swanson 1976). Under a given set of climatic conditions, parent material controls depth, degree of weathering, and weathering products. Structure (bedding, faulting, fracturing, jointing) determines location and distribution of potential failure surfaces, and dictates movement and distribution of subsurface water. The topography of the Mapleton District is characterized by east-west trending, narrow ridges separated by deeply incised drainages. These ridges are developed in massive to thinly bedded sandstones and siltstones striking northwest and dipping gently to the southwest.

Well developed north-trending jointing is superimposed on this basic structure. The slopes are steeper on the north aspect with the gradient apparently controlled by this jointing.

Slope position for in-unit failures appears to exert a considerable influence on landslide occurrence with 78 percent of the inventoried failures located on the mid-slope or at stream-adjacent sites (fig. 9).[16/]

Of the failures inventoried, 92 or about 49 percent occurred in the mid-slope position within incipient drainages where ground water movement from the upper slopes probably produced saturated or near saturated conditions in the soil mantle. Fifty-five or approximately 29 percent occurred at the bottom of the slope adjacent to stream channels and were

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[15/] Colin Lockhard O'Loughlin, 1972. An investigation of the stability of the steepland forest soils in the Coast Mountains, Southwest British Columbia, 147 p., Ph.D. thesis on file, Faculty of Forestry, the University of British Columbia, Canada.

[16/] Slope position as reported here refers to the position on the slope between the ridgetop and the first intersected drainage. This may be a class I, class II, or class III drainage (see footnotes 10, 12, and 13).

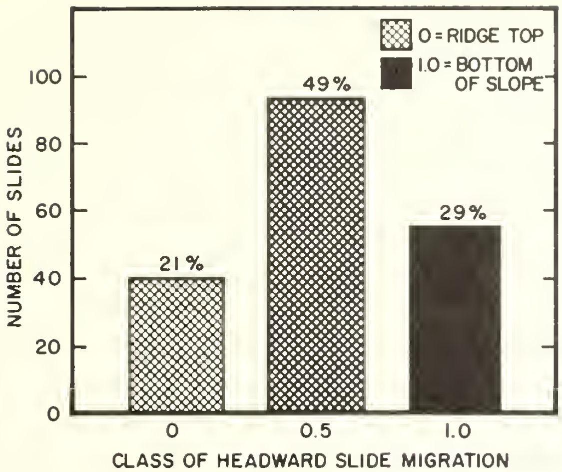

Figure 9.--Number of in-unit slides versus slope position.

probably initiated by lateral cutting along channel banks by storm flow. The remaining 40, or about 21 percent, occurred near the ridgetop in exceptionally steep slope positions.

Time since timber felling also exerted a significant control on number and frequency of in-unit slope failures (fig. 10). Of the 189 inventoried failures in this category, 120, or 63 percent, occurred on clearcut units harvested within the 3 years preceding the storm. Fifty-four failures, or 29 percent, occurred in units cut less than 10 years prior to the storm. Only 12, or about 1 percent of the total, occurred in clearcut units older than 11 years, strongly emphasizing the importance of timber cover on the relative stability of these potentially unstable slopes.

The principal impacts of forest removal by clearcutting are to reduce rooting strength and to alter the hydraulic regime at the site. Swanston (1974) describes the mechanical support provided by vegetation roots as a dominant factor in

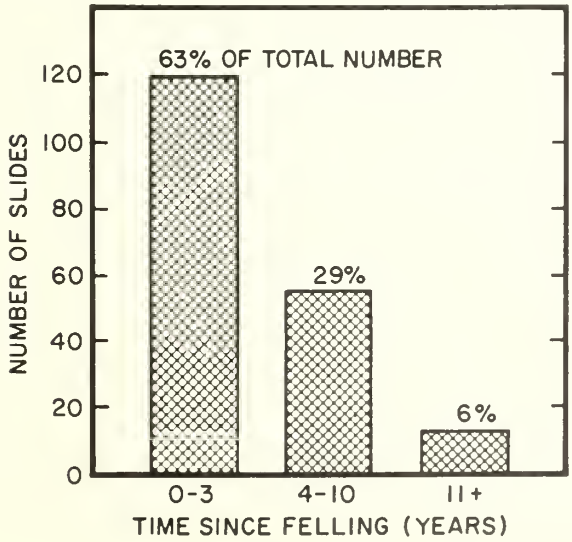

Figure 10.--Incidence of in-unit slides as related to time since timber felling. Age was indeterminant for three clearcut areas accounting for 2 percent of total.

maintaining the shear strength of many steep-slope forest soils in western North America. In Japan, Kitamura and Namba (1966 and 1968) describe a period of greatly reduced soil strength attributable to root decay beginning about 3 years following cutting and attaining a minimum strength 15 years after harvest. Bishop and Stevens (1964) reported a 3- to 5-year lag between clearcutting and accelerated slope failure rates in southeast Alaska. From strength tests on roots taken from clearcut units of various ages in this region (Ziemer and Swanston 1977) a decrease of more than one-half in Sitka spruce and one-third in western hemlock root strength was demonstrated in the first 2 years after cutting. O'Loughlin, after approximately 200 tests of strength loss in roots from Southwest British Columbia, concluded that Douglas-fir roots lose more than half their strength in the first 3 years following clearcutting (see footnote 15).

The hydrologic impacts of timber removal include modification of annual soil-water status and changes in peaks of soil water held in detention storage during periods of storm runoff (Swanston and Swanson 1976). Increases in soil water during storms (due to timber removal) can generate active pore-water pressures, triggering shallow debris avalanches and debris torrents. Reduced evapotranspiration results in soil water status remaining at higher levels for longer periods of time resulting in more rapid saturation and active pore-water pressure development during storms. Timber removal may also increase peaks of soil water by accelerated snowmelt during warm-rain-on-snow conditions (Anderson 1969).

CONCLUSIONS

Timber management activities have clearly accelerated the number and frequency of soil mass movements on the Mapleton District, Siuslaw National Forest, as the result of the November 29-December 1, 1975 storm. Clearcut harvesting, exclusive of roads, stands out as the most damaging activity with over three-fourths of the generated failures and about two-thirds of the released volume of debris occurring as a result of this activity. Less than one-fifth of the storm-generated failures occurred within the road rights-of-way and they produced only one-third of the total volume of debris. The impact of forest roads relative to clearcuts is considerably smaller than reported elsewhere, suggesting that the special efforts made by District personnel in overall improved road location, design, construction practices, and maintenance of drainages and culverts during the storm had a substantial effect on reducing road-generated failures. Although the number of failures and total volume of debris produced was significantly lower from road rights-of-way, the average volume per slide was approximately seven times that of natural failures and approximately two times that of in-unit failures. This strongly emphasizes the potential for maximum damage from road-related failures if adequate design and maintenance are not continued.

Slope gradient, SRI units, and aspect exerted a strong influence on occurrence of the slope failures generated during the November 29-December 1 storm. Most of the failures occurred on high risk SRI units 41, 44, and 47. Major differences in failure were noted between units. Of these three, unit 47 accounted for more than one-half of all failures with the rest distributed between units 41 and 44. SRI unit 47 has the highest degree of dissection and highest slide frequency, perhaps because degree of dissection determines the number of locations at which failures can occur.

Most of the failures inventoried occurred on slopes greater than 70 percent (31.5 degrees). Slopes of this gradient are near their maximum angle of natural stability and are highly susceptible to any activities which may reduce their strength-stress ratios.

North facing slopes had the largest number of failures, particularly for the in-unit category. Too few inventory samples of natural failures were obtained to develop this relationship. Roads tended to mask the aspect relationship because of the dominating influence of road drainage on slide generation.

In-unit failures were strongly influenced by both position on the slope and time since cutting. Almost one-half of all the in-unit failures occurred at the midslope position, from one-third to two-thirds of the way between the ridgetop and the first intersected drainage. Such a position allowed for maximum development of saturated soil conditions due to upper slope drainage. Almost one-third of the in-unit failures occurred at sites adjacent to streams and were probably initiated by undercutting of slopes during stormflow or debris torrent activity. The remaining failures occurred near the ridgetop and may have developed on exceptionally steep faces, triggered by excess water from local spring flow.

Almost two-thirds of all in-unit failures occurred in clearcuts harvested less than 4 years before the storm. Most of the remaining failures occurred in units cut less than 11 years before the storm. The dominance of failures in the 0- to 3-year bracket suggests that removal of timber canopy and deterioration of root systems may exert a substantial effect on landslide generation on this potentially unstable ground.

Benefits to Ongoing Management Programs

Information from this inventory provided input to both short- and long-range management decisionmaking. Perhaps most importantly, it provided the District Ranger and his staff with a quantitative overview of mass movement activity on the District. The inventory related soil mass movements to: location (both geographically and topographically), general management categories (roads or clearcuts), impacts to resources (frequency and volumes as related to soils and stream systems), and to winter storms with a return frequency of about 1 in 10 years. By defining landsliding on a District-wide basis, efforts have been more effectively focused toward short- and long-range problem solving. Immediate changes in timber sale planning efforts are a short term response. More time and effort during sale planning has been focused upon location of potential "high risk" landslide areas. On a regular basis, protective or mitigative management prescriptions are now routinely applied. This most commonly involves vegetative leave areas on high risk headwalls and slopes adjacent to streams.

The inventory provided significant immediate benefits by locating where landsliding had occurred. Using mapping done during the inventory, the District was able to quickly formulate a very comprehensive request for road repair ERFO (Emergency Repair Federal Other) and Emergency Flood Rehabilitation, Section 216 funds. This mapping located potential sites for future flood damage and made project reconnaissance much more efficient. Ultimately, more than $260,000 was received for rehabilitation work. Without such an inventory, this comprehensive work would not have been possible in the time allotted.

The information derived gave very positive, quantitative indications about the efficiency of various road location, design, and construction techniques presently being employed on the District. It also pointed to the importance of road maintenance, particularly road drainage, in controlling road-related slope failures.

The inventory also served to substantiate and further define the risk ratings given to various mapping units under the FSRI. Such information made the relative risk ratings much more of a quantitative and understandable measure for District personnel.

Longer term benefits, resulting from the inventory, included quantitative inputs into ongoing timber management and land use planning and identification and prioritizing of research needs regarding landsliding and soil stability and impacts to other resources, particularly water and fisheries.

Economic Analysis and Future Application

This field inventory approach presents land managers with a reliable tool for gathering quantitative data on mass movements. The total cost of the inventory was about $5,300. Table 6 shows the breakdown of these costs.

Personnel costs accounted for 77 percent of the total cost. These costs were held down by using Comprehensive Employment and Training Act employees as assistants. Vehicle and photographic costs accounted for the remaining 23 percent

Table 6--Component breakdown of inventory costs

	Man days	Cost	% of total
1. Personnel costs (total)	110	$4,100	77
a. Field inventory Two (2-man) teams [1/]	(100)	(2,900)	(55)
b. Data analysis and compilation	(10)	(1,200)	(22)
2. Transportation			
(Two 1/2-ton pickups)		950	18
3. Photography		250	5
Total cost		$5,300	100

[1/] Teams composed of (GS-9) Forester, (GS-7) Fishery Biologist, two Comprehensive Training Act employees.

of the total. About 70 percent of the area of the Mapleton Ranger District, or 140,000 acres, was inventoried. The information gathering costs averaged about 4 cents per acre for the total inventory area. Much more complete reconnaissance, however, occurred along roads and in clearcut units. These areas totaled about 33,500 acres. The cost, considering only these areas, was 16 cents per acre. These costs likely compare very favorably with other field inventory procedures. Stand examinations presently cost an average of $3.00-$6.00 per acre on the District. Limited stream survey work presently averages $35-45 per acre.

With increased emphasis on project and program evaluation in the Forest Service, this type of inventory process to evaluate soil stability conditions appears readily adaptable to ongoing land management programs. The application is flexible to both manpower and funding limitations.

Given basic training in landslide identification and in information gathering required by the inventory form (see fig. 2), a wide variety of personnel could be used to perform such an inventory. They need not be soil scientists. They need only be able to recognize a landslide, to perform some basic measurements and observations, and to record information on a data form. The inventory, as reported in this paper, if performed by two GS-5 Foresters, two Comprehensive Employment and Training Act (CETA) employees, and a GS-9 Soil Scientist or Geologist for training and data analysis could have been performed for a cost of about $4,000.

Another means of adapting this inventory process to funding and manpower limitations is to accomplish it yearly but on a reduced scale. For example, the Mapleton Ranger District could be divided into three inventory areas. Each year, one of the areas would be inventoried so that every 3 years a District inventory is completed. Although such a method would not be sensitive to individual storm events, it would provide continuous information feedback to the land manager regarding landsliding. Such information should indicate changes in total numbers, frequency, locations, etc., of landslides as improved management techniques (road location and construction, timber sale layout and harvesting) are implemented. Over time, such an ongoing inventory program should even allow for objective comparison of various management prescriptions and the ultimate selection of the most efficient prescription in terms of limiting the occurrence and magnitude of landsliding.

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RESOURCE BULLETIN PNW-85
AUGUST 1979

Pacific Northwest Forest and
Range Experiment Station
U.S. Department of Agriculture
Forest Service

WESTERN REDCEDAR - A FOREST RESOURCE IN TRANSITION

by Charles L. Bolsinger

CONTENTS

WESTERN REDCEDAR—A FOREST RESOURCE IN TRANSITION

Reference Abstract

Bolsinger, Charles L.
1979. Western redcedar--a forest resource in transition. USDA For. Serv. Resour. Bull. PNW-85, 24 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Available information on inventory, growth, price, and consumption trends for western redcedar in Western United States is compiled. The future of western redcedar as a product resource and component of the forest is discussed.

KEYWORDS: Western redcedar, Pacific Northwest forest resources, timber supply, shake and shingle industry, forest statistics.

RESEARCH SUMMARY
Resource Bulletin PNW-85
1979

The prices and consumption rate of western redcedar products have increased more rapidly than most other west coast woods. Long important to the Northwest's timber economy, western redcedar is currently being used more rapidly than it is being replaced in the forests, especially in Washington and Oregon. Most products are currently manufactured from old-growth cedar; and in Washington, which contains about 40 percent of the resource, old-growth cedar will soon become scarce on lands outside National Forests. The shake and shingle industry, which consumes about 38 percent of the total cedar harvested in all States and 45 percent of the cedar harvested in Washington, depends almost entirely on old-growth cedar and will be forced to curtail production before most other cedar-using industries. Although young-growth cedar is suitable for some products, the total amount of cedar that will be available in the future is expected to be considerably less than is now

being consumed. Very little cedar is being planted, although some cedar is naturally restocking logged areas. Most forest managers are featuring other species in timber management plans. The species is not threatened or endangered, however, and has several traits that could be used by resource managers--its ability to grow on very moist soils and under tree or brush canopy, for example.

Relocation of cedar processing facilities and reduction of output are likely in the near future, especially in western Washington and Oregon. The depletion rate in other States is negligible. British Columbia's tremendous inventory of redcedar--three and a half times the volume in the United States--assures that high quality old-growth cedar will not soon disappear. It remains to be seen how much will be available for industrial use and consumption in the United States.

SOURCE OF INFORMATION

Information in this publication was compiled from various sources. Published references are listed on page 21. Timber inventory and growth data were obtained from Resources Evaluation offices in Anchorage, Alaska; Ogden, Utah; and Portland, Oregon. Inventory volume of live redcedar in western Washington was updated to 1977 by the author using growth factors and reported harvest of live redcedar since the field data were collected in 1963 to 1967. Other information from unpublished sources was compiled by the author and is filed at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon. Some of the background information is based on the author's experience and conversations and suggestions from scientists, retailers, mill operators, nursery managers, foresters, loggers, and representatives of companies and industrial associations. Special thanks for information and/or helpful suggestions are due to:

Alan Green, Intermountain For. and Range Exp. Stn, Ogden, Utah
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Charles McKetta, Univ. of Idaho, Moscow, Idaho
Rex Johnson, Idaho State Dep. of Lands, Coeur d'Alene, Idaho
V. G. Peterson, Red Cedar and Handsplit Shake Bureau, Bellevue, Washington
John Harris, Canadian For. Prod. Ltd., Vancouver, B. C.
Michael Sullivan, Industrial Forestry Assoc., Portland, Oreg.
Frank Ter Bush, Region 6, USDA For. Serv., Portland, Oreg.
Lee Winner, USDI Bureau of Indian Affairs, Portland, Oreg.
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Loren Gee, Washington State Dep. of Natural Resources, Olympia, Washington
Gary Morishima, Quinault Indian Nation, Taholah, Washington.

INTRODUCTION

Western redcedar (*Thuja plicata* Donn) is a major tree species in the forests of Northwestern North America. Its range extends from southeastern Alaska to northwestern California and inland to Idaho, Montana, and eastern British Columbia. It rarely occurs in extensive pure stands but is commonly associated with several other tree species. In Pacific coast forests it grows with Douglas-fir, western hemlock, Sitka spruce, Pacific silver and noble firs, and red alder, to name a few. In the Rocky Mountains it is usually found with western white pine, western larch, grand fir, western hemlock, Douglas-fir, and Engelmann spruce (USDA Forest Service 1965).

Forest inventory data show that cedar tends to grow slowly--trees are smaller in diameter and shorter than Douglas-fir and hemlock trees of the same age in young-growth stands on most sites. On some moist sites, however, redcedar is capable of growing more rapidly than other conifers, and it can survive in areas that are too wet for most species.

Western redcedar is highly resistant to tree-killing diseases and has the ability to recover from severe damage by many agents. So, despite the species slow growth, it can live several hundred years and attain large sizes.

Demand for western redcedar products has increased rapidly over the past 10 years. Consumption rate and prices of cedar have risen more sharply than for other northwestern woods. As the quantity of cedar consumed has increased, many people have begun to wonder about the future of the resource. Cedar product manufacturers, resource managers, planners, and legislators have been examining the cedar situation. They are asking questions like: Can the supply keep up with the demand? What are the trends in various cedar products? How long will cedar last at the present consumption rate--especially high quality old-growth cedar? Can production be increased? Is the species being replenished in the forests? Should cedar allocation policies be altered? Is the species threatened or endangered?

This study was done to provide decisionmakers with information on the western redcedar resource. Included are statistics on consumption, prices, forest inventory, growth rates, and a discussion of western redcedar's future.

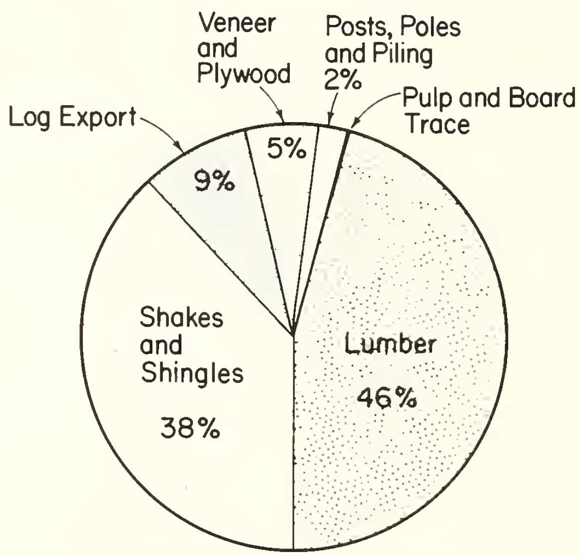


Figure 1.--Distribution of western redcedar timber harvested in the United States in 1976 by product.

How Is Western Redcedar Used?

Western redcedar is used in a variety of products, including shakes and shingles, siding, poles and posts, fence material, casket stock, outdoor furniture, paneling, and many specialty items.

Lumber production ranks first in total consumption of cedar in all Western States, and shake and shingle production ranks a close second (fig. 1). These two broad product categories accounted for 84 percent of the redcedar processed by mills in 1976. Lumber accounted for over 70 percent of the cedar processed in Montana and Oregon (table 1) and 65 percent in Idaho.[1]

[1] Based on reported lumber production for Idaho and derived total cedar production using total U.S. shake and shingle production, National Forest timber sale data, and product conversion factors.

Table 1--Volume and percent of western redcedar logs processed by forest industries in Oregon, Washington, and Montana, by industry category in 1976[1/]

Industry category	Oregon		Washington		Montana	
	Thousand board feet[2/]	Percent	Thousand board feet[2/]	Percent	Thousand board feet[2/]	Percent
Lumber	122,136	72	194,204	31	9,837	74
Veneer and plywood	6,766	4	48,953	8	0	0
Pulp and board	0	0	400	trace	0	0
Shake and shingle	36,116	21	286,092	45	[3/]3,420	25
Export	4,763	3	91,683	14	0	0
Pole, post, piling	614	trace	15,388	2	106	1
All industry categories	170,395	100	636,720	100	13,363	100

Sources: Bergvall, Bullington, and Gee (1977), Howard and Hiserote (1978). Data on file at the Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

[1/]Data not available for Alaska, Idaho, and California.

[2/]Scribner log scale.

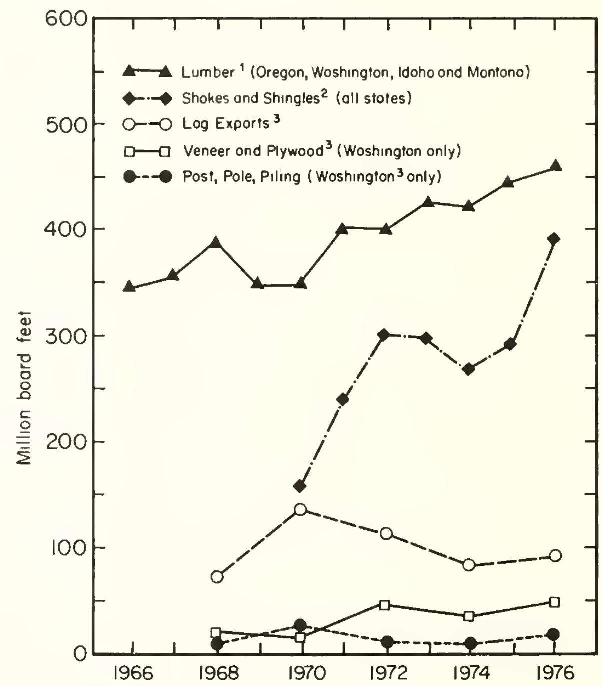
[3/]Includes house logs and specialty items.

In Washington the picture changes: Shakes and shingles ranked first, amounting to 45 percent of total production; lumber accounted for 31 percent. Northwestern Washington has the greatest concentration of cedar shake and shingle producers, located near sources of high-quality old-growth timber. Log exports from Washington and Oregon accounted for 9 percent of the total cedar harvested in all States. Most of the redcedar harvested in Alaska--less than 2 percent of total harvested in the United States--was shipped in the form of logs to Oregon and Washington. It is not considered export. Veneer and plywood, posts, poles and piling, and pulp and board production amounted to about 7 percent of the total cedar processed. Most of this was in Washington.

What Are The Production Trends Of Various Redcedar Products?

Shake and shingle production has increased more rapidly than production of other cedar products. In 1976, 3.9 million squares were produced in the United States, a 160-percent increase from 1970. Cedar lumber production in Oregon, Washington, Idaho, and Montana increased from 415 million board feet in 1970 to 552 million board feet in 1976, about 33 percent (fig. 2). The increase in lumber production for all species in these States was only 9 percent (fig. 3).2/ Cedar log exports have fluctuated considerably; in 1976 they were 32 percent lower than in 1970 and 10 percent higher than in 1974.

The production of western redcedar veneer and plywood has increased modestly, but amounts to a relatively insignificant part of the total cedar consumption.



[1] Lumber tally converted to log scale 1.2-board foot lumber tally = 1 board foot, Scribner scale

[2] Production reported in squares, converted to board feet 10 squares = 1,000 board feet.

[3] Log consumption as reported, Scribner scale

Figure 2.--Western redcedar production trends by product category.

In Washington, the 1976 production of redcedar posts, poles, and piling was down from 1970. Production trends are not available for cedar posts, poles, and piling in Idaho and Montana; production is thought to be increasing.

2/ Because 1970 was a year of low construction activity, the absolute magnitude of these changes may be exaggerated. Comparison of change by species is considered valid.

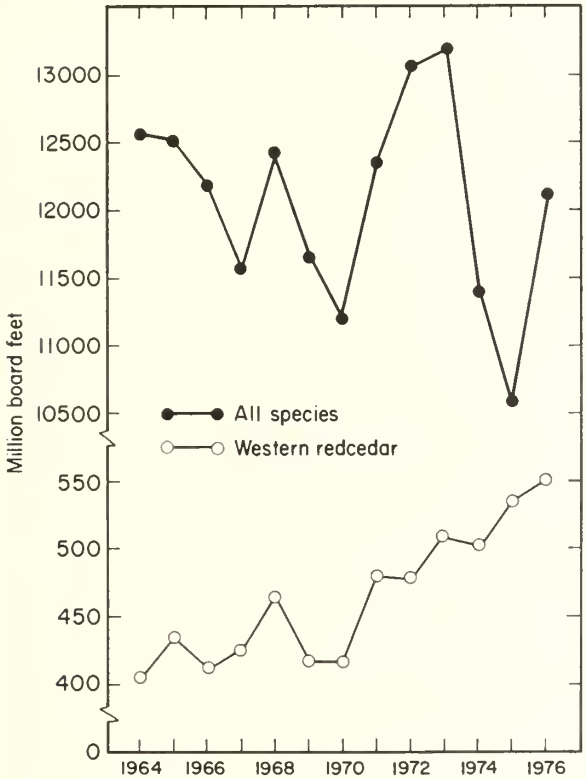


Figure 3.--Lumber production in Idaho, Montana, Oregon, and Washington, 1964-1976--all species and western redcedar.

Have Redcedar Prices Increased More Rapidly Than Prices Of Other Species?

In 1977 the average price paid for all sales of western redcedar logs in western Washington and northwest Oregon was $320.80 per thousand board feet compared with $57.30 in 1965. The average annual increase over that period was 15 percent. Douglas-fir and hemlock saw-log prices increased by 12 percent during the same period. Western redcedar prices have increased even more rapidly than other species recently as shown in the following tabulation (Ruderman 1978):

Species	Average annual price increase for all log sales 1975-77
	Percent
Western redcedar	35
Sitka spruce	29
White fir	11
Western hemlock	13
Douglas-fir saw logs	20
Douglas-fir peeler logs	8

Stumpage prices for timber sold on National Forests in Idaho and Montana have also increased more rapidly for western redcedar than for most other species. The average annual increase in western redcedar prices 1965 to 1977 (from $10.10 per thousand board feet to $72) was slightly higher than the average annual price increase for all species (from $9 to $53.20).

Prices for western redcedar logs for export are currently higher than for logs purchased for domestic use. In 1977 the average price for domestic logs was $301.10 per thousand board feet, compared with $418.70 for export logs (Ruderman 1978). Since 1970, the difference between domestic log prices and export log prices has narrowed for most log grades (fig. 4).

Figure 4.--Average annual rate of price increase of western redcedar logs in western Washington and northwest Oregon for domestic and export sales, by log grade, 1970 to first half of 1978.

How Much Western Redcedar Timber Is There?

The total estimated volume of western redcedar in the United States in live trees that are at least 25 percent sound is 34 billion board feet (Scribner log rule) and 9 billion cubic feet (see tables 2 and 3). British Columbia has over 120 billion board feet, 3½ times the volume in the States (British Columbia Forest Service 1972). Nearly 40 percent of the western redcedar in the United States is in Washington. Idaho ranks second with 23 percent; Alaska is third with 19 percent; and Oregon is fourth with 15 percent. Montana has 4 percent and California has a trace (see fig. 5 and tables 2 and 3).

The greatest concentration of western redcedar in the United States is on Washington's Olympic Peninsula in Clallam, Grays Harbor, and Jefferson Counties. In 1966 these three counties contained about 6 billion board feet of live redcedar, one-fourth of the total in Oregon and Washington. The net effect of timber harvesting and growth reduced the cedar sawtimber inventory in these counties to about 3.4 billion board feet by 1977.

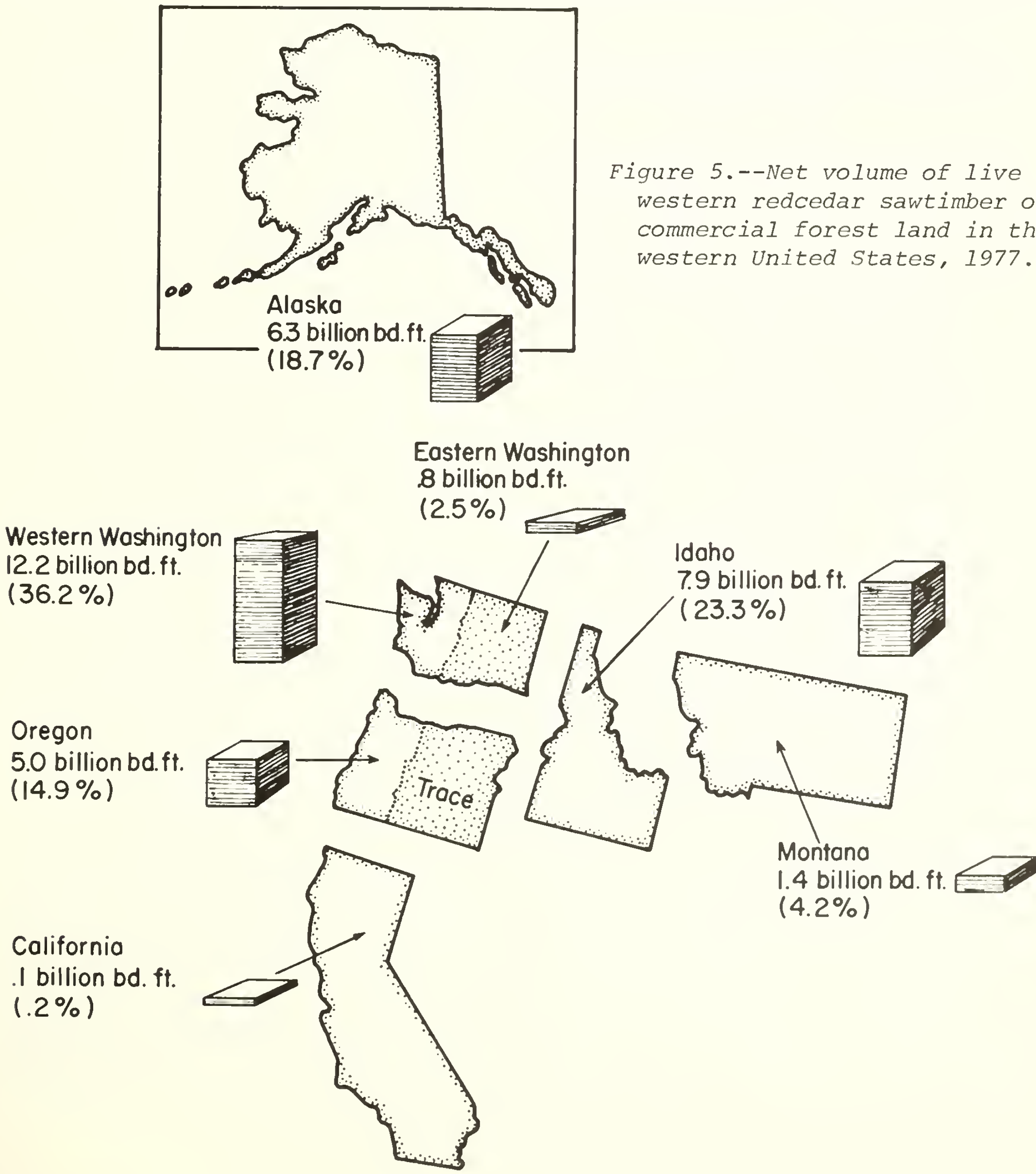


Figure 5.--Net volume of live western redcedar sawtimber on commercial forest land in the western United States, 1977.

Table 2--Net volume of live western redcedar sawtimber on commercial forest land in the United States, by State or half-State and ownership, 1977

State or half-State	National Forest	Other public	Private	All ownerships
	- - - - - Million board feet (Scribner rule) - - - - - -			
Western Washington	5,673	2,418	4,111	12,202
Eastern Washington	412	157	277	846
Total Washington	6,085	2,575	4,388	13,048
Western Oregon	2,427	828	1,739	4,994
Eastern Oregon	20	14	0	34
Total Oregon	2,447	842	1,739	5,028
Alaska	5,926	322	76	6,324
Idaho	4,760	1/3,092		7,852
Montana	1,210	1/208		1,418
California	32	2/	44	76
All States	20,460	1/13,286		33,746

1/Other public and private combined.

2/Less than 0.5 million board feet.

What About Salvable Dead Cedar?

Because of the durability of western redcedar heartwood, trees that have been dead for many years--even many decades--generally contain usable wood. A substantial portion of the cedar used in shakes and shingles is from dead trees, down logs, and broken pieces. In western Washington, the estimated volume of usable wood in dead cedar trees that are at least 25 percent sound is 1.2 billion board feet. This is about 10 percent of the volume in live cedar in western Washington,

Table 3--Net volume of western redcedar growing stock on commercial forest land in the United States, by State or half-State and ownership, 1977

State or half-State	National Forest	Other public	Private	All ownerships
	Million cubic feet			
Western Washington	1,053	844	1,438	3,335
Eastern Washington	93	49	88	230
Total Washington	1,146	893	1,526	3,565
Western Oregon	598	188	451	1,237
Eastern Oregon	4	3	1/	7
Total Oregon	602	191	451	1,244
Alaska	1,517	83	19	1,619
Idaho	1,135	2/872		2,007
Montana	233	2/66		299
California	7	1/	11	18
All States	4,640	2/4,112		8,752

1/Less than 0.5 million cubic feet.

2/Other public and private combined.

enough material to supply the State's shake and shingle mills for about 4 years if it all could be recovered. The amount of usuable western redcedar wood in trees that are less than 25 percent sound and in broken chunks and pieces has not been determined but is substantial in some areas. Howard (1973) found that residue in clearcut cedar stands averaged 3,400 cubic feet per acre, including 668 cubic feet in pieces greater than 36 inches in diameter. Cedar "residue" from stands logged during the past several years is being salvaged on a regular basis.

Cedar cutters, working with chain saws, splitting wedges, mallets, and froes, can use pieces of a variety of sizes and shapes so long as they will produce 24-inch-long shake boards or blocks.

Who Owns The Western Redcedar Resource?

Three-fifths of the total sawtimber volume of redcedar is in National Forests. In Oregon and western Washington, however, National Forests contain less than half of the cedar volume. In Oregon, 17 percent is on State and Bureau of Land Management lands, and 35 percent is on private lands. In western Washington, 20 percent is on State and Indian lands, and 34 percent is on private lands (tables 2 and 3). About 56 percent of Idaho's and 78 percent of Montana's cedar is in National Forests. Details are not available on the ownership of cedar outside National Forests in Idaho and Montana. Most of the western redcedar in Alaska is in the Tongass National Forest.

What Are The Quality And Size Characteristics Of The Cedar Resource?

Although western redcedar heartwood is resistant to decay, living trees are susceptible to attack by a number of wood-rotting fungi.[3] Root, butt, and trunk rots cause considerable cull and make trees vulnerable to windthrow and breakage. Fungi attack cedar trees of all ages, but their impact increases with the age of trees. Buckland (1946) found that 30 percent of 100-year-old cedar trees in coastal British Columbia were infected with wood-rotting fungi; 60 percent of 200-year-old trees were infected; and 85 percent of 300-year-old trees were infected. In general, decay is more prevalent in the interior than in the coastal areas. Buckland found that 90 percent of the 200-year-old trees in the interior were infected with decay, compared with 60 percent in coastal areas. Kimmey (1956) related board-foot cull to tree diameter in western redcedar in Alaska. For trees with no visible cull indicators, he found that cull

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[3] For a discussion of the fungi that attack western redcedar, see Hepting 1972, p. 480-484.

ranged from about 40 percent in 11.0-inch trees to 57 percent in trees over 50 inches. For trees with visible indicators, cull ranged from 67 to 100 percent.

Despite the fact that large, old cedars are typically defective, these are the trees most in demand for most products and almost exclusively for shakes and shingles. The wood of old trees is tight-grained, high in oil content, relatively free of knots, and has a small proportion of sapwood. These characteristics enhance the workability of the wood and the attractiveness and durability of the products.

In all six States, 66 percent of the western redcedar volume is in trees 21 inches in d.b.h. and larger; 44 percent is in trees 29 inches and larger (table 4). Washington's cedar averages the largest; Idaho's trees are the smallest (fig. 6).

Table 4--Net volume of western redcedar sawtimber on commercial forest land in the United States, by State and diameter class, 1977

State	Diameter class (inches at breast height)			
	11.0-20.9	21.0-28.9	29.0 +	All classes
	Million board feet (Scribner rule)			
Washington	2,817	2,337	7,894	13,048
Oregon	1,075	1,066	2,887	5,028
Alaska	2,530	1,960	1,834	6,324
Idaho	4,232	1,815	1,805	7,852
Montana	709	305	404	1,418
California	8	17	51	76
All States	11,371	7,500	14,875	33,746

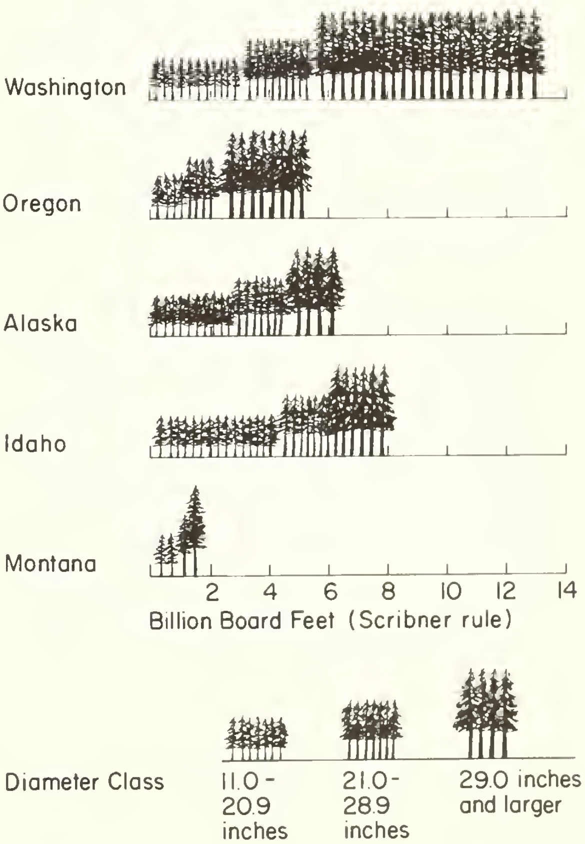

Figure 6.--Net volume of western redcedar sawtimber by State and diameter class, 1977.

How Much Western Redcedar Is Being Cut Annually?

The estimated annual western redcedar harvest in the United States for 1975 to 1976 was 950 million board feet. Washington, with 40 percent of the total cedar volume, contributed nearly 60 percent of the harvest. Idaho's cedar harvest amounted to 21 percent of the total, and Oregon's was 17 percent. About 86 percent of the cedar harvested in western Washington was from live trees over 100 years old; 7 percent was from salvaged dead trees; and 7 percent was from live trees under 100 years of age (fig. 7 and table 5).

The harvest of western redcedar in western Washington was disproportionate to the inventory volume by ownership, as shown in the following tabulation:

Ownership	Percent of inventory volume	Percent of harvest
U.S. Forest Service	46	12
Other public	20	34
Private	34	54
Total	100	100

For all ownerships in western Washington, there has been a slight upward trend in the cedar harvest since 1965. The cut on private lands has fluctuated less than on public lands (fig. 8).

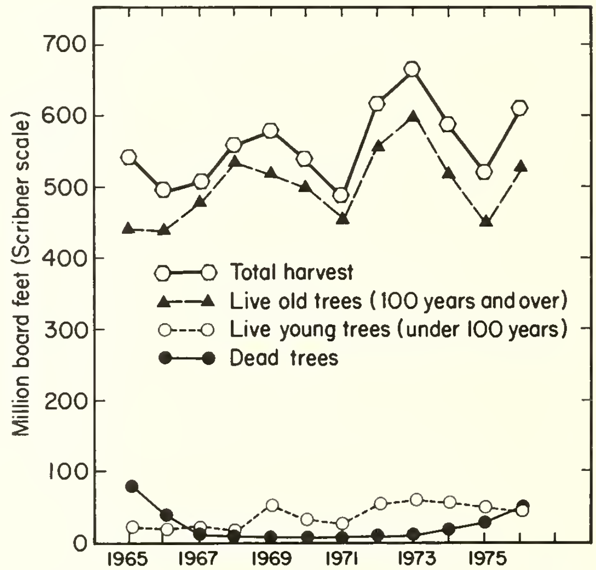

Figure 7.--Volume of western redcedar harvested in western Washington, 1965-1976, by age class.

Table 5--Volume of western redcedar harvested in western Washington in 1976 by ownership and age class

Ownership	Live trees 100 years +	Live trees under 100 years	Dead trees	Total
	- Million board feet (Scribner log scale) -			
National Forest	68.8	0.5	trace	69.3
Indian	117.8	.3	5.1	123.2
State	77.8	3.2	3.1	84.1
Other public	.6	.2	0	.8
Private	256.2	36.8	33.0	326.0
All ownerships	521.2	41.0	41.2	603.4

Source: Bergvall, Bullington, and Gee (1977).

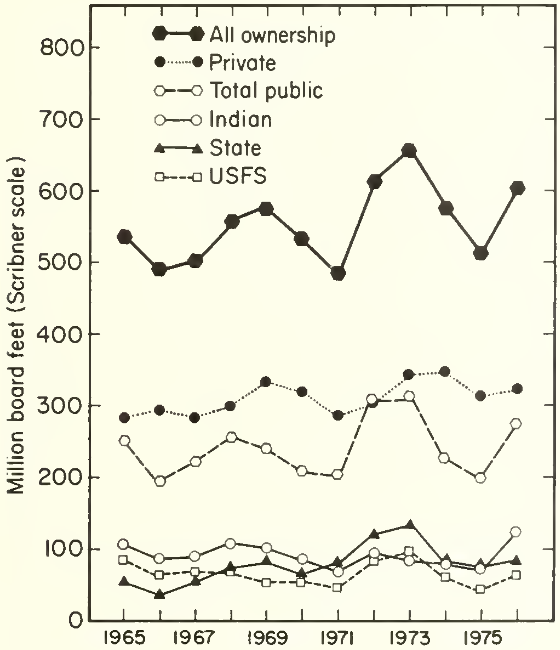

Figure 8.--Volume of western redcedar harvested in western Washington, 1965-1976, by ownership.

What Is The Annual Growth Rate Of Western Redcedar?

In all States the estimated net annual growth of redcedar is 457 million board feet (tables 6 and 7). Idaho and Montana, with a large proportion of small, young-growth redcedar (see figure 6), have higher growth rates than Oregon and Washington, which have a relatively small proportion of young growth cedar. Alaska, at the northern extremity of redcedar's natural range, has the lowest growth rate, as shown in the following tabulation:

State	Net annual growth as a percent of inventory	
	Cubic foot (trees 5.0 inches +)	Scribner board foot (trees 11.0 inches +)
Washington and Oregon	1.5	1.5
Idaho and Montana	2.5	2.0
Alaska	.1	.1

Table 6--Net annual growth of western redcedar growing stock on commercial forest land in the United States by State and half-State and ownership, 1977

State or half-State	National Forest	Other public and private	All ownerships
	- Million cubic feet (trees 5.0 inches +) -		
Western Washington	8	38	46
Eastern Washington	2	6	8
Total Washington	10	44	54
Western Oregon	6	13	19
Eastern Oregon	1	trace	1
Total Oregon	7	13	20
Alaska	1	trace	1
Idaho	22	28	50
Montana	6	1	7
California	trace	trace	trace
All States	46	86	132

Table 7--Net annual growth of western redcedar sawtimber on commercial forest land in the United States by State and half-State and ownership, 1977

State or half-State	National Forest	Other public and private	All ownerships
	- Million board feet[1] (trees 11.0 inches +) -		
Western Washington	33	110	143
Eastern Washington	7	15	22
Total Washington	40	125	165
Western Oregon	25	58	83
Eastern Oregon	4	trace	4
Total Oregon	29	58	87
Alaska	4	trace	4
Idaho	94	85	179
Montana	18	3	21
California	trace	1	1
All States	185	272	457

[1] Scribner rule.

Is The Redcedar Resource Being Depleted?

In all States combined, the net annual growth of western redcedar is about half the cutting rate (fig. 9). The net effect on the inventory volume is a 1.5-percent annual reduction. A closer examination shows that the depletion rates in Idaho and Alaska are negligible. Montana seems to be gaining cedar by a small amount annually. The situation is different for Washington and Oregon. At current growth and cutting rates, Washington's redcedar would last for little more than 30 years, and the old growth, expressed in volume of trees 21 inches and larger, would last about 20 years. Oregon's old-growth redcedar would be gone in about 50 years.

These are approximations. The relationship between the forest resource and the potential recoverable volume for products is poorly understood for redcedar. Among the factors are: (1) Redcedar is more variable in quality and defect than most western softwoods; cruising and scaling cedar is subjective, and results are often inconsistent among cruisers and scalers in one given locality, as well as from one area to another. (2) Milling efficiency is variable for cedar and has been changing as mill owners modernize their equipment and as the quality of available cedar has changed (Stirling 1979). (3) The volume of usable cedar in down logs, chunks, and pieces is unknown. This material has been accumulating for many decades to over a century. Once it is gone it cannot be replaced. (4) Accessibility of cedar is changing. Much of the forest resource that is left is in areas difficult to reach. The high prices of cedar have recently made it economical to log individual trees by helicopter, but this may not be a long-term option.

Research studies now underway or planned will help provide better information to answer some of these cedar resource questions.

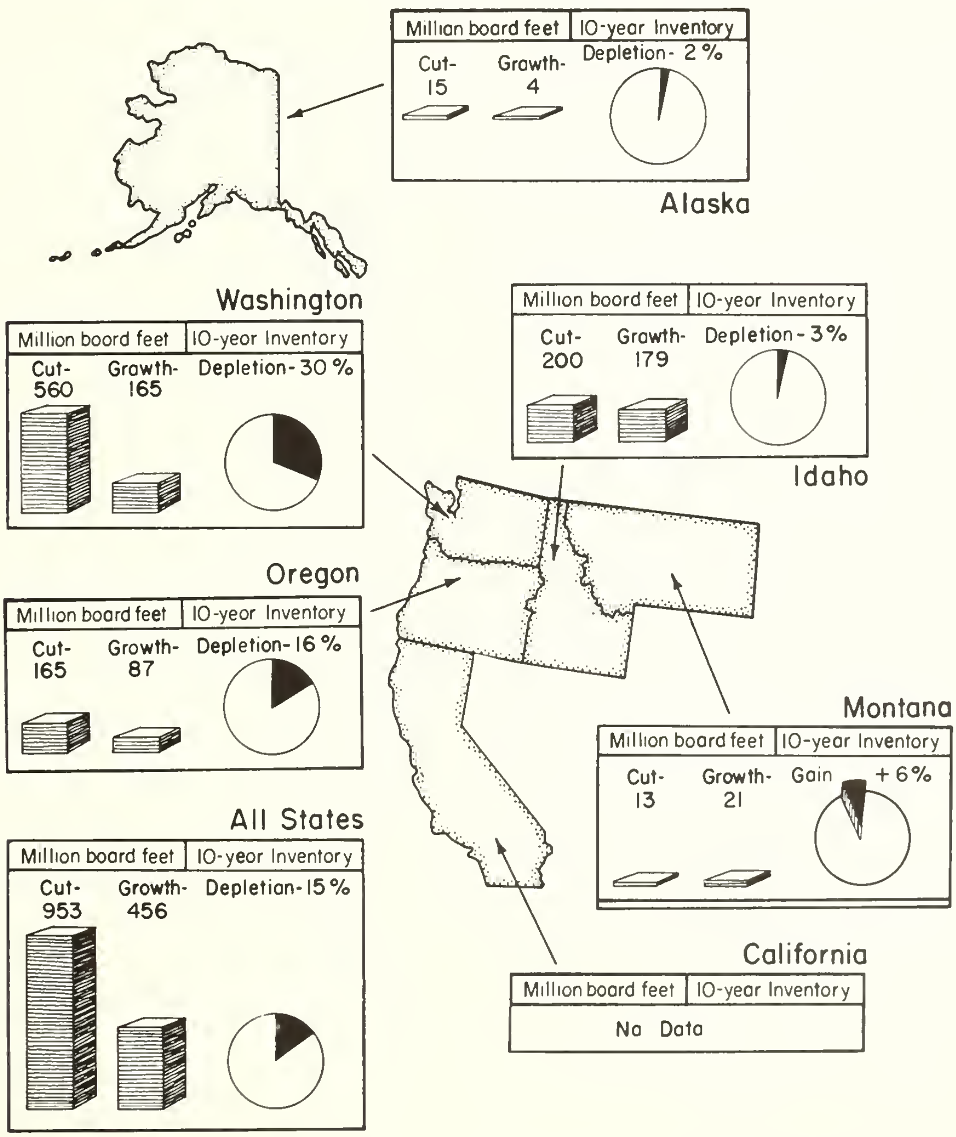

Figure 9.--Current annual cut, net annual growth, and 10-year inventory change of western redcedar in the western United States.

Because much of the redcedar volume in both Washington and Oregon is on National Forests, which have closely regulated timber harvest ceilings, the total redcedar resource will not be depleted as the overall cut and growth relationships seem to indicate. What is likely to happen is this: Concentrated reserves of old-growth cedar on private lands will be exhausted as the remaining stands of old growth of all species are cut. This will happen in less than 20 years in most areas and in less than 10 years in some localities. A sharp drop in cedar production in Washington and Oregon will follow. Redcedar will be available from public lands indefinitely, but in lesser quantities than are now being consumed. The exact amount of redcedar that will be available in the future will depend mainly on the policy of the Forest Service, and to a lesser extent on the policies of the Bureau of Land Management in Oregon, the Department of Natural Resources in Washington, and the managers of the Quinault Indian Reservation on Washington's Olympic Peninsula.

Although timber harvests on National Forests are closely regulated, it is difficult to predict the amount of redcedar that will be available from these lands. Allowable harvests are calculated for all softwood species, and most of the redcedar comes from clearcutting operations in which all species are removed. Because the mix of species varies considerably from one drainage to another, the proportion of cedar harvested can vary from year to year depending on the kind of stands logged. Some redcedar is cut from National Forests in prelogging and salvage logging operations and also on a selective basis in landscape management zones. The amount of cedar produced in these operations and the potential resource in areas amenable to these practices is not known.

What Are Western Redcedar's Survival Traits?

Western redcedar's desirable wood qualities combined with its slow growth characteristics have historically worked against its chances of surviving. It is a persistent species, however, with a number of features that could be used by forest resource managers. Among western redcedar's survival traits are: (1) frequent and heavy seed production, (2) seed-bearing capability at a young age, (3) seeds that are eaten less by rodents that the seeds of many associates, (4) high rate of germination on a variety of seedbeds and under tree or brush canopy, (5) ability to grow in a variety of sites over a wide elevational range and to thrive in moist soils where many softwoods would die, (6) ability to grow to full maturity in full shade or sunlight, and (7) ability to stay alive or even recover after being damaged by various agents.

Western redcedar's persistence has been noted by Forest Survey crews. Trees tallied on permanently established forest plots were still alive 15 years after having the tops killed and the bark girdled over 80 percent of the bole's girth. Uprooted trees have been found that survived as the branches became new trees: A grove of cedars originating vegetatively from one fallen tree. In the Olympic Peninsula layering is common--new trees originate where cedar branches touch the ground and take root.

With increasing concern for stream protection and a growing awareness of forest esthetics, western redcedar's characteristics could make the species more desirable in resource management. Its increasing value on the market may also make it a somewhat more attractive species for investment. A number of alternatives present themselves. Cedar could be featured in management on swampy sites where it outperforms other softwoods species. It could be grown in long rotations in narrow streamside protection zones in some areas and logged selectively in such a way as to minimize streambank disturbance. Three objectives would be accomplished: Stream protection, maintenance of forest cover for esthetic purposes, and production of high quality cedar wood for special products.

What Does The Future Look Like For Western Redcedar?

Although most cedar products are currently produced from the wood of old trees, all industries could, theoretically, use young cedar trees. The quality of the products and the way in which they are manufactured and used would have to change, however. For example, building codes would have to be changed to allow lower grades of cedar material to be used in house construction. The deteriorability of sapwood, which makes up a large proportion of young-growth cedar, could be compensated for by treating with preservatives. Treated cedar still offers some advantages over other treated woods because of its workability, appearance, light weight, and reputation on the market.

Whether or not these and other possibilities become realities depends on resource availability, economic factors, and market acceptability.

Even if development of manufacturing and utilization techniques make young-growth cedar products acceptable, the amount of cedar available will be considerably less than is now being consumed.

Private timber companies in western Oregon and Washington plan to grow trees in 40- to 60-year rotations in most areas. Douglas-fir and western hemlock are the major species. In 40 to 60 years, these two species can produce up to 12,000 cubic feet of wood per acre, in trees that average 10 to 18 inches in d.b.h., depending on soil productivity. Dominant trees will range from 12 to 26 inches in diameter and 70 to 150 feet in height. Western redcedar will produce much less wood in the same time period; few redcedar trees will be larger than 12 inches in well-stocked stands, and they will be considerably shorter than the Douglas-fir or hemlock. Private timber growers feel that it is not economical to manage for western redcedar production.

Western redcedar does naturally restock many logged areas where seed trees are present and conditions are suited to its survival. Logging and forestry practices of the past, though often not conducive to continuous high yields of softwood timber, did often promote redcedar stocking. For example, hundreds of thousands of acres that supported Douglas-fir stands in the Puget Sound lowlands, were logged in a way that left the sites unsuited to Douglas-fir restocking. Hardwoods--mostly red alder and maple--restocked much of this land. Because of redcedar's ability to germinate and develop under a hardwood canopy, it is a common component of these stands. Where extensive areas have been clearcut and burned then artifically reforested, western redcedar has become scarce. As the area of intensively managed forest increases, the amount of western redcedar is likely to decrease.

CONCLUSION

Western redcedar is not a threatened or endangered tree species, but the harvest of cedar in the forests of the United States has been greater than can be sustained in the future. Currently, the depletion rate of redcedar is negligible in Idaho, Montana, and Alaska; in Washington and Oregon, cedar supply problems are in sight. The shake and shingle industry is most likely to feel the effect of the cedar supply pinch first, because of its dependence on old-growth cedar. Other industries use old growth, but can also use young cedar. Young-growth cedar will be available in smaller quantities in the future than the total cedar volume now available. Eventually other industries that use cedar will also experience supply problems.

It appears that some relocation of cedar processing facilities is likely in the near future, as well as a reduction in cedar product output. The tremendous volume of western redcedar in British Columbia assures that high quality old-growth cedar wood will not disappear for a long time. Whether or not it is made available to the United States in quantities desired remains to be seen.

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Available information on inventory, growth, price, and consumption trends for western redcedar in Western United States is compiled. The future of western redcedar as a product resource and component of the forest is discussed.

KEYWORDS: Western redcedar, Pacific Northwest forest resources, timber supply, shake and shingle industry, forest statistics.

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.

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2. Developing and evaluating alternative methods and levels of resource management.

3. Achieving optimum sustained resource productivity consistent with maintaining a high quality forest environment.

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USDA Forest Service
Resource Bulletin PNW-86

August 1979

1977 WASHINGTON TIMBER HARVEST

by

J. D. Lloyd Jr., *Supervisory Forester*

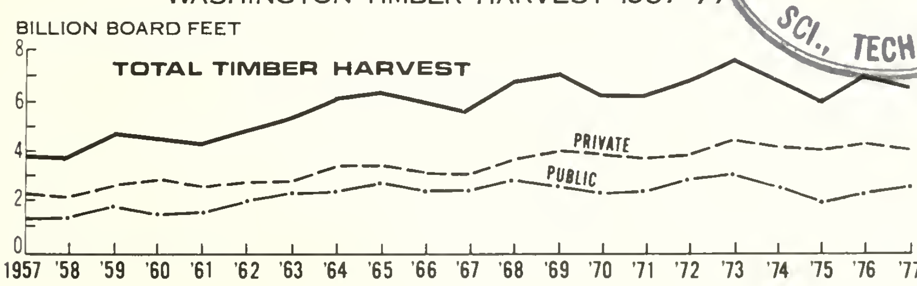
After a near record output in 1976, Washington log production declined 5.4 percent in 1977 to 6.59 billion board feet. Western Washington production was 415 million board feet lower than in 1976; eastern Washington, 36 million board feet higher. The private harvest was 62 percent of the total, the lowest in 4 years. For the past 15 years, the harvest from the western half of the State has remained a steady 83 to 84 percent of the State total.

Production on public lands declined 1.3 percent compared with 1976. In western Washington the net reduction on these lands was 32 million board feet; in eastern Washington production increased 20 million board feet. Harvest on National Forest lands was lower than in 1976 by 44 million board feet; on Indian lands, by 39 million board feet. Harvest on State-managed lands was increased by 30 million board feet; on the remaining public lands, by 20 million board feet.

Forest industry reduced harvest by 458 million board feet. This was a decline of 12 percent in both the western and the eastern half of the State. This reduction was partially offset by an increase on nonindustrial private lands of 66 million board feet and 46 million board feet, respectively, in western and eastern Washington.

Average stumpage prices on National Forest, Indian, and State-owned or managed lands continued increasing, to $129 per thousand board feet (up $6) in western Washington and $79 per thousand board feet (up $11) in eastern Washington. Sold and uncut volumes under contract on National Forest and State lands both increased 9 percent--volume sold to 2.5 billion board feet and uncut volumes to 6.3 billion.

WASHINGTON TIMBER HARVEST 1957-77



PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION
Forest Service
U.S. Department of Agriculture
809 N.E. Sixth Ave.,
Portland, Oregon 97232

Timber harvest by ownership in the State of Washington, 1977 1/

(In thousand board feet, Scribner log scale)

Half-State and county	Private 2/ Industrial Live	Private 2/ Industrial Dead 3/	Private 2/ Other Live	Private 2/ Other Dead 3/	Total Private Live	Total Private Dead 3/	State 2/ Live	State 2/ Dead 3/	Bureau of Land Management 4/ Live	Bureau of Land Management 4/ Dead 3/	National Forest 4/ Live	National Forest 4/ Dead 3/	Indian lands 4/ Live	Indian lands 4/ Dead 3/	Other public 2/ Live	Other public 2/ Dead 3/	Other Federal 5/ Live	Other Federal 5/ Dead 3/	Total production
Western Washington:																			
Clallam	176,231	3,804	53,128	3,582	229,359	7,386	75,867	1,694	--	--	86,150	2,346	5,448	570	17	--	--	--	408,837
Clark	11,415	--	20,661	17	32,076	17	10,811	--	--	--	7,647	403	--	--	--	--	--	--	50,954
Cowlitz	717,561	153	20,682	418	738,243	571	59,999	78	--	--	688	106	--	--	--	--	--	--	799,685
Grays Harbor	202,301	5,810	32,273	1,540	234,574	7,350	10,201	153	--	--	71,527	3,080	149,713	18,695	6,520	--	--	--	501,813
Island	345	--	11,544	--	11,889	--	499	--	--	--	--	--	--	--	45	--	--	--	12,433
Jefferson	130,738	5,092	9,398	1,438	140,136	6,530	299,182	4,595	--	--	68,812	229	--	--	978	--	--	--	520,462
King	305,121	83	28,964	314	334,085	397	11,009	312	--	--	33,243	1,413	--	--	13,146	--	2,880	--	396,485
Kitsap	15,390	--	23,428	3	38,818	3	2,329	--	--	--	--	--	3,825	--	1,400	--	--	--	46,375
Lewis	539,481	2,624	104,378	1,425	643,859	4,049	29,369	118	--	--	88,552	5,796	--	--	43	--	--	--	771,786
Mason	47,293	832	32,786	36	80,079	868	7,242	--	--	--	88,650	11,652	--	--	330	--	--	--	188,821
Pacific	403,539	1,422	14,522	84	418,061	1,506	17,020	34	--	--	--	--	--	--	43	36	--	--	436,700
Pierce	129,745	13	88,607	98	218,352	111	14,653	--	--	--	33,415	5,084	--	--	1,334	--	8,274	--	281,223
San Juan	--	--	10,456	3	10,456	3	--	--	--	--	--	--	--	--	--	--	--	--	10,459
Skagit	52,627	2,379	29,653	963	82,280	3,342	48,239	380	--	--	50,632	2,253	--	--	53	--	--	--	187,179
Skamania	90,603	--	3,185	10	93,788	10	17,118	--	--	--	174,479	21,339	--	--	17	--	--	--	306,751
Snohomish	46,479	234	45,392	341	91,871	575	45,316	126	--	--	66,225	6,669	--	--	140	--	--	--	210,922
Thurston	59,255	441	43,430	360	102,685	801	7,403	14	--	--	--	--	--	--	--	--	5,564	--	116,467
Wahkiakum	51,450	--	4,563	--	56,013	--	26,595	29	--	--	--	--	--	--	--	--	--	--	82,637
Whatcom	31,776	508	13,304	132	45,080	640	27,547	32	--	--	16,297	2,067	--	--	107	3	--	--	91,773
Total	3,011,350	23,395	590,354	10,764	3,601,704	34,159	710,399	7,565	--	--	786,317	62,437	158,986	19,265	24,173	39	16,718	--	5,421,762
Total live and dead	3,034,745		601,118		3,635,863		717,964		--		848,754		178,251		24,212		16,718		5,421,762
Eastern Washington:																			
Adams	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Asotin	--	--	4,684	--	4,684	--	147	--	--	--	11,634	231	--	--	102	--	--	--	16,798
Benton	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chelan	42,660	64	10,486	213	53,146	277	--	--	--	--	31,346	2,519	--	--	642	--	--	--	87,930
Columbia	--	--	4,138	--	4,138	--	1,394	--	--	--	--	--	--	--	--	--	--	--	5,532
Douglas	--	--	1,934	--	1,934	--	--	--	--	--	--	--	--	--	--	--	--	--	1,934
Ferry	8,766	3	7,756	--	16,522	3	--	--	--	--	27,017	1 843	72,709	--	--	--	--	--	118,094
Franklin	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Garfield	--	--	2,321	--	2,321	--	--	--	--	--	12,962	264	--	--	--	--	--	--	15,547
Grant	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Kittitas	43,619	--	20,035	11	63,654	11	7,055	99	--	--	40,175	4,191	--	--	26,635	--	--	--	141,820
Klickitat	40,378	--	24,856	111	65,234	111	15,236	--	--	--	494	6	19,582	125	--	--	--	--	100,788
Lincoln	--	--	8,718	--	8,718	--	243	--	--	--	--	--	--	--	--	--	--	--	8,961
Okanogan	225	--	19,318	--	19,543	--	24,740	180	2,732	--	65,624	2,897	63,512	--	--	--	--	--	179,228
Pend Oreille	21,594	27	25,345	54	46,939	81	1,631	--	23	--	20,617	7,462	165	--	3,359	62	--	--	80,339
Spokane	9,906	--	32,257	--	42,163	--	4,318	50	--	--	--	--	--	--	297	--	--	--	46,828
Stevens	32,628	119	54,071	105	86,699	224	14,640	46	1,603	--	21,857	1,791	15,143	--	--	--	2,582	--	144,585
Walla Walla	--	--	1,118	--	1,118	--	--	--	--	--	--	--	--	--	--	--	--	--	1,118
Whitman	--	--	997	--	997	--	--	--	--	--	--	--	--	--	--	--	--	--	997
Yakima	6,845	2,432	4,296	--	11,141	2,432	8,942	--	--	--	58,672	10,201	126,589	666	--	--	--	--	218,643
Total	206,621	2,645	222,330	494	428,951	3,139	78,346	375	4,358	--	290,398	31,405	297,700	791	31,035	62	2,582	--	--
Total live and dead	209,266		222,824		432,090		78,721		4,358		321,803		298,491		31,097		2,582		1,169,142
Total Washington	3,217,971	26,040	812,684	11,258	4,030,655	37,298	788,745	7,940	4,358	--	1,076,715	93,842	456,686	20,056	55,208	101	19,300	--	6,590,904
Total live and dead	3,244,011		823,942		4,067,953		796,685		4,358		1,170,557		476,742		55,309		19,300		6,590,904

1/ Includes volume in logs, poles, piling, shingles, bolts, etc.
2/ Compiled by Washington State Department of Natural Resources.
3/ Includes snags and down material existing prior to initial logging.
4/ Compiled by respective agencies, Bureau of Land Management and Bureau of Indian Affairs, U.S. Department of the Interior; and Forest Service, U.S. Department of Agriculture.
5/ Includes lands logged under jurisdiction of U.S. Department of the Interior (Bonneville Power Administration, National Park Service, Bureau of Sport Fisheries and Wildlife) and U.S. Department of the Army.

Prepared by Renewable Resources Evaluation Work Unit, Pacific Northwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture, Portland, Oregon.

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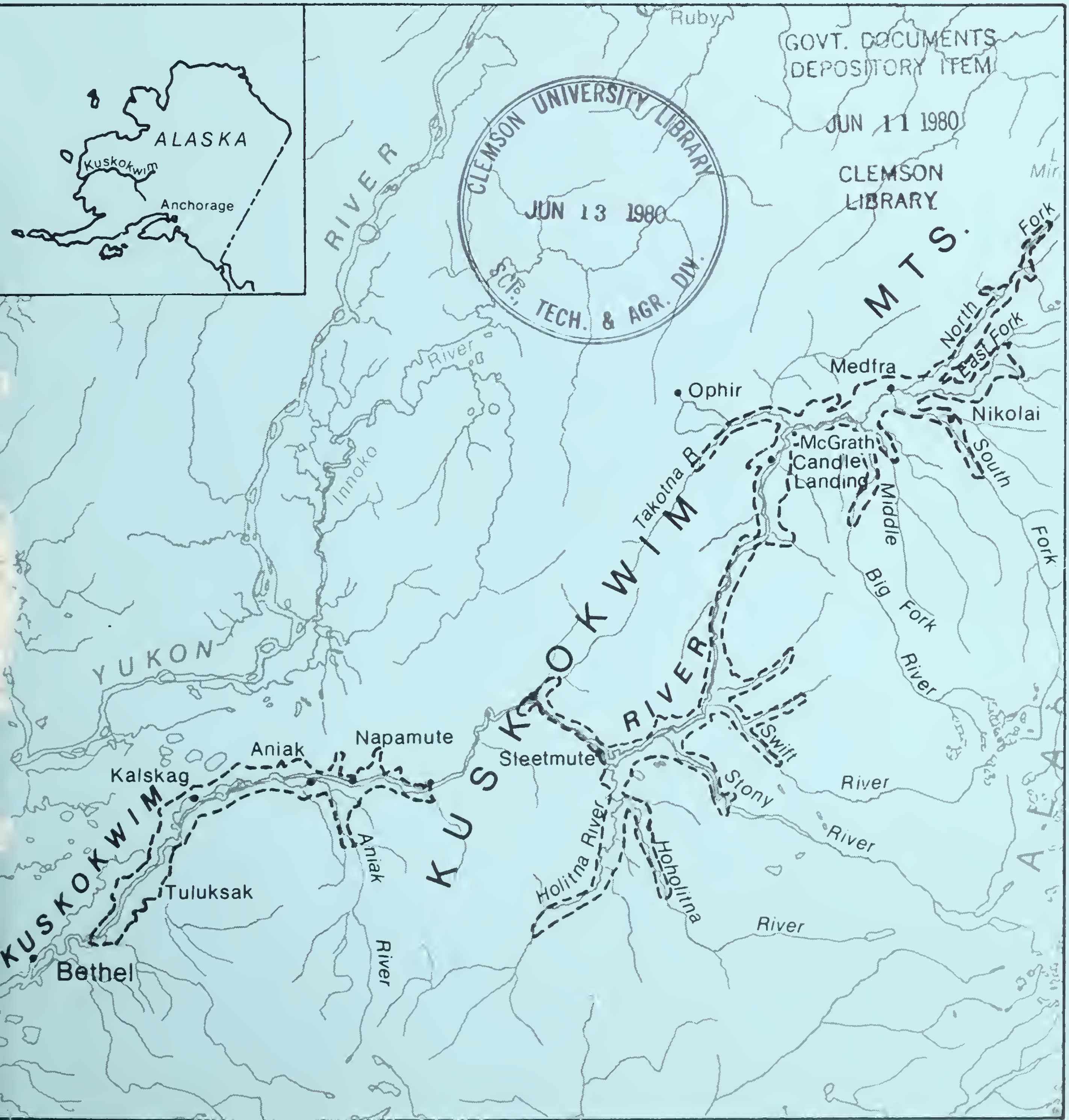
Timber Resources of the Kuskokwim Flood Plain and Adjacent Upland

Karl M. Hegg and Harold Sieverding



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The successful completion of this study was made possible through the generous assistance of the Bureau of Land Management in providing aerial photography, personnel, funds, and transportation.

Metric Conversions

1 acre	= 0.4047 hectare
1 hectare	= 2.47 acres
1 cubic foot	= 0.0283 cubic meter
1 cubic meter	= 35.3145 cubic feet
1 cubic foot per acre	= 0.06997 cubic meter per hectare
1 cubic meter per hectare	= 14.29 cubic feet per acre
20 cubic feet per acre	= 1.3994 cubic meter per hectare
1 square foot basal area per acre	= 0.2296 square meter per hectare
1 square meter per hectare	= 4.356 square feet per acre

TIMBER RESOURCES OF THE KUSKOKWIM RIVER FLOOD PLAIN AND ADJACENT UPLANDS

Reference Abstract

Hegg, Karl M., and Harold Sieverding.
1979. Timber resources of the Kuskokwim River flood plain and adjacent uplands. USDA For. Serv. Resour. Bull. PNW-87, 40 p., illus.

The first intensive forest inventory of the Kuskokwim River flood plains and adjacent uplands was conducted in 1967. A commercial forest area of 252.5 thousand acres (102.2 thousand hectares) was identified with a growing-stock volume of 343.0 million cubic feet (9.7 million cubic meters). A noncommercial stratum was also examined that had substantial standing volume but did not qualify as commercial forest land. This stratum contained 70.4 thousand acres (28.5 thousand hectares) with a volume of 65.9 million cubic feet (1.9 million cubic meters).

Keywords: Timber resources, statistics (forest), forest surveys, Alaska (Kuskokwim River Valley).

Research Summary
Resource Bulletin PNW-87
1979

The forest inventory of the Kuskokwim River inventory unit was a joint effort of the Forest Service, U.S. Department of Agriculture, and the Bureau of Land Management, U.S. Department of Interior. Data was gathered to meet the needs of the National Forest Survey and for management planning.

Aerial photography was acquired by the Bureau of Land Management and the Forest Service in 1965-1966. Preliminary field investigation was made in 1966 and interpretation of photos completed in early 1967. Field plot work was finished in 1967 and data processing in 1972.

Final inventory results show that 252.5 thousand acres (102.2 thousand hectares) of the 1,231.2 thousand-acre (498.3 thousand hectares) inventory unit were classed as commercial forest land. The commercial forests have a total cubic volume of 343 million cubic feet (9.7 million cubic meters) and a total sawtimber volume of 1,111.8 million board feet. An additional 65.9 million cubic feet (1.9 million cubic meters) are found on 70.4 thousand acres (28.5 thousand hectares) of forest land with substantial standing volume but not meeting the growth criteria for commercial forest land. The effects of climate, soils, and flooding are discussed and how these factors bear on the differing growth and regeneration characteristics noted in the upper and lower blocks of this inventory unit. Data is presented for the two blocks illustrating those differences.

Past and present uses of the forest are noted including comments on the recreation potential, subsistence use, and land conflicts. A maximum allowable cut is calculated with commentary on factors reducing the cut and the effect of adjacent high volume noncommercial stands. Problems that may be encountered in developing internal and external timber markets are cited and the conclusion drawn that the Kuskokwim timber resource should continue to be managed for local needs.

HIGHLIGHTS

	Thousand acres	Thousand hectares
Total Kuskokwim River unit area:	1,231.2	498.3
with forests on	874.3	353.8
with nonforest on	215.8	87.3
with noncensus water on	57.0	23.1
with census water on	84.1	34.1
Forested area:		
commercial forest land	252.5	102.2
noncommercial forest land		
more than 800 cubic feet per acre	70.4	28.5
less than 800 cubic feet per acre	551.4	223.1
Commercial forest composition:		
sawtimber	158.6	64.2
poletimber	69.9	28.3
seedling/sapling	16.7	6.8
nonstocked	7.3	2.9

Inventory unit volumes	Thousand cubic feet 1/	Thousand cubic meters 1/	Thousand board feet 2/	Thousand cubic meters 3/
Total net volume	343,014.5	9 713.1	1,111,844.1	6 774.8
Total gross volume	370,821.6	10 500.5	1,211,735.0	7 036.9
Annual net growth	4,476.2	126.8	29,394.6	100.0
Annual net mortality	382.6	10.8	1,103.9	7.2

1/ Volume of roundwood in live trees 5.0-inch d.b.h. and larger.

2/ Net volume, International 1/4-inch rule.

3/ Volume in roundwood in softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

CONTENTS

TABLES

These data for the total Kuskokwim unit have been compiled for forest land producing 20 cubic feet or more per acre per year. Data tables for the upper and lower Kuskokwim blocks are available upon request.

Volume data herein is for cubic feet or board feet International 1/4-inch rule.

INTRODUCTION

This resource bulletin presents the findings of the first intensive forest inventory of lands adjacent to the Kuskokwim River, Alaska, although the Kuskokwim valley was inventoried in its entirety as part of a statewide reconnaissance inventory in 1957-1962[1] (Hutchison 1967). This earlier inventory was statistically valid for the entire State but not for individual drainages and thus is considered inadequate for management planning.

The impetus of the Kuskokwim inventory was indirectly provided in 1963 by a timber sale proposal covering most of the Kuskokwim. This established a definite and pressing need for more reliable information of the area. The Bureau of Land Management (BLM), U.S. Department of Interior, subsequently delineated the most accessible areas adjacent to the river and contracted for aerial photography. Complete photocoverage was obtained by 1966.

The inventory of the Kuskokwim River unit was conducted as a cooperative effort by the U.S. Department of Interior, Bureau of Land Management, and the Forestry Sciences Laboratory, U.S. Forest Service (Juneau). Photointerpretation and fieldwork were cooperatively shared by the two agencies. Supervision and editing of plot records was done by the Forestry Sciences Laboratory. Data processing was handled by the Pacific Northwest Forest and Range Experiment Station at Portland.

Unlike the Susitna Valley inventory (Hegg 1970), a comparison between the extensive and intensive inventories cannot be made. The area being reported comprises but 5 percent of the original subunit of the statewide inventory. Undoubtedly there is additional commercial forest land in the remaining 95 percent of the Kuskokwim drainage. Eventually, using new techniques in sampling and remote sensing, we plan to complete the inventory for the entire drainage.

PHYSICAL DESCRIPTION

Geographical Location

This inventory unit of 1,231,180 acres occupies a small part of the 26-1/2 million-acre Kuskokwim drainage system (fig. 1). The Kuskokwim drainage

[1] Wilson, Richard C. 1957. Working plan for the forest survey of interior Alaska, USDA For. Serv. Div. For. Econ. Res., Washington, D.C. Unpublished.

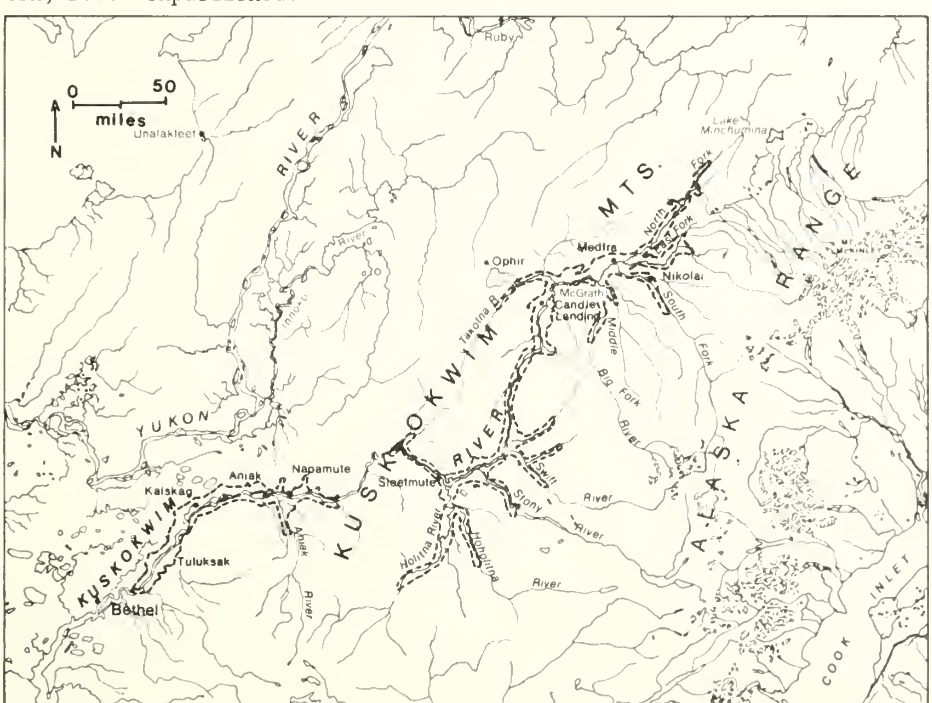

Figure 1.--The shaded areas are the 1,231,180 acre Kuskokwim inventory unit. On the right are Mt. McKinley and the Alaska Range. On the left is the Yukon River.

lies to the west of the Alaska Range with a majority of its waters coming from those mountains. On the west and northwest, the Kuskokwim River is bounded by the Kuskokwim Mountains and has its headwaters in those mountains about 120 miles southwest of Fairbanks. An overall view of the Kuskokwim River and Mountains is shown in figure 2.

Figure 2.--The Kuskokwim Mountains, extending from tide water northward and with elevations to 4,400 feet, shields the Kuskokwim drainage from the cold maritime influence of the Bering Sea.

The general flow of the Kuskokwim is southwest with a current of 5 to 6 miles per hour in the upper reaches, but slowing to 3 to 5 miles per hour as it becomes broader or more winding downstream. Faster water is found in many of the tributaries, but with the exception of the Swift River, they become sinuous winding rivers compounded by cut-off meanders and oxbow lakes long before they reach the Kuskokwim.

The inventory unit includes only those lands within about 5 miles of the navigable waters of the Kuskokwim and its tributaries. Although the unit stretches only 300 airline miles, we estimate that about 800 to 1,000 miles of river are actually included in the inventory area.

Soils and Drainage

Thick moraine, alluvial, and eolian deposits of unconsolidated silts, sands, gravels, and organic deposits cover most of the area inventoried (Fernald 1955). In only a few instances, in the hills flanking the west bank of the Kuskokwim, are sandstone, limestone, and shale bedrock cliffs exposed (Fernald 1960).

The soils that have developed from this parent material are predominately the subarctic brown podzolics and alluvials (Kellog and Nygard 1951). In a more temperate climate these soils would be fairly productive. In this area, however, growth is severely restricted since the entire Kuskokwim basin is underlain by continuous to discontinuous permafrost (material that has a temperature lower than 32° F and is not subject to seasonal thawing) (Ferrians 1965). Only on moderate- to well-drained sites adjacent to the river or on south-facing slopes is the soil warm enough for tree growth comparable to that of the lower latitudes.

The better drained soils are adjacent to the river and are subjected to periodic flooding and silting. This annual deposition provides the mineral soil needed for good regeneration, but it has drawbacks. The deposited soil is usually fine silt with a high water-holding capacity which, with additional layers, means impeded drainage. And as the inner bend river bank continues building, earlier deposits are left far removed from the main stream and its influence in maintaining drainage and permafrost depth. The naturally slow water movement in this fine-textured soil slows even more as permafrost moves closer to the surface and contributes to the change from commercial forest land to noncommercial and finally to nonforest (Viereck 1970).

The floods that deposit most of the mineral soil are usually caused by ice damming during the spring breakup. As a provider of mineral seedbeds, these floods are favorable; but they also have a detrimental effect on existing stands. As the ice moves downriver after the breakup of an ice dam, standing trees are heavily abraded and uprooted thus reducing the quality and quantity of the resource (fig. 3).

Climate

The climate of the Kuskokwim basin can be best described as continental. Summers are fairly wet--over half of the total (18- to 23-inch) precipitation occurs then--and winters are long, cold, and dry. Winter temperatures in the minus 50° to 60° F range are not uncommon (minimum recorded -64° F). The January

Figure 3.--Spring breakup on the Kuskokwim brings ice dams, flooding, siltation, bank erosion, and tree uprooting and abrasion.

average daily minimum at McGrath is a minus 8°, the July monthly average is a +58.7° F (U.S. Dep. of Commerce Weather Bureau 1965). The last killing frost usually occurs in late May, the first fall frost in late August or early September, a frost-free season of about 100 to 105 days.

A striking feature of these northern latitudes (61° to 64° north) are the long daylight and twilight hours. This reaches the extremes of nearly continuous daylight (sun and twilight) during May, June, and July. A considerable lengthening of the day by twilight is caused by the sun's shallow angle as it crosses the northern latitudes. Not only does the sun take a longer time (compared to temperate latitudes) to rise and set, but this low angle also increases the atmospheric refraction of the sun's rays and extends the twilight period (Johnson and Hartman 1969).

Despite these long days, the actual amount of solar radiation is no more than that received in more southern locations since the same features (shallow angle and refraction) that extend daylight also combine to reduce the acutal energy received (Johnson and Hartman 1969). By comparison, the northern part of the contiguous United States (International Falls, Minnesota) has an average growing season of 107 days, but a July monthly average of 67.5° or 9° higher than McGrath's 58.7° F (U.S. Department of Agriculture 1941).

FOREST DESCRIPTION

Land Capability Classification

Commercial forest land, noncommercial forest land, nonforest land, and water were the land types recognized in this inventory. Definitions of all these classes and other terms used are found in the appendix.

Forest Survey classifies forest land on the basis of mean annual increment (MAI). MAI is the volume, in cubic feet, that 1 acre of forest land is producing or capable of producing in 1 year. An increment of 20 cubic feet per acre per year is the minimum to qualify as commercial forest land.

Forest land producing less than 20 cubic feet per acre annually is classed as noncommercial. Preliminary observations and experiences in other areas, however, caused us to question this blanket noncommercial classification. We had noted many areas with stands carrying potentially marketable volumes that did not meet the commercial forest land minimum and felt this area needed sampling. This we did on the Kuskokwim and are calling this class operable noncommercial. To qualify for this operable category, the stand must have 800 cubic feet ($22.65M^3$) of volume--equivalent to about nine cords per acre. In many areas of the U.S. and Canada, pulp logging occurs in stands of only 3 cords per acre; and we feel that under the present economics of logging and marketing in Alaska that 9 cords might be a prudent operating level. Figure 4 illustrates an operable noncommercial stand of the lower Kuskokwim.

Figure 4.--Operable noncommercial stands are difficult to identify except by knowledge of the area and an understanding of the conditions leading to slow growth. This stand of white spruce on the lower Kuskokwim has a gross volume of 1,580 cubic feet per acre and a mean annual increment of 12 cubic feet.

The distinction between this stand and one with commercial potential can be determined only by onsite growth measurements.

Forest Location

The Kuskokwim Mountain Range (illustrated in figure 2) bisects the inventory area effectively creating two individual blocks that we have called the upper and lower Kuskokwim (fig. 1 map). This mountain range probably is the indirect cause of differing stand characteristics of the two blocks. The upper Kuskokwim lies east of these mountains and has a true continental climate. Tree growth and vegetation appear normal for the latitude.

The lower Kuskokwim lies to the west of the Kuskokwim range and is an area of gentle gradients and low hills. Cold air movement from the Bering Sea, ice covered several months of the year, gives the unshielded lower Kuskokwim area a cold maritime climate. Under these conditions, tree height growth in the area appears to stagnate and regeneration is nearly nonexistent. The elevational limit of tree growth in the lower Kuskokwim is also severely restricted with only occasional stunted trees found above 500 feet. This block includes what is probably the westernmost extension of commercial tree growth on the North American Continent although stands of noncommercial timber and scattered trees are found as far west as Bethel at the mouth of the Kuskokwim and on the Seward Peninsula to within 50 miles of Nome.

Distribution of the total area by land class for the two blocks is shown in table 1.

Table 1--*Area by productivity, land class, and block, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Land/operability class	Block		
	Total	Upper	Lower
Commercial	252.5	234.8	17.7
Noncommercial			
Operable[1/]	70.4	42.0	28.4
Inoperable[2/]	551.4	328.4	223.0
Nonforest	215.8	95.6	120.2
Noncensus water	57.0	42.4	14.6
Census water	84.1	49.1	35.0
Total	1,231.2	792.3	438.9

[1/] Operable noncommercial forest land is defined as areas presently carrying a gross volume of more than 800 cubic feet per acre.

[2/] Inoperable noncommercial forest land is defined as areas supporting a gross volume of less than 800 cubic feet per acre.

The proportions of commercial forest land within each block are in direct relation to the miles of river in each block since the best sites are adjacent to flowing water. The lower Kuskokwim has only one major tributary, the Aniak, whereas the upper Kuskokwim is fed by the Tonzona, the North, South, and Middle Forks of the Kuskokwim, the Big River, the Takotna, the Swift, the Stony, and the Holitna-Hoholitna Rivers.

The upper Kuskokwim block includes 64 percent of the area and 69 percent of the forest land (93 percent of the commercial and 60 percent of noncommercial forest land).

The areas included in the inventory area are close to the river system (all field plots with the exception of about five were within 3 miles of the river). This does not mean that we have sampled all easily accessible or all of the forest land in the Kuskokwim drainage. We believe there are considerable acreages of commercial forest land scattered throughout the remaining 25 million acres of this drainage. A more complete inventory of this area will be considered following completion of the remaining inventory units of interior Alaska.

Intermixed with the commercial forest acreages are substantial areas of the operable noncommercial forest land. A total of 70.4 thousand acres of this type are distributed fairly uniformly throughout the inventory area (table 1). Generally this type is found just behind the commercial forest fringe on river meanders, although on the lower Kuskokwim commercial forests are mostly restricted to river islands with the operable noncommercial occupying the river meander alluvium. A typical lower Kuskokwim stand of this type is illustrated in figure 4.

Forest Stocking - Commercial

Stocking is determined by numbers of trees and their spacing. It is a measure of the proportion of the site that is occupied by various classes of trees (desirable, acceptable, cull) and other vegetative cover. For the Kuskokwim this picture is one of medium- to well-stocked stands of growing stock trees. Seventy-six percent of the commercial forest area is in this category; 12.2 percent is overstocked with 11.5 percent of the area in poorly stocked and understocked classes. Although this 11.5 percent understocked area will represent a management problem, it is not nearly as serious as the Susitna Valley where 35 percent of the area was so affected (Hegg 1970).

While the above discussion is applicable to the upper Kuskokwim stands, on the lower block other serious problems were observed. Commercial and operable noncommercial forest areas appear to be undergoing gradual site deterioration. Very little regeneration was observed even where seedbeds were favorable. It appears that the coincidence of good seed years and a favorable seedbed (caused by flooding) are not as frequent as needed.

We cannot back these observations with facts but the stand situation in that area seems to fit the above premise. Most white spruce in the lower Kuskokwim are about 200 years old with only a thin scattering of younger age trees. Openings created by dying trees were being filled in by alder brush as illustrated in figure 5. This was the case even where fresh layers of silt were found. Zasada has advanced the premise that marginal spruce stands may have wide intervals between good seed years and this may be part of the problem in western Alaska (Zasada 1970, 1972).

Figure 5.--A ground view of figure 4 illustrating heavy brush competition and low tree vigor.

Forest Area Condition

Stocking is also interpreted by area condition (see terminology for definitions). Area condition is a procedure by which the stand is classified into management opportunity categories. The first three management classes refer to managing for sawtimber, the next two would include smallwood management as well. These categories give the land manager an overall view of the need for management intensities. On the Kuskokwim, the view is fair since but 2.9 percent of the commercial forest area is in the first three classes (table 2). If smallwood is the objective, then at least 24 percent of the area is in good condition (classes 10-50) and perhaps class 60 would also be considered satisfactorily stocked for smallwood management. Twenty two percent of the commercial area rates as needing treatment to improve stocking using the smallwood management criteria. Treatment, of course, requires understanding of the effects and economics of the various management tools. This understanding, except from extrapolation from other areas, is almost totally lacking for Alaska.

Table 2--*Proportion of commercial and operable noncommercial forest land by area condition class, Kuskokwim River, Alaska, 1967*[1/]

Condition Class	Commercial forest land	Operable noncommercial forest land
	Percent	
10	.9	0.0
20	0.0	0.0
30	2.0	0.0
40	5.2	10.8
50	15.7	22.5
60	54.3	33.8
70	21.9	32.9
Total	100.0	100.0

[1/] Actual acreages can be found in table 16.

NONCOMMERCIAL FORESTS

Inoperable Forests

Although we extended our inventory into the noncommercial forest area, we really examined only the best of this class. The inoperable noncommercial acreage was checked only when a photo-point reexamined in the second stage of our sample was thought to be commercial or noncommercial operable forest land, thus needing a ground check. On the upper Kuskokwim block, noncommercial stands are in the main composed of black spruce and tamarack with occasional stands of aspen and birch on droughty sand dunes adjacent to the river. As portrayed by figure 6, these are areas of small, short trees with a high number of stems per acre.

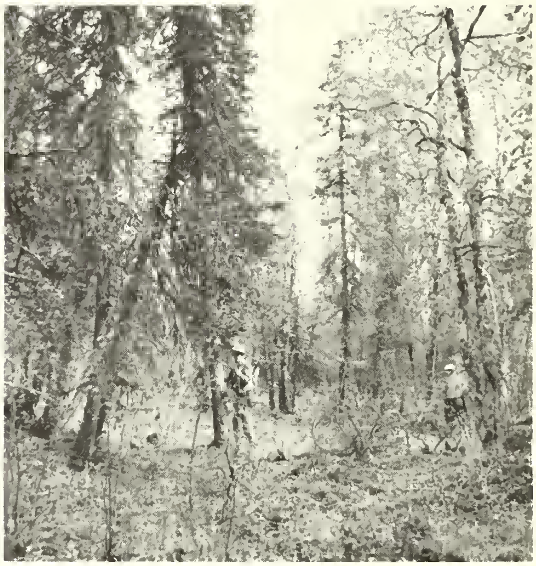

Figure 6.--Although this scene may not appear to be significantly different than that of figures 4 and 5, volume per acre was but 440 cubic feet. Tree height was the major difference. This stand averages only 33 feet versus 54 feet in the operable stand.

The lower Kuskokwim noncommercial stands also have this type of stand characteristics but with fewer stems per acre. These stands are usually on side hills adjacent to the river and are mainly birch (fig. 7). They occur on what are apparently burned over areas and the trees were found to be extremely short (15 to 30 feet) in relation to their diameters (5 to 8 inches) and age (50 to 60 years).

The volume of timber in the noncommercial stands can only be an estimate. We know the stand average to be between 0 and 799 cubic feet. At an

Figure 7.--Cold winds from the Bering Sea may be the major reason for the slow growth of this birch stand. Diameters are 4 to 8 inches, maximum height of 30 feet with an age range of 50 to 70 years.

average volume of 300 cubic feet per acre, the 551.4 thousand acres of noncommercial forest land would carry 165.4 million cubic feet of timber.

Operable Noncommercial Forests

The stand size distribution, shown in table 3, is only for sawtimber and poletimber. Our 800-cubic foot minimum for operable noncommercial forest land essentially eliminates the seedling-sapling and nonstocked classes as they would rarely have the minimum standing volume.

The acreages of sawtimber and poletimber in the two blocks confirm our impressions of the area. The upper Kuskokwim noncommercial stands appeared to have more stems per acre than commercial stands and this is shown in the high proportion of poletimber stands. The lower Kuskokwim stands appear to be overmature and stagnant. Generally, this would mean larger diameters with fewer stems per acre and a high proportion of sawtimber stands.

Table 3--*Area of operable noncommercial forest land, by stand-size class, by forest type, and by block, Kuskokwim River, Alaska, 1967*[1]

(Thousand acres)

Stand-size class	BLOCK Upper	BLOCK Lower	Total
Sawtimber	14.8	17.9	32.7
Poletimber	27.2	10.5	37.7
Forest type			
Balsam poplar	2.6	--	2.6
Black spruce	2.6	--	2.6
Paper birch	18.3	2.8	21.1
White spruce	18.5	25.6	44.1

[1] Additional tabular data for operable noncommercial stands can be found in the tables at the back of this publication.

The significant difference between blocks by species distribution is the overwhelming dominance of white spruce in the lower block as compared to the balance between birch and white spruce in the upper block. White spruce seems to be the only one of our four commercial species that can grow successfully to any size under the adverse conditions of the lower Kuskokwim. Although balsam poplar may have wider area distribution, it rarely reaches merchantable size at the extremes of its range, but assumes a shrub characteristic; whereas white spruce maintains tree form until its range limit is reached.

About 60 percent of operable noncommercial forest area of 73,390 acres is in the upper Kuskokwim block, and the proportions of hardwoods, softwoods, poletimber, and sawtimber occur in the upper block in roughly the same ratio. Cubic-foot volume per acre is considerably higher on the upper Kuskokwim (1,056 vs. 760) but board-foot volumes per acre are reversed (1,785 vs. 2,130), reflecting the high proportion of sawtimber stands on the lower Kuskokwim.

Growth in these noncommercial operable stands averages 12.9 and 6.5 cubic feet per acre per year for the upper and lower blocks respectively. Annual softwood increment totals 427 thousand cubic feet and hardwood increment 297 thousand cubic feet.

COMMERCIAL FOREST LAND

Area

Commercial forests cover 252.5 thousand acres or about 20 percent of the inventory unit. This acreage, as shown in table 4, is mostly in the upper block. With this concentration of commercial forest land in the upper block, it follows that most of the discussion in this report applies to that area. However, the lower block use and potential cannot be dismissed since in the past 10 years or so most of the cutting and milling has occurred in that area. This lower block of timber is closest to Bethel--the only market on the river of any consequence.

The concentration of timber in the upper block is a result of the river flow rates and patterns as well as climate. The upper Kuskokwim originates in the northernmost part of the Kuskokwim Mountains a little over a 100 miles west-southwest of Fairbanks. Although relatively fast flowing, it is a very meandering river, with the meander loops growing more and more exaggerated until it swings west and cuts through the Kuskokwim Mountains on its way to the Bering Sea. The lower Kuskokwim is a relatively straight-flowing river except for a stretch of islands and meanders below Aniak. Consequently, there is more active cutting and filling with new soil and good drainage on the upper reaches of the river and this is where most of the better forests are found.

Table 4--*Area of commercial forest land by stand-size class, by softwoods and hardwoods, and by block, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Stand-size class	Upper			Lower		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
Sawtimber	142.6	111.4	31.2	16.0	13.1	2.9
Poletimber	69.9	21.1	48.8	0.0	0.0	0.0
Seedling-sapling	16.7	1.9	14.8	0.0	0.0	0.0
Nonstocked	5.6	0.0	5.6	1.7	0.0	1.7
Total	234.8	134.4	100.4	17.7	13.1	4.6

Harsh climatic conditions undoubtedly limit hillside growth on the lower block where most stands growing away from river drainage influence are stunted (fig. 7). On the upper block with its milder climate, hillside stands rivaling bottomland stands are found at numerous locations. Starting from the north, areas with extensive stands are: the East Fork Hills (unfortunately just outside the inventory area), a range of hills on the north side of the river between Medfra and McGrath, and from McGrath to Stony River stands are found on favorable aspects (figs. 9, and 10) on the west side of the river.

Figure 8.--Loops, meanders, and oxbows are typical of most of the Kuskokwim River east of the Kuskokwim Range.

Figure 9.--Hillsides with other than northerly exposures have the potential for commercial forest growth. This view of a hill south of McGrath shows almost complete forest cover--some with commercial potential.

Figure 10.--A ground view of a commercial site located on the hill slope shown in figure 9.

These differing growing conditions are also reflected in the stand-size structure shown in table 4. The upper block has a normal distribution for natural stands whereas the lower block is completely without poletimber or seedling-sapling stands. Although we may have missed seeing or sampling these size classes, we feel this deficiency to be a true picture for the lower Kuskokwim.

Current regeneration studies in the Fairbanks area will probably be directly applicable to the upper block of the Kuskokwim as soils and climate do not differ appreciably. If good seed years are sporadic but predictable, it would seem that adjustments in cutting cycles or emphasis on seedbed preparation prior to a good seed year might become part of a silvicultural practice aimed at white spruce regeneration.

This concern with regeneration could well be ignored if white spruce loses its preferred status in the market and management shifts to hardwood instead. Wildfires have in the past burned extensive areas in this drainage, although most burns lie outside of the present inventory area. Table 4 shows 5,600 nonstocked acres in the upper block, most of which is fire origin. After fire, we usually can expect an immediate regeneration of hardwoods.

Cubic-Foot Volume

As could be expected from the foregoing area descriptions, a majority of the commercial volume is also concentrated in the upper block. Total unit volume is 343.0 million cubic feet, 93 percent of which, or in nearly the same proportion as commercial forest land occurrence, is found in the upper area (table 5).

Tree measurement data were collected concurrently at the inventory field sample locations, and volume equations were developed specifically for this inventory unit (Dippold and Farr 1971). Cubic- and board-foot volumes in this publication are expanded from those equations.

Softwood volume, most of which is in the white spruce type, comprises over 70 percent of the total unit volume and, as seen in table 4, also makes up a significant portion of the hardwood type volume.

The effects of concentrating our efforts in the river bottom stands are strikingly apparent in per acre volume comparisons. The reconnaissance inventory reported an average of 1,500 board feet per acre for the interior area. For the Kuskokwim unit this per acre average is 4,400 board feet with averages of 1,200 feet and 6,700 feet for hardwood and softwood types respectively.

Total unit sawtimber volume is 1.1 billion board feet (table 6). The white spruce type has about 80 percent of this

Table 5--*Net cubic volume of growing stock on commercial forest land by local forest type and by softwood and hardwood, Kuskokwim River, Alaska, 1967*

(Thousand cubic feet)

Forest type	Species group		
	Total	Softwood	Hardwood
Spruce	247,908.7	214,703.6	33,205.1
Birch	57,066.3	24,622.2	32,444.1
Balsam poplar	38,039.5	8,256.8	29,782.7
Total	343,014.5	247,582.6	95,431.9

Table 6--*Net board-foot volume on commercial forest land by forest type, and by softwood and hardwood species groups, Kuskokwim River, Alaska, 1967*

(Thousand board feet)

Forest type	Species group		
	Total	Softwood	Hardwood
White spruce	889,387.1	855,202.9	34,184.2
Paper birch	104,511.6	92,404.9	12,106.7
Balsam poplar	117,945.4	39,403.5	78,541.9
Total	1,111,844.1	987,011.3	124,832.8

sawtimber volume and as a species makes up about 90 percent. The hardwood species would become increasingly important in a small wood economy because of their characteristics of prolific seeding and sprouting. With their naturally shorter rotation more fiber can be produced per acre over time (Farr 1967, Gregory and Haack 1965).

Forest Types

Classification by forest type at a field plot location is based on the species forming a plurality of the live-tree stocking. The photointerpretation strata are adjusted by the field plot corrections and an expansion factor is calculated for the adjusted strata to develop forest type tables (table 7).

WHITE SPRUCE

White spruce in the Kuskokwim Valley occurs as an essentially pure type with but a minor hardwood component. Average volume per acre in this type is about 1,700 cubic feet, about one-fifth of which is composed of hardwoods. Average net board-foot volume is about 6,700 feet per acre with a maximum of 18,000 feet in sampled strata. Volumes per acre in the upper block are about 400 cubic feet per acre higher than those in the lower block. Figures 4 and 6 are aerial views of stands typical of the two blocks and illustrate the stocking differences and the related volume levels.

On both the upper and lower blocks, white spruce occupies a subclimax position. While white spruce is the climax "commercial species," it is eventually replaced by black spruce which in time becomes nonforest (Viereck 1970). This successional trend for the Kuskokwim is illustrated by figure 11. The rivers are constantly depositing on their inner bends. Willow and sometimes balsam poplar are the pioneer species with dense bands of willow being the normal development. Balsam poplar develops under the willow and eventually overtops it. As the willow begins dying out, white spruce invades the opening and over time outgrows or overtops the balsam poplar. During this time, permafrost has been moving closer to the surface and, with the increasing insulating litter and moss layer, white spruce is eventually frozen out and replaced by black spruce or brush and muskeg.

Although the best stands of white spruce and balsam poplar are mostly found on inner bends of the river (fig. 12), extensive commercial white spruce stands were also noted on south- and southwest-facing slopes on the hills between Medfra and McGrath and less continuous stands from Vinasale to the Stony River area. West of the Kuskokwim Mountains, the spruce stands found within a 20-mile

Table 7--*Area of commercial forest land by forest type and by block, Kuskokwim River, Alaska, 1967*

Forest type	Block		
	Total	Upper	Lower
White spruce	147.6	134.5	13.1
Paper birch	58.2	58.2	0.0
Balsam poplar	39.4	36.5	2.9
Nonstocked	7.3	5.6	1.7
Total	252.5	234.8	17.7

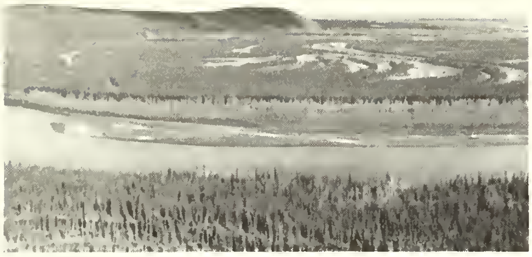

Figure 11.--Successional patterns from primary willow through forest land to nonforest bogs are shown in this view of a large sweeping bend in the Kuskokwim.

Figure 12.--White spruce with diameter to 24 inches d.b.h. were found in this spruce-birch stand near Medfra.

radius of Aniak are but marginally commercial.

Growing-stock volume in the white spruce type is 248 million cubic feet, about 70 percent of the total unit growing-stock volume (table 7). Volume of sawtimber is 889 million feet or 80 percent of the total sawtimber volume (table 6). The diameter group distribution, (table 8) shows white spruce species rather than type distribution. The proportions of white spruce volume by species and by type are nearly the same and probably have a comparable diameter group distribution.

Table 8--*Proportions of total cubic- and board-foot volumes for white spruce on commercial forest land by diameter groups, Kuskokwim River, Alaska, 1967*

Kind of volume	Diameter groups (inches)				
	5.0-8.9	9.0-12.9	13.0-16.9	17.0-20.9	21.0+
	- - - - - - - - -Percent- - - - - - - -				
Cubic foot--growing stock trees[1/]	18.5	37.9	29.3	11.2	3.1
Cubic foot--sawtimber[2/]	--	46.5	35.9	13.8	3.8
Board foot[3/]	--	42.1	38.1	15.4	4.4

[1/] Includes the total cubic volume distribution of this species.

[2/] Represents cubic volume in sawtimber-sized trees only.

[3/] Represents the distribution of board feet (Int 1/4") by diameter classes.

BALSAM POPLAR

On freshly deposited river alluviam, balsam poplar and willow are the primary invader species, but more commonly balsam poplar is found coming in under the willow. The aerial view in figure 13 illustrates the successional stages. In the Kuskokwim drainage the better stands are found in the upper block, particularly in the McGrath area and upriver and, except for a few instances, balsam poplar is confined to alluvial areas. Figure 14 illustrates one of these stands. As shown in tables 8 and 9, balsam poplar does not on the average attain as large diameters as white spruce.

Figure 13.--This low level view of successional stages in cottonwood is unusual in its total absence of spruce and of continuing brush competition. With this condition, this site may never produce a commercial spruce crop but continue degrading to nonforest.

Figure 14.--Balsam poplar stands on the Kuskokwim are generally well stocked. This stand has 173 square feet of basal area per acre, average diameter of 9.6 inches, average total height of 66 feet, and a volume of 3,300 cubic feet per acre.

Table 9--*Proportions of total cubic- and board-foot volumes for balsam poplar on commercial forest land by diameter groups, Kuskokwim River, Alaska, 1967*

Kind of volume	Diameter groups (inches)				
	5.0-8.9	9.0-12.9	13.0-16.9	17.0-20.9	21.0+
	- - - - - - - -	- -	-Percent-	- - - - - - -	- -
Cubic foot--growing stock trees1/	46.0	23.8	25.4	4.3	.5
Cubic foot--sawtimber2/	--	44.2	47.0	7.9	.9
Board foot3/	--	42.5	47.5	8.8	1.2

1/Includes the total cubic volume distribution of this species.

2/Represents cubic volume in sawtimber-sized trees only.

3/Represents the distribution of board feet (Int 1/4") by diameter classes.

Nearly half of the total cubic-foot volume is in pole-sized trees, and less than 5 percent is in trees with 17.0-inch d.b.h. and over. This relationship also holds for sawtimber-sized trees where over 90 percent of the volume is in trees less than 17.0 inches in diameter.

Total volume in the balsam poplar type is 38 million cubic feet or 118 million board feet which equals about 11 percent of the total unit volume. The majority of this volume is found in the upper block.

PAPER BIRCH

Nearly all valley bottom stands of the birch type have large proportions of spruce and balsam poplar. Only on the hillsides, in particular the area from McGrath to Stony River, did we note relatively pure stands of birch or birch with balsam poplar and quaking aspen in mixture (fig. 10). Considerable areas of birch type were noted in back of the balsam poplar and spruce meander bands, but most of these stands were very marginally productive.

The upper block contains all of the birch-type commercial forest acreage and volume. The birch stands of the lower Kuskokwim were all noncommercial. The 58,200 acres in the commercial birch type carry 57.1 million cubic feet or 104.5 million board feet of volume. Most birch volume is in the smaller diameter classes as shown in the species volume distribution table 10.

The concentration of volume in the smaller diameter classes illustrates the impracticality of planning a purely sawtimber harvest in the birch type. However, as mentioned previously, regeneration of birch is quite rapid and with seedbed preparation two rotations of pulp-size birch might be grown before a comparable spruce stand would reach sawtimber size.

Table 10--*Proportions of total cubic- and board-foot volumes for paper birch on commercial forest land by diameter groups, Kuskokwim River, Alaska, 1967*

Kind of volume	Diameter groups (inches)				
	5.0-6.9	9.0-12.9	13.0-16.9	17.0-20.9	21.0+
	- - - - - - - - Percent - - - - - - - -				
Cubic foot--growing stock trees[1/]	87.6	9.1	3.3	0.0	0.0
Cubic foot--sawtimber[2/]	--	73.0	27.0	0.0	0.0
Board foot--[3/]	--	71.4	28.6	0.0	0.0

[1/] Includes the total cubic volume distribution of this species.

[2/] Represents cubic volume in sawtimber-sized trees only.

[3/] Represents the distribution of board feet (Int 1/4") by diameter classes.

Quality-Log Grade

WHITE SPRUCE

White spruce was graded under "Official Grading Rules for Northern Hardwood and Softwood" (Northern Hemlock and Hardwood Manufacturers Association 1959). A relatively high 10 percent of the spruce volume is in grade 1 and 2 logs (requiring a 16-inch and a 12-inch small-end scaling diameter respectively) with 74 percent in grade 3 (requiring an 8-inch scaling diameter)(table 11). Although most trees failed to qualify for the upper two log grades because of small size, limbiness, a characteristic of white spruce in Alaska, also contributed heavily to degrade.

The volume in grade 1 and 2 logs is 97.8 million board feet or about 660 feet per acre for the type. We believe that most of this higher grade material is concentrated in the stands above McGrath.

BALSAM POPLAR AND BIRCH

Birch and cottonwood were graded according to "Hardwood Log Grades for Standard Lumber" (Forest Products Laboratory 1959). The specifications for these grades are correlated closely with specifications for hardwood lumber grades. Grade 1 logs require a 13-inch and grade 2, an 11-inch inside-bark, small-end scaling diameter, requiring trees of 16- and 14-inch d.b.h. and larger, respectively, to meet these minimum diameters. This is assuming a 1-inch bark thickness and a 2-inch taper in 16 feet.

Under this criteria, none of the birch qualifies for grade 1 and only 4 percent for grade 2. Balsam poplar is a little better with 5 percent and 28 percent of the total species volume qualifying as grade 1 and 2 respectively. The volume in hardwood grades 1 and 2, however, represents less than 3 percent of the total unit volume or, assuming it all to be in hardwood types, less than 350 board feet per acre. As a species it is probably safe to assume that birch could not attain a use level equal to balsam poplar and white spruce. Views of felled trees in figures 15 and 16 show the quality to be expected in balsam poplar and white spruce.

Growth

Net annual growth of the Kuskokwim stands is 4.5 million cubic feet and 29.4 million board feet. This represents a growth rate of 1.3 percent of the net cubic-foot growing-stock volume and 2.6 percent of the net board-foot volume. These growth rates are significantly lower than those for other areas we have inventoried.

Table 11--*Proportions of sawtimber, net board-foot volume by species and by quality class, Kuskokwim River, Alaska, 1967*

Log Grade	White spruce	Balsam poplar	Paper birch	Total volume proportion
	Percent			
1	0.5	4.8	0.0	0.8
2	9.5	28.1	4.2	10.9
3	74.0	52.6	74.5	72.2
[1/] 4	16.0	14.5	21.3	16.1
Total	100.0	100.0	100.0	100.0

[1/] Grade 4 logs are those below minimum standards for grade 3, but not cull.

Figure 15.--A 12-inch balsam poplar felled for volume table construction. This species is generally self pruning. Degrade is usually caused by failure to meet minimum size requirements for log grade 1 and 2.

Figure 16.--This spruce sawtimber stand displays the combination of limbiness and small size that contributes to the high proportion of volume in the lower log grade.

A comparison of growth rates by species does not appear significant as both spruce and birch are about the same and balsam poplar a little higher. Inspection by d.b.h. classes (table 12) shows the most rapid growth rate in the 5.0- to 6.9-inch d.b.h. class, with a general leveling out through the remainder of the diameter classes. Unfortunately, ingrowth (total volumes of trees moving into the 5.0-inch class) complicates this picture. Without ingrowth, the actual growth of trees in the 5.0- to 6.9-inch d.b.h. class is only slightly higher than the larger diameter classes.

Table 12--*Rate of growth as a percent of net cubic growing-stock volume, by species and diameter classes, Kuskokwim River, Alaska, 1967*

Species	All diameters	Diameter classes								
		5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21+
		Percent								
White spruce	1.25	4.4	1.1	1.2	1.1	1.0	.9	1.1	.5	1.0
Paper birch	1.15	2.1	.9	.5	1.0	.7	--	--	--	--
Balsam poplar	1.86	4.0	1.8	1.3	1.6	1.9	1.9	3.7	0.7	1.0
All species	1.30	3.4	1.1	1.1	1.2	1.1	1.0	1.3	0.7	1.0

Earlier discussions about the effect of low stocking, inhibiting vegetation, and overmature stands were concerned mostly with the present stand volume. This same discussion can also apply to growth. Holes in the stand and overmature conditions show in the 17.8 mean annual increment rate for all commercial forest lands. If the data were available for the better stocked stands, it is quite likely the actual mean annual increment for those stands would exceed 20 cubic feet per acre.

Volume Loss--Defect

Field estimates were made of the amount of rough or rotten material in the tree. The use of log volume distribution tables and our practice of felling trees for volume table construction at each plot enabled us to make reasonably accurate estimates of volume loss caused by defect.

As an example of on-the-ground knowledge gained through tree felling: when balsam poplar is found growing in anything less than the dominant or codominant crown position, there will be substantial amounts of decay--even though there are no surface indicators. White spruce also showed few indicators of rot. Figure 17 is an example of a tree appearing to be sound but having heart rot. We were able to determine, through tree sectioning that this type of decay usually does not extend more than 4 to 6 feet up the bole. Common decay organisms causing extensive damage include *Fomes igniarius* and *F. applanatus* in birch, aspen, and cottonwood; *Polyporus resinosus* in birch; and *F. pini* and *Peridermium coloradense* in spruce (Kimmey and Stevenson 1957).

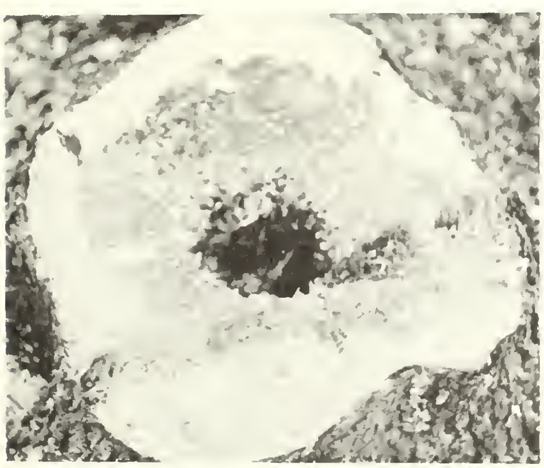

Figure 17.--No evidence of decay was externally visible on this white spruce. Fortunately this type of rot usually extends up the bole less than 6 feet.

The importance of loss caused by roughness and decay can be seen by comparing appendix tables 15 and 16. Board-foot reductions from gross volume amount to 7, 18, and 19 percent of spruce, balsam poplar, and birch respectively. This is a total volume loss of 100 million board feet.

Volume Loss--Mortality

Estimating the number of years since a tree died seems to be quite subjective and variable. The mortality rate for all Kuskokwim stands is but 0.1 percent of the net cubic-foot growing-stock volume. Actual annual volume loss was 382.6 thousand cubic feet and 956.4 thousand board feet. The mortality rate for the Kuskokwim is much less than that of the Susitna Valley (Hegg 1970) and but one-tenth of the rate for similar areas in the continental U.S. (U.S. Department of Agriculture Forest Service 1965). Future remeasurements should improve on these estimates, although in the Susitna Valley several plots have been remeasured and the calculated mortality rate is not significantly different from previous estimates (File letter March 8, 1972, 4810 2-1.0, Forestry Sciences Laboratory, Anchorage, Alaska).

ALLOWABLE CUT

Definitive knowledge of ownership and management objectives, as well as the timber resource itself, are prerequisites to allowable cut determination. The ownership and management responsibility of the forest lands along the Kuskokwim River will be constantly changing during the ensuing few years because of continuing State land selections and the Alaska Native Claims Settlement Act. Management objectives cannot be outlined, except in a broad sense, until definitive knowledge of the other resource values (recreation, wildlife, fisheries, etc.) are obtained. Because of these and other unknowns, any estimate of allowable cut must be tentative.

The Kuskokwim drainage contains both commercial and noncommercial forest lands. By definition, to be commercial a stand must be capable of producing wood fiber at an annual rate of at least 20 cubic feet per acre. Although this standard is somewhat arbitrary, it serves to delineate those lands on which sustained yields are most feasible.

One class of forest land that deserves mention is the "operable noncommercial." These are the areas presently having more than 800 gross cubic feet of volume per acre, but do not meet the "commercial" standard of 20 cubic feet per acre annual growth. Put another way, these lands contain a "sufficient" volume for logging, but likely will not produce and grow at a rate sufficient for prudent sustained yields. Additonal research is needed on the silvics of these stands before any truly informed judgments can be made relative to their sustained yield characteristics. The "White Spruce Silvicultural Study," headed by the U.S. Forest Service, Institute of Northern Forestry and principally funded by the Bureau of Land Management should provide some of this needed information.

The allowable cut calculation for the commercial forest lands is a conditioned one because none of the "take-outs" for watershed protection, fisheries and game habitat, recreation, esthetics, etc. have been determined through comprehensive land use planning. Until such plans are formulated, the allowable cut is tentative and subject to change as need is determined.

An annual allowable cut of 4.6 million cubic feet (16.3 million board feet) would be possible for the Kuskokwim River drainage if all the commercial forest land were committed to timber production and economically accessible. Under existing log export restrictions it is questionable if any of this resource would be economically accessible for external markets. The total allowable cut was calculated using the following formula:

$$\text{Annual cut} = \frac{\text{Present commercial forest land volume + MAI}}{\text{Rotation}}$$

Where: MAI = net annual growth and rotation was taken from empirical yield tables (122 years).

A number of differing formulas are available to make estimates of annual cuts. One of these, the Kemp formula, has been used in Alaska in the past because of its ease of application with available Forest Survey data. This formula is marginally applicable to the Kuskokwim because it is usually applied in areas where there is a surplus of timber beyond rotation age. The volume obtained using the Kemp formula is approximately 6.05 million cubic feet (21.5 million board feet) or about 30 percent above that calculated with the MAI formula.

The interior forest allowable cut volumes reported by the U.S. Forest Service in 1967 were computed using the Kemp formula (Hutchison 1967). The crossover between the above calculations and the 1967 report is poor at best because the latter data is not statistically accurate for the Kuskokwim alone.

FOREST USES

Timber Products

The forests along the Kuskokwim River have provided the essentials of life--food, heat, shelter--to natives since the time of first human habitation. Early white settlers came to this valley in search of furs and gold. Prior to 1900, wood use was for heat and logs for building cabins. The gold stampede in 1908 resulted in a dramatic increase in the number of people using the forest resources of the region (Berg 1965). Fuelwood to fire the boilers of the increased river-steamer activity, timbers for use in the mines, fuel for the mine steam-donkey engines, logs for building, and fuelwood for heat are uses that dramatically increased during this period. By 1914 the gold stampede was over and the use of the region's forests decreased (Berg 1965).

Several small portable sawmills are located in the area and have intermittently produced rough lumber for local use (fig. 18). Bureau of Land Management files[3/] show 19 sales containing 897 MBF were made during the 4 years of 1965-1968. During this same period, 14 free-use permits containing 83 MBF were issued.

[3/] Bureau of Land Management files on timber sales located at the Anchorage District Office.

Figure 18.--The Nelson Brothers sawmill above Aniak. Although this operation is in an area of marginal commercial forest land, it is sited here because of relative proximity of markets.

At present, the principal use of the Kuskokwim timber resource is for fuel--8 to 12 cords of wood are required for each cabin heated because of the long, cold winters. This use is decreasing due to the increased use of fuel-oil heaters. In addition, logs for houses (fig. 19), poles for fish-drying racks, fish wheels, and dog sleds come from the forests. A recent sale of 311 MBF of white spruce was made by the BLM with a local sawmill. This sale is located about 18 miles above Stony River.

Economic incentives for large-scale development of the Kuskokwim timber resources were lacking until early 1963 when an Alaskan corporation applied to the Bureau of Land Management for purchase of 715 million board feet, Scribner log scale, of white spruce over a 20-year period. This corporation had established a market in Japan for round logs and intended to export all that would be cut.[4/] The application was not approved by BLM on the grounds that the Kuskokwim valley could not sustain a cut of this magnitude. Statistically accurate information was lacking, however, prompting BLM to cooperate with the U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, in an inventory of the forest resources of this valley so that an accurate determination of sustainable allowable cuts could be made.

[4/] Bureau of Land Management, Anchorage District Timber Sale File No. LS/N 031740.

Figure 19.--Because of availability, cost, and good insulation value many homes in the Aniak area are built of these three-sided logs.

Recreation

Recreation use of the Kuskokwim Valley is presently confined to fly-in sport fishing and hunting. Several of the clearwater streams feeding the Kuskokwim River support sport fish populations.

A road system roughly following the Kuskokwim River has been considered in some long range planning. Actual construction is probably 20 or more years away. If such a road is constructed, the recreation use of the Kuskokwim area will undoubtedly increase.

Livelihood and Subsistence Use

The wildlife and fish resources in the past were the foundation of the economy of the region. The Natives depended upon these resources for food, clothing, and cash income. Today, the need for cash is being satisfied in part by seasonal employment, and more frequently individual families tend to depend upon the resources as a secondary rather than a primary source of food and income (Federal Field Committee 1968). Although an important amount of their subsistence comes from the environment, they purchase the bulk of their food needs from stores (Federal Field Committee 1968).

Timber harvesting operations, if properly executed, should not degrade the opportunities for subsistence use of fish and wildlife resources of the Kuskokwim drainage. With proper attention to season of logging, cutting methods, cutting boundaries, and equipment employed, the subsistence uses should at least be maintained.

Conflicts (a brief summation)

Identification of potential land uses that would conflict with the utilization of a renewable resource like timber requires a time and space discussion. Alternative uses, to be in conflict, must demand land use not only for the same acre, but also at the same time. For example, timber could be totally harvested now from the same acres that in the future would be developed for intensive recreation use, provided that the intended recreation development is far enough into the future to allow stand reestablishment. Obviously, the regeneration characteristics of the species in question must be known as the time frame for recreation development.

Logging practices that tended to degrade or destroy fisheries habitat along the several freshwater streams would seriously affect the existing fisheries resource (fig. 20). These areas should be identified so that future activities can be carried on with full recognition of these other values.

Subsistence use of the Kuskokwim Valley is not particularly compromised by timber harvest. Fuelwood needs can be accommodated adjacent to towns and villages and subsistence fisheries and hunting can be protected and enhanced.

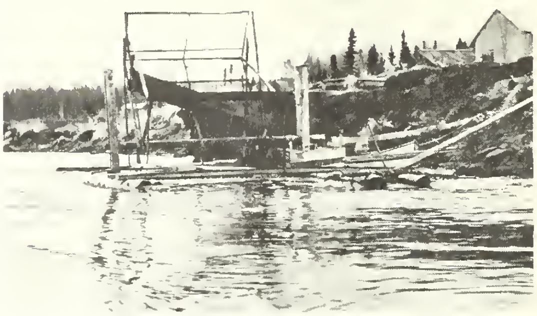

Figure 20.--The movement of the river current operates this fish wheel at Medfra. Salmon swimming upriver are caught in the bail and automatically transferred to a holding box.

Kuskokwim Timber--Present and Future Interest

The Alaska Native Claims Settlement Act has effectively curtailed any potential timber harvesting activities of substance along the Kuskokwim River. Small sales such as the contract for 311 MBF above Stony River have been allowed by the Native groups. The timber involved has been used to satisfy internal demand.

A recent study indicates that the total of the annual local demand along the upper Kuskokwim River is approximately 2 million board feet.[5] The unavailability of dried,

[5] Kay Koweluk, Local market demand for timber products in the middle Yukon and upper Kuskokwim Rivers, 26 p. Fed. Field Comm. for Dev. Plann. in Alaska. Anchorage. 1970. Unpublished.

surfaced, and graded native lumber and the unreliability of supply has influenced purchasers to prefer imported brand-name Douglas-fir for construction grade or better, kiln dried and surfaced, for their construction purposes. This preference would be temporary if native material were available and could meet construction specifications and timetables (see footnote 5).

Utilization

In order to capture some share of the local and export markets for timber products, suppliers must be competitive in price, supply, and quality with alternative sources. Most sawmills depend on regular and large volume production for profits. For local markets, a lack of economies of size can be partly or wholly offset by the transportation advantage local mills enjoy over external suppliers.

The Kuskokwim Market

One of the impediments to the development of lumber produce manufacturing as a viable economic base in the Kuskokwim is the large investment required on the part of the millowners to produce finished dimensional lumber for a relatively small market. In the past, project construction, such as the Bethel Housing project, had requirements for kiln-dried dressed lumber for typical 2 x 4 framed-wall construction. These requirements make it very difficult for local manufacturers to supply a project.

The Kuskokwim Forest Resource Committee has recommended that future project house designs be planned with a greater use of local materials fitting the manufacturing capabilities of the local sawmill operations (Federal Field Committee 1968). The use of three-sided house logs in place of conventional 2 x 4 framed walls is cited as an example. This would greatly increase the local manufacturers share of the local market.

Another necessity for increasing the local share of the Kuskokwim market is a dependable method of moving products to market. At present, the only economical transportation for timber products is the river barges. Service is restricted to the ice-free months. Even then, low water can curtail operations because of shoals and sandbars.

One new development that may have potential for providing year-round transportation for the Kuskokwim is the Air Cushion Vehicle (ACV). Several companies are working to develop ACV's with payload capacities of 100 tons, ranges of up to 1,000 miles, and speeds up to 60 mph. The transportation costs per ton-mile are not well known yet because of the newness of this mode of transportation, but the developers are optimistic that it will be competitive.[6/]

The Export Market

Local enterprises that have difficulty competing for a larger share of a Kuskokwim market are faced with even larger obstacles in trying to capture a share of export markets, mainly because of transportation costs. The greatest potential external market for forest products from the Kuskokwim probably is Japan.

Assuming a market exists in Japan for cants produced by mills in the Kuskokwim drainage, and further that a net[7/] allowable cut of 12 million board feet per year would be allowed by the managing agencies, we can analyze the potential of this area to compete for this external market by comparing it to the existing situation in Haines, Alaska, where cants are presently sawn for shipment to Japan. As noted earlier however, local mills would also have to solve transportation problems to Bethel plus maintaining a steady flow of material.

The timber resources of the Kuskokwim drainage, to compete with the other sources of supply for a share of the cant market in Japan, would have to be available at similar f.o.b. dock prices. Transportation of logs or cants down the Kuskokwim River from McGrath to Bethel (the closest potential large ship port) in rafts towed by tugs would cost about $20.00 per MBF, plus bundling and rafting. Movement via air cushion vehicle at 6 cents per ton-mile[8/] would cost about $43.00 per

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6/ Testimony before the Alaska Transportation Commission, Anchorage, Alaska, January 1971, Docket No. 70-364-ACV.

7/ Net refers to the 16.3 million board feet allowable cut referred to elsewhere in this report less the "take-outs" necessary to protect other resource values.

8/ Testimony before the Alaska Transportation Commission, Anchorage, Alaska, January 1971, Docket No. 70-364-ACV.

MBF plus loading and unloading costs. Logging, sawmilling, fixed and miscellaneous costs would add an additional $25.00 to $50.00 per MBF. Difficulty in obtaining economics of scale in the milling and logging operations when only 12 MMBF of timber (assumed) are available per year will likely push these costs toward the higher range of figures. Unless product prices increase significantly, these factors plus the harsh environment-inflicted costs will make capture of a share of the cant market questionable. Thus, the future use of the forests of the Kuskokwim drainage may be confined to supplying local demands. The small annual allowable cut and the high cost of the factors of producing to supply any external market in relation to alternate sources forces this conclusion.[9]

SURVEY METHODS

The estimates of area and timber volumes are based on a double sampling procedure (Bickford 1952). Enough points to satisfy specific levels of statistical precision were uniformly distributed on aerial photographs. At each of these photo points, 1 acre was classified by land type, forest type, and volume strata. A subsample was drawn from all land types and reexamined. All points in the subsample which were originally classified as commercial forest land as well as any other points questionably classified were visited on the ground.

[9] Harold P. Sieverding, Economist, Bureau of Land Management, Alaska State Office, Anchorage.

For the Kuskokwim unit we interpreted 6,452 photopoints and reexamined 122 noncommercial and nonforest points. This reexamination served as a substitute ground check and yielded eight questionable points which, with the 162 commercial forest and operable noncommercial points, totaled 170 locations actually checked on the ground. The ground plot was located at the exact point established on the photo. At each ground location, a 10-point cluster of plots was measured. A 40 basal-area factor gauge was used to select sample trees at each point for detailed measurements of size and vigor. Through data processing procedures, the total sample and the individual tree volumes were expanded to obtain the various data needed or specified on area and volume. The tables herein depart from the standard Forest Survey tables, however, with addition of a noncommercial forest category called "operable." During the initial inventory of interior Alaska, we found that much noncommercial forest land had relatively high per-acre volume. When more intensive inventories were begun in the mid-1960's, we and our cooperators agreed that some of this noncommercial strata had potential value as a commercial wood supply. By extrapolation, from cutting minimums of 3 cords per acre used in the Lake States and Canada, we established 9 cords or 800 cubic feet per acre as a prudent level for Alaska. This threefold increase in the minimum economic operating level should help compensate for the higher production and shipping costs in Alaska.

SAMPLING ERROR

The reliability of the inventory is expressed in terms of relative sampling errors.

TABLE OF SAMPLING ERROR

Specified base area and volume	Design sampling error	Sampling error achieved	Sampling error of total volume or area reported
	Percent		
Area:			
Commercial forest land, per million acres	3.0	3.0	7.0
Noncommercial forest land, per million acres	10.0	6.0	6.0
Volume:			
Commercial forest land, per billion cubic feet	5.0	5.0	8.0
Commercial forest land, growth per billion cubic feet	5.0	1.0	9.0

For the Kuskokwim River unit, we are reporting 343,014,000 cubic feet of growing-stock volume ± 8.0 percent. If repeated samples were taken of this population, the chances are two in three that this sample is one of the samples for which the true value is contained within the sample confidence interval (315,573,000 to 370,455,000).

PRINCIPAL TREE SPECIES OF INTERIOR ALASKA[10/]

Softwoods:	
Black spruce	*Picea mariana* (Mill.) B.S.P.
White spruce	*Picea glauca* (Moench) Voss
Tamarack	*Larix laricina* (Du Roi) K. Koch
Hardwoods:	
Black cottonwood	*Populus trichocarpa* Torr. & Gray
Balsam poplar	*Populus balsamifera* L.
Paper birch	*Betula papyrifera* Marsh.
Quaking aspen	*Populus tremuloides* Michx.

TERMINOLOGY[11/]

Allowable cut--The volume of timber that would be cut on commercial forest land during a given period under specified management plans for sustained production such as those in effect on National Forests.

Area condition class--Area condition class provides a general stratification of commercial forest land by management opportunity class as indicated by the stocking or area controlled by tree and cover class.

Code

10 Areas 100 percent or more stocked with desirable trees and not overstocked. Stands in this category generally do not require any treatment at present to maintain high level of growth.

20 Areas 100 percent or more stocked with desirable trees and overstocked. Stands in this category need a treatment such as thinning to produce maximum levels of growth for desirable trees.

30 Areas 60 to 100 percent stocked with desirable trees, and with less than 30 percent of the area controlled by acceptable growing-stock trees, cull trees, inhibiting vegetation, slash, or nonstockable conditions. Stands in this category generally have conditions favorable for natural improvement of stocking without special treatment.

40 Areas 60 to 100 percent stocked with desirable trees and with 30 percent or more of the area controlled by other trees (or overstocked areas) and/or conditions that ordinarily prevent occupancy by desirable trees. Stands in this category generally have little prospect for improvement in desirable tree stocking without special treatment such as thinning, cull tree removal, etc.

50 Areas less than 60 percent stocked with desirable trees, but with 100 percent or more stocking with growing-stock trees. Stands in this category generally have little prospect for improved desirable tree stocking without special treatment. Stands almost to rotation age would usually not be treated.

60 Areas less than 60 percent stocked with desirable trees, but with 60- to 100-percent stocking with growing-stock trees. Stands in this category generally have little prospect for improved desirable tree stocking without special treatment such as timber stand improvement or planting.

70 Areas less than 60 percent stocked with desirable trees and with less than 60-percent stocking with growing-stock trees. Stands in this category generally have little prospect for improved desirable tree or growing-stock stocking without treatment such as site preparation and regeneration, etc.

[10/] Scientific names are according to Elbert L. Little, Jr., Checklist of native and naturalized trees of the United States (including Alaska). Agriculture Handbook No. 41, 472 p. USDA Forest Service, Washington, D.C. 1953.

[11/] Terminology from USDA Forest Service, Forest Service Handbook, Title 4813.1, 1967.

Commercial species--Trees presently or prospectively suitable for industrial wood products.

Cull--Portions of a tree that are unusable for industrial wood products, because of rot, form, or other defect.

Cull trees--Live trees of sawtimber or poletimber size that are unmerchantable for saw logs now or prospectively because of defect, rot, or species.

Rough trees: Live trees of 5.0-inch and larger d.b.h. that do not contain a saw log now or prospectively primarily because of roughness, poor form, or noncommercial species.

Rotten trees: Live trees of 5.0-inch and larger d.b.h. that do not contain a saw log now or prospectively primarily because of rot.

Forest land--Land at least 16.7 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest use.

Commercial forest land: Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. (Note: Areas qualifying as commercial forest land have the capability of producing in excess of 20 cubic feet per acre per year of industrial wood under management.)

Noncommercial forest land: Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions (producing less than 20 cubic feet per acre per year) and productive forest land withdrawn from commercial timber use through statute or administrative regulation.

Noncommercial operable--noncommercial forest land presently carrying a gross volume in excess of 800 cubic feet per acre. Noncommercial inoperable--noncommercial forest land presently carrying a gross volume of less than 800 cubic feet per acre.

Forest types--A classification of forest land based upon the species forming a plurality of the live tree stocking.

Spruce: Forests in which a plurality of the stand is white spruce. Common associates include birch, aspen, and cottonwood.

Cottonwood: Forests in which a plurality of the stand is black cottonwood and/or balsam poplar. Common associates include white spruce and birch.

Aspen or birch: Forests in which a plurality of the stand is aspen and paper birch, singly or in combination. Common associates include black cottonwood and white spruce.

Growing-stock trees--Sawtimber trees, poletimber trees, saplings, and seedlings; that is, all live trees except cull trees.

Desirable trees: Growing-stock trees having no serious defects in quality limiting present or prospective use, relatively high vigor, and containing no pathogens that may result in death or serious deterioration before rotation age. They include the type of trees forest managers aim to grow; that is, the trees left in silvicultural cutting or favored in cultural operations.

Acceptable trees: Trees meeting the specifications for growing stock but not qualifying as desirable trees.

Hardwoods--Dicotyledonous trees, usually broad leaved and deciduous. Alaska hardwood species are paper birch, quaking aspen, black cottonwood, and balsam poplar.

Inhibiting vegetation--Cover sufficiently dense to prevent establishment of tree seedlings.

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

Land area--The area of dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tides), streams, sloughs, estuaries, and canals less than 120 feet in width; and lakes, reservoirs, and ponds less than 1 acre in size.

Log grades--A classification of logs based on external characteristics as indicators of quality or value.

Mean annual increment (MAI)--A measure of the volume of wood, in terms of cubic feet, produced on 1 acre during 1 year. Forest Survey minimum standard for commercial forest land is the ability to produce 20 cubic feet per acre per year.

Mortality--Number of sound-wood volume live trees dying from natural causes during a specified period (5 years).

Net annual growth of growing stock--The annual change in volume of sound wood in live sawtimber and poletimber trees during a specified period.

Net annual growth of sawtimber--The annual change in net board-foot volume of live sawtimber trees during a specified period.

Net volume--The gross volume of a tree less deductions for rot, sweep, or other defects affecting product use.

> Growing-stock volume: The net volume of sound wood in the bole of growing stock, cull, and salvable dead trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top outside bark or the point where the central stem breaks into limbs.

Noncommercial species--Tree species of typically small size, poor form, or inferior quality which normally do not develop into trees suitable for industrial wood products.

Nonforest land--Land that does not qualify as forest land. Includes land that has never supported forests and lands formerly forested where forest use is precluded by development for nonforest uses, such as crops, improved pasture, residential areas, and city parks. Also includes improved roads and certain areas of water classified by the Bureau of Census as land. Unimproved roads, streams, canals, and nonforest strips in forest areas must be more than 120 feet wide and clearings in forest areas must be more than 1 acre in size to qualify as nonforest land.

Nonstockable--Areas of forest land not capable of supporting forest growth because of presence of rock, water, etc.

Salvable dead trees--Standing dead trees that are considered currently or potentially merchantable by regional standards. A poletimber tree must be more than one-half sound; a sawtimber tree more than one-third sound (board measure).

Saw log--A log meeting minimum standards of diameter, length, and defect including logs at least 8 feet long, sound, and straight and with a minimum diameter inside bark for softwoods of 6 inches (8 inches for hardwoods).

Saw-log portion--That part of the bole of sawtimber trees between the stump and the saw-log top.

Saw-log top--The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw-log top is 7.0-inches d.o.b. for softwoods and 9.0-inches d.o.b. for hardwoods.

Site classes--A classification of forest land in terms of inherent capacity to grow crops of industrial wood.

Softwoods--Coniferous trees, usually evergreen having needles or scalelike leaves.

Stocking--The degree of occupancy of land by trees measured by basal area and/or the number of trees in a stand by size or age and species, compared to the basal area and/or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

> Overstocked areas: Areas where growth of trees is significantly reduced by excessive numbers of trees.

> Nonstocked areas: Commercial forest lands less than 16.7 percent stocked with growing-stock trees.

Stand-size classes--A classification of forest land based on the size class of the growing stock present; that is, sawtimber, poletimber, or saplings and seedlings.

> Sawtimber stands: Stands at least 16.7 percent stocked with growing-stock trees, with half or more of total stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands: Stands at least 16.7 percent stocked with growing-stock trees of which half or more of this stocking is in poletimber and sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands: Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the stocking is sapling and seedlings.

Tree-size classes--A classification based on the diameter of the tree at breast height (4-1/2 feet above the ground on the uphill side of the tree):

Sawtimber-size tree: Softwood tree of 9.0-inch d.b.h. and larger. Hardwood tree of 11.0-inch d.b.h. and larger.

Poletimber-size tree: Softwood tree of 5.0- to 8.9-inch d.b.h. Hardwood tree of 5.0- to 10.9-inch d.b.h.

Sapling-size tree: A tree of 1.0- to 4.9-inch d.b.h.

Seedling-size tree: A tree of less than 1.0-inch d.b.h.

Upperstem portion--That part of the main stem or fork of sawtimber trees above the saw-log top to a minimum top diameter of 4.0 inches outside bark or to the point where the main stem or fork breaks into limbs.

Water--Bureau of the Census definition: Streams, sloughs, estuaries, and canals more than 1/8 of a statute mile in width; and lakes, reserviors, and ponds more than 40 acres in area.

Water--Forest Survey definition: The same as the Bureau of the Census, except minimum width of streams, etc., is 120 feet and minimum size of lakes, etc., is 1 acre.

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Table 13--*Area of commercial and operable noncommercial forest land, by stand-size classes, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Stand-size class	Commercial	Operable noncommercial[1/]	Total
Sawtimber stands	158.6	32.7	191.3
Poletimber stands	69.9	37.7	107.6
Seedling and sapling stands	16.7	0.0	16.7
Nonstocked areas	7.3	0.0	7.3
Total	252.5	70.4	322.9

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 14--*Area of commercial and operable noncommercial forest land, by board-foot volume classes, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Stand volume per acre[1/]	Commercial	Operable noncommercial[2/]	Total
0 - 799	34.5	7.2	41.7
800 - 1,499	24.0	15.4	39.4
1,500 - 2,999	48.8	37.5	86.3
3,000 - 4,999	58.3	10.3	68.6
5,000 - 6,999	43.3	0.0	43.3
More than 7,000	43.6	0.0	43.6
Total	252.5	70.4	322.9

1/ Net volume International 1/4-inch rule.

2/ Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 15--*Area of commercial and operable noncommercial[1/] forest land, by stand-volume and stand-size classes, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Stand-volume class	Stand-size				
	Non-stocked	Seedling sapling	Poletimber	Sawtimber	Total
Cubic feet					
0 - 299	7.3	10.4	0.0	1.9	19.6
300 - 799	0.0	6.3	31.2	36.1	73.6
800 - 1,499	0.0	0.0	53.8	79.1	132.9
1,500 - 2,199	0.0	0.0	18.2	43.9	62.1
More than 2,200	0.0	0.0	4.4	30.3	34.7
Total	7.3	16.7	107.6	191.3	322.9

1/ Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 16--*Area of commercial forest land by area condition class, Kuskokwim River, Alaska, 1967*

Code	Area condition class	Thousand acres
10	Areas 100 percent or more stocked with desirable trees and not overstocked.	2.2
20	Areas 100 percent or more stocked with desirable trees and overstocked.	0.0
30	Areas 60 to 100 percent stocked with desirable trees, and with less than 50 percent of the area controlled by acceptable growing-stock trees, cull trees, inhibiting vegetation, slash, or nonstockable conditions.	5.1
40	Areas 60 to 100 percent stocked with desirable trees and with 30 percent or more of the area controlled by other trees (or overstocked areas) and/or conditions that ordinarily prevent occupancy by desirable trees.	13.1
50	Areas less than 60 percent stocked with desirable trees, but with 100-percent or more stocking with growing-stock trees.	39.7
60	Areas less than 60 percent stocked with desirable trees, but with 60- to 100-percent stocking with growing-stock trees.	137.2
70	Areas less than 60 percent stocked with desirable trees, and with less than 60-percent stocking of growing-stock trees.	55.2
All classes		252.5

Table 17--*Area of commercial forest land, by site class, Kuskokwim River, Alaska, 1967*

Site class[1]	Thousand acres
Cubic feet[2]	
50 or more	0.0
20 - 50	252.5
Total	252.5

[1] Site class is a classification of forest land in terms of inherent capability to grow crops of industrial wood based on fully stocked natural stands.

[2] Potential yield, mean annual increment.

Table 18--*Area of commercial and noncommercial forest land, by forest type, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Forest type	Commercial	Noncommercial		
		Operable[1]	Inoperable[2]	Total
Balsam poplar	39.4	2.6	0.0	42.0
Black spruce	0.0	2.6	519.2	521.8
Nonstocked	7.3	0.0	0.0	7.3
Paper birch	58.2	21.1	19.3	98.6
Quaking aspen	0.0	0.0	1.9	1.9
White spruce	147.6	44.1	11.0	202.7
Total	252.5	70.4	551.4	874.3

[1] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

[2] Inoperable noncommercial forest land has a gross volume of less than 800 cubic feet per acre.

Table 19--*Area of commercial forest land, by stand-age and stand-size classes, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Stand-age	Stand-size				
	Nonstocked	Seedling-sapling	Poletimber	Sawtimber	Total
Years					
Nonstocked	--	--	--	--	--
1 - 10	0	1.6	0	0	0
10 - 20	0	3.8	0	1.9	5.7
20 - 30	0	3.5	0	0	3.5
30 - 40	0	4.3	0	0	4.3
40 - 50	0	0	1.6	0	1.6
50 - 60	0	0	0	2.6	2.6
60 - 70	1.7	0	16.6	0	18.3
70 - 80	0	0	2.1	4.9	7.0
80 - 90	0	0	4.3	8.6	12.9
90 - 100	5.6	1.6	6.0	3.8	17.0
100 - 120	0	0	10.8	8.9	19.7
120 - 140	0	0	9.3	26.3	35.6
140 - 160	0	0	8.5	16.8	25.3
160 - 180	0	0	4.4	19.1	23.5
180 - 200	0	0	0	15.3	15.3
200 - 300	0	0	0	18.4	18.4
300 and over	0	0	0	2.6	2.6
Mixed ages	0	1.9	6.3	29.4	37.6
Total	7.3	16.7	69.9	158.6	252.5

Table 20--*Area of operable noncommercial*[1/] *forest land, by stand-age and stand-size classes, Kuskokwim River, Alaska, 1967*

(Thousand acres)

Stand-age	Stand-size				
	Nonstocked	Seedling-sapling	Poletimber	Sawtimber	Total
Years					
Nonstocked	--	--	--	--	--
1 - 10	0	0	0	2.6	2.6
10 - 20	0	0	0	0	0
20 - 30	0	0	0	0	0
30 - 40	0	0	0	0	0
40 - 50	0	0	0	0	0
50 - 60	0	0	0	0	0
60 - 70	0	0	1.9	0	1.9
70 - 80	0	0	0	0	0
80 - 90	0	0	0	0	0
90 - 100	0	0	4.9	0	4.9
100 - 120	0	0	4.3	4.3	8.6
120 - 140	0	0	4.9	2.8	7.7
140 - 160	0	0	7.4	8.3	15.7
160 - 180	0	0	2.2	2.8	5.0
180 - 200	0	0	1.9	4.2	6.1
200 - 300	0	0	2.8	4.9	7.7
300 and over	0	0	0	0	0
Mixed ages	0	0	7.4	2.8	10.2
Total	0	0	37.7	32.7	70.4

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 21--*Number of growing-stock trees on commercial forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(Thousand trees)

Diameter class	Balsam poplar	Paper birch	Quaking aspen	White spruce	Total
Inches d.b.h.					
1.0 - 2.9	2,397.8	9,473.8	66.5	8,711.1	20,649.2
3.0 - 4.9	977.9	7,654.8	0.0	6,520.1	15,152.8
5.0 - 6.9	1,097.3	5,977.7	0.0	5,860.7	12,935.7
7.0 - 8.9	1,231.4	3,737.4	133.8	5,092.2	10,194.8
9.0 - 10.9	1,137.1	1,660.8	127.2	3,543.1	6,468.2
11.0 - 12.9	687.5	452.2	0.0	2,812.8	3,952.5
13.0 - 14.9	353.3	125.1	0.0	1,499.3	1,977.7
15.0 - 16.9	132.3	11.4	0.0	846.8	990.5
17.0 - 18.9	29.2	0.0	0.0	360.9	390.1
19.0 - 20.9	18.9	0.0	0.0	153.1	172.0
21.0 - 28.9	2.2	0.0	0.0	88.4	90.6
29.0+	0.0	0.0	0.0	0.0	0.0
Total	8,064.9	29,093.2	327.5	35,488.5	72,974.1

Table 22--*Number of growing-stock trees 5.0-inch d.b.h. and larger on commercial and operable noncommercial forest land, by species and 5-foot height classes, Kuskokwim River, Alaska, 1967*

(Thousand trees)

Height classes	White spruce	Paper birch	Balsam poplar	Quaking aspen	Total
0 - 30	1,596.8	777.7	109.0	0.0	2,483.5
31 - 35	2,092.8	1,190.4	424.4	0.0	3,707.6
36 - 40	3,264.7	2,546.1	675.8	0.0	6,486.6
41 - 45	3,232.1	3,641.2	750.9	43.3	7,667.5
46 - 50	3,752.5	4,290.3	1,013.7	52.4	9,109.9
51 - 55	3,076.4	2,479.6	485.5	72.9	6,114.4
56 - 60	2,881.8	797.6	591.4	98.9	4,369.7
61 - 65	2,106.5	244.2	407.1	39.4	2,797.2
66 - 70	1,923.8	103.4	238.0	49.9	2,315.1
71 - 75	997.8	18.7	96.6	0.0	1,113.1
76 - 80	773.7	0.0	49.8	0.0	823.5
81 - 85	420.3	0.0	2.2	0.0	422.5
86 - 90	185.1	0.0	0.0	0.0	185.1
91 - 95	99.7	0.0	0.0	0.0	99.7
96 - 100	34.0	0.0	0.0	0.0	34.0
100+	18.7	0.0	0.0	0.0	18.7
Total	26,456.7	16,089.2	4,844.4	356.8	47,747.1

Table 23--*Net volume of timber on commercial and operable noncommercial*[1/] *forest land, by class of timber and softwoods and hardwoods, Kuskokwim River, Alaska, 1967*

(Million cubic feet)

Class of timber	Commercial forest land			Operable noncommercial forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Sawtimber trees:						
Saw-log portion	177.3	27.0	204.3	26.7	1.4	28.1
Upper-stem portion	24.5	2.4	26.9	4.1	0.1	4.2
Total	201.8	29.4	231.2	30.8	1.5	32.3
Poletimber trees	45.8	66.0	111.8	15.3	18.4	33.7
All growing-stock trees	247.6	95.4	343.0	46.1	19.9	66.0
Rough trees	1.7	0.5	2.2	1.7	0.1	1.8
Rotten trees	3.8	7.4	11.2	.8	2.2	3.0
Salvable dead trees	1.0	0.7	1.7	1.8	0.0	1.8
Total	254.1	104.0	358.1	50.4	22.2	72.6

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 24--*Net volume of growing stock on commercial forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(Million cubic feet)

Species	Diameter class (inches at breast height)										
	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-26.9	27.0+	Total
Softwoods:											
White spruce	14.1	31.7	42.7	51.2	41.4	31.1	18.5	9.3	7.6	0.0	247.6
Total	14.1	31.7	42.7	51.2	41.4	31.1	18.5	9.3	7.6	0.0	247.6
Hardwoods:											
Paper birch	14.4	18.6	12.4	5.8	1.9	0.2	0.0	0.0	0.0	0.0	53.3
Balsam poplar	2.5	5.9	9.9	9.5	6.8	3.3	1.1	.6	.2	0.0	39.8
Quaking aspen	0.0	.8	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Total	16.9	25.3	23.8	15.3	8.7	3.5	1.1	.6	.2	0.0	95.4
Total	31.0	57.0	66.5	66.5	50.1	34.6	19.6	9.9	7.8	0.0	343.0

Table 25--*Net volume of growing stock on commercial and operable noncommercial*[1/] *forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(Million cubic feet)

Species	Diameter class (inches at breast height)										
	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-26.9	27.0+	Total
Softwoods:											
White spruce	20.0	41.0	56.4	59.1	47.4	33.5	19.3	9.3	7.6	0.0	293.6
Total	20.0	41.0	56.4	59.1	47.4	33.5	19.3	9.3	7.6	0.0	293.6
Hardwoods:											
Paper birch	18.8	26.3	17.9	6.5	2.2	.2	0.0	0.0	0.0	0.0	71.9
Balsam poplar	2.5	6.4	10.0	9.6	7.1	3.3	1.1	.6	.2	0.0	40.8
Quaking aspen	.2	.9	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6
Total	21.5	33.6	29.4	16.1	9.3	3.5	1.1	.6	.2	0.0	115.3
Total	41.5	74.6	85.8	75.2	56.7	37.0	20.4	9.9	7.8	0.0	408.9

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 26--*Net volume of sawtimber on commercial forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
	- - - - - - - - - - - - - - - -Million board feet- - - - - - - - - - - - - - - - -								
Softwoods:									
White spruce	174.1	241.5	211.2	164.7	100.5	51.7	43.3	0.0	987.0
Total	174.1	241.5	211.2	164.7	100.5	51.7	43.3	0.0	987.0
Hardwoods:									
Paper birch	--	20.0	7.0	1.0	0.0	0.0	0.0	0.0	28.0
Balsam poplar	--	41.2	30.1	15.9	5.6	2.9	1.1	0.0	96.8
Total	--	61.2	37.1	16.9	5.6	2.9	1.1	0.0.	124.8
Total	174.1	302.7	248.3	181.6	106.1	54.6	44.4	0.0	1,111.8

Table 27--*Net volume of sawtimber on commercial and operable noncommercial*[1/] *forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
	-Million board feet-								
Softwoods:									
White spruce	226.9	275.8	239.0	176.1	104.7	51.7	43.3	0.0	1,117.5
Total	226.9	275.8	239.0	176.1	104.7	51.7	43.3	0.0	1,117.5
Hardwoods:									
Paper birch	--	22.2	7.7	1.1	0.0	0.0	0.0	0.0	31.0
Balsam poplar	--	41.6	31.7	15.9	5.6	2.9	1.1	0.0	98.8
Total	--	63.8	39.4	17.0	5.6	2.9	1.1	0.0	129.8
Total	226.9	339.6	278.4	193.1	110.3	54.6	44.4	0.0	1,247.3

1/ Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 28--*Gross volume of sawtimber on commercial forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
	-Million board feet-								
Softwoods:									
White spruce	180.7	254.6	224.7	181.6	111.4	58.5	47.8	0.0	1,059.3
Total	180.7	254.6	224.7	181.6	111.4	58.5	47.8	0.0	1,059.3
Hardwoods:									
Paper birch	--	24.3	9.1	1.3	0.0	0.0	0 0	0.0	34.7
Balsam poplar	--	48.6	37.3	19.8	6.6	4.3	1.1	0.0	117.7
Total	--	72.9	46.4	21.1	6.6	4.3	1.1	0.0	152.4
Total	180.7	327.5	271.1	202.7	118.0	62.8	48.9	0.0	1,211.7

Table 29--*Gross volume of sawtimber on commercial and operable noncommercial*[1] *forest land, by species and diameter classes, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
	Million board feet								
Softwoods:									
White spruce	235.8	291.1	254.6	194.9	115.5	58.5	47.8	--	1,198.2
Total	235.8	291.1	254.6	194.9	115.5	58.5	47.8	--	1,198.2
Hardwoods:									
Paper birch	--	27.1	9.9	1.3	0.0	0.0	0.0	--	38.3
Balsam poplar	--	49.4	40.0	19.8	6.6	4.3	1.1	--	121.2
Total	--	76.5	49.9	21.1	6.6	4.3	1.1	--	159.5
Total	235.8	367.6	304.5	216.0	122.1	62.8	48.9	--	1,357.7

[1]Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 30--*Net volume of sawtimber on commercial forest land, by species and log grade, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Log grade[1]				Total
	1	2	3	4[2]	
	Million board feet				
Softwoods:					
White spruce	4.7	93.1	725.1	164.1	987.0
Total	4.7	93.1	725.1	164.1	987.0
Hardwoods:					
Paper birch	--	1.1	19.6	7.3	28.0
Balsam poplar	4.4	25.6	47.9	18.9	96.8
Total	4.4	26.7	67.5	26.2	124.8
Total	9.1	119.8	792.6	190.3	1,111.8

[1]U.S. Forest Products Laboratory. Hardwood log grades for standard lumber. USDA Forest Products Laboratory Report R1737, 61 p., 1959.

[2]Local-use logs.

Table 31--*Net volume of sawtimber on operable noncommercial*[1/] *forest land, by species and log grade, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Log grade[2/]				Total
	1	2	3	4[3/]	
	- - - - -Million board feet- - - - -				
Softwoods:					
White spruce	0.0	2.7	79.9	47.8	130.4
Total	0.0	2.7	79.9	47.8	130.4
Hardwoods:					
Paper birch	0.0	0.0	2.7	.4	3.1
Balsam poplar	0.0	.7	1.1	.2	2.0
Total	0.0	.7	3.8	.6	5.1
Total	0.0	3.4	83.7	48.2	135.5

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

[2/] U.S. Forest Products Laboratory. Hardwood log grades for standard lumber. USDA Forest Products Laboratory Report R1737, 61 p., 1959.

Northern Hemlock and Hardwood Manufacturers Assoc. Official grading rules for northern hardwood and softwood logs and tie cuts. Green Bay, Wisconsin, 12 p., 1959.

[3/] Local-use logs.

Table 32--*Net annual growth of growing stock, by forest land class and species, Kuskokwim River, Alaska, 1967*

(Thousand cubic feet)

Species	Forest land class		
	Commercial	Operable noncommercial[1/]	Total
Softwoods:			
White spruce	3,098.7	427.4	3,526.1
Total	3,098.7	427.4	3,526.1
Hardwoods:			
Paper birch	611.8	282.0	893.8
Balsam poplar	743.2	12.0	755.2
Quaking aspen	22.5	2.9	25.4
Total	1,377.5	296.9	1,674.4
Total	4,476.2	724.3	5,200.5

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 33--*Net annual growth of sawtimber, by forest land classes and species, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Forest land class		
	Commercial	Operable noncommercial[1/]	Total
	- - - - - -Thousand board feet- - - - - -		
Softwoods:			
White spruce	19,699.9	6,053.5	25,753.4
Total	19,699.9	6,053.5	25,753.4
Hardwoods:			
Paper birch	1,947.1	12.5	1,959.6
Balsam poplar	7,747.6	23.1	7,770.7
Total	9,694.7	35.6	9,730.3
Total	29,394.6	6,089.1	35,483.7

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 34--*Annual mortality of growing stock, by species and forest land classes, Kuskokwim River, Alaska, 1967*

(Thousand cubic feet)

Species	Forest land class		
	Commercial	Operable noncommercial[1]	Total
Softwoods:			
White spruce	268.8	79.1	347.9
Total	268.8	79.1	347.9
Hardwoods:			
Paper birch	53.6	3.1	56.7
Balsam poplar	60.2	0.0	60.2
Total	113.8	3.1	116.9
Total	382.6	82.2	464.8

[1] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 35--*Annual mortality of sawtimber, by species and forest land classes, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Species	Forest land class		
	Commercial	Operable noncommercial[1]	Total
	- - - - - -Thousand board feet- - - - - -		
Softwoods:			
White spruce	956.4	326.4	1,282.8
Total	956.4	326.4	1,282.8
Hardwoods:			
Paper birch	0.0	9.9	9.9
Balsam poplar	147.5	0.0	147.5
Total	147.5	9.9	157.4
Total	1,103.9	336.3	1,440.2

[1] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 36--*Annual mortality of growing stock on commercial and noncommercial forest land, by cause, and softwoods and hardwoods, Kuskokwim River, Alaska, 1967*

(Thousand cubic feet)

Cause	Commercial forest land			Operable noncommercial[1/] forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Fire	0.0	0.0	0.0	0.0	0.0	0.0
Insects	93.4	0.0	93.4	0.0	0.0	0.0
Disease	23.2	0.0	23.2	0.0	0.0	0.0
Windthrow	0.0	0.0	0.0	64.5	0.0	64.5
Other	36.1	29.8	65.9	14.6	3.1	17.7
Unknown	116.1	84.0	200.1	0.0	0.0	0.0
Total	268.8	113.8	382.6	79.1	3.1	82.2

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

Table 37--*Annual mortality of sawtimber on commercial and noncommercial forest land, by cause, and softwoods and hardwoods, Kuskokwim River, Alaska, 1967*

(International 1/4-inch rule)

Cause	Commercial forest land			Operable noncommercial[1/] forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
	- - - - - - - - - - - -	- - - -	-Thousand board feet-	- - - -	- - - -	- - - -
Fire	0.0	0.0	0.0	0.0	0.0	0.0
Insects	458.7	0.0	458.7	0.0	0.0	0.0
Disease	0.0	0.0	0.0	0.0	0.0	0.0
Windthrow	0.0	0.0	0.0	326.4	0.0	326.4
Other	125.6	147.5	273.1	0.0	9.9	9.9
Unknown	372.1	0.0	372.1	0.0	0.0	0.0
Total	956.4	147.5	1,103.9	326.4	9.9	336.3

[1/] Operable noncommercial forest land has a gross volume of more than 800 cubic feet per acre.

GPO 990-478

Hegg, Karl M., and Harold Sieverding.
1979. Timber resources of the Kuskokwim River flood and adjacent uplands. USDA For. Serv. Resour. Bull. PNW-87, 40 p., illus.

The first intensive forest inventory of the Kuskokwim River flood plains and adjacent uplands was conducted in 1967. A commercial forest area of 252.5 thousand acres (102.2 thousand hectares) was identified with a growing-stock volume of 343.0 million cubic feet (9.7 million cubic meters). A noncommercial stratum was also examined that had substantial standing volume but did not qualify as commercial forest land. This stratum contained 70.4 thousand acres (28.5 thousand hectares) with a volume of 65.9 million cubic feet (1.9 million cubic meters).

Keywords: Timber resources, statistics (forest), forest surveys, Alaska (Kuskokwim River Valley)

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. Department of Agriculture
Forest Service
Pacific Northwest Forest
Range Experiment Station
Resource Bulletin
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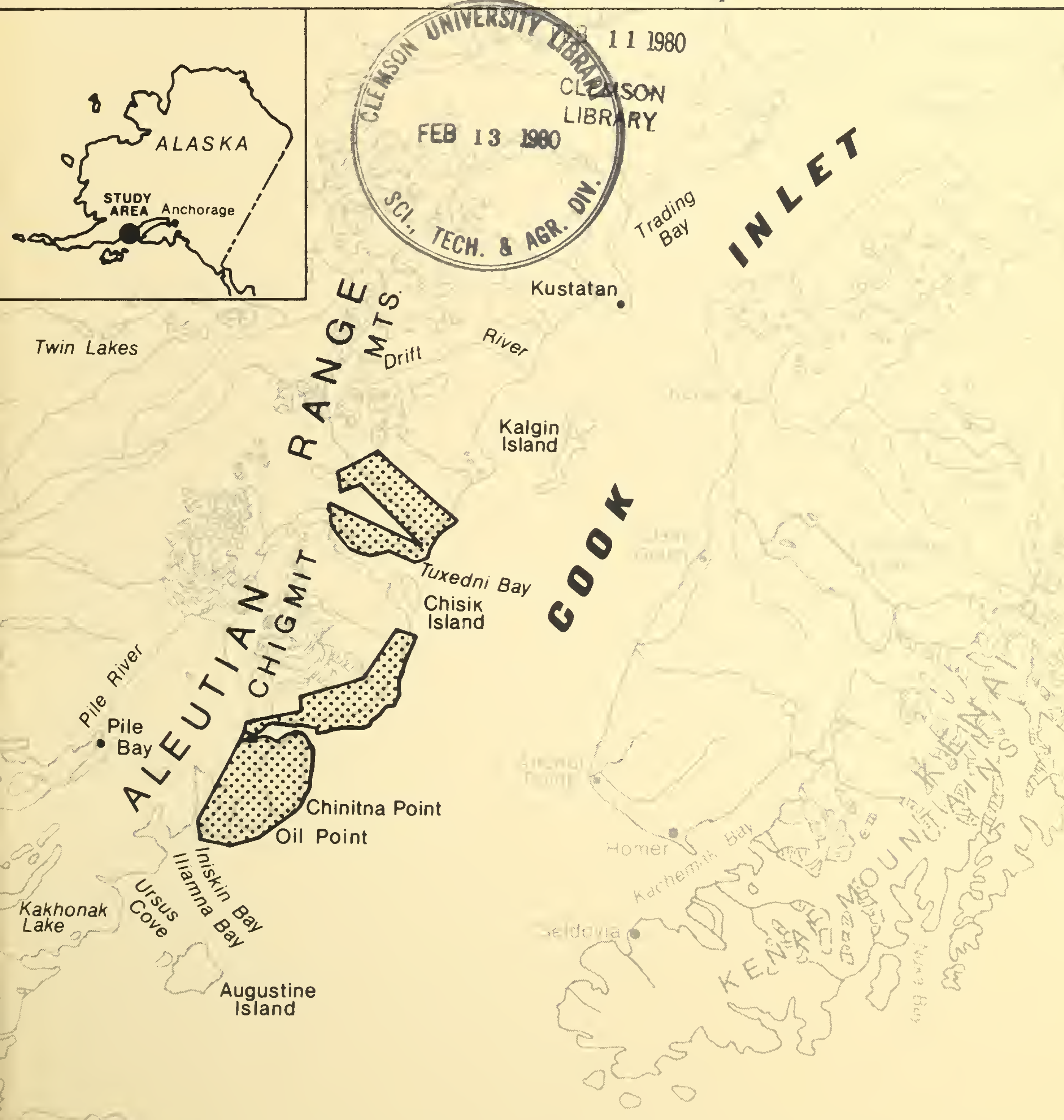
Timber Resource Statistics for the Tuxedni Bay Inventory Unit, Alaska, 1971

Karl M. Hegg



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This inventory was accomplished through the cooperation of the Bureau of Land Management, U.S. Department of Interior who provided much of personnel help, funds, and logistical air support.

Metric Conversions

1 acre = 0.404 7 hectare
1 hectare = 2.47 acres
1 cubic foot = 0.028 3 cubic meter
1 cubic meter = 35.314 5 cubic feet
1 cubic foot per acre = 0.069 97 cubic meter per hectare
1 cubic meter per hectare = 14.29 cubic feet per acre
20 cubic feet per acre = 1.399 4 cubic meter per hectare
1 square foot basal area per acre = 0.229 6 square meter per hectare
1 square meter per hectare = 4.356 square feet per acre

TIMBER RESOURCE STATISTICS FOR THE TUXEDNI BAY INVENTORY UNIT, ALASKA, 1971

Reference Abstract

Hegg, Karl M.
1979. Timber resource statistics for the Tuxedni Bay Inventory Unit, Alaska, 1971. USDA For. Serv. Resour. Bull. PNW-88, 43 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Area and volume data are given for the first intensive inventory of a 180,000-acre unit on the west side of Cook Inlet, 130 miles southwest of Anchorage. Commercial forest land totaled 45 thousand acres with a total cubic volume of 105 million feet. The major species component is a hybrid mixture of Sitka and white spruce. An introductory section has comments on this hybridization, forest location, use, defect, regeneration, and stocking.

KEYWORDS: Forest surveys, timber resources, statistics (forest), Alaska (Tuxedni Bay).

Research Summary

Resource Bulletin PNW-88

1979

The forest inventory in the Tuxedni Bay area was conducted as a joint effort of the Forest Service, U.S. Department of Agriculture, and the Bureau of Land Management, U.S. Department of Interior. Preliminary studies were made and photo interpretation control data collected in the spring of 1969. The Forest Service developed the sampling design and photo interpretation procedures. Photo interpretation was done in 1969 by the Bureau of Land Management. Fieldwork was a cooperative effort and completed in 1971. Data editing and processing were done by the Forest Service.

Inventory results show a commercial forest area of 45,123 acres in a total unit of 179,720 acres. Another 29,730 acres was identified as noncommercial of which 7,551 acres were found to have volumes in excess of 800 cubic feet per acre. This forest class was field sampled, and statistical data is provided for this as well as the commercial class. Data is presented for the entire inventory unit and three natural geographical divisions or blocks--the Polly Creek, Red Glacier, and Iniskin blocks.

All of the commercial forests are in poletimber and sawtimber size-classes. No sapling or seedlings stands were noted. Extensive areas of recent nonstocked windthrow were observed but not sampled; the blowdown occurred after the aerial photography was flown.

The timber stands of the Tuxedni Unit represent one of the better concentrations of high volume commercial forest land on the mainland of interior Alaska. Average volumes per acre are 2,333 cubic feet and 11,835 board feet. Total unit volume is 105,301,500 cubic feet and 534,043,200 board feet. Much of this volume is in overmature stands with a high incidence of heart rot.

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TABLES

HIGHLIGHTS

	Thousand acre	Thousand hectares
Total Tuxedni Bay unit area:	179.7	72.8
with forests	74.9	30.3
with nonforests	99.7	40.4
with noncensus water	1.8	0.7
with census water	3.3	1.3
Forested areas:		
commercial forest land	45.1	18.3
noncommercial forest land		
more than 800 cubic feet per acre	7.6	3.1
less than 800 cubic feet per acre	22.2	9.0
Commercial forest composition:		
sawtimber	42.5	17.2
poletimber	2.6	1.1
seedling/sapling	0	0
nonstocked	0	0

Inventory unit volumes	Thousand cubic[1] feet	Thousand cubic[1] meters	Thousand board[2] feet	Thousand cubic[3] meters
Total net volume	105,301.5	2,980.0	534,043.2	2,636.6
Total gross volume	109,633.1	3,102.6	566,382.4	2,743.2
Annual net growth	2,035.3	57.6	13,214.2	43.3
Annual net mortality	40.6	1.1	132.3	.8

[1]/Volume of roundwood in live trees 5.0-inch d.b.h. and larger.

[2]/Net volume, International 1/4-inch rule.

[3]/Volume of roundwood in softwood trees 9.0-inch d.b.h. and larger and hardwood trees 11.0-inch d.b.h. and larger.

INTRODUCTION

This resource bulletin reports on the first intensive inventory of an area on the west side of Cook Inlet about 130 miles southwest of Anchorage. This area is identified as the Tuxendi unit (fig. 1).

Aerial photography of the area was flown in 1966 by the Bureau of Land Management (BLM). Plans for a forest inventory were developed in 1969 by the Forestry Sciences Laboratory (Juneau) of the Pacific Northwest Forest and Range Experiment Station. Photo interpretation was accomplished by the BLM in 1969 and fieldwork completed in 1971 through the cooperative efforts of the BLM and the FSL. Field supervision and editing of plot records were done by the Forestry Sciences Laboratory. Data processing was done at Portland by the Pacific Northwest Forest and Range Experiment Station.

Forest Survey, authorized by the McSweeny-McNary Act in 1928 and extended to Alaska in 1954, is a nationwide effort conducted at various locations to obtain information on forest lands--their extent, condition, volume, growth, and depletion. The first inventories of the interior portion of Alaska were begun in 1956 and completed in 1962 (Hutchison 1967). These were extremely extensive inventories, and subsequently areas with concentrations of commercial forest land have been defined for more intensive effort. In addition to the Tuxedni Bay unit, areas for which intensive inventories have been conducted and for which reports are available or pending are: Susitna Valley (Hegg 1970), Kuskokwim River, Copper River (Hegg 1975b), Koyukuk (Hegg 1974), the Norton Bay Indian Reservation, and the Kantishna, Fairbanks (Hegg 1975a), Upper Tanana, and Wood-Salcha blocks of the Tanana unit.

The factual data and discussions in this report on forest area, location, condition, volume growth, and regeneration relate to the supply of wood available for local, regional, and national needs. These data are presented for use of State planners, legislators, land and forest managers, forest industry, and other forest inventory data users.

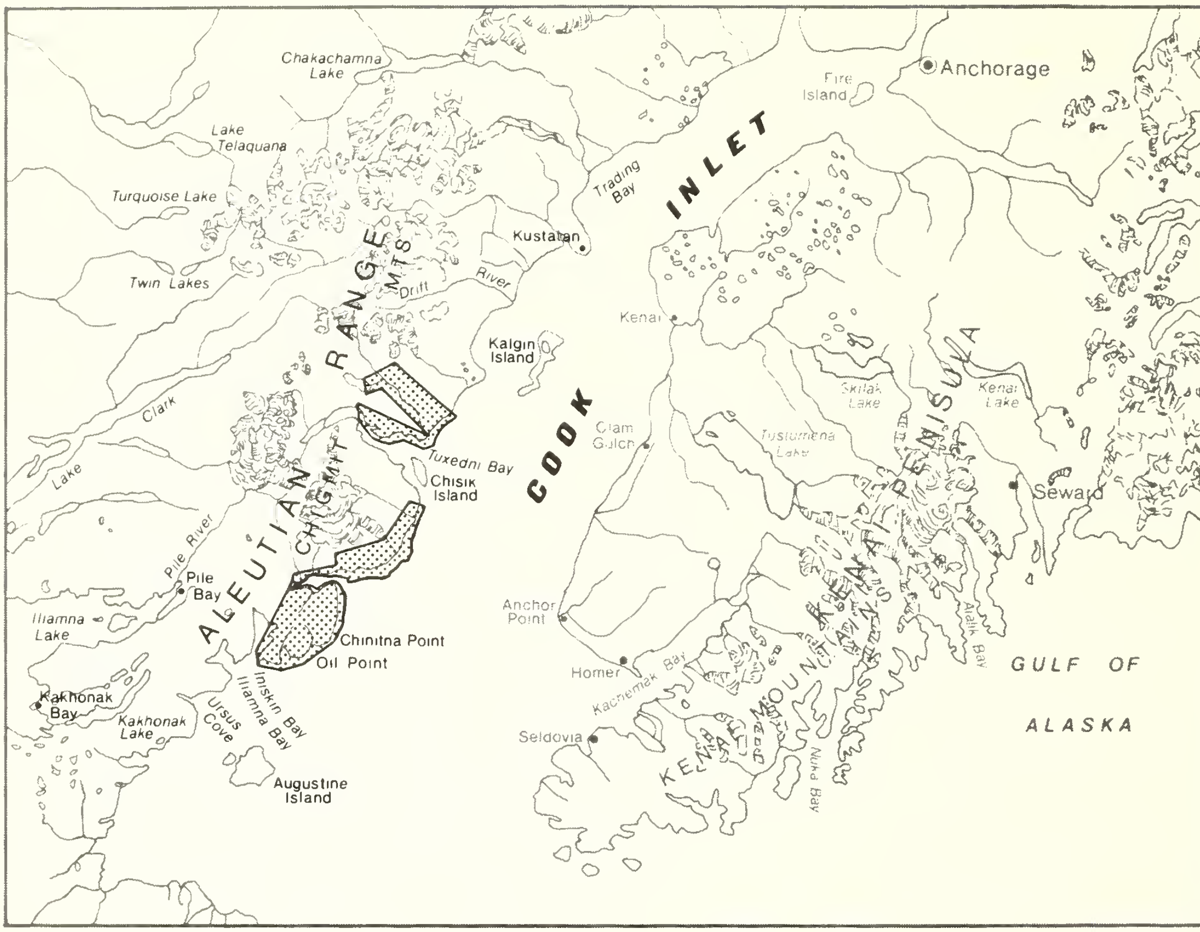

Figure 1.--The Tuxedni Bay inventory unit.

OBSERVATIONS

Area and Location

The Tuxedni unit is located due west of Homer on the west side of Cook Inlet. The unit is highlighted by having three active volcanos nearby. Mount Redoubt (10,197 feet) lies 5 miles north of the unit, Mount Illiamna (10,116 feet) is located near the middle of the unit, and Augustine Island (3,927 feet) lies 20 miles south. Augustine Island had been predicted to erupt during the period that fieldwork was in progress. Fortunately, it did not.

Tidewater and intervening 10,000-foot volcanos in such close juxtaposition necessitated that the area be photographed and inventoried as three blocks: Polly Creek, Red Glacier, and Iniskin Peninsula. The Polly Creek and Red Glacier blocks are alluvial river drainages and beach-fringed foothills, and the Iniskin Peninsula block is an area of moderate terrain with maximum elevations of 3,000 feet with forests scattered throughout. The Iniskin Peninusla was the site of considerable, oil-drilling activities in the early 1900's although commercial quantities apparently were not found (Moffit 1927).

The forests of the Tuxedni area are of special interest geographically and taxonomically. These forests represent the southern-most concentrations of commercial forests on the Pacific side of the Alaska Peninsula with only scattered pockets found further south in the Kamishak Bay Area. Due to the ameliorating effects of the surrounding ocean, however, island stands of Sitka spruce are found another 80 miles south on Kodiak Island.

Taxonomically, the Tuxedni forests are a hybridized mixture. We found what appeared to be genetically pure white spruce and Sitka spruce and all gradients of hybridization between them. This same situation occurred with black cottonwood and balsam poplar. For the purposes of this inventory we identified all spruce as white spruce and the Populus species as balsam poplar.

The forests in the Polly Creek and Red Glacier blocks are generally confined to less than 1,000-foot elevation (fig. 2 and 3) and are medium to well stocked and with large extensive stands. The Iniskin block by contrast has forest cover at higher elevations, but these forests are scattered and patchy. Throughout all three blocks and most of the Pacific side of the Alaska Peninsula, stands of alder and willow shrubs blanket those areas without forest cover to about 2,000-foot elevation.

The Tuxedni unit is essentially a virgin timber area. Spruce is the dominant forest species, and most stands (96 percent) are sawtimber sized. There are no settlements in the area, although there are a few scattered cabins and an abandoned sawmill. Most signs of man's activities are fast being covered over by encroaching vegetation.

Figure 2.--The abrupt transition from valley bottom to steep slopes contributes to the forests being restricted to less than 1,000 feet elevation.

Forest Uses

By reason of remoteness and a rather wet, harsh climate, this area is quite hostile to man. At present, no use is made of the forest for timber products. The one sawmill that formerly operated in this area cut mostly for the local use of a fish cannery and local residents.

Several cabins are located along the beach in the Polly Creek area and are apparently chiefly used during periods of low tides by clam diggers working the well-known razor clam beds in the area. Salmon fishing has declined in recent years, but there must still be a fairly substantial run as evidenced by one field crew sighting 11 brown bear feeding in a 1-mile stretch of river.

Figure 3.--Stands on the Red Glacier/Polly Creek Area are nearly continuous across these valleys, interrupted only by the river drainages.

With the contrasting blue-green saltwater, lush green mountain sides, bare grey and red rock, and snow-capped volcanos, this scenic area is probably as spectacular as any in Alaska (fig. 4). Although this situation seems to call for some sort of a reserve status, the forests are overmature, have extensive heart rot, and are increasingly subject to blowdown. Prudent management would call for some harvesting. Since the area appears quite resilient, logging and blowdown scars would probably cover over quite rapidly.

Defect

Considerable amounts of heart rot were found in the spruce stands although this would not have been so readily apparent to the cruiser except for the evidence provided by blowdown. All of the windblown trees were broken off from 1 to 4 feet above ground level and most of them had heart rot.

Figure 4.--Views such as this are commonplace in the Tuxedni area.

Based on this evidence, cruiser estimates of defect in spruce should have been somewhat higher than for the white spruce stands of interior Alaska. Instead, these estimates are nearly the same. Since the type of heart rot is a hidden defect with few external indicators, it is likely that the cull estimate (3 percent) was conservative. Estimates of defect for birch (9 percent) and balsam poplar (11 percent) are about as expected.

Regeneration and Stocking

Our inventory shows no acreage for nonstocked or seedling/sapling classes and there is a lower than normal proportion of the total number of stems in trees less than 5.0-inch d.b.h. Comparative data for southeast Alaska and interior Alaska have 57 to 84 percent of the total stems in trees less than 5.0-inch d.b.h. while the Tuxedni unit has but 35 percent. Stand table data is not available by block, but visual observations indicate that the lower number of small stems occurs chiefly in the Iniskin block where there is intense brush competition and very little tree regeneration. The Polly Creek and Red Glacier blocks are made up of more contiguous stands, also with a predominance of sawtimber. In this case, area condition class (table 5) gives a better portrayal of the Tuxedni unit stands. This table shows that about 55 percent of the forest area is in the medium-stocked category with 7 percent poorly stocked. Inspection of plot records confirm this showing a large number of points occupied by inhibiting brush.

The Tuxedni stands may be in an advancing treeline situation where most regeneration is at the edge of the forest/nonforest boundary. Some edge areas of regeneration may not have been adequately sampled.

SURVEY METHOD

The estimates of area and timber volumes are based on a double sampling procedure (Bickford 1952). Enough 1-acre points to satisfy specific levels of statistical precision were uniformly distributed on aerial photographs. These photo points were classified by land type, forest type, and volume strata. A subsample was then drawn from all land types and reexamined on the photos. All subsample points originally classified as commercial forest land, as well as any other subsample points questionably classified, were visited on the ground.

For the Tuxedni inventory unit, we interpreted 1,515 photo points and reexamined 37 noncommercial and nonforest points. This reexamination served as a ground check and yielded 8 questionable points which, with the 48 commercial forest and operable noncommercial points, totaled 56 locations actually checked on the ground. The ground plot was located at the exact point established on the photo. At each ground location, a 10-point cluster of plots was measured. A 40-factor, basal area gage was used to select sample trees at each point for detailed measurements of size and vigor. Through data processing procedures, the total sample and the individual tree volumes were expanded to obtain the various data needed or specified on area and volume. The tables herein, however, depart from the standard Forest Survey tables with the addition of a noncommercial forest category called "operable." During the initial inventory of interior Alaska, we found that much noncommercial forest land had a relatively high per-acre volume. When more intensive inventories were begun in the mid-1960's, we and our cooperators agreed that some of this noncommercial strata had potential value as a commercial wood supply. By extrapolation, from cutting minimums of 3 cords per acre used in the Lake States and Canada, we established 9 cords or 800 cubic feet per acre as a prudent level for Alaska. This threefold increase in the minimum economic operating level should help compensate for the higher production and shipping costs in Alaska. The operable noncommercial areas presently have more than 800 gross cubic feet per acre in poletimber and sawtimber trees. The area and volume in this classification, although considered adequate for some cutting operations, should not be included in allowable cut computations. Future studies may show, through logging or other silvicultural practices, if these marginal sites can be managed as commercial forest land. None of the reported areas and volumes (whether classed as commercial or other) should be used in any calculation of an allowable cut without consideration of possible management and land-use alternatives.

SAMPLING ERROR

The reliability of the inventory is expressed in terms of relative sampling errors.

Area and volume	Design sampling error	Sampling error achieved	Sampling error of total area or volume reported
		Percent	
Area:			
Commercial forest land, per million acres	3.0	3.0	±12.0
Noncommercial forest land, per million acres	10.0	7.0	±38.0
Volume:			
Commercial forest land, per billion cubic feet	5.0	4.0	±13.0
Commercial forest land, growth per billion cubic feet--net	5.0	1.0	±14.0

For the Tuxedni unit, we are reporting 105.3 million cubic feet of growing-stock volume, ±13 percent. If repeated samples were taken of this population, the chances are two in three that the true total cubic-foot volume lies between 91.6 and 119.0 million cubic feet.

In all instances we more than achieved our design sampling error.

PRINCIPAL TREE SPECIES OF INTERIOR ALASKA[4]

Softwoods:	
Black spruce	*Picea mariana* (Mill.) B.S.P.
Sitka spruce	*Picea sitchensis* (Bong.) Carr.
Tamarack	*Larix laricina* (Du Roi) K. Koch
White spruce	*Picea glauca* (Moench) Voss
Hardwoods:	
Balsam poplar	*Populus balsamifera* L.
Black cottonwood	*Populus trichocarpa* Torr. & Gray
Paper birch	*Betula papyrifera* Marsh.
Quaking aspen	*Populus tremuloides* Michx.

[4]Scientific names are according to Little (1953).

TERMINOLOGY

Allowable cut.--The volume of timber that could be cut on commercial forest land during a given period under specified management plans for sustained production such as those in effect on National Forests.

Area condition class.--Area condition class provides a general stratification of commercial forest land by management opportunity class as indicated by the stocking or area controlled by tree and cover class.

Area condition classification code	
10	Areas 100 percent or more stocked with desirable trees and not overstocked. Stands in this category generally do not require any treatment at present to maintain high level of growth.
20	Areas 100 percent or more stocked with desirable trees and overstocked. Stands in this category need a treatment such as thinning to produce maximum levels of growth of desirable trees.
30	Areas 60 to 100 percent stocked with desirable trees, and with less than 30 percent of the area controlled by acceptable growing-stock trees, cull trees, inhibiting vegetation, slash, or nonstockable conditions. Stands in this category generally have conditions favorable for natural improvement of stocking without special treatment.
40	Areas 60 to 100 percent stocked with desirable trees and with 30 percent or more of the area controlled by other trees (or overstocked areas) or conditions that ordinarily prevent occupancy by desirable trees. Stands in this category generally have little prospect for improvement in desirable tree stocking without special treatment such as thinning, cull tree removal, etc.
50	Areas less than 60 percent stocked with desirable trees but with 100-percent or more stocking with growing-stock trees. Stands in this category generally have little prospect for improved desirable tree stocking without special treatment. Stands almost to rotation age would usually not be treated.
60	Areas less than 60 percent stocked with desirable trees but with 60- to 100-percent stocking with growing-stock trees. Stands in this category generally have little prospect for improved desirable tree stocking without special treatment such as timber stand improvement or planting.

70 Areas less than 60 percent stocked with desirable trees and with less than 60-percent stocking with growing-stock trees. Stands in this category generally have little prospect for improved desirable tree or growing-stock stocking without treatment such as site preparation and regeneration, etc.

Commercial species.--Trees presently or prospectively suitable for industrial products.

Cull.--Portions of a tree unusable for industrial products because of rot, form, or other defect.

Cull trees.--Live trees of sawtimber or poletimber size unmerchantable for saw logs now or prospectively because of defect, rot, or species.

Rough trees: Live trees of 5.0-inch and larger d.b.h. that do not contain a saw log now or prospectively, primarily because of roughness, poor form, or because they are a noncommercial species.

Rotten trees: Live trees of 5.0-inch and larger d.b.h. that do not contain a saw log now or prospectively, primarily because of rot.

Forest land.--Land at least 16.7 percent stocked by forest trees of any size, or formerly having such tree cover, and not currently developed for nonforest use.

Commercial forest land: Forest land producing or capable of producing crops of industrial wood and not withdrawn from timber utilization. Areas qualifying as commercial forest land have the capability of producing in excess of 20 cubic feet per acre per year of industrial wood under management.

Noncommercial forest land: Unproductive forest land incapable of yielding crops of industrial wood because of adverse site conditions (producing less than 20 cubic feet per acre per year) and productive forest land withdrawn from commercial timber use through statute or administrative regulation.

Noncommercial operable--noncommercial forest land with a gross volume in excess of 800 cubic feet per acre.
Noncommercial inoperable--noncommercial forest land with a gross volume of less than 800 cubic feet per acre.

Forests types.--A classification of forest land based on the species forming a plurality of the live tree stocking.

Spruce: Forests in which a plurality of the stand is white spruce. Common associates include birch, aspen, and cottonwood.

Cottonwood: Forests in which a plurality of the stand is black cottonwood or balsam poplar or both. Common associates include white spruce and birch.

Aspen or birch: Forests in which a plurality of the stand is aspen or paper birch or both. Common associates include black cottonwood and white spruce.

Growing stock trees.--Sawtimber trees, poletimber trees, saplings, and seedlings; that is, all live trees except cull trees.

Desirable trees: Growing-stock trees with no serious defects in quality limiting present or prospective use, relatively high vigor, and no pathogens that could result in death or serious deterioration before rotation age. They include the type of trees forest managers aim to grow; that is, the trees left in silvicultural cutting or favored in cultural operations.

Acceptable trees: Trees meeting the specifications for growing stock but not qualifying as desirable.

Hardwoods.--Dicotyledonous trees, usually broad leaved and deciduous. Alaska hardwood species are paper birch, quaking aspen, black cottonwood, and balsam poplar.

Inhibiting vegetation.--Cover sufficiently dense to prevent establishment of tree seedlings.

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

Land area.--The area of dry land and land temporarily or partly covered by water such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than 120 feet wide; and lakes, reservoirs, and ponds less than 1 acre in area.

Log grades.--A classification of logs based on external characteristics as indicators of quality or value.

Mean annual increment (MAI).--A measure of the volume of wood, in cubic feet, produced on 1 acre during 1 year. Forest Survey minimum standard for commercial forest land is the ability to produce 20 cubic feet per acre per year.

Mortality.--Number or sound-wood volume of live trees dying from natural causes during a 5-year period.

Net annual growth of growing stock.--The annual change in volume of sound wood in live sawtimber and poletimber trees.

Net annual growth of sawtimber.--The annual change in net board-foot volume of live sawtimber trees.

Net volume.--The gross volume of a tree less deductions for rot, sweep, or other defect affecting product use.

Growing-stock volume: The net volume of sound wood in the bole of growing-stock trees 5.0 inches and larger in diameter at breast height, from stump to a minimum 4.0-inch top outside bark or to the point where the central stem breaks in to limbs.

Noncommercial species.--Tree species of typically small size, poor form, or inferior quality which normally do not develop into trees suitable for industrial products.

Nonforest land.--Land that does not qualify as forest land. Includes land that has never supported forests and lands formerly forested where forest use is precluded by development for nonforest uses, such as crops, improved pasture, residential areas, and city parks. Also includes improved roads and certain areas of water classified by the Bureau of Census as land. Unimproved roads, streams, canals, and nonforest strips in forest areas must be more than 120 feet wide; and clearings in forest areas must be more than 1 acre in size to qualify as nonforest land.

Nonstockable land.--Areas of forest land not capable of supporting forest growth because of rock, water, etc.

Salvable dead trees.--Standing dead trees that are considered currently or potentially merchantable by regional standards. A poletimber tree must be more than one-half sound; a sawtimber tree more than one-third sound (board measure).

Saw log.--A log meeting minimum standards of diameter, length, and defect, including logs at least 8 feet long, sound and straight, and with a minimum diameter inside bark of 6 inches for softwoods (8 inches for hardwoods).

Saw-log portion.--That part of the bole of sawtimber trees between the stump and the saw log top.

Saw-log top.--The point on the bole of sawtimber trees above which a saw log cannot be produced. The minimum saw-log top is 7.0-inch d.o.b. (diameter outside bark) for softwoods and 9.0-inch d.o.b. for hardwoods.

Site classes.--A classification of forest land by its capacity to grow crops of industrial wood.

Softwoods.--Coniferous trees, usually evergreen with needles or scalelike leaves.

Stocking.--The degree of occupancy of land by trees, measured by basal area or the number of trees in a stand by size or age and spacing, compared with the basal area or number of trees required to fully utilize the growth potential of the land; that is, the stocking standard.

Overstocked areas: Areas where growth of trees is significantly reduced by excessive numbers of trees.

Nonstocked areas: Commercial forest lands less than 16.7 percent stocked with growing-stock trees.

Stand-size classes.--A classification of forest land based on size of the growing stock present; that is, sawtimber, poletimber, or saplings and seedlings.

Sawtimber stands: Stands at least 16.7 percent stocked with growing-stock trees, with half or more of total stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

Poletimber stands: Stands at least 16.7 percent stocked with growing-stock trees of which half or more of this stocking is in poletimber and sawtimber trees, and with poletimber stocking exceeding that of sawtimber.

Sapling-seedling stands: Stands at least 16.7 percent stocked with growing-stock trees of which more than half of the stocking is saplings and seedlings.

Tree-size classes.--A classification based on the diameter of the tree at breast height (4-1/2 feet above the ground on the uphill side of the tree):

Sawtimber-size tree: Softwood tree of 9.0-inch d.b.h. and larger, hardwood tree of 11.0-inch d.b.h. and larger.

Poletimber-size tree: Softwood tree of 5.0- to 8.9-inch d.b.h., hardwood tree of 5.0- to 10.9-inch d.b.h.

Sapling-size tree: A tree of 1.0- to 4.9-inch d.b.h.

Seedling-size tree: A tree of less than 1.0-inch d.b.h.

Upper stem portion: That part of the main stem or fork of sawtimber trees above the saw-log top to a minimum top diameter of 4.0-inches outside bark or to the point where the main stem or fork breaks into limbs.

Water.--Bureau of the Census definition: Streams, sloughs, estuaries, and canals more than 1/8 of a statute mile in width; and lakes, reservoirs, and ponds more than 40 acres in area.

Forest Survey: The same as the Bureau of Census definition, except minimum width of streams etc. is 120 feet and minimum size of lakes etc. is 1 acre.

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TABLES

The statistical tables for the Tuxedni Bay inventory unit have been prepared for the total unit and by three blocks--the Polly Creek, Red Glacier, and Iniskin. The three blocks were management units established by the Bureau of Land Management before this inventory.

Table 1--Area by productivity and land classes, Tuxedni Unit, Alaska, 1971

Land class	Thousand acres
Forest land:	
Commercial	45.1
Noncommercial:	
Operable[1]	7.6
Inoperable[2]	22.2
Total	74.9
Nonforest land:[3]	101.5
Total land	176.4
Census water:	3.3
Total area	179.7

1/ Operable noncommercial forest land is defined as areas supporting a gross volume of more than 800 cubic feet per acre.

2/ Inoperable noncommercial forest land is defined as areas supporting a gross volume of less than 800 cubic feet per acre.

3/ Includes swampland, industrial and urban areas, other nonforest land, and 1,805 acres, classed as water by Forest Survey standards, but defined by the Bureau of the Census as land.

Table 2--Area of commercial and operable noncommercial forest land, by stand-size classes, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand-size class	Forest land		
	Commercial	Operable noncommercial	Total
Sawtimber stands	42.5	7.6	50.1
Poletimber stands	2.6	0.0	2.6
Seedling and sapling stands	0.0	0.0	0.0
Nonstocked areas	0.0	0.0	0.0
Total	45.1	7.6	52.7

Table 3--Area of commercial and operable noncommercial forest land, by board-foot volume classes, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand volume per acre[1]	Forest land		
	Commercial	Operable noncommercial	Total
0- 799	0.6	0.0	0.6
800-1,499	0.0	0.0	0.0
1,500-2,999	2.3	0.0	2.3
3,000-4,999	3.4	3.7	7.1
5,000-6,999	3.5	3.9	7.4
More than 7,000	35.3	0.0	35.3
Total	45.1	7.6	52.7

[1]Net volume International 1/4-inch rule.

Table 4--Area of commercial and operable noncommercial forest land, by stand-volume and stand-size classes, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand volume class	Stand-size classes				
	Non-stocked	Seedling-sapling	Poletimber	Sawtimber	Total
Cubic feet					
0- 299	0.0	0.0	0.0	0.0	0.0
300- 799	0.0	0.0	0.6	2.3	2.9
800-1,499	0.0	0.0	0.0	16.5	16.5
1,500-2,199	0.0	0.0	0.0	5.9	5.9
More than 2,200	0.0	0.0	2.0	25.4	27.4
Total	0.0	0.0	2.6	50.1	52.7

Table 5--Area of commercial forest land by area condition class, Tuxedni Unit, Alaska, 1971

Code	Area condition class	Thousand acres
10	Areas 100 percent or more stocked with desirable trees and not overstocked.	0.0
20	Areas 100 percent or more stocked with desirable trees and overstocked.	0.0
30	Areas 60 to 100 percent stocked with desirable trees, and with less than 50 percent of the area controlled by acceptable growing-stock trees, cull trees, inhibiting vegetation, slash, or nonstockable conditions.	0.0
40	Areas 60 to 100 percent stocked with desirable trees, and with 30 percent or more of the area controlled by other trees (or overstocked areas) and/or conditions that ordinarily prevent occupancy by desirable trees.	0.0
50	Areas less than 60 percent stocked with desirable trees, but with 100-percent or more stocking with growing-stock trees.	17.5
60	Areas less than 60 percent stocked with desirable trees, but with 60- to 100-percent stocking with growing-stock trees.	24.6
70	Areas poorly stocked with desirable trees, and poorly stocked with growing-stock trees.	3.0
All classes		45.1

Table 6--Area of commercial forest land, by site class, Tuxedni Unit, Alaska, 1971

Site class[1]	Thousand acres
Cubic feet	
165 or more[2]	0.0
120-165	0.0
85-120	0.0
50- 85	1.4
20- 50	43.7
Total	45.1

[1] Site class is a classification of forest land in terms of inherent capability to grow crops of industrial wood based on fully stocked natural stands.

[2] Potential yield, mean annual increment.

Table 7--Area of commercial and noncommercial forest land, by forest type, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Forest type	Commercial forest land	Noncommercial forest land		
		Operable[1]	Inoperable[2]	Total
Balsam poplar	6.6	0.0	0.9	7.5
Black spruce	0.0	0.0	[3] 21.3	21.3
Paper birch	0.0	0.0	0.0	0.0
Quaking aspen	0.0	0.0	0.0	0.0
White spruce	38.5	7.6	0.0	46.1
Total	45.1	7.6	22.2	74.9

[1] Operable noncommercial forest land is defined as areas presently supporting more than 800 cubic feet of volume (gross).

[2] Inoperable noncommercial forest land is defined as area supporting a gross volume of less than 800 cubic feet per acre.

[3] All inoperable noncommercial forest land is assumed to be black spruce.

Table 8--Area of commercial forest land, by stand-age and stand-size classes, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand age (years)	Stand-size class				
	Non-stocked	Seedling-sapling	Poletimber	Sawtimber	Total
Nonstocked	--	--	--	--	--
1- 10	0	0	0	0	0
10- 20	0	0	0	0	0
20- 30	0	0	0	0	0
30- 40	0	0	0	0	0
40- 50	0	0	0	2.3	2.3
50- 60	0	0	0	3.4	3.4
60- 70	0	0	0	0	0
70- 80	0	0	0	5.4	5.4
80- 90	0	0	0	3.1	3.1
90-100	0	0	0	5.1	5.1
100-120	0	0	2.6	5.3	7.9
120-140	0	0	0	6.2	6.2
140-160	0	0	0	3.8	3.8
160-180	0	0	0	6.5	6.5
180-200	0	0	0	1.4	1.4
200-300	0	0	0	0	0
300 and over	0	0	0	0	0
Mixed ages	0	0	0	0	0
Total	0	0	2.6	42.5	45.1

Table 9--Area of operable noncommercial forest land, by stand-age and stand-size classes, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand age (years)	Stand-size class				
	Non-stocked	Seedling-sapling	Poletimber	Sawtimber	Total
Nonstocked	--	--	--	--	--
1- 10	0	0	0	0	0
10- 20	0	0	0	0	0
20- 30	0	0	0	0	0
30- 40	0	0	0	1.5	1.5
40- 50	0	0	0	0	0
50- 60	0	0	0	0	0
60- 70	0	0	0	0	0
70- 80	0	0	0	0	0
80- 90	0	0	0	0	0
90-100	0	0	0	0	0
100-120	0	0	0	1.4	1.4
120-140	0	0	0	0	0
140-160	0	0	0	2.9	2.9
160-180	0	0	0	0.4	0.4
180-200	0	0	0	1.4	1.4
200-300	0	0	0	0	0
300 and over	0	0	0	0	0
Mixed ages	0	0	0	0	0
Total	0	0	0	7.6	7.6

Table 10--Number of growing-stock trees on commercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(Thousand trees)

Diameter class (Inches d.b.h.)	Balsam poplar	Paper birch	Quaking aspen	White spruce	Total
1.0- 2.9	0.0	0.0	0.0	2,058.0	2,058.0
3.0- 4.9	159.1	193.5	0.0	1,716.2	2,068.8
5.0- 6.9	180.5	306.8	0.0	1,508.8	1,996.1
7.0- 8.9	124.0	417.9	0.0	750.2	1,292.1
9.0-10.9	92.3	229.5	0.0	725.2	1,047.0
11.0-12.9	58.7	36.1	0.0	623.4	718.2
13.0-14.9	76.0	17.5	0.0	452.8	546.3
15.0-16.9	41.6	0.0	0.0	249.7	291.3
17.0-18.9	33.6	0.0	0.0	223.7	257.3
19.0-20.9	22.3	0.0	0.0	170.5	192.8
21.0-28.9	39.6	0.0	0.0	245.5	285.1
29.0+	10.1	0.0	0.0	31.6	41.7
Total	837.8	1,201.3	0.0	8,755.6	10,794.7

Table 11--Number of growing-stock trees 5.0-inch d.b.h. and larger on commercial and operable noncommercial forest land, by species and 5-foot height classes, Tuxedni Unit, Alaska, 1971

(Thousand trees)

5-foot height	White spruce	Paper birch	Balsam poplar	Quaking aspen	Total
0- 30	1,537.6	292.8	60.4	0.0	1,890.8
31- 35	561.9	29.1	39.8	0.0	630.8
36- 40	775.7	38.3	72.7	0.0	886.7
41- 45	369.2	98.0	87.1	0.0	554.3
46- 50	558.3	370.7	75.3	0.0	1,004.3
51- 55	406.5	157.8	96.5	0.0	660.8
56- 60	447.5	34.9	79.8	0.0	562.2
61- 65	389.6	0.0	90.5	0.0	480.1
66- 70	221.3	0.0	18.8	0.0	240.1
71- 75	210.6	0.0	13.6	0.0	224.2
76- 80	171.1	0.0	16.5	0.0	187.6
81- 85	148.2	0.0	13.2	0.0	161.4
86- 90	69.7	0.0	6.9	0.0	76.6
91- 95	55.3	0.0	6.3	0.0	61.6
96-100	38.0	0.0	1.4	0.0	39.4
100+	58.9	0.0	0.0	0.0	58.9
Total	6,019.4	1,021.6	678.8	0.0	7,719.8

Table 12--Net volume of timber on commercial and operable noncommercial forest land, by class of timber and softwoods and hardwoods, Tuxedni Unit, Alaska, 1971

(Million cubic feet)

Class of timber	Commercial forest land			Operable noncommercial forest land[1]		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Sawtimber trees:						
Saw-log portion	81.5	7.8	89.3	6.1	0.0	6.1
Upper-stem portion	3.0	.9	3.9	.4	0.0	.4
Total	84.5	8.7	93.2	6.5	0.0	6.5
Poletimber trees	6.5	5.6	12.1	1.7	.1	1.8
All growing stock trees	91.0	14.3	105.3	8.2	.1	8.3
Rough trees	.6	.2	.8	0.0	0.0	0.0
Rotten trees	1.4	.4	1.8	.1	0.0	.1
Salvable dead trees	.2	0.0	.2	.1	0.0	.1
Total	93.2	14.9	108.1	8.4	0.1	8.5

Table 13--Net volume of growing stock on commercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(Million cubic feet)

Species	Diameter class (inches at breast height)										
	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-26.9	27.0+	Total
Softwoods:											
White spruce	2.7	3.8	7.0	9.8	11.2	8.4	9.9	9.4	19.7	9.1	91.0
Total	2.7	3.8	7.0	9.8	11.2	8.4	9.9	9.4	19.7	9.1	91.0
Hardwoods:											
Paper birch	.6	1.8	1.7	.5	.2	0.0	0.0	0.0	0.0	0.0	4.8
Balsam poplar	.2	.6	.8	.7	1.2	.8	1.1	.9	1.9	1.3	9.5
Quaking aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.8	2.4	2.5	1.2	1.4	.8	1.1	.9	1.9	1.3	14.3
Total	3.5	6.2	9.5	11.0	12.6	9.2	11.0	10.3	21.6	10.4	105.3

Table 14--Net volume of growing stock on commercial and operable noncommercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(Million cubic feet)

Species	Diameter class (inches at breast height)										
	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-26.9	27.0+	Total
Softwoods:											
White spruce	3.0	5.2	8.7	10.8	13.1	8.9	10.9	9.8	19.8	9.1	99.3
Total	3.0	5.2	8.7	10.8	13.1	8.9	10.9	9.8	19.8	9.1	99.3
Hardwoods:											
Paper birch	.6	1.8	1.7	.5	.2	0.0	0.0	0.0	0.0	0.0	4.9
Balsam poplar	.2	.5	.7	.8	1.2	.9	1.1	.9	1.9	1.3	9.5
Quaking aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	.8	2.3	2.4	1.3	1.4	.9	1.1	.9	1.9	1.3	14.3
Total	3.8	7.5	11.1	12.1	14.5	9.8	12.0	10.7	21.7	10.4	113.6

Table 15--Net volume of sawtimber on commercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, million board feet)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
Softwoods:									
White spruce	41.4	55.0	62.7	46.8	56.3	52.6	139.2	34.4	488.4
Total	41.4	55.0	62.7	46.8	56.3	52.6	139.2	34.4	488.4
Hardwoods:									
Paper birch	0.0	2.3	1.1	0.0	0.0	0.0	0.0	0.0	3.4
Balsam poplar	0.0	2.2	4.9	3.9	6.0	5.0	14.2	6.0	42.2
Quaking aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	4.5	6.0	3.9	6.0	5.0	14.2	6.0	45.6
Total	41.4	59.5	68.7	50.7	62.3	57.6	153.4	40.4	534.0

Table 16--Net volume of sawtimber on commercial and operable noncommercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, million board feet)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
Softwoods:									
White spruce	51.7	60.8	72.9	49.7	61.3	54.9	139.6	34.4	525.3
Total	51.7	60.8	72.9	49.7	61.3	54.9	139.6	34.4	525.3
Hardwoods:									
Paper birch	0.0	2.5	1.1	0.0	0.0	0.0	0.0	0.0	3.6
Balsam poplar	0.0	2.2	4.9	4.0	6.0	5.0	14.2	6.0	42.3
Quaking aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	4.7	6.0	4.0	6.0	5.0	14.2	6.0	45.9
Total	51.7	65.5	78.9	53.7	67.3	59.9	153.8	40.4	571.2

Table 17--Gross volume of sawtimber on commercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, million board feet)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
Softwoods:									
White spruce	41.9	56.3	64.2	48.7	58.8	56.8	147.3	39.9	513.9
Total	41.9	56.3	64.2	48.7	58.8	56.8	147.3	39.9	513.9
Hardwoods:									
Paper birch	0.0	2.5	1.3	0.0	0.0	0.0	0.0	0.0	3.8
Balsam poplar	0.0	2.4	5.5	4.8	6.6	5.7	16.6	7.1	48.7
Quaking aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	4.9	6.7	4.8	6.6	5.7	16.6	7.1	52.5
Total	41.9	61.2	71.0	53.5	65.4	62.5	163.9	47.0	566.4

Table 18--Gross volume of sawtimber on commercial and operable noncommercial forest land, by species and diameter classes, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, million board feet)

Species	Diameter class (inches at breast height)								
	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0+	Total
Softwoods:									
White spruce	52.8	62.3	75.0	52.2	64.3	59.4	147.8	39.9	553.7
Total	52.8	62.3	75.0	52.2	64.3	59.4	147.8	39.9	553.7
Hardwoods:									
Paper birch	0.0	2.7	1.3	0.0	0.0	0.0	0.0	0.0	4.0
Balsam poplar	0.0	2.4	5.5	4.8	6.6	5.7	16.6	7.1	48.7
Quaking aspen	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	5.1	6.8	4.8	6.6	5.7	16.6	7.1	52.7
Total	52.8	67.4	81.8	57.0	70.9	65.1	164.4	47.0	606.4

Table 19--Net volume of growing stock on commercial and operable noncommercial forest land, by forest type and stand-size classes, Tuxedni Unit, Alaska, 1971

(Thousand cubic feet)

Forest type	Nonstocked	Sapling-seedling	Poletimber	Sawtimber	Total
Commercial					
White spruce	0.0	0.0	6,105.3	87,485.1	93,590.4
Balsam poplar	0.0	0.0	192.0	11,519.1	11,711.1
Quaking aspen	0.0	0.0	0.0	0.0	0.0
Paper birch	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	6,297.3	99,004.2	105,301.5
Operable noncommercial					
White spruce	0.0	0.0	0.0	8,286.0	8,286.0
Other types	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	8,286.0	8,286.0

Table 20--Net volume of sawtimber on commercial and operable noncommercial forest land, by forest type and stand-size classes, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, thousand board feet)

Forest type	Nonstocked	Sapling-seedling	Poletimber	Sawtimber	Total
Commercial					
White spruce	0.0	0.0	18,277.6	461,970.4	480,248.0
Balsam poplar	0.0	0.0	385.1	53,410.1	53,795.2
Quaking aspen	0.0	0.0	0.0	0.0	0.0
Paper birch	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	18,662.7	515,380.5	534,043.2
Operable noncommercial					
White spruce	0.0	0.0	0.0	37,169.1	37,169.1
Other types	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0	0.0	37,169.1	37,169.1

Table 21--Net volume of sawtimber on commercial forest land, by species and log grade, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, million board feet)

Species	Log grade				Total
	1	2	3	4[1]	
Softwoods:					
White spruce	2.9	34.7	423.7	27.1	488.4
Total	2.9	34.7	423.7	27.1	488.4
Hardwoods:					
Paper birch	0.0	0.0	3.4	0.0	3.4
Balsam poplar	4.2	10.7	25.4	1.9	42.2
Quaking aspen	0.0	0.0	0.0	0.0	0.0
Total	4.2	10.7	28.8	1.9	45.6
Total	7.1	45.4	452.5	29.0	534.0

[1] Local-use logs.

Table 22--Net volume of sawtimber on operable noncommercial forest land, by species and log grade, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, million board feet)

Species	Log grade				Total
	1	2	3	4[1]	
Softwoods:					
White spruce	3.0	34.7	457.7	30.0	525.4
Total	3.0	34.7	457.7	30.0	525.4
Hardwoods:					
Paper birch	0.0	0.0	3.6	0.0	3.6
Balsam poplar	4.2	10.7	25.4	1.9	42.2
Quaking aspen	0.0	0.0	0.0	0.0	0.0
	4.2	10.7	29.0	1.9	45.8
Total	7.2	45.4	486.7	31.9	571.2

[1]Local-use logs.

Table 23--Net annual growth of growing stock, by forest land class and species, Tuxedni Unit, Alaska, 1971

(Thousand cubic feet)

Species	Forest land class		
	Commercial	Operable noncommercial	Total
Softwoods:			
White spruce	1,674.0	145.1	1,819.1
Total	1,674.0	145.1	1,819.1
Hardwoods:			
Paper birch	85.0	.5	85.5
Balsam poplar	276.0	0.0	276.3
Quaking aspen	0.0	0.0	0.0
Total	361.3	.5	361.8
Total	2,035.3	145.6	2,180.9

Table 24--Net annual growth of sawtimber, by forest land classes and species, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, thousand board feet)

Species	Forest land class: Commercial	Operable noncommercial	Total
Softwoods:			
White spruce	11,668.3	277.2	11,945.5
Total	11,668.3	277.2	11,945.5
Hardwoods:			
Paper birch	73.8	2.6	76.4
Balsam poplar	1,472.1	0.0	1,472.1
Quaking aspen	0.0	0.0	0.0
Total	1,545.9	2.6	1,548.5
Total	13,214.2	279.8	13,494.0

Table 25--Net annual mortality of growing stock, by species and forest land classes, Tuxedni Unit, Alaska, 1971

(Thousand cubic feet)

Species	Forest land class: Commercial	Operable noncommercial	Total
Softwoods:			
White spruce	30.5	28.8	59.3
Total	30.5	28.8	59.3
Hardwoods:			
Paper birch	10.1	0.0	10.1
Balsam poplar	0.0	0.0	0.0
Quaking aspen	0.0	0.0	0.0
Total	10.1	0.0	10.1
Total	40.6	28.8	69.4

Table 26--Net annual mortality of sawtimber, by species and forest land classes, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, thousand board feet)

Species	Forest land class: Commercial	Operable noncommercial	Total
Softwoods:			
White spruce	132.3	175.1	307.4
Total	132.3	175.1	307.4

Table 27--Net annual mortality of growing stock, by forest land classes, by causes, and softwoods and hardwoods, Tuxedni Unit, Alaska, 1971

(Thousand cubic feet)

Cause	Commercial forest land			Operable noncommercial forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Fire	0.0	0.0	0.0	0.0	0.0	0.0
Insects	26.8	0.0	26.8	0.0	0.0	0.0
Disease	0.0	0.0	0.0	0.0	0.0	0.0
Windthrow	3.7	0.0	3.7	18.1	0.0	18.1
Other	0.0	0.0	0.0	10.7	0.0	10.7
Unknown	0.0	10.1	10.1	0.0	0.0	0.0
Total	30.5	10.1	40.6	28.8	0.0	28.8

Table 28--Annual mortality of sawtimber by forest land classes, by causes, and softwoods and hardwoods, Tuxedni Unit, Alaska, 1971

(International 1/4-inch rule, thousand board feet)

Cause	Commercial forest land			Operable noncommercial forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Fire	0.0	0.0	0.0	0.0	0.0	0.0
Insects	111.7	0.0	111.7	0.0	0.0	0.0
Disease	0.0	0.0	0.0	0.0	0.0	0.0
Windthrow	20.6	0.0	20.6	118.9	0.0	118.9
Other	0.0	0.0	0.0	56.2	0.0	56.2
Unknown	0.0	0.0	0.0	0.0	0.0	0.0
Total	132.3	0.0	132.3	175.1	0.0	175.1

Polly Creek Block

Table 29--Area by productivity and land class, Polly Creek Block, Tuxedni Unit, Alaska, 1971

Land class	Thousand acres
Forest land:	
Commercial	16.3
Noncommercial:	
Operable	1/.4
Inoperable	2/10.2
Total	26.9
Nonforest land	3/23.9
Total	50.8
Census water	1.5
Total area	52.3

1/Operable noncommercial forest land is defined as areas supporting a gross volume of more than 800 cubic feet per acre.

2/Inoperable noncommercial forest land is defined as areas supporting a gross volume of less than 800 cubic feet per acre.

3/Includes swampland, industrial and urban areas, other nonforest land, and 223 acres classed as water by Forest Survey standards, but defined by the Bureau of Census as land.

Table 30--Area of commercial and operable noncommercial forest land, by stand-size classes, Polly Creek Block, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Species	Forest land		
	Commercial	Operable noncommercial	Total
Sawtimber stands	14.3	0.4	14.7
Poletimber stands	2.0	0.0	2.0
Seedlings and sapling stands	0.0	0.0	0.0
Nonstocked areas	0.0	0.0	0.0
Total	16.3	.4	16.7

Table 31--Net volume of timber on commercial and operable noncommercial forest land, by class of timber and softwoods and hardwoods, Polly Creek Block, Tuxedni Unit, Alaska, 1971

(Million cubic feet)

Class of timber	Commercial forest land			Operable noncommercial forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Sawtimber trees:						
Saw-log portion	25.6	2.8	28.4	0.3	0.0	0.3
Upper-stem portion	1.5	.3	1.8	0.0	0.0	0.0
Total	27.1	3.1	30.2	.3	0.0	.3
Poletimber trees	3.8	4.1	7.9	.1	0.0	.1
All growing-stock trees	30.9	7.2	38.1	.4	0.0	.4
Rough trees	.1	.2	.3	0.0	0.0	0.0
Rotten trees	.2	.3	.5	0.0	0.0	0.0
Salvable dead trees	0.0	0.0	0.0	0.0	0.0	0.0
Total	31.2	7.7	38.9	.4	0.0	.4

Red Glacier Block

Table 32--Area by productivity and land classes, Red Glacier Block, Tuxedni Unit, Alaska, 1971

Land class	Thousand acres
Forest land:	
Commercial	12.9
Noncommercial:	
Operable	1/2.9
Inoperable	2/8.5
Total	24.3
Nonforest land	3/15.1
Total	39.4
Census water	1.4
Total area	40.8

1/Operable noncommercial forest land is defined as areas supporting a gross volume of more than 800 cubic feet per acre.

2/Inoperable noncommercial forest land is defined as areas supporting a gross volume of less than 800 cubic feet per acre.

3/Includes swampland, industrial and urban areas, other nonforest land, and 223 acres classed as water by Forest Survey standards, but defined by the Bureau of Census as land.

Table 33--Area of commercial and operable noncommercial forest land, by stand-size classes, Red Glacier Block, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand-size class	Forest land		
	Commercial	Operable noncommercial	Total
Sawtimber stands	12.9	2.9	15.8
Other size classes	0.0	0.0	0.0
Total	12.9	2.9	15.8

Table 34--Net volume of timber on commercial and operable noncommercial forest land, by class of timber and softwoods and hardwoods, Red Glacier Block, Tuxedni Unit, Alaska, 1971

(Million cubic feet)

Class of timber	Commercial forest land			Operable noncommercial forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Sawtimber trees:						
Saw-log portion	32.0	0.8	32.8	2.0	0.0	2.0
Upper-stem portion	.9	.1	1.0	.2	0.0	.2
Total	32.9	.9	33.8	2.2	0.0	2.2
Poletimber trees	1.5	.2	1.7	.9	0.0	.9
All growing-stock trees	34.4	1.1	35.5	3.1	0.0	3.1
Rough trees	.4	0.0	.4	0.0	0.0	0.0
Rotten trees	.7	0.0	.4	0.0	0.0	0.0
Salvable dead trees	0.0	0.0	0.0	0.1	0.0	0.1
Total	35.5	1.1	36.6	3.2	0.0	3.2

Iniskin Block

Table 35--Area by productivity and land classes, Iniskin Block, Tuxedni Unit, Alaska, 1971

Land class	Thousand acres
Forest land:	
Commercial	15.9
Noncommercial:	
Operable	[1]4.3
Inoperable	[2]3.5
Total	23.7
Nonforest land	[3]62.5
Total	86.2
Census water	.4
Total area	86.6

[1]Operable noncommercial forest land is defined as areas supporting a gross volume of more than 800 cubic feet per acre.

[2]Inoperable noncommercial forest land is defined as areas supporting a gross volume of less than 800 cubic feet per acre.

[3]Includes swampland, industrial and urban areas, other nonforest land, and 223 acres classed as water by Forest Survey standards, but defined by the Bureau of Census as land.

Table 36--Area of commercial and operable noncommercial forest land, by stand-size classes, Iniskin Block, Tuxedni Unit, Alaska, 1971

(Thousand acres)

Stand-size class	Forest land		
	Commercial	Operable noncommercial	Total
Sawtimber stands	15.4	4.2	19.6
Poletimber stands	.6	0.0	.6
Seedling and sapling stands	0.0	0.0	0.0
Nonstocked areas	0.0	0.0	0.0
Total	16.0	4.2	20.2

Table 37--Net volume of timber on commercial and operable noncommercial forest land, by class of timber and softwoods and hardwoods, Iniskin Block, Tuxedni Unit, Alaska, 1971

(Million cubic feet)

Class of timber	Commercial forest land			Operable noncommercial forest land		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
Sawtimber trees:						
Saw-log portion	23.9	4.2	28.1	3.8	0.0	3.8
Upper-stem portion	0.6	.5	1.1	0.2	0.0	0.2
Total	24.5	4.7	29.2	4.0	0.0	4.0
Poletimber trees	1.2	1.3	2.5	.7	0.0	.7
All growing-stock trees	25.7	6.0	31.7	4.7	0.0	4.7
Rough trees	.1	0.0	.1	0.0	0.0	0.0
Rotten trees	.5	0.0	.6	0.0	0.0	0.0
Salvable dead trees	.2	0.0	.2	.1	0.0	.1
Total	26.5	6.1	32.6	4.8	0.0	4.8

GPO 989-588

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. Developing and evaluating alternative methods and levels of resource management.

3. Achieving 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 are made available promptly. Project headquarters are at:

Anchorage, Alaska
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Mailing address: Pacific Northwest Forest and Range
Experiment Station
809 N.E. 6th Ave.
Portland, Oregon 97232

Table 18--Area and prospective annual yield of timberland on high and medium sites suitable for hardwood stand conversion and planting opportunities by ownership, California, 1975

Ownership	Treatment opportunities: Hardwood stand conversion	Planting	Total	Prospective mean annual yield 70 years after planting	
	---- Thousand acres ----			Million cubic feet	Cubic feet per acre
National Forest	153	123	276	112	31
Other public	28	18	46	130	6
Forest industry	127	54	181	116	21
Other private timber growers	11	57	68	103	7
Farmer and miscellaneous private	352	325	677	109	74
All ownerships	671	577	1,248	111	139

The other two underproductive forest conditions (opportunities for improvement cutting and regeneration cutting) present a problem not so easily solved. The poletimber and young sawtimber stands that could benefit from improvement cutting occupy 318,000 acres outside National Forests. The current "loss" in productivity in these stands is only 5 million cubic feet per year (table 16), but the potential loss may be much greater. As these stands grow older, the difference between actual growth and potential growth will probably increase. Without improvement cutting, the relative growth in some stands may increase naturally; but in many stands, the hardwoods and cull conifers will continue to compete with the higher-valued conifers. Most of these stands if selectively logged in the manner practiced historically in California will become low-growth residual sawtimber stands. Improvement cutting now would result in higher future yields. Currently most of the small trees that make up these young, low-volume stands have little value in the California market. Improving these stands cannot be paid for with the material removed. Future demand for wood may change this, but treatment of these stands today can be done only as an investment.

Low-growth conifer sawtimber stands occupy 2.2 million acres or 27 percent of the commercial forest land outside National Forests.[39] They are producing 60 million cubic feet per year, yet they could be producing 273 million (table 16). The loss in productivity on these lands outside National Forests is greater than the total loss in hardwood stands and nonstocked areas on all ownerships including National Forests.

Fourteen percent or 300,000 acres of these stands are uncut old-growth stands with an average softwood volume of 43,000 board feet per acre. Growth averages 32 cubic feet per acre in these stands. The remaining 1.9 million acres are cutover stands in poor growing condition with an average softwood volume of 13,000 board feet per acre and an average growth of 26 cubic feet per acre. These stands have resulted from removal of the more valuable trees in sequential logging operations.

[39] Sawtimber stands on National Forests total 6.4 million acres. The area of low-growth stands is unknown but thought to be substantial.

The low-growth stands need drastic treatment – usually clearcutting and planting – if the land is to produce to its capacity.[40] It is obviously not possible, nor desirable, to harvest the 37 billion board feet of timber in these stands in a short time. This volume is about 13 times that harvested annually from lands outside National Forests, and 8 times the volume harvested from all lands including National Forests, counting mortality salvage. At the time these stands are logged, however, is the time to do what is necessary to get a vigorous young stand started. Unfortunately not much of this is being done. Instead, selective cutting continues to keep these stands in poor growing condition (see table 12). By ownership, the 2.2 million acres in these stands are distributed as follows:

Ownership	Percent of area
Other public	8
Forest industry	40
Other private timber growers	19
Farmer and miscellaneous private	33
	100

[40] Important to successful regeneration and to capturing the yield potential of the land is immediate restocking. If delayed for a year or more, brush and other vegetation usually become established, making restocking more difficult and costly.

Physical Factors Affecting Feasibility of Silvicultural Treatment

In the analysis of treatment opportunities outside National Forests, dollar costs and benefits, effect on nontimber values, or other social consequences were not considered. They should be taken into account before an extensive treatment program can be undertaken. For example, converting all nonstocked areas to conifer plantations or removing all competing hardwoods from conifer stands would probably not be justifiable economically and would reduce the habitat for a number of animals.

The physical nature of the land itself bears on the costs and benefits of treatment, how a silvicultural treatment might affect other resources, and the social acceptance of various treatments. Three physical factors considered in this study are: (1) the land's productivity expressed as site class, (2) steepness of slope (fig. 51), and (3) stockability (see definition of stockability, page 133).

Figure 51. – Steep slopes like this are costly to treat and often prone to erosion and soil slippage. This 130-percent slope in Humboldt County was logged about 20 years ago. In 1977 it was covered with a mixture of bigleaf maple, tanoak, madrone, California-laurel, willow, blue blossom ceanothus, and Douglas-fir clumps that could be thinned. Can such areas be managed for successive crops of timber?

Treatment opportunity data were developed by site class for all resource areas and ownerships. They are shown in tables 51-69 in the appendix. For example, table 57 shows that of the 84,000 acres of improvement cutting opportunities on farmer and miscellaneous private lands in the north coast, 34,000 acres or 40 percent are on low sites. The increase in yields afforded by improvement cutting on these low sites may not pay for the cost of treatment.

Slope information was not collected on all coastal area inventory plots. In a study done for the California State Water Resources Control Board (Jones and Stokes Associates, Inc. 1973), all land in the north coast area was rated by erosion hazard. The basic criteria were soil type and depth, slope percent, and annual precipitation. Forest inventory plots were located on the erosion hazard maps and used as a means to estimate commercial forest area by erosion hazard class in north coast counties. The following tabulation shows the results:

Erosion hazard	Percent of commercial forest land
Low to moderate	17
High	46
Very high	37

Forest managers in the north coast area will have to consider the erosion hazards prevalent there if forest productivity and other resource values such as fisheries and clean water are to be maintained (fig. 52).

In California's interior, steepness of the land and limited stockability restrict forest manageability. Slopes over 45 percent are usually difficult to manage regardless of stockability because of operating costs, erosion hazard, and safety risk; lands incapable of supporting 60 percent of full stocking as shown in normal yield tables (Dahms 1964; Dunning and Reineke 1933; McArdle, Meyer, and Bruce 1961; Meyer 1961; Schumacher 1926, 1930) are considered by the author to be difficult to manage regardless of slope. These areas are harsh, often rocky, and difficult to reforest.

Of all timberland outside National Forests in California's interior, 31 percent are difficult to stock or have steep slopes (table 19). Only 26 percent of forest industry lands are difficult to stock or have steep slopes. Other public agencies have most of the lands difficult to manage: 41 percent.

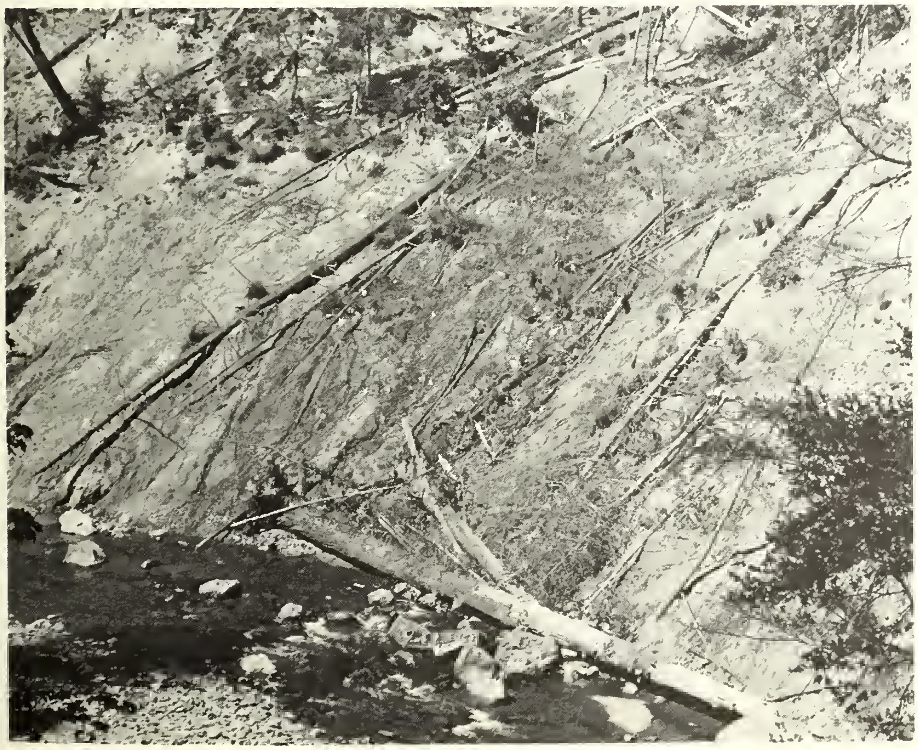


Figure 52.—Landslides have long plagued land managers in California Coast Ranges.

Table 19--Area of timberland outside National Forests by ownership and by stockability and slope percent class[1], California interior, 1975

Ownership	Stockability 60 percent plus, and slopes 0-45 percent (amenable sites)		Stockability 60 percent or less, and/or slopes greater than 45 percent (problem sites)		Total	
	Thousand acres	Percent	Thousand acres	Percent	Thousand acres	Percent
Other public	160	59	109	41	269	100
Forest industry	1,098	74	392	26	1,490	100
Other private timber growers	887	66	461	34	1,348	100
Farmer and miscellaneous private	1,329	68	633	32	1,962	100
Total	3,474	69	1,595	31	5,069	100

[1]Excludes southern California.

Tables 61 through 69 in the appendix show treatment classes by site class, resource area, and stockability and slope class for private lands in the interior. Table 62 shows, for example, that 55,000 acres or 40 percent of the planting opportunity on other private timber-growers' lands in the northern interior are on steep slopes or sites with limited stockability.

Forest-Damaging Agents

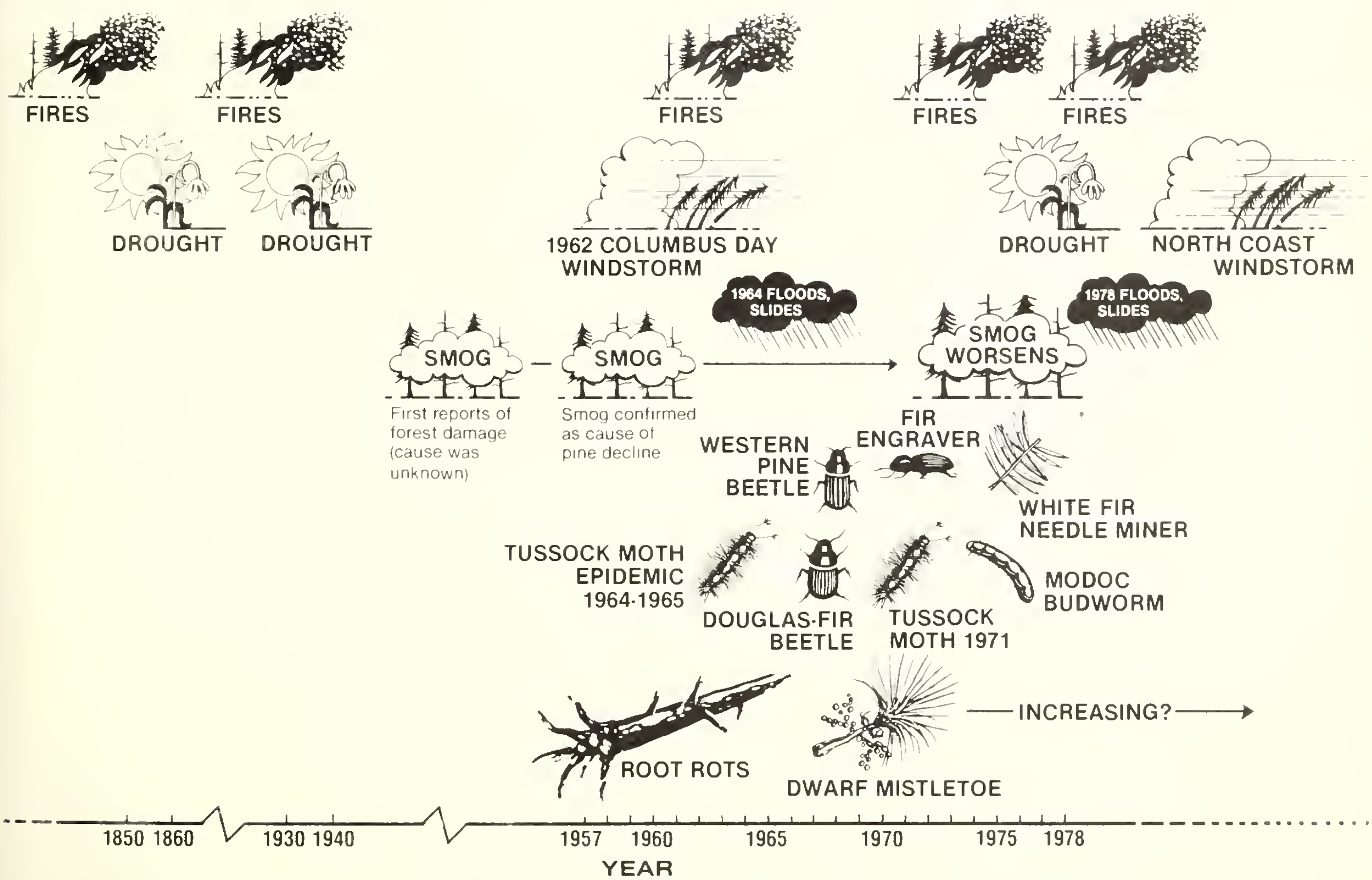
A history of California forests could be, to a large extent, a chronology of calamities (fig. 53). Forest management is very much a continuous battle against forest-damaging agents. If forest managers are to increase future timber yields through intensive management, they must also intensify their efforts in forest protection and damage control.

Figure 53. — California forests have been besieged by numerous epidemics and catastrophes in the past 128 years.

Fire

Fire protection[41] is probably the most important management activity in California's highly flammable forests. The forest fire fighting organizations of California are well known and effective. Since 1964, the average acreage burned per year has changed little, although the number of fires has more than tripled (fig. 54). Still, the occasional catastrophic year reminds us of the devastating potential of fire (fig. 55).

[41] Fire, properly used, can be a useful wildland management tool. The discussion here deals strictly with uncontrolled fire.



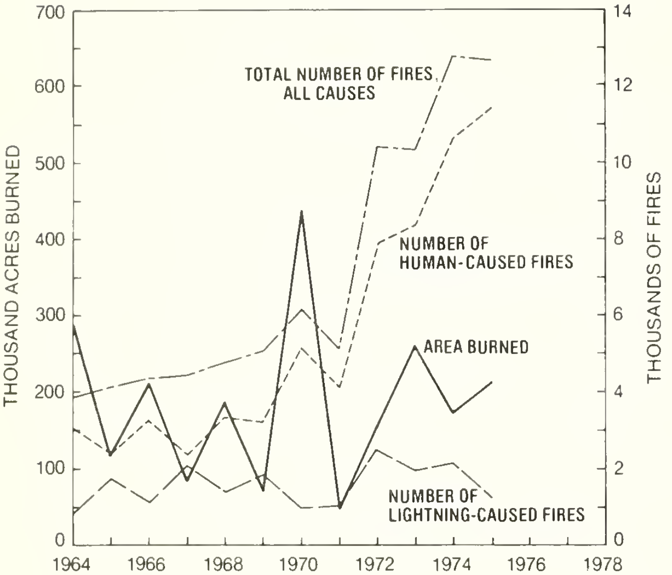


Figure 54.—Total acres burned and number of wildfires by cause in California, 1953-74 (State of California, Division of Forestry 1953-74).

Figure 55.—In 1977, one of California's worst wildfire years, about 175,000 acres of commercial forest burned.

The annual average value of resources damaged on the 42 million acres of State-protected lands[42] in California over the period 1964-74 was $22 million (State of California, Division of Forestry 1953-74, 1964-74 issues). Forest inventory data collected in 1970 through 1972 in California's interior show an estimated annual fire-caused mortality of 12 million board feet of sawtimber. This is roughly 3 percent of the total volume lost to mortality (table 20). Most of the volume in

[42] Included are areas contracted by the State to other agencies.

Table 20--Annual sawtimber mortality by cause, northern interior, Sacramento, and San Joaquin resource areas, California[1/]

Cause of death	Annual mortality	Percent
	Million board feet (Scribner rule)	
Insects[2/]	107	23
Weather[3/]	74	16
Disease	48	11
Logging[4/]	19	4
Suppression	17	4
Fire	12	3
Animals	2	--
Unknown/unclassified	177	39
Total	[5/]456	100

[1/] Estimated over a 5-year period ending at the date of inventory: 1966-70 to 1968-72 for all but Siskiyou County (1964-68). These data are not available for other resource areas.

[2/] Includes trees weakened by disease, weather, smog or other agents, then killed by insects.

[3/] Includes trees weakened by disease or other agents, then killed by weather.

[4/] Includes trees killed by uprooting, breaking, or other logging damage but does not include trees sawn down and left in the woods.

[5/] The estimate of mortality is probably conservative; trees salvaged between time of death and inventory were not included.

the fire-caused mortality was potentially salvable. Of more significance to forest yields is the effect of fire on plantations and submerchantable trees. Fire in young trees usually results in a total loss because small trees are generally not salvable. When a 25-year-old stand burns, a quarter century's growth is completely lost.

As the large, old-growth trees are removed and more of the forest is occupied by small trees, the relative effect of a fire on yields will be more severe, and less of the fire-killed volume will be salvable.

Fire statistics indicate that all of the increase in fire is human-caused (see fig. 54). The predicted increase in recreational use of forests and intensification of timber management will increase the likelihood of wildfires placing an additional burden on forest owners, managers, and protection agencies.

Insects

Many species of insects attack California forests. As the character of the forest changes from open stands of large trees to dense stands of small trees, the kinds of insect problems change. Sound forest management generally will minimize losses to insects, but continued research is needed if management knowledge is to keep up with the changing insect problems (fig. 56).

A brief chronology of some of California's worst forest insect problems since 1965 follows[43] (California Forest Pest Control Action Council 1964-75):

1964-65	California's worst Douglas-fir tussock moth epidemic.
1966	Douglas-fir beetle epidemic, one of California's worst.
	Jeffrey pine beetle attack; started in old trees, moved to dense poletimber.
1967	Western pine beetle outbreak attacked ponderosa pines in drought stricken areas.
1968	Western pine beetle infestation.
	Fir engraver beetle infestation (fig. 57).
1970	Douglas-fir tussock moth infestations.
	Western pine and Douglas-fir beetle losses high locally (fig. 58).
1971	Tussock moth infestation worsened.
	Fir engraver damage high.
1972	Various bark beetles at moderate levels.
1973	Modoc budworm outbreak – largest forest defoliator outbreak on record in California.
1974	Budworm epidemic continued.
	White fir sawfly outbreak.
1975	White fir needleminer, an associate of the budworm, continued to damage trees after the budworm population dropped.
1976-77	Severe bark beetle losses of trees weakened by drought. Several species were involved.

[43] Office records of USDA Forest Service, Pacific Southwest Region.

Figure 56. — Spraying ponderosa pines with Lindane before western pine beetle attack. A pilot project near a recreation site on the Los Padres National Forest.

Figure 57. — The top of this white fir was killed by the fir engraver beetle which entered the tree at dwarf mistletoe infections on the bole. Lassen County.

Insect-caused mortality in California's interior was estimated at 107 million board feet per year during a period of relatively normal infestation levels (table 20), 23 percent of total mortality. This is roughly equal to the annual timber harvested from all ownerships in Sierra and Yuba Counties combined.

Figure 58.—Douglas-fir trees killed by the Douglas-fir beetle. Trinity National Forest.

In addition to killing trees, insects — especially defoliators — weaken millions of trees, reducing their growth. Extensive insect damage occurs in plantations and natural stands of young trees. Insects causing damage include the pine needle-sheath miner, pine tip moth, pitch moths, the reproduction weevil, pine resin midge, Douglas-fir bud mite and the native pine shoot moth. From 1971 to 1975, the total acreage infested by defoliators and insects that attack young trees ranged from 100,000 acres a year to 450,000 acres (California Forest Pest Control Action Council 1964-75, 1971-75 issues).

A number of insects attack hardwood trees in California. Some of these may have potential for releasing conifers from competition, a kind of biological management tool. Some insects are of no interest to timber managers but may be of concern to wildlife biologists, or those who are looking to the currently noncommercial hardwoods as a source of energy. Included are the fall webworm, tent caterpillar, satin moth, alder flea beetle, and the common California oakworm that has defoliated oaks in scenic areas from Mendocino County to Kings County.

Diseases

Less spectacular than the effects of fire or insects, forest diseases are nonetheless a serious forest management problem in California. Three root diseases that weaken trees' resistance to insects, weather, or other diseases and sometimes kill trees outright are *Fomes annosus, Armillaria mellea,* and *Verticicladiella wagnerii.* They attack both large and small trees of several species. In 1966, for example, *A. mellea* killed young pines and firs in several campgrounds and plantations and also weakened the roots of a giant sequoia 24 feet in diameter, causing it to fall (California Forest Pest Control Action Council 1964-75, 1967 issue).

Other damaging diseases include the rusts, cytospora canker, needle diseases, heart-rotting fungi, and dwarf mistletoe.

Dwarf mistletoe, considered to be ". . . the most serious disease agent infesting forests of western North America . . .",[44] reduces growth and seed production, invites insect attack, and kills trees outright. About 21 percent of California's timberland is infested with dwarf mistletoe in several conifer species (Bolsinger 1978b). About 15 percent of National Forest lands and 25 percent of other lands are infested. In the three major species, the area infested is:

Species	Area infested (Thousand acres)
Douglas-fir	646
Ponderosa and Jeffrey pines (fig. 59)	924
True firs	1,002

Dwarf mistletoe infections are common in the interior, but rare on the west slopes of the Coast Ranges.

[44] Quote from the announcement of *A Symposium on Dwarf Mistletoe Control Through Forest Management,* Berkeley, Calif., April 11-13, 1978.

Figure 59. — Piling pruned limbs and small trees cut in dwarf mistletoe control project in ponderosa pine. Los Padres National Forest.

Weather Damage

Windthrow or windsnap are periodically widespread in California forests, often associated with root disease or heart rot. Other kinds of weather damage experienced in recent years include late spring frosts; foliage burn on sunny, windy days when the ground is frozen; hail; heavy snow; ice storms; and drought. The 1975-77 drought in California was particularly severe. A survey of 12 National Forests found 12.3 million trees killed by drought, or weakened by drought and finished off by bark beetles and/or disease. These trees contained an estimated 8.6 billion board feet. The greatest damage was to ponderosa pine, sugar pine, and white fir. Further loss may be forthcoming as insects continue to work on drought-weakened trees.

In California's interior, the annual estimated mortality attributed to disease and weather over the 5-year period ending in 1972 was 122 million board feet (table 20).

Animal Damage

Many of the wild animals that delight forest visitors, attract hunters, and add to the richness of life also damage and kill forest trees. Deer browsing on young conifers is a serious animal damage problem in parts of California (fig. 60). Extensive damage by pocket gophers in plantations in northern California has occurred. Other damaging animals include mice, rabbits, porcupines, elk, and bear.

Figure 60. — These deer-browsed Douglas-fir trees in Mendocino County are 18 years old. Trees of the same age that escaped damage in this area are about 40 feet high. The loss of wood production attributable to deer in this stand is about 130 cubic feet per acre, over 18 years.

People-Caused Forest Damage

Many of the activities of people damage trees, either directly or indirectly. Causes range from logging to air pollution.

Logging damage to uncut trees caused about 4 percent of the estimated annual timber mortality in California's interior (table 20). Logging damage serious enough to threaten trees' chances of surviving for 10 years was found on 20 percent or more of residual trees on 130,000 acres on private lands in the interior (based on sample plots in recently logged stands).

Chemical damage to trees has occurred along powerlines and near homesites and industrial installations throughout the State. Soil compaction or tree root disruption by machinery, animals, and even people in some areas can weaken or kill trees (California Forest Pest Control Action Council 1964-75).

Smog damage is a serious and growing forestry problem in California (California Forest Pest Control Action Council 1964-75). In the last 1940's, unhealthy ponderosa pines were noted in the Arrowhead-Crestline area in San Bernardino County, but not until 1957 was air pollution confirmed as the cause. By that time thousands of trees had died. In many cases insects finished off the smog-weakened trees. A survey in 1969 revealed that 161,000 acres in southern California were affected; 3 percent of the trees were killed and 15 percent were severely damaged (California Forest Pest Control Action Council 1964-75, 1970 issue). By 1975, smog damage had spread throughout southern California and was killing trees on the western slopes of the Sierra Nevada as far north as Fresno County. Data from smog-evaluation plots on the Los Padres and Sequoia National Forests indicate that severity of damage is increasing.

The problems posed by forest-damaging agents are complex and cut across many disciplines. Many of the problems are clearly related to more than one forest use or resource, and treatments done on a one-use basis may be counterproductive. For example, controlling deer damage to a Douglas-fir plantation may be at odds with desired wildlife goals if not carefully planned.

Availability of Forest Land for Timber Production

National Forests

National Forests contain over 60 percent of California's standing timber volume and half of the timberland. They are managed for continuous production of various commodities and amenities including outdoor recreation, water, fish and wildlife, timber, and forage for livestock (USDA Forest Service, Pacific Southwest Region 1975a). Timber management is planned within a framework of all recognized resource values. Timber is sold on the stump to purchasers who are required to remove trees according to a detailed contract. Through the contract, provisions are made to protect nontimber resource values, maintain timber yield, and minimize waste.

In developing National Forest timber management plans (USDA Forest Service 1977a, section 2412 Land classification), the timberland has been classified into four components which bear on timber management intensity:

1. **Standard component**: Regulated timberland on which crops of industrial wood can be grown and harvested with adequate protection of forest resources under the provisions of the timber sale contract (fig. 61).

2. **Special component**: Regulated timberland for which multiple use plans require specially designed treatment to achieve other resource objectives. Also included are areas where timber management activities are delayed pending multiple use planning and management decisions, travel and water influence zones, peripheral portions of developed sites (fig. 62), classified recreation areas, and areas where timber harvest is a secondary or minor management objective.

Figure 62. – Forests adjacent to developed campgrounds, such as this one in the Sierra National Fore[st], are classified as special component. Timber produc[tion] in such areas is a secondary objective.

Figure 61. – Young stand of ponderosa pine and Jeffrey pine on standard component commercial forest land. Tahoe National Forest, Nevada County.

3. **Marginal component:** Regulated timberland not qualifying as standard or special primarily because of excessive development cost, low product value (fig. 63), or constraints from resource protection. Included may be sites requiring unusual logging techniques such as helicopters, areas where harvesting is blocked until roads are constructed, or species not presently in demand. Also included is the backlog of nonstocked areas that would otherwise be classed as standard, but cannot be reforested without funding.

Figure 63. – Knobcone pine, a low-value species, on marginal component timberland. Mendocino National Forest, Glenn County.

4. **Unregulated component:** This is timberland that will not be managed for timber production under sustained yield principles. It includes:

a. Experimental forests.

b. Existing and planned recreation development sites, special interest areas, and administrative sites where timber harvest is not a major goal of management such as ranger stations, guard stations, nurseries, etc.

c. Isolated tracts of timberland where sustained periodic harvest is impractical.

The bulk of the timber comes from the standard component, which consists of the most manageable land. The other components yield some timber, but they are less dependable. In National Forests in the Pacific Southwest Region, which comprise 98 percent of U.S. Forest Service land in California, the standard component amounts to 62 percent of the timberland but contributes 90 percent of the programed harvest (table 21).

Over the 3-year period 1973-75, the removals from all California National Forests averaged 106 percent of the potential yield from the standard component and 83 percent of the potential yield from all components (table 22) (USDA Forest Service 1976). Removals measured in cubic feet amounted to 85 percent of the softwood cubic-foot growth. Scribner board-foot removals amounted to 107 percent of the board-foot softwood growth.

It would appear that the recent annual harvest level in National Forests of about 1.8 billion board feet could be maintained indefinitely. The high estimated biological potential – nearly twice the current growth rate – seem to indicate that intensified forest management could eventually increase the growth rates so that more timber could be harvested. Before the long-run timber productivity can be determined, however, more information is needed on management techniques and response, resource interactions, and demand for various outputs; and the area devoted to timber production must be clearly defined and stabilized. Because these problems are not likely to be solved in the near future, the area of land devoted to timber use and the exact amounts of timber to be harvested are somewhat uncertain.

Table 21--Percent of timberland, programed harvest, and timber sold in National Forests of the Pacific Southwest Region, by timberland component, California, 1977

Timberland component	Timberland	Programed harvest in 1977	Timber sold sold in 1977
Standard	62	90	84
Special	11	6	5
Marginal	24	4	11
Unregulated	3	0	0
All components	100	100	100

Table 22--Current annual timber removals, and removals as percent of potential yield from standard components and all components of National Forest timberland, by National Forest group, California

National Forest group	Current annual removals1/	Removals as percent of potential yield from standard components1/	Removals as percent of potential yield from all components
	Cubic feet per acre per year		
Northwestern California2/	38	97	74
Northeastern California3/	29	111	81
Northern Sierra Nevada4/	49	117	91
Southern Sierra Nevada5/	43	103	86
Southern California6/	9	7/	112
All groups	37	106	83

1/Average for 1973-75.

2/Includes Klamath, Mendocino, Six Rivers, Trinity, and California portion of Rogue River and Siskiyou National Forests.

3/Includes Lassen, Modoc, and Shasta National Forests.

4/Includes Eldorado, Plumas, and Tahoe National Forests.

5/Includes Sequoia, Sierra, Stanislaus, and California portion of Toiyabe National Forests.

6/Includes Angeles, Cleveland, Los Padres, San Bernardino, and California portion of Inyo National Forests.

7/Four of the five National Forests in southern California have no land classified as standard component.

Other Public Agencies

Lands administered by the U.S. Department of the Interior, Bureau of Land Management (BLM) are managed for sustained yield under multiple use principles defined in the Federal Land Policy and Management Act of 1976 (Public Law 94-579). These lands total about 240,000 acres in scattered parcels throughout the State.

In 1975 the cut from BLM lands was 46 million board feet. The average cut during the period 1965-75 was 33 million (Ruderman 1976). The current annual allowable cut on BLM lands, based on a new forest inventory, is 25 million board feet (Scribner rule). This is a reduction from the allowable cut of 51 million board feet, based on an older forest inventory. The new allowable cut incorporates nontimber values and the effect of fragile sites on forest productivity.[45]

Indian lands are managed under the guidance of the U.S. Department of the Interior, Bureau of Indian Affairs to provide income for the Indian owners. These lands are privately owned, though historically they have been classified as part of the public lands. They total about 100,000 acres in the larger Reservations (mainly the Hoopa Valley in Humboldt County and the Tule River in Tulare County) and scattered parcels. Timber is managed on a sustained-yield basis with a long-term allowable harvest equal to the land's capacity under planned management intensity. In 1977, 38 million board feet were harvested from Indian forests. The average cut during the period 1965 to 1977 was 49 million board feet (Ruderman 1979).

State-owned timberland includes seven State Forests and scattered parcels of other State lands. Four of the State Forests are managed for timber production by full-time forestry staffs. The total acreage in these four forests is about 68,000 acres (State of California Department of Forestry 1977):

State Forest	County	Resource area	Acres
Boggs Mountain	Lake	Sacramento	3,464
Jackson	Mendocino	North coast	50,505
Latour	Shasta	Northern interior	9,013
Mountain Home	Tulare	San Joaquin	4,562
Total			67,544

[45] Personal communication with BLM staff in Sacramento.

All categories of State lands classified as timberland in the Forest Service inventory total 79,000 acres.

The State Forests are used primarily for forestry experiments and demonstrations. Timber sales are closely supervised to assure that these goals are reached. In 1977, 28 million board feet were cut on State lands. The average cut during the period 1965-77 was 36 million board feet.

Private Lands

The area in private ownership in California that is classified as timberland totals 7,632,000 acres (see tabulation, page 10). By no means is all this land available for growing and harvesting timber, though much of it has been logged in the past.

Perhaps most dependable of the private lands for timber production are the 2,688,000 acres owned by companies that operate forest products mills, and the 1,348,000 acres owned by other companies that grow timber for sale to the companies that operate mills. These companies have forestry staffs (fig. 64) and manage timber on a continuous-yield basis. The total acreage in these ownerships has increased over the years. Though intensity of timber management varies from company to company, investment in mills and high quality timberland is some assurance that the companies will continue to produce timber. These companies cut an estimated 2.1 billion board feet of timber from their lands in 1972 and 2.2 billion in 1976.

Timberland owned by farmers and ranchers totals 1,646,000 acres. Miscellaneous private owners including nonfarmer individuals, banks, churches, real estate development companies, and other organizations hold 1,950,000 acres of commercial forest. Included are some timberlands being managed by consulting foresters and many tracts that are logged sporadically but are not managed specifically to grow timber. The total area of farmer and miscellaneous private forest has decreased due to grazing, clearing, residential development and other conversions, and purchases by timber companies and government agencies.

Figure 64. — Company forester examining a ponderosa pine in October 1977 which was planted in 1971. Butte County.

About 950 million board feet of timber was cut from the farmer and miscellaneous private lands in 1972, and 761 million in 1976.[46]

It is not possible to determine how much of the 3,596,000 acres in this ownership class will be used for timber production. The timber preserve zoning requirements of the Z'Berg-Warren-Keene-Collier Forest Taxation Reform Act of 1976 (State of California 1976) will eventually provide a basis for determining the acreage of forest used for timber production. (The main purpose of the Act, however, is to encourage landowners to keep land in forestry use and producing higher yields.) A preliminary list of properties compiled by the State Board of Equalization indicates that about 2.0 million acres of the 3.6 million acres are currently assessed for other than timber use. These areas probably cannot be depended upon for timber production in the future.

Size of forested property and place of owner's residence are sometimes related to the owner's ability or willingness to manage for timber production. A study by Extension Forestry, University of California, was conducted to learn more about the forest owners in California so that extension programs can be more effective. Data collected in this study show that half to three-fourths of the acreage in nonindustrial ownership in Humboldt, Lassen, Mendocino, Plumas, Shasta, Sierra, and Tuolumne Counties is in properties 500 acres or larger in size, and is held by only 5 to 1[illegible] percent of the owners (see table 23 for details). Properties 5,000 acres or larger in these counties represent 0.6 percent of the total number of properties, but contain 24 percent of the total area.[47]

Place of owner's residence varies considerably from one geographic area to another. In Humboldt County, for example, 72 percent of the forest landowners live in the County, compared with only 14 percent in Sierra County. For all counties studied, 50 percent

[46] Based on the reported log consumption by ownership (Hiserote and Howard 1978).

[47] This information was provided jointly by Dr. Robert J. Laacke, formerly Extension Forester, University of California, Berkeley, and Gary Crawford, graduate student in Urban and Regional Planning, California State University, Fresno.

Table 23--Percent of owners of forested properties and of acreage by acreage class for all farmer and miscellaneous private ownerships, Humboldt, Lassen, Mendocino, Plumas, Shasta, Sierra, and Tuolumne Counties, California, 1976-78

County	Acreage class								
	4-19	20-39	40-119	120-499	500-999	1,000-4,999	5,000-9,999	10,000+	Total
	Percent of owners								
Humboldt	18	13	31	25	5	6	1	1/	100
Lassen	33	14	23	19	5	5	1/	1/	100
Mendocino	25	16	32	19	4	2	1/	1/	100
Plumas	36	19	24	15	4	2	1/	1/	100
Shasta	35	17	28	15	4	2	0	1/	100
Sierra	34	15	20	21	5	4	1/	0	100
Tuolumne	15	12	38	27	4	3	0	0	100
	Percent of acreage								
Humboldt	1/	1	5	16	11	36	18	13	100
Lassen	1	1	4	14	12	38	11	19	100
Mendocino	1	2	10	20	11	28	13	14	100
Plumas	2	3	8	20	16	25	18	9	100
Shasta	3	4	13	26	18	27	0	8	100
Sierra	1	2	6	25	17	40	8	0	100
Tuolumne	1	2	15	38	19	24	0	0	100

Sources: Dr. Robert J. Laacke, former Extension Forester, University of California, Berkeley, and Gary Crawford, graduate student in Urban and Regional Planning, California State University, Fresno.

1/ Less than 0.6 percent.

of the forest landowners live in the county in which the property is located or in an adjacent county; 42 percent live elsewhere in the State, and 8 percent live out of State (see the following tabulation).

Location of property	Place of owner's residence			
County	In-county	Adjacent county	Elsewhere in State	Out-of-State and foreign
	Percent of owners			
Humboldt	72	2	21	5
Lassen	28	12	51	9
Mendocino	37	9	46	8
Plumas	30	10	44	16
Shasta	38	5	50	7
Sierra	14	12	64	10
Tuolumne	40	9	47	4
Average of all above counties	43	7	42	8

During the inventory of California's interior and central coastal forests, numerous nonforest developments in process were encountered (fig. 65). Included were recreational and residential developments, grazing clearings, and others. Plots were established in these areas if they were still forested. Summary data from these plots are included in this report. Most of these areas will probably be lost to timber production. Some of the timber on these tracts may be marketed as the land is cleared. Small trees will probably be stacked and burned. In some areas much of the timber will be left standing (fig. 66). The total area of productive forest in these areas as determined from sample plots at the time of inventory (1970-72) was 221,000 acres. This is about 11 percent of the farmer and miscellaneous private timberland in the interior and central coast areas.

Figure 65. – Aerial view of unfinished recreational-residential development on high site timberland in Calaveras County. About 220,000 acres of privately owned timberland were being developed for nonforest use in Califorr at the time of the inventory.

Figure 66. – New houses in the pines. An unfinished residential development in Plumas County.

Total softwood volume on these 221,000 acres was 2.3 billion board feet (Scribner rule), or about 14 p cent of the total on farmer and miscellaneous priva lands in the interior and central coast areas. Net annual growth in these stands was 10.1 million cub feet, 11 percent of the total. About 18,000 acres were redwood type, 33,000 acres Douglas-fir type and 34,000 acres mixed conifer type, including Douglas-fir and/or sugar pine. Much of the remainin 136,000 acres was in ponderosa and Jeffrey pine types. The developments were usually on flat to gently sloping lands; and with the exception of graz ing clearings, they were generally in heavy conifer timber stands.

Timber Harvest: Past, Present, and Future

Past and Present

Since 1900, well over 200 billion board feet of softwood timber have been logged and processed in California. The peak of California's timber cutting was in 1955 when over 6 billion board feet were hauled from the woods (State of California, Department of Forestry 1947-77). Since then, the cut has declined to about 4.5-5.0 billion. Cutting in early years was predominantly on private lands. Later, as the cut declined on private lands, the National Forest cut increased (see fig. 67).

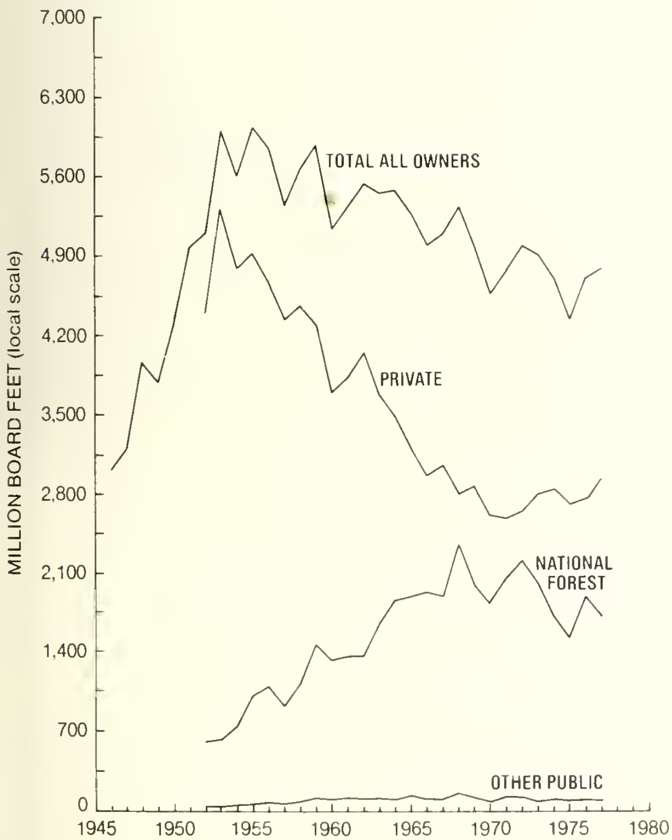


Figure 67. – Timber harvest in California, 1946-77, by ownership.

In 1976, 4,731 million board feet were harvested in California, 42 percent from public forests and 58 percent from privately owned forests:

Ownership	Million board feet (local scale)	Percent
National Forest	[48]1,890	40
Other public	[49]84	2
Forest industries[50]	2,154	45
Farmer and miscellaneous private[50]	603	13
Total	[51]4,731	100

Timber harvested in the north coast resource area in 1976 amounted to 39 percent of the State total. The remaining 61 percent was harvested in the interior, as shown below:

Resource area	Million board feet (local scale)	Percent
North coast	1,825	39
Central coast and southern California	34	–
Northern interior	1,292	27
Sacramento	1,035	22
San Joaquin	545	12
Total	4,731	100

Timber cutting in the north coast has fluctuated considerably since the 1950's. In the interior the cut has remained fairly stable, especially in the Sacramento and San Joaquin resource areas (fig. 68). Very little timber has been cut in the central coast since the 1930's, though this area has produced lumber products for well over a century (Wilson 1938). California's first power sawmill was established in this area in 1841; and from 1842 to 1937 over 275 mills operated in San Mateo, Santa Cruz, and Santa Clara Counties.

[48] Reported by Intermountain, Pacific Southwest, and Pacific Northwest Regions of the USDA Forest Service.

[49] Reported by the State of California; U.S. Department of the Interior, Bureau of Indian Affairs, and Bureau of Land Management.

[50] Based on reported log consumption by forest products mills (Hiserote and Howard 1978).

[51] Total reported by California Department of Forestry.

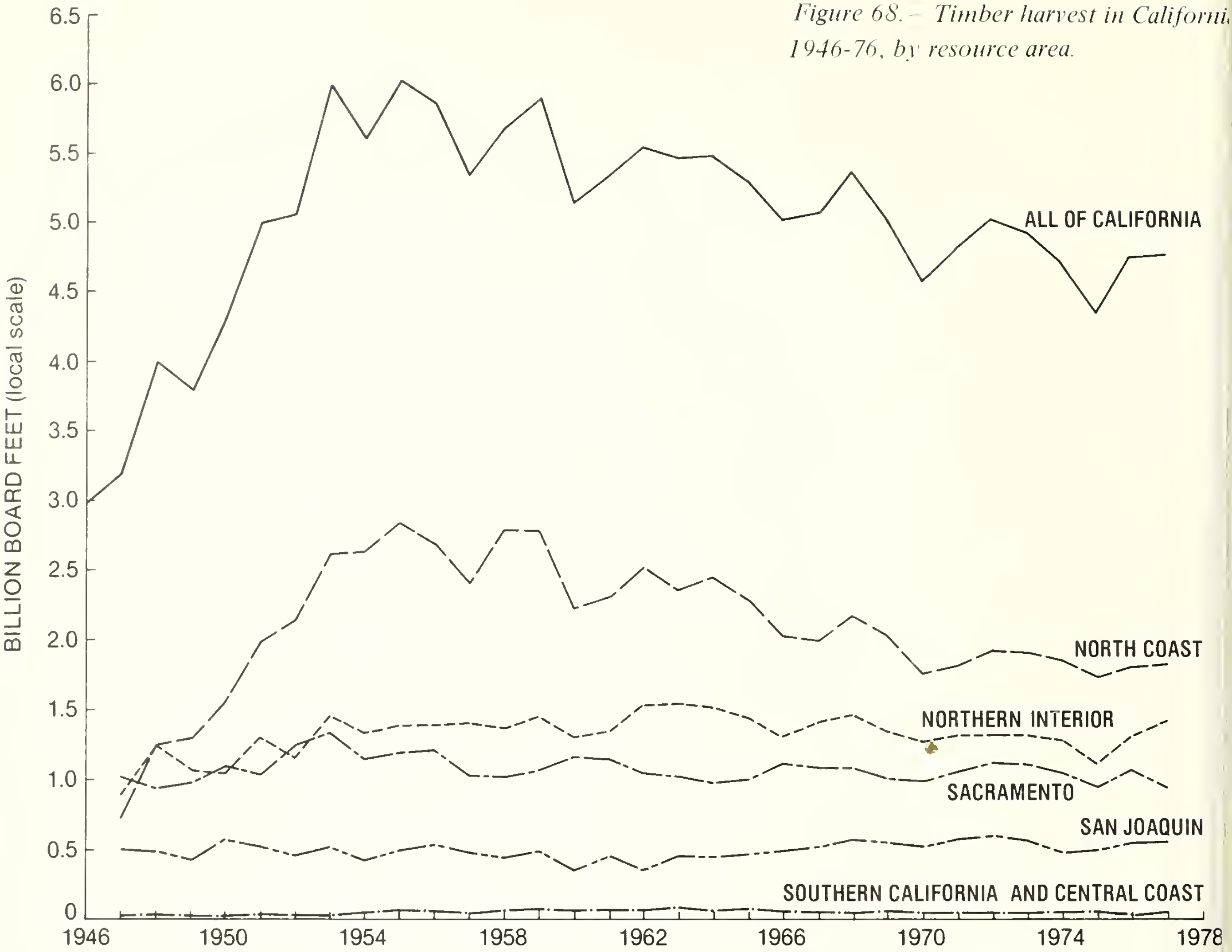


Figure 68. – Timber harvest in Californi[a], 1946-76, by resource area.

California's forest industries have relied almost exclusively on old-growth timber (fig. 69) until recent years. As the available old growth has been logged, a gradual transition to young growth has taken place. Still, 70 percent of the 1976 log consumption was from trees 100 years or older:

Year	Old growth (100+ years)	Young growth (less than 100 years)
	— — — Percent of log consumption — — —	
1968	80	20
1972	73	27
1976	70	30

The increase in the use of young growth is notable in the coastal areas where much of the old growth on private lands has been logged and little government timber exists. In 1976, 39 percent of the timber sawn in the central coast and north coast lumber mills wa[s] from trees less than 100 years old. Industries in the northern interior resource area use the largest propo[r]tion of old growth:

Resource area and region	Old growth (100+ years)	Young growth (less than 100 yea[rs])
	— Percent of logs sawn in 1976	
North coast	62	38
Central coast	9	91
Average coastal region	61	39
Northern interior	80	20
Sacramento	74	26
San Joaquin	70	30
Average interior region	75	25

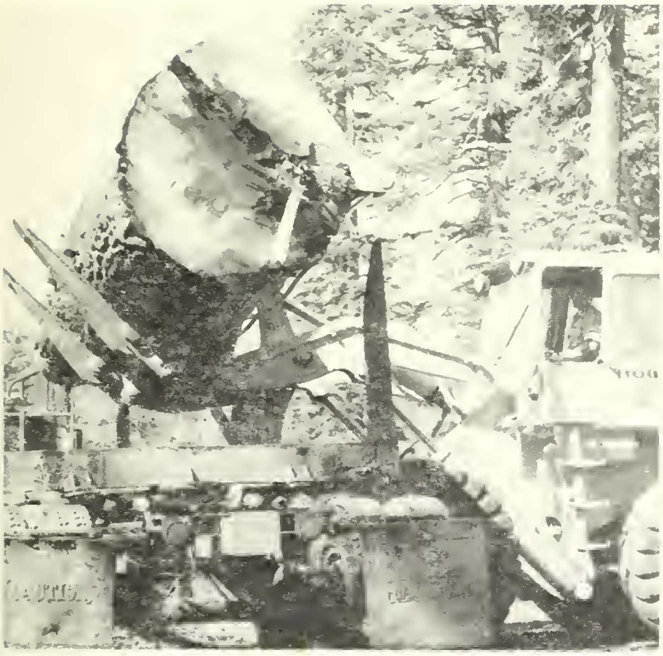


Figure 69. – Old-growth timber still makes up 70 percent of California's timber harvest. The large red fir log was cut in the Sierra National Forest.

Changing Size and Species

The changing mix of log sizes will require more diversity in logging and processing facilities in the future. Though an increasing volume in small logs from young trees is being used, large logs will make up a substantial part of the resource for many decades (fig. 70). Softwood trees 29-inch d.b.h. and larger make up 67 percent of the inventory on National Forests and 33 percent of the inventory on other ownerships.

The mix of species harvested has changed over the years because of the changing market and species availability (table 24). Douglas-fir was used very little before the post-World-War II housing boom and the concomitant rise of the veneer-plywood industry. In 1956, Douglas-fir amounted to 44 percent of total consumption as north coast owners of Douglas-fir timber took advantage of the new market. Now Douglas-fir amounts to about one-quarter of California's industrial wood consumption.

Figure 70. – Large trees such as this Douglas-fir in Glenn County are gradually disappearing from California forests but will be part of the resource for a long time.

True firs made up only 13 percent of total consumption as late as 1956 and amounted to only 19 percent in 1976. Because of the large inventory in true firs (28 percent of softwood sawtimber volume), especially in National Forest old-growth stands, some increase in the cut in this species might be expected in the future.

Redwood accounted for nearly half of California's timber production for a short period at the turn of the century. It has remained relatively constant, proportionally, at slightly less than 20 percent for the past 20 years. The volume and growth potential of redwood indicate this species could continue to be an important part of California's timber resource provided all redwood areas remain in timber production. Because of pressures to use redwood forests for nontimber purposes, it is difficult to predict the future contribution of this species to the timber supply.

Table 24--Consumption of logs in mills by species, California, selected years 1869-1976

Year[1/]	Douglas-fir		True firs		Redwood		Ponderosa pine		Sugar pine		Incense-cedar		Other softwoods		Hardwoods		All species	
	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent	Million board feet, local scale	Percent
1869	30	8	0	0	75	21	204	58	35	10	--	0	10	3	0	0	354	100
1899	18	2	0	0	360	49	286	39	52	7	1	trace	20	3	1	trace	738	100
1906	127	9	68	5	660	49	347	26	130	10	12	1	4	trace	1	trace	1,349	100
1931	105	11	66	7	210	22	458	48	100	10	18	2	1	trace	2/	trace	958	100
1946	551	19	435	15	252	9	1,243	44	292	10	68	2	11	1	2/	trace	2,852	100
1956	3,090	44	936	13	1,197	17	1,194	17	410	6	113	2	79	1	0	0	7,019	100
1962	2,134	39	857	16	939	18	881	17	399	7	173	3	3/	3/	26	trace	5,410	100
1968	1,763	32	1,226	23	1,000	18	860	16	438	8	176	3	3/	3/	14	trace	5,477	100
1972	1,467	27	1,186	22	1,019	19	1,381	25	4/	4/	221	4	164	3	13	trace	5,451	100
1976	1,282	27	879	19	915	19	1,012	22	178	4	194	4	220	5	8	trace	4,688	100

Sources: Burks et al. (1948), May (1953), May and Baker (1957) May (1958), May and Baker (1958), Muerle and Hornibrook (1965), Barrette et al. (1970), Howard (1974), Hiserote and Howard (1978).

1/ 1869-1931 data are based on lumber production; 1946 data are based on log consumption by lumber mills; 1962-1976 data are based on log consumption by all industries.

2/ Less than 500,000.

3/ Included with incense-cedar.

4/ Ponderosa pine and sugar pine combined.

Ponderosa and sugar pines accounted for nearly 70 percent of California's industrial wood use in 1869 and over 50 percent as late as 1946 (fig. 71). Since 1956 they have contributed 23 to 26 percent of the total. Though many ponderosa pine plantations will result in substantial volume of this species in the somewhat distant future, the declining inventory would suggest some reduction in ponderosa pine consumption in the near future. Sugar pine consumption will probably decline even more.

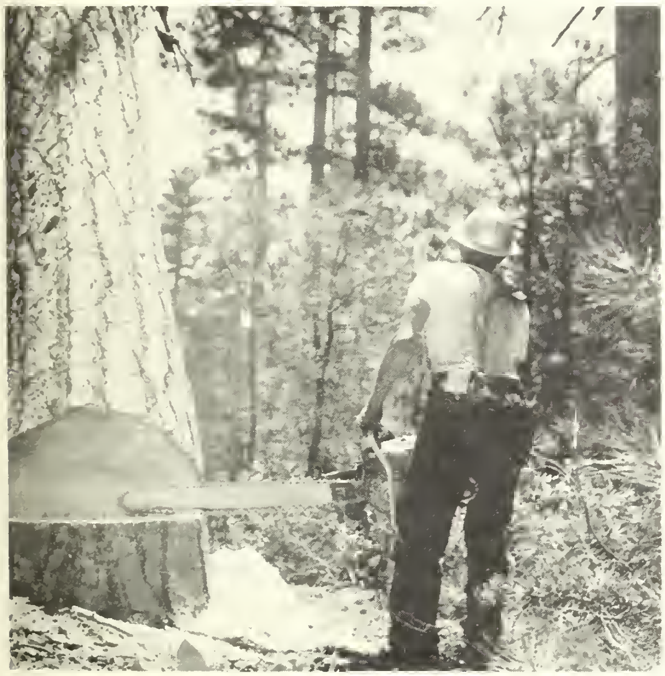


Figure 71.— Felling a ponderosa pine, Lassen National Forest. Proportionally, the harvest of ponderosa pine has declined since the 1940's.

Other softwoods, including incense-cedar (fig. 72), have been of minor importance to California forest industries. Incense-cedar has recently increased in value and is being used for some of the products traditionally made of redwood and western redcedar. The opportunities to increase the use of incense-cedar are limited, however. It accounts for only 4 percent of the softwood volume, and its growth potential is less than that of associated conifers on most sites.

Figure 72.— Loading an incense-cedar log, Sequoia National Forest.

Over 25 species of hardwoods grow in California forests, including 17 that are classified as commercial.[52] The total volume in these 17 species is 7.8 billion board feet, and their annual growth is about 132 million board feet. They have been used very little by the industry but are currently being considered as a potential source of energy or pulp.

Future Timber Harvest

While the real price of lumber and other forest products has increased, the amount of timber harvested from all ownerships has decreased (fig. 73). National Forest timber harvests increased from less than 1.0 billion board feet in the early 1950's to 1.5-2.0 billion board feet in the 1970's; but this was not enough to compensate for the decrease in timber harvest from private lands—from 4.7-5.3 billion in the early 1950's to 2.6-2.9 billion in the 1970's. In recent years, private timber harvests have leveled off; but studies based on analyses of growth, harvest, and inventory stocks indicate that further decreases in private timber harvests can be expected, especially in the northern part of the State (Gedney, Oswald and Fight 1975; Oswald 1978). Recent forest investments and planned intensification in forestry activities will result in increased timber yields, but the benefits cannot be realized until well after the year 2000. A shortfall in private timber supply is likely to occur before then.

[52] See Griffin and Critchfield (1972) for details on California hardwood species and their distribution.

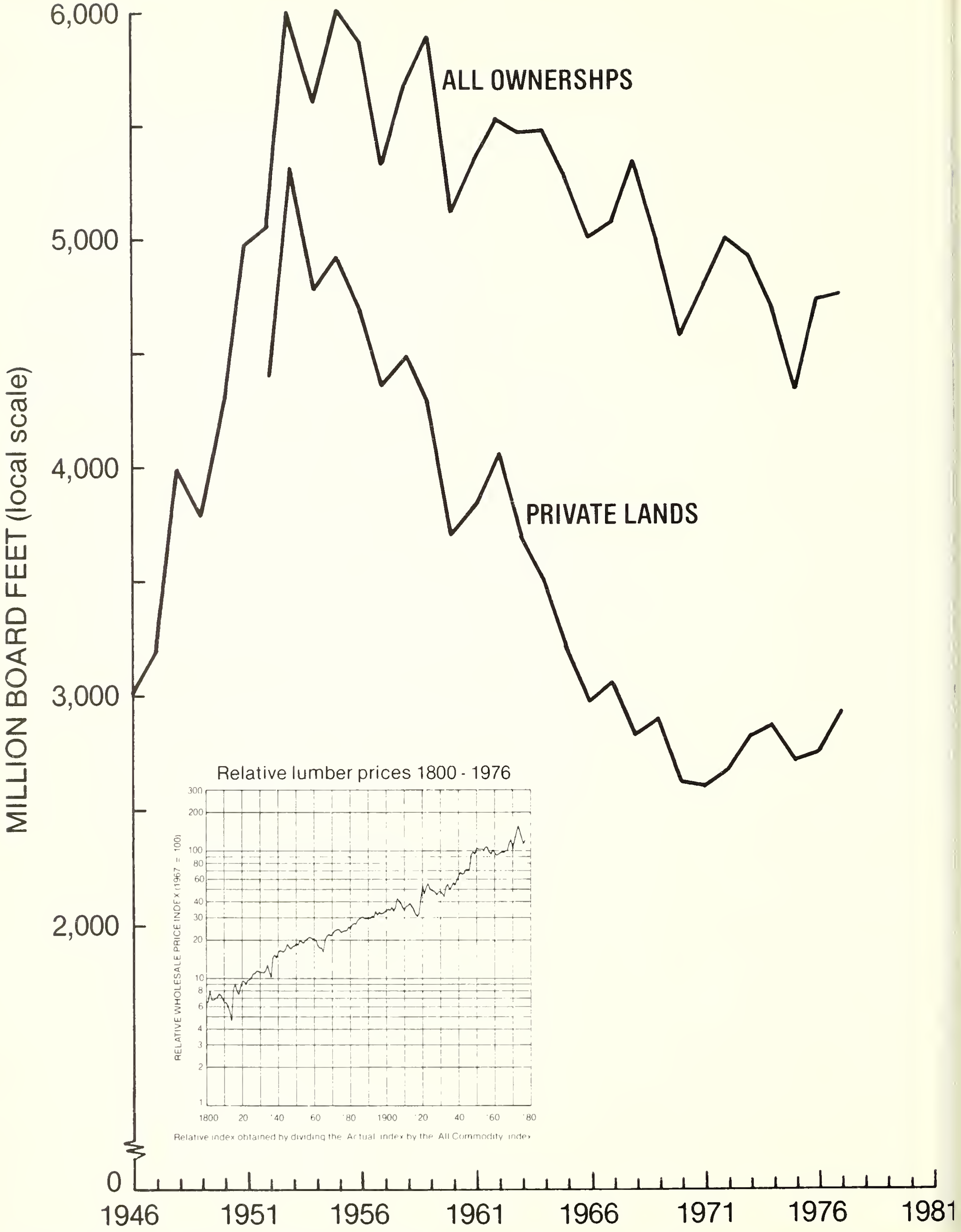


Figure 73.— Timber harvest in California on private lands and all ownerships, 1946-77, and relative lumber price in the United States, 1800-1976. Source for lumber prices: Phelps (1977).

Forest Industries and Employment

Although National Forest timber harvests have doubled since the early 1950's, in recent years they have more or less stabilized. The National Forest Management Act of 1976 (Public Law 94-588) and the accompanying proposed rules for land and resource management planning do not set specific timber cutting levels. They provide flexible guidelines determining the size of cutting units, silvicultural systems, and area to be treated during a given period. Long-run harvest levels are not to exceed the land's potential under management. Departures from the traditional non-declining even-flow policy are possible but only after much debate. The rules call for screening land for the suitability of timber production which is likely to reduce the total area managed for timber. As with private lands, recent increases in forest management activities in National Forests will result in higher future yields. Whether or not this will offset reductions in yields resulting from other decisions is difficult to determine now.

Many opportunities exist for intensified forestry investments on both public and private lands that could result in increased timber yields in the future. Opportunities also are present to vary near-future cutting rates on both public and private lands to alter future timber availability. A program to capitalize on these opportunities would be very complex, involving political, economic, and technical considerations.

In 1976, there were 200 primary forest products mills in California, including 142 lumber mills, 21 veneer and plywood plants, 17 pulp and board plants, and 20 "other industry" plants — including shake and shingle; post, pole, and piling; and export facilities. Since 1962, 85-86 percent of the industrial wood processed in California has been made into lumber (fig. 74) and 10-13 percent has gone into plywood (table 25). The pulp and board industry uses very little roundwood — mill residues (chips) make up most of its raw material supply.

Though relative consumption by the various sectors of the forest products industry has remained fairly constant for many years, changes in the number of firms and mills continue. From 1962 to 1976, the number of sawmills declined from 297 to 142 and the number of veneer and plywood mills declined from 39 to 21. The trend in forest industries in California, as throughout the Pacific Coast States, has been toward fewer and larger firms with greater plant capacity and larger land holdings.

Figure 74 — About 85 percent of the timber harvested in California forests is sawn into lumber. Bendix Forest Products Corporation mill, Madera County.

Table 25--Number of forest products mills and percent of log consumption by industry sector, California, selected years 1946-76

Industry	1946	1956	1962	1968	1972	1976
Lumber:						
Number of mills	907	695	297	216	176	142
Percent of log consumption	95	91	85	86	86	86
Veneer and plywood:						
Number of mills	2	21	39	26	25	21
Percent of log consumption	2	7	13	10	12	12
Pulp and board:						
Number of mills	--	9	11	17	18	17
Percent of log consumption	--	1	1/	1/	1/	1/
Other:						
Percent of log consumption	3	1	2	4	2	2

Sources: Burks et al. (1948), May (1953), May and Baker (1957), May (1958), May and Baker (1958), Muerle and Hornibrook (1965), Barrette et al. (1970), Howard (1974), Hiserote and Howard (1978).

1/Less than 0.5 percent. The pulp board industry relies almost entirely on mill residues in the form of chips.

Table 26--Employment in forest industries by resource area and industry sector, California, 1975
(In number of employees)

Resource area	Logging	Sawmills and planing mills	Veneer and plywood mills	Other wood products mills	Pulp and paper mills	Total
North coast	1,350	7,875	1,316	2,193	773	13,507
Central coast	47	277	0	2,329	9,632	12,285
Northern interior	940	3,562	682	428	462	6,074
Sacramento	859	3,591	16	4,518	1,135	10,119
San Joaquin	318	2,682	0	3,790	2,438	9,228
Southern California	46	386	499	15,159	20,137	36,227
All areas	1/3,560	18,373	2,513	28,417	34,577	87,440

Source: State of California, Employment Development Department (1960-75).

1/Does not include contract log haulers and may exclude some independent ("gyppo") loggers.

Conclusions

'orest industries in California employed 87,440 per-
ons in 1975 (table 26). This is about 1.2 percent of
otal employment and 5.5 percent of manufacturing
mployment in the entire State. The importance of
orest industries varies geographically. They account
or over 70 percent of manufacturing employment in
3 counties and over 20 percent of total employment
1 20 counties (table 34, appendix). Most of the forest
ıdustry employment in southern California and the
entral coast and some in the Sacramento resource
reas do not depend directly on California-grown
mber. Roughly 50,000-55,000 persons do depend
n California's timber for jobs.

'rom 1960 to 1975, forest industry employment
eclined the most in the north coast resource area.
See Zivnuska et al. (1965) for a detailed discussion
f forest industry employment in the 1960's.) Em-
loyment declined very little in all interior areas
ombined, though a number of counties dropped
ightly (northern interior counties, for example)
hile other counties increased (Tulare and Yuba,
or example).

1 a number of counties, forest industry employment
eclined in number of persons employed but in-
reased as a percent of manufacturing employment.
'his situation is notable in rural counties with some-
hat weak economies such as Lassen, Modoc, Plumas,
iskiyou, and Trinity (see fig. 75).

lany of the counties in which timber has been the
conomy's foundation are facing an adjustment
eriod because of declining timber supplies. Planners
re grappling with questions like: How can we allocate
emaining timber stands without sacrificing future
ields? Should the economy be diversified, and if so,
ow? Can a program of forestry intensification save
he current forest economy? Wrapped up in these
uestions are other resource concerns; changing atti-
ıdes of society; changing technology; and changing
egional, national, and worldwide demand-supply
elationships.

California could produce more timber than it has been producing. Current timber growth is only half of the State's biological potential. Forest management intensification during the past few years will result in increased future yields. A much more concerted effort is needed if the State's output is to be maintained or increased. In many cases an increase in timber production can be realized only at the expense of other resource values.

In the long run, California's timber productivity will be dictated by people's decisions more than by the biological potential of the State's forests.

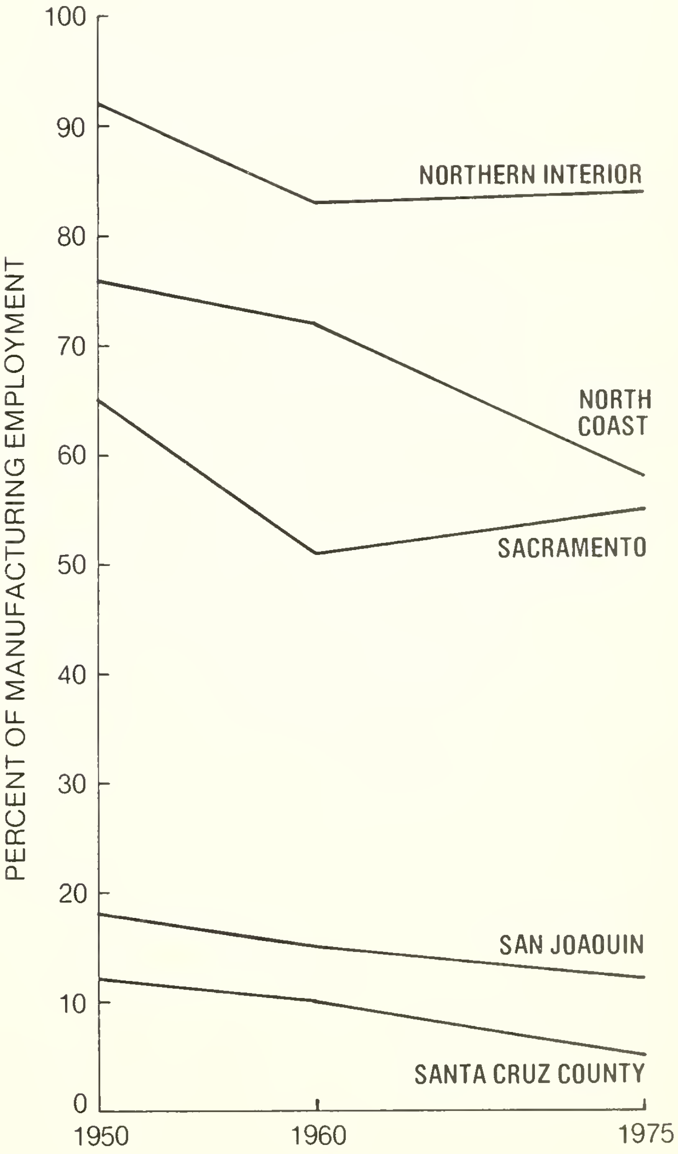


Figure 75.—Employment in forest industries as a percent of manufacturing employment by geographic area in California, 1950, 1960, and 1975.

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Appendix

Table 27--Net volume of growing stock and sawtimber on timberland by ownership, California, 1953 and 1975

Ownership	Growing stock			Sawtimber		
	1953	1975	Percent change	1953	1975	Percent change
	Million cubic feet1/			Million board feet (International 1/4-inch rule)2/		
National Forest	32,656	29,206	-11	178,913	158,206	-12
Other public	2,791	1,391	-50	14,898	6,809	-54
Private	30,964	19,071	-38	166,190	93,679	-44
Total and average	66,411	49,668	-25	360,001	258,694	-28

1/Includes trees 5.0-inch d.b.h. and larger.
2/Includes trees 11.0-inch d.b.h. and larger. Sawtimber volume was not determined in 1953 for trees 9.0- to 10.9-inch d.b.h.

Table 28--Net volume of sawtimber on timberland by species, California, 1953 and 1975

Species	1953	1975	Percent change
	Million board feet[1/] (International 1/4-inch rule)		
Softwoods:			
Douglas-fir	116,912	71,893	-38
Ponderosa and Jeffrey pines	66,741	50,339	-25
Sugar and western white pines	29,515	21,497	-27
Redwood	36,124	21,239	-41
True firs	88,724	70,034	-21
Incense-cedar and other conifers	16,008	15,617	-2
Total softwoods	354,024	250,619	-29
Hardwoods	5,977	8,075	+35
All species	360,001	258,694	-28

[1/] Includes trees 11.0-inch d.b.h. and larger.

Table 29--Net volume of timber on timberland by class of timber, ownership group, softwoods, and hardwoods, California, 1975
(In billion cubic feet)

Class of timber	National Forest			Other ownerships			National Forest and other ownerships		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	To[tal]
Growing stock trees:									
Sawtimber trees--									
Saw-log portion	25.7	0.3	26.0	16.5	1.0	17.5	42.2	1.3	43.
Upper-stem portion	1.2	.4	1.6	0.6	0.9	1.5	1.8	1.3	3.
Total sawtimber	26.9	.7	27.6	17.1	1.9	19.0	44.0	2.6	46.
Poletimber trees	1.2	.4	1.6	.8	.7	1.5	2.0	1.1	3.
Total growing stock trees	28.1	1.1	29.2	17.9	2.6	20.5	46.0	3.7	49.
Cull and dead trees:									
Rough trees	0.1	.3	0.4	0.1	.4	0.5	0.2	0.7	0.
Rotten trees	.4	.1	.5	.3	.2	.5	.7	.3	1.
Salvable dead trees	.2	1/	.2	.2	1/	.2	.4	1/	
Total cull and dead trees	.7	.4	1.1	.6	.6	1.2	1.3	1.0	2.
Total all timber	28.8	1.5	30.3	18.5	3.2	21.7	47.3	4.7	52.

[1/] Less than 50 million cubic feet.

Table 30--Gross and net growth and mortality of softwoods on timberland in National Forests by Forest, California, 1975
(In cubic feet per acre per year)

Forest Service Region and National Forest	Gross growth	Mortality	Net growth
Intermountain Region			
Toiyabe	48	4	44
Pacific Southwest Region			
Angeles	13	7	6
Cleveland	21	1/	21
Eldorado	82	4	78
Inyo	26	2	24
Klamath	57	10	47
Lassen	53	6	47
Los Padres	40	17	23
Mendocino	46	11	35
Modoc	35	6	29
Plumas	59	6	53
San Bernardino	23	4	19
Sequoia	42	6	36
Shasta	56	4	52
Sierra	46	20	26
Six Rivers	47	16	31
Stanislaus	94	7	87
Tahoe	74	9	65
Trinity	39	14	25
Pacific Northwest Region			
Rogue River	31	4	27
Siskiyou	20	4	16
Weighted average for all National Forests	54	9	45

1/ Less than 0.5 cubic feet.

Table 31--Net annual growth and biological potential (site class) of softwoods on timberland by resource area, National Forest group, and ownership, California, 1975

(In cubic feet per acre per year)

Resource area[1] and National Forest group	Growth and potential	National Forest	Other public	Forest industry	Other private timber growers	Farmer and miscellaneous private
North coast, and northwestern California National Forests[2]	Net growth	36	28	60	--	36
	Biological potential	85	115	152	--	126
	Net growth as percent of potential	42	24	40	--	28
	Gross growth as percent of potential	58	35	43	--	33
Central coast	Net growth	--	24	96	129	97
	Biological potential	--	146	172	176	164
	Net growth as percent of potential	--	16	56	73	59
	Gross growth as percent of potential	--	24	56	73	60
Northern interior, and northeastern California National Forests[3]	Net growth	46	28	36	36	28
	Biological potential	89	68	87	77	72
	Net growth as percent of potential	52	41	41	46	39
	Gross growth as percent of potential	57	51	50	54	46
Sacramento, and northern Sierra Nevada National Forests[4]	Net growth	61	37	56	46	48
	Biological potential	91	72	92	96	81
	Net growth as percent of potential	67	52	61	48	60
	Gross growth as percent of potential	74	70	73	62	68
San Joaquin, and southern Sierra Nevada National Forests[5]	Net growth	48	35	56	56	54
	Biological potential	83	82	129	95	86
	Net growth as percent of potential	58	43	44	58	63
	Gross growth as percent of potential	71	49	60	69	71
Southern California National Forests[6]	Net growth	20	--	--	--	--
	Biological potential	53	--	--	--	--
	Net growth as percent of potential	38	--	--	--	--
	Gross growth as percent of potential	49	--	--	--	--

1/For lands outside National Forests data are grouped by county as shown in figure 3.

2/Includes California portion of Klamath, Mendocino, Rogue River, Siskiyou, Six Rivers, and Trinity National Forests.

3/Includes Lassen, Modoc, and Shasta National Forests.

4/Includes Eldorado, Plumas, and Tahoe National Forests.

5/Includes Sequoia, Sierra, Stanislaus, and California portion of Toiyabe National Forests.

6/Includes Angeles, Cleveland, Los Padres, San Bernardino, and California portion of Inyo National Forests.

Table 32--Acres of forest planting and seeding by ownership, California, 1964-77[1]
(In acres)

Year	National Forest			Other public			Forest industry			Other private timber growers[2]			Farmer and miscellaneous private			Total
	North coast	Other resource areas	State total	North coast	Other resource areas	State total	North coast	Other resource areas	State total	North coast	Other resource areas	State total	North coast	Other resource areas	State total	
1964	NA	NA	20,931	8	4,057	4,065	4,907	1,976	6,883	NA	NA	117	1,063	1,232	2,295	34,291
1965	NA	NA	18,569	26	4,107	4,133	6,352	0	6,352	NA	NA	2,281	1,461	2,026	3,487	34,822
1966	NA	NA	22,880	37	2,496	2,533	7,900	0	7,900	NA	NA	923	1,409	3,286	4,695	38,931
1967	NA	NA	27,357	32	2,858	2,890	6,826	380	7,206	NA	NA	311	2,110	3,541	5,651	43,415
1968	NA	NA	38,553	34	2,842	2,876	5,633	0	5,633	NA	NA	1,303	852	2,753	3,605	51,970
1969	NA	NA	29,656	16	2,533	2,549	11,050	6	11,056	NA	NA	926	870	3,050	3,920	48,107
1970	NA	NA	29,383	31	4,092	4,123	12,885	1,032	13,917	NA	NA	917	4,705	3,057	7,762	56,102
1971	NA	NA	25,957	37	2,658	2,695	18,429	1,739	20,168	NA	NA	475	1,544	3,996	5,540	54,835
1972	NA	NA	30,814	36	3,225	3,261	18,210	3,373	21,583	NA	NA	855	1,835	4,463	6,298	62,811
1973	NA	NA	31,358	150	3,174	3,324	17,186	3,472	20,658	NA	NA	1,542	4,266	3,974	8,240	65,122
1974	NA	NA	28,146	123	1,034	1,157	12,940	– 0	12,940	NA	NA	532	2,381	1,989	4,370	47,145
1975	NA	NA	30,175	11	960	971	10,388	7,423	17,811	NA	NA	2,551	1,604	3,306	4,910	56,418
1976	NA	NA	31,450	NA	NA	1,750	NA	NA	23,933	NA	NA	2,955	NA	NA	5,250	65,338
1977	NA	NA	33,719	NA	NA	2,202	NA	NA	37,449	NA	NA	5,133	NA	NA	4,557	83,060

NA = Not available.

1/Based on fiscal years (from July 1 of the preceding year to June 30; except for 1976 which ran from July 1, 1975 to September 30, 1976; and 1977 which ran from October 1, 1976 to September 30, 1977). Sources: USDA Forest Service (1964-78) and field records of State of California, Department of Forestry, on file in Sacramento.

2/Classified as "other industry" in the USDA Forest Service (1964-78) forest planting reports.

Table 33--Potential yield[1/] of timber in National Forests by Forest and timberland component, California, for the current planning period

Forest Service Region and National Forest	Standard component	Special component	Marginal component	Total for all components
	- - - Percent of potential yield - - -			Cubic feet per acre per year
Intermountain Region:				
Toiyabe	54	1	45	31.9
Pacific Southwest Region:				
Angeles	--	65	35	11.3
Cleveland	--	100	--	0.9
Eldorado	88	11	1	58.2
Inyo	70	1	29	15.7
Klamath	88	1	11	47.3
Lassen	84	1	15	39.3
Los Padres	--	100	--	4.7
Mendocino	95	2	3	43.0
Modoc	62	19	19	22.7
Plumas	67	2	31	54.3
San Bernardino	--	100	--	10.3
Sequoia	88	6	6	46.3
Shasta	67	6	27	50.8
Sierra	89	6	5	47.8
Six Rivers	69	--	31	59.0
Stanislaus	77	6	17	56.5
Tahoe	91	5	4	47.2
Trinity	63	1	36	50.8
Pacific Northwest Region:				
Rogue River	94	6	--	65.0
Siskiyou	100	--	--	45.0
Average for all National Forests	78	4	18	45.1

[1/]The maximum timber harvest planned for the next 10 years to achieve the optimum perpetual sustained-yield harvesting level attainable with intensive forestry on regulated areas.

Table 34--Employment in forest industry, percent of manufacturing employment, and percent of total employment by resource area and county, California, 1950, 1960, and 1975[1]

Resource area and county	1950			1960			1975		
	Thousands of persons employed	Percent of manufacturing employment	Percent of total employment	Thousands of persons employed	Percent of manufacturing employment	Percent of total employment	Thousands of persons employed	Percent of manufacturing employment	Percent of total employment
North coast:									
Del Norte	0.9	90	30	2.3	92	38	1.5	94	35
Humboldt	8.7	89	33	11.1	87	30	6.9	83	24
Mendocino	4.1	92	29	4.3	81	25	3.5	79	24
Sonoma	.9	23	2	2.1	29	4	1.6	18	3
	14.6	76	18	19.8	73	18	13.5	58	13
Northern interior:									
Lassen	1.9	95	29	0.7	81	15	0.4	90	13
Modoc	.7	90	18	.3	80	10	.2	90	8
Shasta	2.3	88	18	3.2	83	16	3.0	79	13
Siskiyou	3.2	93	29	2.2	87	18	1.9	90	22
Trinity	.6	99	36	1.0	96	31	.6	99	31
	8.7	92	24	7.4	83	17	6.1	85	16
Sacramento:									
Lake	.1	56	4	.1	28	2	.1	32	2
Butte	1.8	55	8	1.4	45	5	1.4	40	5
Eldorado	1.3	90	22	.9	51	9	.7	70	6
Glenn	2/	--	--	.2	34	3	.1	17	2
Nevada	.4	63	6	.6	55	8	.5	50	8
Placer	.4	38	3	.7	28	4	.7	40	4
Plumas	1.5	95	30	.9	92	22	.8	96	28
Sierra	.2	83	21	.3	98	32	.2	NA	NA
Tehama	.5	59	6	1.5	68	17	1.5	78	22
Yuba	.6	65	7	.5	46	5	.8	69	8
	6.8	65	9	7.1	51	7	6.8	3/55	7
San Joaquin:									
Amador	.4	81	15	.5	66	15	.7	90	23
Calaveras	.7	72	26	.7	53	18	.1	22	4
Fresno	.9	10	1	1.3	8	1	1.5	8	1
Kern	.2	3	--	.1	1	4/	.2	2	4/
Madera	.2	26	2	.4	35	3	.4	19	3
Mariposa	.1	86	6	.1	53	3	2/	51	1
Tulare	.6	18	1	.4	8	1	1.4	17	2
Tuolomne	.8	85	19	.8	79	17	.6	87	11
	3.9	18	2	4.3	13	1	4.9	12	1
Central coast:									
Santa Cruz	.3	12	1	.5	10	2	.3	5	1

NA = Not available.

1/Includes only heavily timbered counties with forest industry employment of 100 or more persons in 1950, 1960, or 1975.

2/Less than 50 persons.

3/Excludes Sierra County for which manufacturing employment was omitted to avoid disclosure.

4/Less than 0.5 percent.

Table 35--Total land and total timberland area managed by the USDA Forest Service by Region and National Forest or management unit, California, 1975
(In thousand acres)

Region and National Forest or management unit	Total land	Total timberland
Intermountain Region:		
Toiyabe	632	120
Pacific Southwest Region:		
Angeles	650	31
Cleveland	416	12
Eldorado	575	314
Inyo	1,604	90
Klamath	1,672	1,016
Lassen	1,142	759
Los Padres	1,750	80
Mendocino	876	350
Modoc	1,635	558
Plumas	1,162	769
San Bernardino	631	119
Sequoia	1,303	456
Shasta	1,036	498
Sierra	1,286	534
Six Rivers	969	775
Stanislaus	897	464
Tahoe	781	521
Tahoe Basin management unit	108	46
Trinity	1,041	588
Total	19,534	7,980
Pacific Northwest Region:		
Rogue River	52	44
Siskiyou	32	24
Total	84	68
All Regions	20,250	8,168

able 36--Area of timberland outside National Forests by county and ownership, California, 1975
(In thousand acres)

County	Other public	Forest industry	Other private timber growers	Farmer and miscellaneous private	Total private	All ownerships outside National Forests
lameda	--	--	--	--	--	--
lpine	2	--	--	16	16	18
mador	1	22	4	37	63	64
utte	10	113	46	79	238	248
alaveras	8	64	2	60	126	134
olusa	--	--	--	3	3	3
ontra Costa	--	--	--	--	--	--
el Norte	--	143	--	21	164	164
ldorado	11	99	5	167	271	282
resno	1	3	9	23	35	36
lenn	--	20	--	11	31	31
umboldt	130	527	--	741	1,268	1,398
mperial	--	--	--	--	--	--
nyo	--	--	--	2	2	2
ern	1	--	--	34	34	35
ings	--	--	--	--	--	--
ake	--	12	--	47	59	59
assen	15	74	203	38	315	330
os Angeles	--	--	--	1	1	1
adera	--	3	3	9	15	15
arin	--	--	--	7	7	7
ariposa	1	1	--	43	44	45
endocino	98	468	--	628	1,096	1,194
erced	--	--	--	--	--	--
odoc	2	29	115	34	178	180
ono	1	--	--	6	6	7
onterey	1	--	--	26	26	27
apa	--	--	--	36	36	36
evada	13	5	46	140	191	204
range	--	--	--	--	--	--
lacer	15	58	25	101	184	199
lumas	4	138	73	93	304	308
iverside	--	--	--	5	5	5
acramento	--	--	--	--	--	--
an Benito	--	--	--	--	--	--
an Bernardino	--	--	--	13	13	13
an Diego	1	--	--	16	16	17
an Francisco	--	--	--	--	--	--
an Joaquin	--	--	--	--	--	--
an Luis Obispo	--	--	--	1	1	1
an Mateo	1	8	--	35	43	44
anta Barbara	--	--	--	--	--	--
anta Clara	2	--	--	12	12	14
anta Cruz	6	2	17	110	129	135
hasta	67	221	388	173	782	849
ierra	3	30	10	57	97	100
iskiyou	24	233	213	265	711	735
olano	--	--	--	--	--	--
onoma	1	60	--	199	259	260
tanislaus	--	--	--	--	--	--
utter	--	--	--	3	3	3
ehama	4	222	--	19	241	245
rinity	46	76	167	171	414	460
ulare	21	4	--	18	22	43
uolumne	7	52	3	53	108	115
entura	--	--	--	1	1	1
olo	--	--	--	2	2	2
uba	2	1	19	40	60	62
Total	499	2,688	1,348	3,596	7,632	8,131

Table 37--Net volume of growing stock and sawtimber on timberland outside National Forests by county and ownership class, California, 1975

County	Other public: Million cubic feet1/	Other public: Million board feet2/	Private: Million cubic feet1/	Private: Million board feet2/	Total: Million cubic feet1/	Total: Million board feet2/
		Scribner rule		Scribner rule		Scribner rule
Alpine	2	10	36	163	38	173
Amador	1	5	217	1,067	218	1,072
Butte	10	48	589	2,263	599	2,311
Calaveras	16	73	344	1,651	360	1,724
Colusa	--	--	2	9	2	9
Del Norte	--	--	468	2,256	468	2,256
Eldorado	30	130	924	4,512	954	4,642
Fresno	5	21	117	562	122	583
Glenn	--	--	87	481	87	481
Humboldt	524	2,607	3,043	12,830	3,567	15,437
Kern	2	9	73	321	75	330
Lake	--	--	85	408	85	408
Lassen	15	60	537	1,997	552	2,057
Madera	--	--	34	150	34	150
Marin	--	--	43	204	43	204
Mariposa	3	10	103	456	106	466
Mendocino	297	1,191	2,816	10,443	3,113	11,634
Modoc	3	10	242	828	245	838
Mono	--	--	17	79	17	79
Monterey	2	7	131	627	133	634
Napa	--	--	48	194	48	194
Nevada	17	59	481	2,258	498	2,317
Placer	29	134	644	3,277	673	3,411
Plumas	22	112	738	3,173	760	3,285
San Mateo	1	6	281	1,325	282	1,331
Santa Clara	2	11	77	357	79	368
Santa Cruz	40	160	621	2,571	661	2,731
Shasta	85	292	1,602	7,453	1,687	7,745
Sierra	4	13	359	1,868	363	1,881
Siskiyou	23	78	1,107	4,749	1,130	4,827
Sonoma	2	8	659	3,122	661	3,130
Sutter	--	--	4	18	4	18
Tehama	7	34	740	3,482	747	3,516
Trinity	145	642	1,216	5,783	1,361	6,425
Tulare	93	444	48	215	141	659
Tuolumne	8	34	325	1,526	333	1,560
Yolo	--	--	2	8	2	8
Yuba	3	11	136	611	139	622
Southern California3/	2	11	83	433	85	444
Total4/	1,393	6,230	19,079	83,730	20,472	89,960

1/ Includes trees 5.0-inch d.b.h. and larger.

2/ Includes trees 11.0-inch d.b.h. and larger.

3/ Includes Inyo, Los Angeles, Riverside, San Bernardino, San Diego, San Luis Obispo, and Ventura Counties.

4/ Totals may be off because of rounding.

Table 38--Net volume of growing stock on timberland in National Forests by Forest and species, California, 1975
(In million cubic feet)

Forest Service Region and National Forest	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Hemlocks and spruce	Sugar and western white pines	Redwood	Giant sequoia	Incense-cedar	Other cedars	Lodgepole pine	Other softwoods	Total softwoods	Hardwoods	All species
Intermountain Region:														
Toiyabe	--	91	38	20	13	--	--	--	--	99	46	307	3	310
Pacific Southwest Region:														
Angeles	--	24	6	--	5	--	--	1	--	1	6	43	2	45
Cleveland	--	7	--	--	--	--	--	1	--	--	4	12	6	18
Eldorado	96	344	523	--	69	--	--	68	--	19	--	1,119	34	1,153
Inyo	--	73	57	6	4	--	--	--	--	25	--	165	--	165
Klamath	1,863	381	822	20	483	--	--	64	9	29	--	3,671	174	3,845
Lassen	93	660	1,141	--	175	--	--	63	--	79	1	2,212	8	2,220
Los Padres	4	57	14	--	5	107	--	--	--	--	16	203	35	238
Mendocino	622	265	268	--	103	--	--	25	--	--	20	1,303	43	1,346
Modoc	--	459	368	6	23	--	--	18	--	33	--	907	7	914
Plumas	415	691	1,244	--	293	--	--	133	--	15	--	2,791	47	2,838
San Bernardino	--	111	47	--	20	--	--	8	--	2	7	195	23	218
Sequoia	--	528	843	--	189	--	45	62	--	55	8	1,730	32	1,762
Shasta	495	339	382	--	132	--	--	56	--	14	--	1,418	35	1,453
Sierra	21	595	953	--	222	--	--	80	--	146	4	2,021	37	2,058
Six Rivers	2,223	93	428	--	178	--	--	43	28	--	1	2,994	276	3,270
Stanislaus	53	499	741	19	251	--	--	300	--	67	8	1,938	130	2,068
Tahoe	248	414	1,107	10	281	--	--	102	-	49	--	2,211	69	2,280
Trinity	1,652	392	241	--	222	--	--	35	--	--	1	2,543	163	2,706
Total	7,785	5,932	9,185	61	2,655	107	45	1,059	37	534	76	27,476	1,121	28,597
Pacific Northwest Region:														
Rogue River	81	11	79	9	12	--	--	3	--	1	1	197	--	197
Siskiyou	73	1	3	2	6	2	--	--	--	--	5	92	10	102
Total	154	12	82	11	18	2	--	3	--	1	6	289	10	299
All Regions	7,939	6,035	9,305	92	2,686	109	45	1,062	37	634	128	28,072	1,134	29,206

Table 39--Net volume of sawtimber on timberland in National Forests by Forest and species, California, 1975
(In million board feet, Scribner rule)

Forest Service Region and National Forest	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Hemlocks and spruce	Sugar and western white pines	Redwood	Giant sequoia	Incense-cedar	Other cedars	Lodgepole pine	Other softwoods	Total softwoods	Hardwoods	All species
Intermountain Region:														
Toiyabe	--	378	176	100	69	--	--	--	--	426	110	1,259	10	1,269
Pacific Southwest Region:														
Angeles	0	151	30	0	29	0	0	2	0	7	31	250	8	258
Cleveland	0	46	1	0	0	0	0	3	0	0	19	69	19	88
Eldorado	494	2,222	2,775	--	454	--	--	364	--	94	--	6,403	174	6,577
Inyo	--	436	322	35	22	--	--	--	--	137	--	952	--	952
Klamath	9,508	1,743	3,839	64	2,545	--	--	267	45	69	109	18,189	232	18,421
Lassen	513	3,384	5,336	--	1,004	--	--	278	--	179	--	10,694	9	10,703
Los Padres	24	356	64	0	30	628	0	0	0	0	77	1,179	149	1,328
Mendocino	3,426	1,420	1,409	--	594	--	--	123	--	--	106	7,078	79	7,157
Modoc	--	2,050	1,588	22	116	--	--	59	--	89	--	3,924	12	3,936
Plumas	2,090	3,526	6,119	--	1,705	--	--	559	--	62	3	14,064	91	14,155
San Bernardino	0	690	230	0	110	0	0	18	0	11	56	1,115	64	1,179
Sequoia	--	2,643	4,221	--	946	--	226	310	--	276	41	8,663	151	8,814
Shasta	2,373	1,574	1,824	--	727	--	--	231	--	36	3	6,768	51	6,819
Sierra	115	3,611	5,308	--	1,302	--	--	392	--	649	4	11,381	175	11,556
Six Rivers	11,159	568	2,264	--	977	--	--	188	139	--	2	15,297	411	15,708
Stanislaus	241	2,404	3,488	64	1,260	--	--	1,181	--	383	42	9,063	698	9,761
Tahoe	1,133	2,209	5,332	31	1,570	--	--	374	--	171	--	10,820	118	10,938
Trinity	9,504	2,194	1,142	--	1,319	--	--	160	--	--	4	14,323	327	14,650
Total	40,580	31,227	45,292	216	14,710	628	226	4,509	184	2,163	497	140,232	2,768	143,000
Pacific Northwest Region:														
Rogue River	409	58	389	33	66	--	--	15	--	3	4	977	--	977
Siskiyou	421	4	12	10	31	12	--	3	1	--	21	515	36	551
Total	830	62	401	43	97	12	--	18	1	3	25	1,492	36	1,528
All Regions	41,410	31,667	45,869	359	14,876	640	226	4,527	185	2,592	632	142,983	2,814	145,797

Table 40--Net volume of growing stock on timberland outside National Forests by resource area, ownership, and species, California, 1975
(In million cubic feet)

Resource area and ownership	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Hemlocks and spruce	Sugar and western white pines	Redwood	Giant sequoia	Incense-cedar	Other cedars	Lodgepole pine	Other softwoods	Total softwoods	Hardwoods	All species
North coast:														
Other public	435.6	4.3	14.9	--	9.5	143.6	--	1.1	--	--	--	609.0	213.7	822.7
Forest industry	891.9	18.1	86.5	63.9	1.4	2,064.0	--	3.9	8.5	--	--	3,138.1	477.4	3,615.5
Farmer and miscellaneous private	1,154.4	22.6	38.6	19.7	--	1,161.6	--	1.7	3.7	7.8	35.5	2,445.7	924.1	3,369.8
Total1/	2,481.8	45.0	140.1	83.6	10.9	3,369.2	--	6.7	12.1	7.8	35.5	6,192.9	1,615.1	7,808.0
Central coast:														
Other public	2.1	1.6	--	--	--	29.2	--	--	--	--	--	33.0	11.5	44.5
Forest industry	6.9	--	--	--	--	60.9	--	--	1.3	--	--	69.2	6.9	76.1
Other private timber growers	3.3	--	--	--	--	42.3	--	--	2.4	--	--	48.1	9.8	57.9
Farmer and miscellaneous private	193.3	7.8	--	--	--	639.3	--	--	42.0	--	--	882.3	135.8	1,018.1
Total1/	205.6	9.5	--	--	--	771.8	--	--	45.7	--	--	1,032.6	164.0	1,196.7
Northern interior:														
Other public	152.4	57.8	22.2	--	10.3	--	--	1.0	--	2.5	0.1	246.7	23.9	270.6
Forest industry	310.9	321.6	569.4	3.1	118.6	--	--	101.2	--	6.7	9.7	1,441.2	45.3	1,486.5
Other private timber growers	471.5	654.1	727.1	--	174.6	--	--	147.3	--	19.3	2.6	2,196.0	60.4	2,256.9
Farmer and miscellaneous private	347.6	277.3	104.4	0.6	27.1	--	--	46.2	--	17.0	--	820.3	136.6	956.9
Total1/	1,282.3	1,310.8	1,423.1	3.8	330.6	--	--	295.8	--	45.5	12.8	4,704.7	266.3	4,971.0
Sacramento:														
Other public	33.1	36.3	16.6	--	7.7	--	--	11.4	--	--	--	105.1	17.2	122.2
Forest industry	436.9	535.3	765.2	4.7	310.5	--	--	196.9	--	53.8	--	2,303.3	120.6	2,423.9
Other private timber growers	78.1	75.5	427.1	--	41.1	--	--	77.6	--	43.6	--	743.0	45.9	788.9
Farmer and miscellaneous private	259.3	451.6	410.2	--	60.5	6.3	--	180.9	--	66.1	--	1,434.7	190.0	1,624.7
Total1/	807.3	1,098.7	1,619.1	4.7	419.8	6.3	--	466.8	--	163.4	--	4,586.1	373.7	4,959.7
San Joaquin:														
Other public	1.1	27.9	16.7	--	16.5	--	38.3	12.3	--	--	--	112.9	16.0	128.8
Forest industry	12.6	189.3	184.3	--	52.0	--	--	67.1	--	--	--	505.3	28.8	534.1
Other private timber growers	24.2	31.7	12.0	--	4.1	--	--	5.4	--	2.9	--	80.3	5.3	85.6
Farmer and miscellaneous private	31.3	333.3	89.2	.6	58.1	--	--	86.2	--	14.8	--	613.5	79.4	692.9
Total1/	69.2	582.2	302.3	.6	130.7	--	38.3	171.0	--	17.7	--	1,311.9	129.5	1,441.4
Southern California:														
Other public	2/	1.1	0.4	--	0.2	--	--	0.1	--	2/	.2	1.9	0.3	2.1
Farmer and miscellaneous private	0.9	42.2	14.0	--	6.6	--	--	1.9	--	0.7	6.2	72.6	10.5	83.1
Total1/	1.0	43.3	14.4	--	6.8	--	--	2.0	--	.7	6.2	74.4	10.8	85.2
All resource areas:														
Other public	624.3	129.0	70.8	--	44.2	172.9	38.3	25.8	--	2.5	.7	1,108.5	282.5	1,391.1
Forest industry	1,659.1	1,064.3	1,605.4	71.7	482.5	2,125.0	--	369.2	9.8	60.5	9.7	7,457.0	679.0	8,136.1
Other private timber growers	1,821.2	761.3	1,166.2	--	219.8	42.3	--	230.3	2.4	65.8	2.6	3,067.9	121.4	3,189.3
Farmer and miscellaneous private	1,986.8	1,134.8	656.5	20.9	152.3	1,807.2	--	317.0	45.7	106.4	41.8	6,269.2	1,476.4	7,745.6
Total1/	4,847.3	3,089.4	3,498.9	92.6	898.7	4,147.3	38.3	942.3	57.9	235.2	54.7	17,902.6	2,559.4	20,462.0

1/Totals may be off because of rounding.

2/Less than 50,000.

Table 41--Net volume of sawtimber on timberland outside National Forests by resource area, ownership, and species, California, 1975
(In million board feet, Scribner rule)

Resource area and ownership	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Hemlocks and spruce	Sugar and western white pines	Redwood	Giant sequoia	Incense-cedar	Other cedars	Lodgepole pine	Other softwoods	Total softwoods	Hardwoods	All species
North coast:														
Other public	2,533.2	12.9	95.0	--	64.0	658.6	--	3.2	--	--	--	3,366.9	439.1	3,806.0
Forest industry	4,483.7	73.9	463.7	331.4	5.6	9,443.7	--	16.6	44.7	--	--	14,863.4	838.9	15,702.3
Farmer and miscellaneous private	5,459.4	121.0	158.4	83.8	--	5,072.7	--	3.2	14.1	30.5	147.1	11,090.2	1,859.6	12,949.8
Total 1/	12,476.3	207.8	717.1	415.2	69.7	15,175.0	--	22.9	58.8	30.5	147.1	29,320.5	3,137.5	32,458.0
Central coast:														
Other public	13.3	9.9	--	--	--	139.8	--	--	--	--	--	163.1	19.5	182.5
Forest industry	39.3	--	--	--	--	288.7	--	--	3.1	--	--	331.1	8.5	339.6
Other private timber growers	13.9	--	--	--	--	135.0	--	--	1.3	--	--	150.1	10.1	160.2
Farmer and miscellaneous private	1,125.0	49.8	--	--	--	2,961.8	--	--	175.9	--	--	4,312.6	266.5	4,579.0
Total 1/	1,191.5	59.7	--	--	--	3,525.4	--	--	180.3	--	--	4,956.9	304.6	5,261.5
Northern interior:														
Other public	652.8	237.5	94.4	--	47.4	--	--	3.7	--	12.9	--	1,048.7	33.1	1,081.8
Forest industry	1,470.5	1,433.4	2,542.1	6.0	652.9	--	--	398.1	--	13.6	26.9	6,543.5	96.5	6,640.0
Other private timber growers	2,320.9	3,030.1	3,651.8	--	979.7	--	--	580.1	--	56.0	9.5	10,628.2	112.4	10,740.6
Farmer and miscellaneous private	1,375.0	981.4	431.5	2.5	126.9	--	--	166.8	--	40.4	--	3,124.5	303.2	3,427.7
Total 1/	5,819.1	5,682.5	6,719.8	8.5	1,806.9	--	--	1,148.7	--	123.0	36.4	21,344.9	545.1	21,890.0
Sacramento:														
Other public	171.3	170.4	77.4	--	43.5	--	--	43.9	--	--	--	506.5	35.0	541.5
Forest industry	2,136.0	2,595.2	4,090.0	22.2	1,721.0	--	--	744.4	--	287.5	--	11,596.4	163.2	11,759.6
Other private timber growers	367.4	333.6	2,400.1	--	211.3	--	--	327.6	--	216.8	--	3,856.7	42.6	3,899.3
Farmer and miscellaneous private	1,183.1	1,934.5	2,044.0	--	304.8	26.8	--	677.3	--	300.3	--	6,470.8	432.5	6,903.3
Total 1/	3,857.8	5,033.6	8,611.4	22.2	2,280.7	26.8	--	1,793.2	--	804.5	--	22,430.3	673.3	23,103.6
San Joaquin:														
Other public	4.0	141.8	85.6	--	99.5	--	191.5	49.8	--	--	--	572.3	33.0	605.2
Forest industry	47.1	1,005.5	1,034.1	--	283.2	--	--	235.9	--	--	--	2,605.8	73.6	2,679.4
Other private timber growers	150.6	181.9	68.3	--	21.7	--	--	21.4	--	12.2	--	456.1	12.0	468.1
Farmer and miscellaneous private	143.4	1,553.1	472.1	--	298.5	--	--	324.2	--	58.6	--	2,851.2	192.2	3,043.3
Total 1/	345.2	2,882.3	1,660.0	--	702.9	--	191.5	631.4	--	70.8	--	6,485.4	310.7	6,796.1
Southern California:														
Other public	0.1	6.4	1.6	--	0.9	--	--	0.1	--	0.1	0.9	10.2	0.9	11.1
Farmer and miscellaneous private	4.9	249.3	64.3	--	34.8	--	--	4.5	--	3.4	36.2	397.4	35.8	433.2
Total 1/	5.0	255.7	65.9	--	35.7	--	--	4.6	--	3.5	37.1	407.6	36.7	444.3
All resource areas:														
Other public	3,374.8	579.0	354.0	--	255.4	798.4	191.5	100.7	--	13.0	.9	5,667.6	560.4	6,228.1
Forest industry	8,176.6	5,108.0	8,129.9	359.6	2,662.7	9,732.5	--	1,395.0	47.8	301.1	26.9	35,940.2	1,180.7	37,120.9
Other private timber growers	2,852.7	3,545.6	6,120.3	--	1,212.8	135.0	--	929.1	1.3	285.0	9.5	15,091.1	177.1	15,268.2
Farmer and miscellaneous private	9,290.8	4,889.1	3,170.2	87.5	765.0	8,061.3	--	1,176.0	190.0	433.2	183.3	28,246.5	3,090.3	31,336.8
Total 1/	23,695.0	14,121.7	17,774.3	447.1	4,895.9	18,727.2	191.5	3,600.8	239.1	1,032.3	220.6	84,945.5	5,008.5	89,954.0

1/ Totals may be off because of rounding.

able 42--Net annual growth of growing stock on timberland in National Forests by Forest and species, California, 1975
(In million cubic feet)

orest Service Region nd National Forest	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Sugar and western white pines	Redwood and giant sequoia	Other softwoods	Total softwoods	Hardwoods	All species
ntermountain Region:									
Toiyabe	-	1.3	0.5	0.1	--	3.2	5.1	0.1	5.2
acific Southwest Region:									
Angeles	--	0.1	1/	1/	--	0.1	0.2	--	0.2
Cleveland	--	.2	1/	--	--	.1	.3	--	.3
Eldorado	2.0	6.4	12.0	1.5	-	2.4	24.3	--	24.3
Inyo	--	1.4	.5	1/	--	.2	2.1	1/	2.1
Klamath	17.6	7.5	16.7	3.4	--	2.3	47.5	6.7	54.2
Lassen	0.9	9.1	22.6	1.5	--	1.6	35.7	.3	36.0
Los Padres	1/	.4	.2	1/	2/0.8	.5	1.9	--	1.9
Mendocino	5.0	3.0	3.1	1.0	--	.3	12.4	1.4	13.8
Modoc	--	8.5	7.4	.3	--	3/-.1	16.1	.2	16.3
Plumas	5.2	10.4	21.8	2.4	--	1.3	41.1	1.1	42.2
San Bernardino	--	1.1	.5	.2	-	.5	2.3	--	2.3
Sequoia	--	4.0	7.8	1.8	4/.9	1.6	16.1	.1	16.2
Shasta	9.7	8.0	9.8	2.1	--	1.4	31.0	1.3	32.3
Sierra	.1	3.5	6.7	1.5	-	2.0	13.8	.1	13.9
Six Rivers	18.3	.8	3.5	1.5	--	.6	24.7	--	24.7
Stanislaus	.9	7.2	15.0	5.3	--	11.9	40.3	--	40.3
Tahoe	4.2	6.8	15.8	2.9	--	2.2	31.9	1.7	33.6
Trinity	9.5	2.8	2.6	.1	--	.1	15.1	2.8	17.9
Total 5/	73.4	81.2	146.0	25.4	1.7	29.0	356.8	15.8	372.7
acific Northwest Region:									
Rogue River	.7	.1	.3	.1	--	.1	1.2	--	1.2
Siskiyou	.2	1/	.1	1/	--	.1	.4	.2	.6
Total	.9	.1	.4	.1	--	.2	1.6	.2	1.8
11 Regions 5/	74.3	82.6	146.9	25.6	1.7	32.5	363.5	16.1	379.7

/Less than 50,000 cubic feet.
/Coastal redwood.
/Minus sign indicates that mortality exceeds gross growth.
/Giant sequoia.
/Totals may be off because of rounding.

Table 43--Net annual growth of sawtimber on timberland in National Forests by Forest and species, California, 1975
(In million board feet, Scribner rule)

Forest Service Region and National Forest	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Sugar and western white pines	Redwood and giant sequoia	Other softwoods	Total softwoods	Hardwoods	All species
Intermountain Region:									
Toiyabe	--	4.7	1.9	0.5	--	4.9	12.0	0.3	12.3
Pacific Southwest Region:									
Angeles	--	0.8	0.1	.1	--	0.2	1.2	--	1.2
Cleveland	--	1.1	1/	--	--	.4	1.5	--	1.5
Eldorado	10.1	39.3	65.0	9.7	--	12.2	136.3	--	136.3
Inyo	--	7.6	3.1	.1	--	1.2	12.0	1/	12.0
Klamath	70.6	23.0	75.8	17.6	--	2.7	189.7	7.1	196.8
Lassen	3.9	33.8	95.5	7.5	--	3.4	144.1	.3	144.4
Los Padres	0.1	2.3	.9	.2	2/5.0	2.4	10.9	--	10.9
Mendocino	18.1	14.2	13.8	4.5	--	1.4	52.0	2.0	54.0
Modoc	--	25.4	32.8	1.4	--	1.5	61.1	1/	61.1
Plumas	21.7	44.2	108.0	11.9	--	5.5	191.3	1.8	193.1
San Bernardino	--	6.7	2.7	1.2	--	2.5	13.1	--	13.1
Sequoia	--	18.5	37.3	8.1	3/4.5	7.7	76.1	.5	76.6
Shasta	34.5	34.1	40.3	9.5	--	5.6	124.0	1.2	125.2
Sierra	.9	20.9	41.0	9.1	--	10.2	82.1	.6	82.7
Six Rivers	99.6	4.7	19.4	8.2	--	2.8	134.7	--	134.7
Stanislaus	3.1	35.5	61.6	22.6	--	33.8	156.6	--	156.6
Tahoe	19.6	31.8	80.0	15.5	--	9.4	156.3	4.0	160.3
Trinity	48.3	14.6	13.2	.2	--	1.2	77.5	6.0	83.5
Total4/	330.5	358.5	690.5	127.4	9.5	104.1	1,620.5	23.5	1,644.0
Pacific Northwest Region:									
Rogue River	2.7	.4	.5	.5	--	.2	4.4	--	4.4
Siskiyou	1.0	1/	.2	1/	--	.3	1.5	.6	2.2
Total	3.7	.4	.7	.5	--	.5	5.9	.6	6.6
All Regions4/	334.2	363.6	693.1	128.4	9.5	109.5	1,638.4	24.4	1,663.0

1/Less than 50,000 board feet.

2/Coastal redwood.

3/Giant sequoia.

4/Totals may be off because of rounding.

Table 44--Net annual growth of growing stock on timberland outside National Forests by resource area, ownership, and species, California, 1975
(In million cubic feet)

Resource area and ownership	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Sugar and western white pines	Redwood	Giant sequoia	Incense-cedar	Other softwoods	Residuals and ingrowth1/	Total softwoods	Hardwoods	All species
North coast:												
Other public	2.7	0.1	2/-0.6	3/	3.3	--	3/	--	0.9	6.4	4.8	11.2
Forest industry	21.0	.6	1.5	3/	42.0	--	3/	2.3	4.9	72.3	14.3	86.6
Farmer and miscellaneous private	17.8	.8	.8	--	30.3	--	2/-0.3	2.7	4.3	56.3	23.2	79.5
Total4/	41.4	1.4	1.6	3/	75.6	--	2/-.2	5.0	10.0	135.0	42.3	177.3
Central coast:												
Other public	--	2/-.1	--	--	0.3	--	--	--	--	0.2	0.7	1.0
Forest industry	0.1	--	--	--	.7	--	--	0.2	--	1.0	.4	1.4
Other private timber growers	.5	--	--	--	1.6	--	--	.1	--	2.2	.6	2.8
Farmer and miscellaneous private	3.0	3/	--	--	11.9	--	--	3.0	--	17.9	2.4	20.3
Total4/	3.6	2/-.1	--	--	14.5	--	--	3.2	--	21.3	4.2	25.5
Northern Interior:												
Other public	2.4	1.3	.6	0.2	--	--	3/	3/	--	4.3	.6	5.0
Forest industry	4.2	3.2	11.8	2.6	--	--	.9	.2	--	22.9	.7	23.6
Other private timber growers	6.1	16.7	11.9	1.3	--	--	2.3	.6	--	39.0	2.2	41.2
Farmer and miscellaneous private	9.6	6.6	1.1	.7	--	--	.8	.2	--	19.0	2.1	21.0
Total4/	22.3	27.8	25.4	4.8	--	--	4.0	1.0	--	85.2	5.6	90.8
Sacramento:												
Other public	2/-.2	1.4	.9	.1	--	--	.1	--	--	2.3	.8	3.0
Forest industry	6.4	11.2	11.2	6.3	--	--	3.1	.7	--	38.9	3.4	42.3
Other private timber growers	1.3	2.9	3.8	1.4	--	--	1.3	2/-.2	--	10.3	.8	11.1
Farmer and miscellaneous private	8.2	14.8	7.5	2.4	.2	--	4.9	.7	--	38.7	3.6	42.2
Total4/	15.7	30.3	23.3	10.1	.2	--	9.4	1.1	--	90.2	8.5	98.6
San Joaquin:												
Other public	.1	.3	.2	.4	--	0.2	.2	--	--	1.5	.2	1.7
Forest industry	.3	3.3	3.0	.9	--	--	.9	--	--	8.3	.3	8.7
Other private timber growers	.2	.5	.2	.1	--	--	.2	.1	--	1.2	.1	1.3
Farmer and miscellaneous private	.6	9.9	1.8	2.3	--	--	1.3	.2	--	16.1	1.1	17.2
Total4/	1.2	14.1	5.1	3.7	--	.2	2.5	.3	--	27.2	1.8	28.9
Southern California:												
Other public	--	3/	3/	3/	--	--	3/	3/	--	3/	--	3/
Farmer and miscellaneous private	3/	.3	.1	.1	--	--	3/	.1	--	.7	--	0.7
Total4/	3/	.4	.1	.1	--	--	3/	.1	--	.8	--	.8
All resource areas:												
Other public	5.0	3.0	1.1	.7	3.6	.2	.3	3/	.9	14.7	7.1	21.9
Forest industry	32.0	18.4	27.5	9.7	42.7	--	4.9	3.4	4.9	143.4	19.1	162.5
Other private timber growers	8.1	20.1	15.8	2.9	1.6	--	3.7	.5	--	52.7	3.7	56.5
Farmer and miscellaneous private	39.1	32.4	11.2	5.4	42.4	--	6.9	6.9	4.3	148.7	32.3	181.0
Total4/	84.2	73.9	55.6	18.7	90.4	.2	15.8	10.7	10.0	359.6	62.3	421.9

1/Includes estimated growth on surviving (residual) trees in stands partially cut since the inventory, and growth on trees estimated to have grown into the 5-inch class since the inventory.

2/Minus sign indicates that mortality exceeds gross growth.

3/Less than 50,000 cubic feet.

4/Totals may be off because of rounding.

Table 45--Net annual growth of sawtimber on timberland outside National Forests by resource area, ownership, and species, California, 1975
(In million board feet, Scribner rule)

Resource area and ownership	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Sugar and western white pines	Redwood	Giant sequoia	Incense-cedar	Other softwoods	Residuals and ingrowth1/	Total softwoods	Hardwoods	All spec
North coast:												
Other public	13.1	0.5	2/-3.4	0.2	16.8	--	3/	--	3.0	30.2	10.0	40
Forest industry	89.5	2.6	8.9	.1	195.5	--	0.1	12.1	18.1	326.9	17.2	344
Farmer and miscellaneous private	82.8	4.4	1.9	--	143.1	--	2/-.8	16.8	15.1	263.4	49.0	312
Total4/	185.3	7.6	7.4	.3	355.5	--	2/-.7	28.9	36.2	620.5	76.2	696
Central coast:												
Other public	--	2/-.6	--	--	2.3	--	--	--	--	1.7	1.0	2
Forest industry	0.4	--	--	--	3.3	--	--	4.6	--	8.4	0.3	8
Other private timber growers	3.1	--	--	--	5.9	--	--	--	--	9.0	.3	9
Farmer and miscellaneous private	17.9	.1	--	--	68.7	--	--	16.0	--	102.8	4.8	107
Total4/	21.4	2/-.5	--	--	80.2	--	--	20.6	--	121.8	6.3	128
Northern Interior:												
Other public	17.8	5.5	3.3	1.1	--	--	3/	2/-0.1	--	27.7	.2	27
Forest industry	19.1	16.6	57.9	9.2	--	--	2.2	--	--	105.1	1.9	107
Other private timber growers	24.2	60.5	65.5	7.6	--	--	9.0	1.4	--	168.1	1.9	170
Farmer and miscellaneous private	47.1	28.5	5.2	3.7	--	--	3.8	.3	--	88.6	5.3	93
Total4/	108.1	111.1	131.9	21.6	--	--	15.1	1.6	--	389.5	9.4	398
Sacramento:												
Other public	2/-1.6	6.9	3.2	.7	--	--	.7	--	--	9.8	.6	10
Forest industry	41.9	70.1	66.0	39.3	--	--	12.0	3.8	--	233.2	3.1	236
Other private timber growers	5.9	17.7	25.0	6.7	--	--	4.4	2/-1.2	--	58.6	.9	59
Farmer and miscellaneous private	34.4	80.5	57.2	12.6	1.2	--	20.5	3.7	--	209.9	6.7	216
Total4/	80.6	175.2	151.4	59.3	1.2	--	37.6	6.3	--	511.6	11.3	522
San Joaquin:												
Other public	.4	2.7	0.9	2.4	--	1.2	.8	--	--	8.4	.4	8
Forest industry	1.0	17.3	24.9	4.9	--	--	3.2	--	--	51.3	1.0	52
Other private timber growers	1.4	2.9	.6	.7	--	--	.8	.4	--	6.8	.4	7
Farmer and miscellaneous private	6.5	55.5	16.8	12.4	--	--	4.9	.8	--	96.9	2.9	99
Total4/	9.3	78.3	43.2	20.4	--	1.2	9.7	1.2	--	163.3	4.6	167
Southern California:												
Other public	3/	.1	3/	3/	--	--	3/	3/	--	0.1	--	0
Farmer and miscellaneous private	3/	2.4	.8	.3	--	--	.3	.9	--	4.7	--	4
Total4/	3/	2.4	.8	.3	--	--	.3	1.0	--	4.8	--	4
All resource areas:												
Other public	29.7	15.0	4.0	4.5	19.1	1.2	1.5	2/-.1	3.0	77.9	12.3	9
Forest industry	152.0	106.6	157.7	53.4	198.9	--	17.6	20.6	18.1	724.9	23.5	74
Other private timber growers	34.6	81.1	91.1	15.1	5.9	--	14.2	.6	--	242.5	3.4	24
Farmer and miscellaneous private	188.6	171.4	81.9	29.0	213.0	--	28.7	38.5	15.1	766.3	68.7	83
Total4/	404.9	374.1	334.7	101.9	436.8	1.2	62.0	59.7	36.2	1,811.5	107.8	1,91

1/Includes estimated growth on surviving (residual) trees in stands partially cut since the inventory, and growth on trees estimated to have grown into t
5-inch class since the inventory.

2/Minus sign indicates that mortality exceeds gross growth.

3/Less than 50,000 board feet.

4/Totals may be off because of rounding.

able 46--Annual mortality of growing stock and sawtimber on timberland by National Forest group, and oftwoods and hardwoods, California, 1975

National Forest group	Growing stock			Sawtimber		
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total
	- - - Million cubic feet - - -			Million board feet (Scribner rule)		
orthwestern California[1/]	34.7	1.8	36.5	195.0	5.3	200.3
ortheastern California[2/]	9.9	0.1	10.0	40.4	0.2	40.6
orthern Sierra Nevada[3/]	10.4	.2	10.6	48.1	.5	48.6
outhern Sierra Nevada[4/]	17.0	--	17.0	96.6	--	96.6
outhern California[5/]	1.9	.2	2.1	10.9	1.7	12.6
All groups	73.9	2.3	76.2	391.0	7.7	398.7

/Includes California portion of Klamath, Mendocino, Rogue River, Siskiyou, Six Rivers, and Trinity ational Forests.

/Includes Lassen, Modoc, and Shasta National Forests.

/Includes Eldorado, Plumas, and Tahoe National Forests.

/Includes Sequoia, Sierra, Stanislaus, and California portion of Toiyabe National Forests.

/Includes Angeles, Cleveland, Los Padres, San Bernardino, and California portion of Inyo National Forests.

Table 47--Annual mortality of growing stock on timberland outside National Forests by resource area, ownership, and species, California, 1975
(In million cubic feet)

Resource area and ownership	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Sugar and western white pines	Redwood	Incense-cedar	Other softwoods	Total softwoods	Hardwoods	All specie
North coast:										
Other public	2.3	--	0.6	--	--	--	--	3.0	0.1	3.
Forest industry	2.2	--	1/	--	2.7	--	0.1	4.9	1.6	6.
Farmer and miscellaneous private	7.8	0.3	.4	0.3	--	--	.1	8.9	.4	9.
Total 2/	12.3	.3	1.0	--	3.0	--	.2	16.8	2.1	18.
Central coast:										
Other public	--	.1	--	--	--	--	--	0.1	--	0.
Forest industry	--	--	--	--	--	--	--	--	--	-
Other private timber growers	--	--	--	--	--	--	--	--	--	-
Farmer and miscellaneous private	0.3	--	--	--	1/	--	.2	.5	.3	.
Total 2/	.3	.1	--	--	1/	--	.2	.6	.3	.
Northern Interior:										
Other public	.3	.1	.5	--	--	--	.1	1.0	.1	1.
Forest industry	.3	2.1	1.7	0.1	--	.5	.1	4.8	1/	4.
Other private timber growers	1.9	1.5	2.2	.8	--	.3	1/	6.8	.1	6.
Farmer and miscellaneous private	1.4	.7	.8	.1	--	.5	.2	3.7	--	3.
Total 2/	3.9	4.5	5.3	1.1	--	1.2	.5	16.4	.2	16.
Sacramento:										
Other public	.7	1/	--	.1	--	.1	--	.8	--	.
Forest industry	1.0	1.4	3.9	.7	--	.4	.2	7.6	--	7.
Other private timber growers	.3	.2	1.6	--	--	--	.8	3.0	--	3
Farmer and miscellaneous private	--	1.7	2.8	.2	--	.5	.3	5.5	.3	5
Total 2/	2.1	3.3	8.2	1.0	--	1.0	1.4	16.9	.3	17
San Joaquin:										
Other public	--	.2	--	--	--	1/	--	.2	1/	
Forest industry	1/	1.0	1.9	--	--	.2	--	3.2	--	3
Other private timber growers	--	.2	--	--	--	--	--	.2	--	
Farmer and miscellaneous private	.1	.6	.3	.1	--	1.1	1/	2.2	1/	2
Total 2/	.1	2.1	2.2	.1	--	1.3	1/	5.9	.1	5
Southern California:										
Other public	1/	1/	1/	--	--	--	1/	1/	1/	
Farmer and miscellaneous private	1/	.2	1/	1/	--	1/	1/	.3	1/	
Total 2/	1/	.2	1/	1/	--	1/	1/	.3	1/	
All resource areas:										
Other public	3.3	.4	1.2	.1	--	.1	1/	5.1	.2	5
Forest industry	3.5	4.6	7.5	.9	2.7	1.1	.4	20.6	1.7	22
Other private timber growers	2.3	1.9	3.8	.8	--	.3	.9	10.0	.1	10
Farmer and miscellaneous private	9.6	3.5	4.3	.4	.4	2.1	.9	21.2	1.0	22
Total 2/	13.6	10.4	16.8	2.2	3.0	3.6	2.2	56.9	3.0	59

1/ Less than 50,000 cubic feet.

2/ Totals may be off because of rounding.

le 48--Annual mortality of sawtimber on timberland outside National Forests by resource area, ownership, and species, California, 1975
(In million board feet, Scribner rule)

Resource area and ownership	Douglas-fir	Ponderosa and Jeffrey pines	True firs	Sugar and western white pines	Redwood	Incense-cedar	Other softwoods	Total softwoods	Hardwoods	All species
th coast:										
ther public	14.4	--	3.7	--	--	--	--	18.1	0.3	18.4
orest industry	10.6	--	0.1	--	12.4	--	0.5	23.6	4.8	28.3
armer and miscellaneous private	45.2	1.2	2.6	--	0.2	--	.6	49.8	.7	50.6
Total1/	70.2	1.2	6.4	--	12.6	--	1.2	91.5	5.8	97.3
tral coast:										
ther public	--	0.7	--	--	--	--	--	0.7	--	0.7
orest industry	--	--	--	--	--	--	--	--	--	--
ther private timber growers	--	--	--	--	--	--	--	--	--	--
armer and miscellaneous private	1.8	--	--	--	2/	--	.9	2.7	--	2.7
Total1/	1.8	.7	--	--	--	--	.9	3.4	--	3.4
thern Interior:										
ther public	0.3	.4	.7	--	--	--	.2	1.5	.2	1.7
orest industry	1.4	8.0	8.2	0.6	--	1.9	.6	20.7	--	20.7
ther private timber growers	7.3	7.0	9.5	3.7	--	0.9	--	28.4	--	28.4
armer and miscellaneous private	4.9	3.3	1.9	.6	--	2.2	.7	13.6	--	13.6
Total1/	13.9	18.6	20.3	4.9	--	5.1	1.5	64.2	.2	64.4
ramento:										
ther public	3.9	--	--	.2	--	--	--	4.1	--	4.1
orest industry	4.4	2.0	19.0	2.0	--	1.2	1.2	29.7	--	29.7
ther private timber growers	1.5	.5	6.8	--	--	--	4.0	12.8	--	12.8
armer and miscellaneous private	--	4.6	13.8	1.1	--	.9	.8	21.3	.4	21.7
Total1/	9.8	7.1	39.6	3.3	--	2.1	6.0	67.9	.4	68.3
Joaquin:										
ther public	--	.5	--	--	--	.1	--	.6	.1	.7
orest industry	--	5.9	9.3	--	--	1.2	--	16.4	--	16.4
ther private timber growers	--	1.5	--	--	--	--	--	1.5	--	1.5
armer and miscellaneous private	--	1.5	1.1	.1	--	4.5	.2	7.3	--	7.3
Total1/	--	9.3	10.4	.1	--	5.8	.2	25.8	.1	25.9
thern California:										
ther public	2/	2/	2/	2/	--	2/	2/	2/	2/	2/
armer and miscellaneous private	.1	.8	.2	.1	--	2/	.1	1.5	.3	1.8
Total1/	.1	.8	.2	.1	--	2/	.1	1.5	.3	1.8
resource areas:										
ther public	18.6	1.5	4.4	.2	--	.1	.2	25.1	.6	25.7
orest industry	16.3	15.9	36.6	2.6	12.4	4.3	2.2	90.4	4.8	95.1
ther private timber growers	8.7	9.0	16.3	3.7	--	.9	4.0	42.7	--	42.7
armer and miscellaneous private	52.1	11.4	19.6	1.9	.2	7.7	3.2	96.2	1.4	97.6
Total1/	95.8	37.8	76.9	8.4	12.6	13.0	9.8	254.3	6.7	261.0

otals may be off because of rounding.
ess than 50,000 board feet.

Table 49--Net volume of growing stock on timberland in all ownerships by species and diameter class, California, 1975

(In million cubic feet)

Species	Diameter class (inches)										
	5.0-6.9	7.0-8.9	9.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-20.9	21.0-28.9	29.0 and larger	All classes
Softwoods:											
Douglas-fir	202	335	374	437	500	595	582	588	2,285	6,888	12,786
Ponderosa and Jeffrey pines	149	237	334	386	515	486	498	541	2,318	3,660	9,124
True firs	258	415	556	641	705	721	782	745	3,012	4,969	12,804
Hemlocks	3	2	8	6	9	6	11	7	39	38	129
Sugar pine	21	49	52	66	68	84	105	115	629	2,166	3,355
White pine	2	4	5	9	10	11	16	14	70	90	231
Redwood	28	56	90	132	172	243	254	274	953	2,100	4,302
Sitka spruce	--	--	4	--	--	4	5	8	19	8	48
Engelmann and other spruces	--	--	1	1	1	--	--	1	2	1	7
Redcedar	1/	1	--	--	--	--	--	2	4	11	18
Incense-cedar	70	103	106	110	138	129	122	127	411	688	2,004
Lodgepole pine	24	49	63	76	72	82	66	74	220	144	870
Other softwoods	12	8	20	21	23	25	14	14	53	107	297
Total softwoods 2/	769	1,259	1,613	1,885	2,213	2,386	2,455	2,510	10,015	20,870	45,975
Hardwoods:											
Cottonwood and aspen	1/	2	4	3	4	3	3	1/	1	1	21
Red alder	3	8	8	6	7	9	6	5	7	5	64
Oak 3/	132	199	201	175	166	142	125	108	362	186	1,796
Other hardwoods 4/	111	190	189	192	172	185	147	124	321	181	1,812
Total hardwoods 2/	246	399	402	376	349	339	281	237	691	373	3,693
All species 2/	1,015	1,658	2,015	2,260	2,562	2,725	2,736	2,747	10,706	21,243	49,668

1/Less than 500,000 cubic feet.
2/Totals may be off because of rounding.
3/About 60 percent is California black oak; 40 percent consists of California white oak, Oregon white oak, California live oak, canyon live oak, and interior live oak.
4/About 60 percent is tanoak; 30 percent is madrone; 10 percent consists mainly of big leaf maple and California laurel.

ble 50--Net volume of sawtimber on timberland in all ownerships by species and diameter class, lifornia, 1975

(In million board feet, International 1/4-inch rule)

Species	9.0–10.9	11.0–12.9	13.0–14.9	15.0–16.9	17.0–18.9	19.0–20.9	21.0–28.9	29.0 and larger	All classes
ftwoods:									
Douglas-fir	1,045	1,466	2,004	2,659	2,864	3,111	12,827	46,962	72,938
Ponderosa and Jeffrey pines	961	1,413	2,277	2,322	2,568	2,971	13,616	25,172	51,300
True firs	1,917	2,841	3,625	3,885	4,381	4,292	18,069	32,941	71,951
Hemlocks	19	18	42	25	46	37	204	236	627
Sugar pine	143	289	322	456	555	682	3,724	14,239	20,410
White pine	15	29	46	54	79	73	403	546	1,245
Redwood	195	306	694	1,156	1,267	1,418	5,041	11,357	21,434
Sitka spruce	10	--	--	19	27	42	114	76	288
Engelmann and other spruces	1	2	2	1/	1/	1/	2	2	9
Redcedar	--	--	3	1	1/	6	23	68	101
Incense-cedar	410	461	579	497	499	570	2,245	4,322	9,583
Lodgepole pine	186	279	328	399	335	404	1,275	936	4,142
Other softwoods	73	94	106	140	86	86	384	617	1,586
Total softwoods 2/	4,975	7,198	10,028	11,613	12,707	13,692	57,927	137,474	255,614
rdwoods:									
Cottonwood and aspen	--	13	11	9	--	--	9	9	51
Red alder	--	16	25	29	24	23	33	29	179
Oak	--	485	504	450	412	389	1,408	782	4,430
Other hardwoods	--	393	404	467	383	365	918	489	3,419
Total hardwoods 2/	--	907	944	955	819	777	2,368	1,309	8,079
l species 2/	4,975	8,105	10,972	12,568	13,526	14,466	60,295	138,783	263,693

Less than 500,000 board feet.

Totals may be off because of rounding.

Table 51--Area of timberland outside National Forests by stand condition and treatment class at time of inventory, and ownership, California[1]
(In thousand acres)

Stand condition and treatment class	Other public: North coast	Other public: Other resource areas	Other public: Total	Forest industry: North coast	Forest industry: Other resource areas	Forest industry: Total	Other private timber growers: North coast	Other private timber growers: Other resource areas	Other private timber growers: Total	Farmer and miscellaneous private: North coast	Farmer and miscellaneous private: Other resource areas	Farmer and miscellaneous private: Total	All ownerships: North coast	All ownerships: Other resource areas	All ownerships: Total
Cut since inventory (north coast only)	30	--	30	179	--	179	--	--	--	117	--	117	326	--	326
Conifer sawtimber with 5,000 or more board feet per acre:															
Low growth															
Stocked with understory conifers															
Overstory removal	0	0	0	50	50	100	--	75	75	26	71	97	76	196	272
Not stocked with understory conifers															
Regeneration cutting	93	76	169	277	504	781	--	351	351	254	371	625	624	1,302	1,926
High growth															
Commercial thinning or no treatment	30	59	89	235	492	727	--	293	293	217	505	722	482	1,349	1,831
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:															
Without cull trees or hardwoods															
Precommercial thinning or no treatment	1	16	17	16	139	155	--	220	220	21	152	173	38	527	565
With cull trees or hardwoods															
Improvement cutting	0	21	21	48	27	75	--	30	30	84	108	192	132	186	318
Poletimber or sawtimber hardwoods without understory conifers:															
Medium and high sites															
Stand conversion	22	6	28	102	25	127	--	11	11	270	82	352	394	124	518
Low sites															
Stand conversion	28	23	51	47	5	52	--	40	40	126	79	205	201	147	348
Total stand conversion	50	29	79	149	30	179	--	51	51	396	161	557	595	271	866
Conifer seedlings and saplings:															
Without overtopping brush or hardwoods															
Precommercial thinning or no treatment	0	14	14	32	118	150	--	155	155	19	135	154	51	422	473
With overtopping brush or hardwoods															
Cleaning or releasing	5	1	6	13	5	18	--	17	17	57	78	135	75	101	176
Nonstocked or inadequately stocked:															
Medium and high sites															
Planting	7	10	17	154	34	188	--	57	57	210	102	356	415	203	616
Low sites															
Planting	12	43	55	45	91	136	--	99	99	119	279	423	201	512	715
Total planting	19	53	72	199	125	324	--	156	156	329	381	779	616	715	1,331
All classes	228	1/269	497	1,198	1,490	2,688	--	1,348	1,348	1,589	1,962	2/3,551	3,015	5,069	8,084

1/Excludes 2,000 acres for which information is not available. Dates of field data collection: north coast 1965-67; other resource areas 1968, 1970-72.

2/Excludes 6,000 acres of Monterey pine in the central coast resource area, and 39,000 acres in southern California for which information is not available.

Table 52--Area of timberland in other public ownership by stand condition and treatment class, stockability and slope class, and biological potential (site class), all resource areas, California[1]

(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent — Biological potential (site class)				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent — Biological potential (site class)				All areas — Biological potential (site class)			Total
	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	
Cut since inventory (north coast only)	5	1	10	16	0	5	9	14	5	6	19	30
Conifer sawtimber with 5,000 or more board feet per acre:												
Low growth												
Stocked with understory conifers												
Overstory removal	0	0	0	0	0	0	0	0	0	0	0	0
Not stocked with understory conifers												
Regeneration cutting	8	71	20	99	8	14	48	70	16	85	68	169
High growth												
Commercial thinning or no treatment	14	25	21	60	4	1	24	29	18	26	45	89
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:												
Without cull trees or hardwoods												
Precommercial thinning or no treatment	1	0	11	12	0	3	2	5	1	3	13	17
With cull trees or hardwoods												
Improvement cutting	0	1	10	11	0	0	10	10	0	1	20	21
Poletimber or sawtimber hardwoods without understory conifers:												
Stand conversion	0	10	20	30	0	18	31	49	0	28	51	79
Conifer seedlings and saplings:												
Without overtopping brush or hardwoods												
Precommercial thinning or no treatment	0	1	5	6	0	2	6	8	0	3	11	14
With overtopping brush or hardwoods												
Cleaning or releasing	2	4	0	6	0	0	0	0	2	4	0	6
Nonstocked or inadequately stocked:												
Planting	0	15	23	38	2	0	32	34	2	15	55	72
All classes	30	128	120	278	14	43	162	219	44	171	282	497

[1] Excludes 1,000 acres in southern California and 1,000 acres in the north coast for which information is not available. Dates of field data collection: north coast 1965-67; central coast 1972; northern interior 1968, 1970-71; Sacramento 1971; San Joaquin 1972.

Table 53--Area of timberland in forest industry ownership by stand condition and treatment class, and biological potential (site class), all resource areas, California[1/]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class)			Tot
	High	Medium	Low	
Cut since inventory (north coast only)	108	66	5	17
Conifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	36	38	26	10
Not stocked with understory conifers				
Regeneration cutting	207	416	158	78
High growth				
Commercial thinning or no treatment	187	282	258	72
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	11	60	84	15
With cull trees or hardwoods				
Improvement cutting	10	33	32	7
Poletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	45	82	52	17
Conifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	6	33	111	15
With overtopping brush or hardwoods				
Cleaning or releasing	5	8	5	1
Nonstocked or inadequately stocked:				
Planting	71	117	136	32
All classes	686	1,135	867	2,68

[1/]Dates of field data collection: north coast 1965-67; central coast 1972; northern interior 1968, 1970-71; Sacramento 1971; San Joaquin 1972.

Table 54--Area of timberland in other private timber growers ownership by stand condition and treatment class, and biological potential (site class), all resource areas, California[1]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class)			Total
	High	Medium	Low	
Conifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	0	48	27	75
Not stocked with understory conifers				
Regeneration cutting	52	145	154	351
High growth				
Commercial thinning or no treatment	27	72	194	293
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	0	39	181	220
With cull trees or hardwoods				
Improvement cutting	3	9	18	30
Poletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	3	8	40	51
Conifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	4	36	115	155
With overtopping brush or hardwoods				
Cleaning or releasing	0	3	14	17
Nonstocked or inadequately stocked:				
Planting	11	46	99	156
All classes	100	406	842	1,348

[1]Dates of field data collection: north coast 1965-67; central coast 1972; northern interior 1968, 1970-71; Sacramento 1971; San Joaquin 1972.

Table 55--Area of timberland in farmer and miscellaneous private ownership by stand condition and treatment class, and biological potential (site class), all resource areas, California[1/]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class) High	Medium	Low	Total
Cut since inventory (north coast only)	29	88	0	117
Conifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	24	15	58	97
Not stocked with understory conifers				
Regeneration cutting	163	325	137	625
High growth				
Commercial thinning or no treatment	113	301	308	722
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	11	45	117	173
With cull trees or hardwoods				
Improvement cutting	5	73	114	192
Poletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	63	289	205	557
Conifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	4	46	104	154
With overtopping brush or hardwoods				
Cleaning or releasing	13	51	71	135
Nonstocked or inadequately stocked:				
Planting	76	280	423	779
All classes	501	1,513	1,537	3,551

[1/]Excludes 6,000 acres in central coast and 39,000 acres in southern California for which information is not available. Dates of field data collection: north coast 1965-67; central coast 1972; northern interior 1968, 1970-71; Sacramento 1971; San Joaquin 1972.

able 56--Area of timberland in forest industry ownership by stand condition and reatment class, and biological potential (site class), north coast resource area, alifornia[1/]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class) High	Medium	Low	Total
ut since inventory (north coast only)	108	66	5	179
onifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	36	9	5	50
Not stocked with understory conifers				
Regeneration cutting	131	132	14	277
High growth				
Commercial thinning or no treatment	146	75	14	235
oletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	11	5	0	16
With cull trees or hardwoods				
Improvement cutting	10	28	10	48
oletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	42	60	47	149
onifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	6	12	14	32
With overtopping brush or hardwoods				
Cleaning or releasing	5	8	0	13
onstocked or inadequately stocked:				
Planting	66	88	45	199
ll classes	561	483	154	1,198

Dates of field data collection: Del Norte County 1965, Humboldt County 1966, endocino County 1967, Sonoma County 1965. Adjustments have been made to account for ark expansion since dates of field data collection.

Table 57--Area of timberland in farmer and miscellaneous private ownership by stand condition and treatment class, and biological potential (site class), north coast resource area, California[1/]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class)			Total
	High	Medium	Low	
Cut since inventory (north coast only)	29	88	0	117
Conifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	15	11	0	26
Not stocked with understory conifers				
Regeneration cutting	93	126	35	254
High growth				
Commercial thinning or no treatment	77	121	19	217
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	11	5	5	21
With cull trees or hardwoods				
Improvement cutting	5	45	34	84
Poletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	53	217	126	396
Conifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	4	10	5	19
With overtopping brush or hardwoods				
Cleaning or releasing	10	37	10	57
Nonstocked or inadequately stocked:				
Planting	73	181	144	398
All classes	370	841	378	1,589

[1/] Dates of field data collection: Del Norte County 1965, Humboldt County 1966, Mendocino County 1967, Sonoma County 1965.

ble 58--Area of timberland in forest industry ownership by stand condition and eatment class, and biological potential (site class), central coast resource area, lifornia[1]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class)			Total
	High	Medium	Low	
nifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	0	0	0	0
Not stocked with understory conifers				
Regeneration cutting	4	0	0	4
High growth				
Commercial thinning or no treatment	1	3	0	4
letimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	0	0	0	0
With cull trees or hardwoods				
Improvement cutting	0	2	0	2
letimber or sawtimber hardwoods without understory conifers:				
Stand conversion	0	0	0	0
nifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	0	0	0	0
With overtopping brush or hardwoods				
Cleaning or releasing	0	0	0	0
nstocked or inadequately stocked:				
Planting	0	0	0	0
l classes	5	5	0	10

Field data were collected in September and October 1972.

Table 59--Area of timberland in other private timber growers ownership by stand condition and treatment class, and biological potential (site class), central coast resource area, California[1/]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class)			Tot
	High	Medium	Low	
Conifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	0	0	0	
Not stocked with understory conifers				
Regeneration cutting	6	0	0	
High growth				
Commercial thinning or no treatment	3	0	0	
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	0	0	0	
With cull trees or hardwoods				
Improvement cutting	3	0	0	
Poletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	3	0	0	
Conifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	0	0	0	
With overtopping brush or hardwoods				
Cleaning or releasing	0	3	0	
Nonstocked or inadequately stocked:				
Planting	0	0	0	
All classes	15	3	0	1[illegible]

[1/]Field data were collected in September and October 1972.

ble 60--Area of timberland in farmer and miscellaneous private ownership by stand ondition and treatment class, and biological potential (site class), central coast esource area, California[1/]

(In thousand acres)

Stand condition and treatment class	Biological potential (site class)			Total
	High	Medium	Low	
onifer sawtimber with 5,000 or more board feet per acre:				
Low growth				
Stocked with understory conifers				
Overstory removal	0	0	0	0
Not stocked with understory conifers				
Regeneration cutting	46	42	0	88
High growth				
Commercial thinning or no treatment	24	28	0	52
oletimber or young sawtimber conifers with less than 5,000 board feet per acre:				
Without cull trees or hardwoods				
Precommercial thinning or no treatment	0	4	0	4
With cull trees or hardwoods				
Improvement cutting	0	6	3	9
oletimber or sawtimber hardwoods without understory conifers:				
Stand conversion	10	7	0	17
onifer seedlings and saplings:				
Without overtopping brush or hardwoods				
Precommercial thinning or no treatment	0	4	0	4
With overtopping brush or hardwoods				
Cleaning or releasing	3	0	0	3
onstocked or inadequately stocked:				
Planting	3	4	0	7
l classes	86	95	3	184

Excludes 6,000 acres of Monterey pine type for which information is not available. eld data were collected in September and October 1972.

Table 61--Area of timberland in forest industry ownership by stand condition and treatment class, stockability and slope class, and biological potential (site class), northern interior resource area, California[1/]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent				Tot
	Biological potential (site class)				Biological potential (site class)				
	High	Medium	Low	Total	High	Medium	Low	Total	
Conifer sawtimber with 5,000 or more board feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	0	10	0	10	0	6	17	23	3
Not stocked with understory conifers									
Regeneration cutting	40	73	30	143	0	15	42	57	20
High growth									
Commercial thinning or no treatment	10	53	57	120	0	16	22	38	15
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	37	58	95	0	0	5	5	10
With cull trees or hardwoods									
Improvement cutting	0	0	0	0	0	0	0	0	
Poletimber or sawtimber hardwoods without understory conifers:									
Stand conversion	0	6	0	6	0	4	5	9	1
Conifer seedlings and saplings:									
Without overtopping brush or hardwooos									
Precommercial thinning or no treatment	0	10	19	29	0	0	30	30	5
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	0	0	0	0	5	5	
Nonstocked or inadequately stocked:									
Planting	0	4	35	39	5	0	19	24	6
All classes	50	193	199	442	5	41	145	191	63

1/Dates of field data collection: Lassen and Modoc Counties 1971, Shasta and Trinity Counties 1970, Siskiyou County 1968. Adjustments have been made to account for ownership changes since dates of collection.

: 62--Area of timberland in other private timber growers ownership by stand condition and treatment class, stockability and slope
, and biological potential (site class), northern interior resource area, California[1/]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent — Biological potential (site class)				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent — Biological potential (site class)				Total
	High	Medium	Low	Total	High	Medium	Low	Total	
'er sawtimber with 5,000 or more ırd feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	0	24	13	37	0	20	10	30	67
Not stocked with understory conifers									
Regeneration cutting	33	86	72	191	5	23	56	84	275
High growth									
Commercial thinning or no treatment	20	21	93	134	0	18	55	73	207
:imber or young sawtimber conifers :h less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	29	118	147	0	0	54	54	201
With cull trees or hardwoods									
Improvement cutting	0	0	10	10	0	0	5	5	15
:imber or sawtimber hardwoods without ıerstory conifers:									
Stand conversion	0	0	5	5	0	4	21	25	30
'er seedlings and saplings:									
Without overtopping brush or hardwoods									
Precommercial thinning or no treatment	4	24	61	89	0	12	44	56	145
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	5	5	0	0	5	5	10
:ocked or inadequately stocked:									
Planting	7	16	58	81	4	10	41	55	136
:lasses	64	200	435	699	9	87	291	387	1,086

:es of field data collection: Lassen and Modoc Counties 1971, Shasta and Trinity Counties 1970, Siskiyou County 1968. Adjustments been made to account for ownership changes since dates of collection.

Table 63--Area of timberland in farmer and miscellaneous private ownership by stand condition and treatment class, stockability and slope class, and biological potential (site class), northern interior resource area, California[1]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent				Tota
	Biological potential (site class)				Biological potential (site class)				
	High	Medium	Low	Total	High	Medium	Low	Total	
Conifer sawtimber with 5,000 or more board feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	0	4	13	17	0	0	4	4	21
Not stocked with understory conifers									
Regeneration cutting	0	33	30	63	0	18	16	34	9
High growth									
Commercial thinning or no treatment	0	26	38	64	0	0	35	35	9
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	16	54	70	0	0	0	0	7
With cull trees or hardwoods									
Improvement cutting	0	8	24	32	0	2	32	34	6
Poletimber or sawtimber hardwoods without understory conifers:									
Stand conversion	0	13	20	33	0	7	11	18	5
Conifer seedlings and saplings:									
Without overtopping brush or hardwoods									
Precommercial thinning or no treatment	0	23	41	64	0	0	18	18	8
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	17	17	0	9	21	30	4
Nonstocked or inadequately stocked:									
Planting	0	29	64	93	0	0	54	54	14
All classes	0	152	301	453	0	36	191	227	68

[1] Dates of field data collection: Lassen and Modoc Counties 1971, Shasta and Trinity Counties 1970, Siskiyou County 1968. Adjustments have been made to account for ownership changes since dates of collection.

able 64--Area of timberland in forest industry ownership by stand condition and treatment class, stockability and slope class, and iological potential (site class), Sacramento resource area, California[1/]

(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent — Biological potential (site class)				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent — Biological potential (site class)				Total
	High	Medium	Low	Total	High	Medium	Low	Total	
onifer sawtimber with 5,000 or more board feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	0	9	0	9	0	0	4	4	13
Not stocked with understory conifers									
Regeneration cutting	11	126	38	175	4	27	28	59	234
High growth									
Commercial thinning or no treatment	23	89	91	203	4	13	65	82	285
oletimber or young sawtimber conifers with less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	4	10	14	0	0	9	9	23
With cull trees or hardwoods									
Improvement cutting	0	0	13	13	0	0	7	7	20
oletimber or sawtimber hardwoods without understory conifers:									
Stand conversion	0	5	0	5	0	4	0	4	9
onifer seedlings and saplings:									
Without overtopping brush or hardwoods									
Precommercial thinning or no treatment	0	8	43	51	0	0	5	5	56
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	0	0	0	0	0	0	0
onstocked or inadequately stocked:									
Planting	0	25	15	40	0	0	18	18	58
ll classes	34	266	210	510	8	44	136	188	698

/Field data were collected in 1971. Adjustments have been made to account for ownership changes since date of collection.

Table 65--Area of timberland in other private timber growers ownership by stand condition and treatment class, stockability and slope class, and biological potential (site class), Sacramento resource area, California[1/]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent — Biological potential (site class)				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent — Biological potential (site class)				Total
	High	Medium	Low	Total	High	Medium	Low	Total	
Conifer sawtimber with 5,000 or more board feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	0	4	0	4	0	0	4	4	8
Not stocked with understory conifers									
Regeneration cutting	0	23	13	36	5	4	13	22	58
High growth									
Commercial thinning or no treatment	5	33	27	65	0	0	13	13	78
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	10	9	19	0	0	0	0	19
With cull trees or hardwoods									
Improvement cutting	0	9	0	9	0	0	0	0	9
Poletimber or sawtimber hardwoods without understory conifers:									
Stand conversion	0	0	9	9	0	4	5	9	18
Conifer seedlings and saplings:									
Without overtopping brush or hardwoods									
Precommercial thinning or no treatment	0	0	0	0	0	0	10	10	10
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	4	4	0	0	0	0	4
Nonstocked or inadequately stocked:									
Planting	0	10	0	10	0	10	0	10	20
All classes	5	89	62	156	5	18	45	68	224

1/Field data were collected in 1971. Adjustments have been made to account for ownership changes since date of collection.

ble 66--Area of timberland in farmer and miscellaneous private ownership by stand condition and treatment class, stockability and slope ass, and biological potential (site class), Sacramento resource area, California[1/]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent — Biological potential (site class): High	Medium	Low	Total	Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent — Biological potential (site class): High	Medium	Low	Total	Total
nifer sawtimber with 5,000 or more board feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	9	0	34	43	0	0	6	6	49
Not stocked with understory conifers									
Regeneration cutting	10	57	13	80	0	10	20	30	110
High growth									
Commercial thinning or no treatment	5	74	95	174	0	14	60	74	248
letimber or young sawtimber conifers with less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	15	29	44	0	0	16	16	60
With cull trees or hardwoods									
Improvement cutting	0	9	0	9	0	0	15	15	24
letimber or sawtimber hardwoods without understory conifers:									
Stand conversion	0	28	16	44	0	5	20	25	69
nifer seedlings and saplings:									
Without overtopping brush or hardwoods									
Precommercial thinning or no treatment	0	9	0	9	0	0	31	31	40
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	12	12	0	0	7	7	19
stocked or inadequately stocked:									
Planting	0	58	59	117	0	6	57	63	180
classes	24	250	258	532	0	35	232	267	799

1/ ield data were collected in 1971. Adjustments have been made to account for ownership changes since date of collection.

Table 67--Area of timberland in forest industry ownership by stand condition and treatment class, stockability and slope class, and biological potential (site class), San Joaquin resource area, California[1/]

(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent — Biological potential (site class)				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent — Biological potential (site class)			
	High	Medium	Low	Total	High	Medium	Low	Total
Conifer sawtimber with 5,000 or more board feet per acre:								
Low growth								
Stocked with understory conifers								
Overstory removal	0	4	0	4	0	0	0	0
Not stocked with understory conifers								
Regeneration cutting	17	43	3	63	0	0	3	3
High growth								
Commercial thinning or no treatment	3	33	6	42	0	0	3	3
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:								
Without cull trees or hardwoods								
Precommercial thinning or no treatment	0	14	2	16	0	0	0	0
With cull trees or hardwoods								
Improvement cutting	0	0	1	1	0	3	1	4
Poletimber or sawtimber hardwoods without understory conifers:								
Stand conversion	3	0	0	3	0	3	0	3
Conifer seedlings and saplings:								
Without overtopping brush or hardwoods								
Precommercial thinning or no treatment	0	3	0	3	0	0	0	0
With overtopping brush or hardwoods								
Cleaning or releasing	0	0	0	0	0	0	0	0
Nonstocked or inadequately stocked:								
Planting	0	0	4	4	0	0	0	0
All classes	23	97	16	136	0	6	7	13

[1/]Field data were collected in 1972.

able 68--Area of timberland in other private timber groups ownership by stand condition and treatment class, stockability and slope lass, and biological potential (site class), San Joaquin resource area, California[1]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent				Total
	Biological potential (site class)				Biological potential (site class)				
	High	Medium	Low	Total	High	Medium	Low	Total	
onifer sawtimber with 5,000 or more board feet per acre:									
Low growth									
Stocked with understory conifers									
Overstory removal	0	0	0	0	0	0	0	0	0
Not stocked with understory conifers									
Regeneration cutting	3	6	0	9	0	3	0	3	12
High growth									
Commercial thinning or no treatment	0	0	6	6	0	0	0	0	6
letimber or young sawtimber conifers with less than 5,000 board feet per acre:									
Without cull trees or hardwoods									
Precommercial thinning or no treatment	0	0	0	0	0	0	0	0	0
With cull trees or hardwoods									
Improvement cutting	0	0	0	0	0	0	3	3	3
letimber or sawtimber hardwoods without understory conifers:									
Stand conversion	0	0	0	0	0	0	0	0	0
nifer seedlings and saplings:									
Without overtopping brush or hardwoods									
Precommercial thinning or no treatment	0	0	0	0	0	0	0	0	0
With overtopping brush or hardwoods									
Cleaning or releasing	0	0	0	0	0	0	0	0	0
nstocked or inadequately stocked:									
Planting	0	0	0	0	0	0	0	0	0
l classes	3	6	6	15	0	3	3	6	21

Field data were collected in 1972.

Table 69--Area of timberland in farmer and miscellaneous private ownership by stand condition and treatment class, stockability and slope class, and biological potential (site class), San Joaquin resource area, California[1]
(In thousand acres)

Stand condition and treatment class	Areas capable of supporting 60 percent or more of full-tree stocking on slopes 0 to 45 percent				Areas incapable of supporting 60 percent of full-tree stocking and/or slopes greater than 45 percent			
	Biological potential (site class)				Biological potential (site class)			
	High	Medium	Low	Total	High	Medium	Low	Total
Conifer sawtimber with 5,000 or more board feet per acre:								
Low growth								
Stocked with understory conifers								
Overstory removal	0	0	0	0	0	0	1	1
Not stocked with understory conifers								
Regeneration cutting	14	26	6	46	0	13	17	30
High growth								
Commercial thinning or no treatment	7	38	22	67	0	0	39	39
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:								
Without cull trees or hardwoods								
Precommercial thinning or no treatment	0	2	3	5	0	3	10	13
With cull trees or hardwoods								
Improvement cutting	0	3	3	6	0	0	3	3
Poletimber or sawtimber hardwoods without understory conifers:								
Stand conversion	0	7	0	7	0	5	12	17
Conifer seedlings and saplings:								
Without overtopping brush or hardwoods								
Precommercial thinning or no treatment	0	0	0	0	0	0	9	9
With overtopping brush or hardwoods								
Cleaning or releasing	0	5	0	5	0	0	4	4
Nonstocked or inadequately stocked:								
Planting	0	2	22	24	0	0	23	23
All classes	21	83	56	160	0	21	118	139

[1]Field data were collected in 1972.

'able 70--Confidence interval[1] for the estimates of timberland, noncommercial forest, ınd growing stock volume, California

Resource area	Total timberland	Total noncommercial forest[2]	Total growing stock volume
	- - - - - - - - - -	Percent	- - - - - - - - - -
Iorth coast:			
Del Norte County	±2.9	NA	±8.0
Humboldt County	±1.4	±17.0	±6.1
Mendocino and Sonoma Counties	±1.9	±4.3	±4.4
entral coast	±5.0	±1.6	±9.1
orthern interior	±1.1	±2.8	±1.9
acramento	±1.5	±4.0	±2.2
an Joaquin	±3.7	±1.8	±5.8

A = not available.

/By random sampling formula: 68-percent probability.

/Includes only the forest area outside parks and other reservations determined by ampling methods. Type-mapping procedures were used for most reservations.

Sources of Timber Resource Data

The basic timber resource data for National Forests were collected by the Intermountain, Pacific Southwest, and Pacific Northwest Regions of the U.S. Forest Service. A combination of type mapping, and aerial photo and ground sampling procedures were used to inventory National Forests. About 3,600 field plots were established on timberland.

Detailed procedures for most of the National Forest inventories have been published in resource area reports (Oswald 1968, 1972, 1979; Bolsinger 1976, 1978a; and Wall 1978). Additional details are available from the Regional Foresters' offices. The dates of inventory are:

Region	National Forest	Inventory date[1]
Intermountain	Toiyabe	1975
Pacific Southwest	Angeles	1975
	Cleveland	1975
	Eldorado	1974
	Inyo	1964
	Klamath	1967
	Lassen	1970
	Los Padres	1975
	Mendocino	1971
	Modoc	1970
	Plumas	1969
	San Bernardino	1975
	Sequoia	1958
	Shasta	1968
	Sierra	1975
	Six Rivers	1966
	Stanislaus	1972
	Tahoe	1972
	Trinity	1969
Pacific Northwest	Rogue River	1967
	Siskiyou	1968

[1] Total area and total volume for most National Forests were adjusted to account for major changes since inventory date. Detailed statistics were prorated.

Timber resource data for lands outside National Forests except those in southern California were collecte by the Renewable Resources Evaluation research uni of the U.S. Forest Service's Pacific Northwest Forest, and Range Experiment Station (PNW), Portland, Oregon. Detailed procedures have been published in resource area reports and are available from the PNW Station. A total of 21,112 aerial photo plots were examined and 1,752 ground plots established on timberland. Photo and field plots were used to develop area and volume estimates by double sampling for stratification estimators as described by Cochran (1963). Figure 76 shows area, number of plots, and date of inventory by resource area. About 39,000 aerial photo plots and 1,500 field plots were examined on unproductive forest land. For lands outside National Forests in southern California, the basic da collected for Forest Survey Release 25, (USDA Fore Service 1954) and the California Fish and Wildlife plan, (State of California, Department of Fish and Game 1966) were used along with records of timbe land and brushland conversions to approximate fore areas and timber volumes in 1975.

Data for the northern interior, Sacramento, and San Joaquin resource areas were accepted as of time of inventory, except for adjustments to account for majo ownership changes, and to break out the "other private timber growers" from the miscellaneous private For the north coast, revisions were made to account for Park expansion, cutting, growth on surviving (residual) trees, 5-inch d.b.h. and larger, and growth on trees estimated to have grown into the 5-inch or larger class since the inventories.

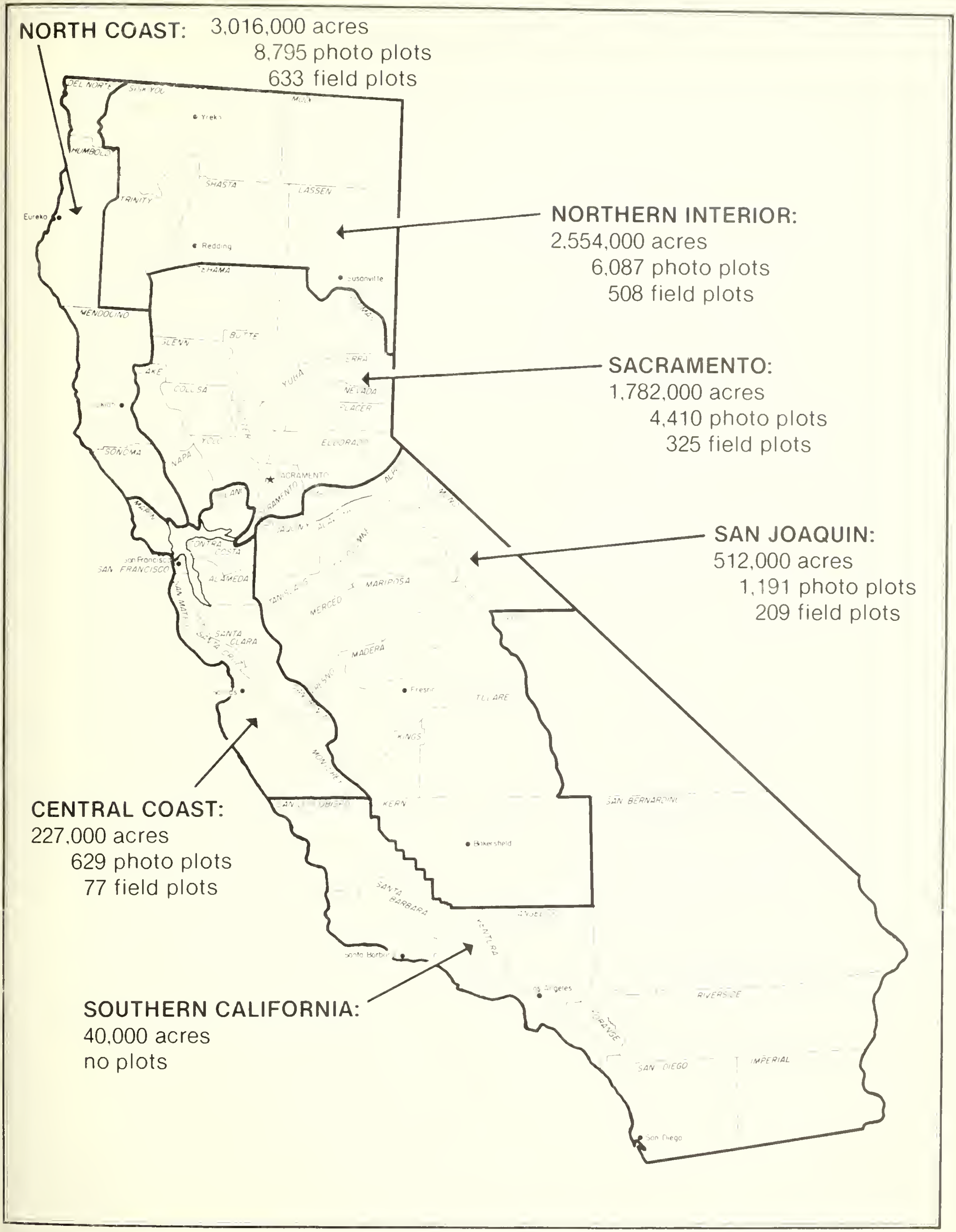


Figure 76. — Timberland area and number of field plots outside National Forests in California, by resource area.

Reliability of Timber Resource Data

The regional reports in which most of the timber resource data were originally published contain details on their reliability (see Bolsinger 1976, 1978a; Oswald 1968, 1972, 1979; Oswald and Walton 1966; Wall 1978). The confidence intervals of the area and volume estimates from these regional reports are shown in table 70.

Definition of Terms

Land Area

Total land area is that reported by the Bureau of the Census and includes dry land and land temporarily or partially covered by water (such as marshes, swamps, and river flood plains), streams, sloughs, and canals less than 1/8-mile wide, and lakes, reservoirs, and ponds less than 40 acres in area.

Forest land is at least 10 percent stocked by trees of any size or formerly had such tree cover, and is not currently developed for nonforest use. Minimum area of forest land recognized is 1 acre.

Nonforest land has never supported forests or was formerly forested and is currently developed for nonforest uses. Included are lands used for agricultural crops, improved pasture, residential areas, city parks, improved roads of any width and their right-of-way clearings, powerline clearings of any width, and 1- to 40-acre areas of water classified by the Bureau of the Census as land. If intermingled in forest areas, unimproved roads and other nonforest strips must be more than 120 feet wide, and clearings etc. more than 1 acre in size to qualify as nonforest land.

Forest Land Classes

Productive forest land is capable of producing 20 cubic feet per acre per year of industrial wood and is manageable for continuous timber crops.

Timberland is productive forest land not withdrawn for nontimber purposes.

Noncommercial forest land includes both productive-reserved and unproductive forest land.

Productive-reserved forest land is withdrawn from timber utilization through statute, ordinance, or administrative order but otherwise qualifies as timberland.

Productive-deferred forest land is designated for reserve status, but has not yet been dedicated.

Unproductive forest land is incapable of yielding crops of industrial wood products because of adverse site conditions such as sterile soil, poor drainage, high elevation, steepness, and rockiness.

Forest Types

Forest types are determined on the basis of species plurality of all live trees that contribute to stocking; both size and spacing are considered.

Tree Classes

GROWING STOCK

Sawtimber trees, poletimber trees, saplings, and seedlings; that is, all live trees except cull trees.

Sawtimber trees are growing stock trees 9.0-inch d.b.h. and larger (11.0 inches and larger for Scribner volume), live, and of commercial species. Softwood trees must contain at least one 12-foot saw log with a top diameter not less than 6 inches inside bark; hardwood trees must contain at least one 8-foot saw log with a top diameter not less than 8 inches inside bark. At least 25 percent of the board-foot volume in either a softwood or hardwood tree must be free of defect.

Poletimber trees are 5.0- to 8.9-inch d.b.h., live, and of commercial species, not less than 25 percent sound on a cubic-foot basis, and have no disease, defects, or deformities likely to prevent their becoming growing-stock sawtimber trees.

Seedling and sapling trees are less than 5.0-inch d.b.h., live, of commercial species, and have no disease, defects, or deformities likely to prevent their becoming growing-stock poletimber trees.

NONGROWING STOCK

Mortality trees are commercial species which have died from natural causes within a specified period and which were not cull trees at the time of death.

Salvable dead trees are standing or down, of commercial species, 11.0 inches or more in diameter; they contain 25 percent or more of sound volume and at least one merchantable 16-foot log for softwoods or one merchantable 8-foot log for hardwoods.

Cull trees are noncommercial species or live trees of commercial species 5.0-inch d.b.h. and larger with excessive defect and deformities, or if less than 5.0 inches, of such poor vigor they are not expected to grow to 5.0 inches.

Stand Size Classes

Sawtimber stands are at least 10 percent stocked with growing-stock trees, with half or more of this stocking in sawtimber and poletimber trees, and with sawtimber stocking equal to or greater than poletimber stocking. In large sawtimber stands, the majority of the sawtimber stocking is in trees 21.0-inch and larger at breast height. In small sawtimber stands, the majority of the sawtimber stocking is in softwood trees from 9.0- to 20.9-inch d.b.h. and hardwood trees 11.0- to 20.9-inch d.b.h.

Poletimber stands are at least 10 percent stocked with growing-stock trees, with half or more of this stocking in sawtimber and poletimber trees, and with poletimber stocking exceeding sawtimber stocking.

Sapling and seedling stands are at least 10 percent stocked with growing-stock trees, with more than half of this stocking in saplings, seedlings, or both.

Nonstocked areas of timberland are less than 10 percent stocked with growing-stock trees.

Timber Volume

LIVE SAWTIMBER

Net volume of live sawtimber trees of commercial species is measured in board feet. Net volume equals gross volume less deduction for rot, sweep, crook, and other defects that affect use for lumber.

Scribner rule is the common board-foot log rule used locally in determining volume of sawtimber. Scribner volume was computed on a 16-foot log basis to a California utilized top[2] for trees 11.0-inch d.b.h. and larger.

[2] Data for the utilization study are on file at the Pacific Southwest Forest and Range Experiment Station, Berkeley, California.

International 1/4-inch rule is the standard board-fo log rule adopted nationally by the Forest Service f the presentation of volume statistics. For calculati International 1/4-inch board-foot volume, the mi- mum diameter for softwood trees is 9.0-inch d.b.h the minimum log length is 12 feet with a small enc diameter of 7.0 inches outside bark. The minimu diameter for hardwoods is 11.0-inch d.b.h., with minimum log length of 8 feet and a small end dian eter of 9.0 inches outside bark.

GROWING STOCK

Net volume in cubic feet of live sawtimber trees a live poletimber trees from stump to a minimum 4- inch top (of central stem) outside bark. Net volun equals gross volume less deduction for rot and mis bole sections.

INDUSTRIAL WOOD

All roundwood products, except fuelwood.

NET ANNUAL GROWTH

The net increase in volume of trees during a speci year. Components of net annual growth includ (a) the increment in net volume of trees at the be ning of the specified year surviving to the year's e plus (b) the net volume of trees reaching the size during the year, minus (c) the net volume of tr that died during the year, minus (d) the net volu of trees that became culls during the year.

Biological Potential (Site Class)

The amount of wood measured in cubic feet that est land is capable of producing if fully stocked suitable trees and grown to the age of mean annu growth culmination (70 to 80 years for most spe on most sites). For all ownerships, estimated biol potential was based on tree height and age relatio ships and normal yield tables for natural even-a stands of single species. For lands outside Natic Forests, yield table values were further discount ockability limitations (see the following definition f stockability). Intensive forest management activies such as fertilization, genetic tree improvement, nd stocking control may result in yields that exceed ie biological potential of natural stands.

tockability

he ability of forest land to support trees. In this port, land that is incapable of supporting 60 percent many trees as shown in normal yield tables (Dahms)64; Dunning and Reineke 1933; Lindquist and alley 1963; McArdle et al. 1961; Schumacher 1926,)30) is considered difficult to manage. These areas e harsh, often rocky, and difficult to reforest. Stockbility was determined on each sample plot in Calirnia's interior using plant indicators, soil depth, and her physical factors as described by MacLean and olsinger (1973a and b, 1974).

otential Yield (National Forests Only)

ne maximum timber harvest planned for the next) years to achieve the optimum perpetual sustainedeld harvesting level attainable with intensive forestry n regulated areas. Potential yield is based on producvity of the land, conventional logging technology, andard cultural treatments, and interrelationships ith other resource uses and the environment. Conntional logging technology and standard cultural eatments include all applicable systems for intensive anagement whether or not they are currently ecoomical or in general use in the area. Excluded are e effects of intensive activities that remain specutive such as genetics, fertilization, and irrigation. or additional details, see Forest Service Manual JSDA Forest Service 1977a, section 2410, Timber anagement plans).

rogramed Allowable Harvest (lational Forests Only)

nat part of the potential yield scheduled for harvestg in a specific year. It is based on current demand, nding, silvicultural practices, and multiple use conlerations. Annually, a programed allowable harvest atement reflecting the expected level of financing d showing the scheduled mix of yield components.

Ownership Classes

National Forest lands are Federal lands which have been designated by Executive Order or statute as National Forests or purchase units and other lands under the administration of the Forest Service, including experimental areas and Bankhead-Jones Title III lands.

Other public lands are Federal lands other than National Forests, including lands administered by the Bureau of Land Management, Bureau of Indian Affairs, and miscellaneous Federal agencies, and lands owned by States, counties, and local public agencies, or lands leased by these governmental units for more than 50 years.

Forest Industry lands are owned by companies or individuals operating wood-using plants.

Other private timber growers' lands are lands owned by companies that manage forests for timber production but do not operate mills. Most of these companies belong to forest industry associations and are considered "timber industry" by the California Department of Forestry.

Farmer-owned lands are lands owned by operators of farms.

Miscellaneous private-corporate lands are owned by companies or corporations that do not operate woodusing plants. Included are corporate farms, some railroad lands, oil company lands, real estate and land-holding company lands, and lands held by banks, other financial institutions, and various other companies and corporations.

Miscellaneous private-noncorporate lands are privately owned lands other than forest industry, farmer-owned, or corporate lands.

Data and Criteria Used in Assessing Silvicultural Treatment Opportunities Outside National Forests

1. **5,000 board feet per acre** is an average minimum volume that most people feel could be recovered economically in most forest situations.

2. **Growth level.** Cubic-foot growth (periodic annual growth of desirable conifers) was chosen as a measure of stand performance to avoid assumptions about utilization associated with board-foot measures and also to account for growth on smaller trees. If a stand has 5,000 or more board feet of volume and is growing less than 0.6 times the mean annual increment at culmination age (0.6 MAI), it is assumed to be underutilizing the site. Fully-stocked stands of ponderosa pine or Douglas-fir will grow at a higher rate until they are about 90 to 100 years old. This is a reasonably long rotation period to produce the size of material being used in California. Shorter rotations will keep growth above 0.6 MAI provided stands are adequately stocked. Stands growing less than 0.6 MAI may be very old, young but poorly stocked (generally less than 35 percent stocked), made up of unproductive trees due to insect or disease infestations, logging damage, etc., or occupied primarily by hardwoods or other low-value trees.

3. **Basal area** per acre in low-volume stands is a measure of site occupied by all trees 5.0-inch d.b.h. and larger. The 50-square foot level corresponds roughly with the basal area of well-stocked stands of Douglas-fir, redwood, or ponderosa pine on mid sites that are at the threshold of the poletimber class.

4. **Stocking.** In the treatment analysis, stocking comes into play only if conifer volume is less than 5,000 board feet per acre.

Trees over 5.0-inch d.b.h. were tallied on a variable radius plot, and trees 6.0 inches high to 4.9 inches d.b.h. were tallied on a fixed radius plot (either 1/578-acre or 1/300-acre). In the north coast, stocking was based on a basal area standard determined from yield tables, using stand age and site index. For the interior, stocking was calculated individually for each tree as though it were in a stand with quadratic-mean diameter equal to its own diameter.

In the north coast, the stocking of trees smaller thar 5.0 inches was discounted back from 5.0 inches base on the yield table data when in stands of larger trees In seedling and sapling stands, one tree was consider to stock a point, or to equal 10-percent stocking. If both desirable conifer and weed trees were present, both were counted, unless the weed tree was smalle and overtopped by the desirable tree. Thus it is possible to have a stand 100-percent stocked with desirable conifers and 100-percent stocked with weed trees. The suggested treatment for such a stand wou be thinning and removing the weed trees.

5. Only softwood trees are considered desirable in terms of volume, growth, or stocking. With rare exception, most forest lands in California will produce considerably more wood and more dollar value in conifers than in hardwoods.

6. Nonstocked areas have 10 percent or less stockin or 9 or 10 points (1/300-acre plots) devoid of desiral conifers if seedling or sapling size. Inadequately stocked areas have 11- to 35-percent stocking, or 7 8 points devoid of desirable conifers if seedling or sapling size.

7. Medium- to well-stocked areas are at least 36 per cent stocked. In seedling and sapling stands, at least points must be stocked to qualify as medium stock (If three or more points are nonstocked in medium stocked stands, some kind of treatment is required.

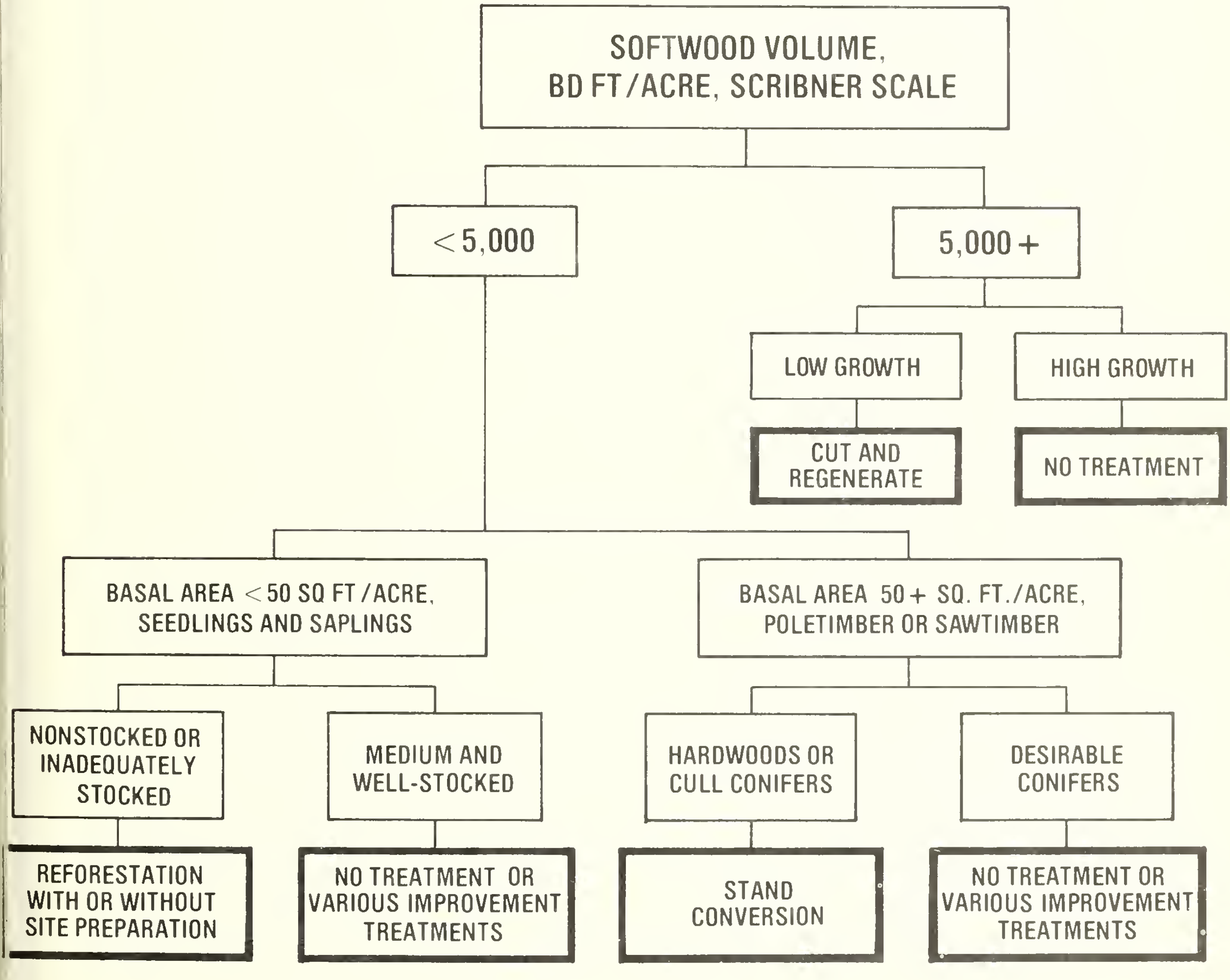
8. The data are shown by three site classes:

High – 165 cubic feet per acre per year and grea
Medium – 85 - 164 cubic feet per acre per year
Low – 20 - 84 cubic feet per acre per year

9. Other data used in the analysis:

Stockability percent
Percent inhibiting brush
Percent overstocked
Percent slope.

SILVICULTURAL TREATMENT OPPORTUNITY ASSESSMENT ANALYSIS
Flow Chart



Scientific and Common Names of Plants Mentioned in This Report[3]

Abies concolor (Gord. & Glend.) Lindl.	white fir
Abies grandis (Dougl.) Lindl.	grand fir
Abies magnifica A. Murr.	California red fir
Abies magnifica var. *shastensis* Lemm.	Shasta red fir
Acacia greggii Gray	catclaw acacia
Acer macrophyllum Pursh	bigleaf maple
Adenostoma fasciculatum H. & A.	chamise
Aesculus californica (Spach) Nutt.	California buckeye
Alnus rhombifolia Nutt.	white alder
Alnus rubra (Bong.)	red alder
Arbutus menziesii Pursh	Pacific madrone
Arctostaphylos spp.	manzanita
Artemisia spp. L.	sagebrush
Ceanothus spp. L.	ceanothus
Cercis occidentalis Torr.	California redbud
Cercocarpos spp. HBK	mountain-mahogany
Cupressus spp. L.	cypress
Fraxinus latifolia Benth.	Oregon ash
Juglans spp. L.	walnut
Juniperus spp. L.	juniper
Libocedrus decurrens Torr.	incense-cedar
Lithocarpus densiflorus (Hook. & Arn.) Rehd.	tanoak
Pinus attenuata Lemm.	knobcone pine
Pinus aristata Engelm.	bristlecone pine
Pinus balfouriana Grev. & Balf.	foxtail pine
Pinus contorta Dougl.	lodgepole pine
Pinus coulteri D. Don	Coulter pine
Pinus jeffreyi Grev. & Balf.	Jeffrey pine
Pinus lambertiana Dougl.	sugar pine
Pinus monticola Dougl.	western white pine
Pinus muricata D. Don	bishop pine
Pinus ponderosa Laws.	ponderosa pine
Pinus radiata D. Don	Monterey pine
Pinus sabiniana Dougl.	Digger pine
Platanus racemosa Nutt.	California sycamore
Populus fremontii S. Wats.	Fremont cottonwood
Populus tremuloides Michx.	quaking aspen
Populus trichocarpa Torr. & Gray	black cottonwood
Prosopis spp. L.	mesquite
Prunus emarginata Dougl.	bitter cherry
Pseudotsuga macrocarpa (Vasey) Mayr	bigcone Douglas-fir
Pseudotsuga menziesii (Mirb.) Franco	Douglas-fir
Quercus agrifolia Née	coast live oak
Quercus chrysolepis Liebm.	canyon live oak
Quercus douglasii Hook. & Arn.	blue oak
Quercus garryana Dougl. var. *breweri* Jeps	Oregon white oak

[3] The source for most tree names is Little (1953); for other plants the source is Munz and Keck (1970). Griffin and Critchfield (1972) are authorities on tree distribution within California.

Scientific and Common Names of Plants Mentioned in This Report--Continued

Quercus kelloggii Newb.	California black oak
Quercus lobata Née	California white oak
Quercus wislizenii A. DC.	interior live oak
Salix L. spp.	willow
Sequoia sempervirens (D. Don) Endl.	redwood, coastal redwood
Sequoiadendron giganteum (Lindl.) Buchholz	giant sequoia, Sierra redwood
Tsuga mertensiana (Bong.) Carr.	mountain hemlock
Umbellularia californica (Hook. & Arn.) Nutt.	California-laurel

Metric Conversions

1,000 acres	=	404.69 hectares
1,000 cubic feet	=	28.3 cubic meters
1 cubic foot per acre	=	0.0700 cubic meter per hectare
1 square foot basal area per acre	=	0.2296 square meter per hectare
1 foot	=	30.48 centimeters
1 inch	=	2.540 centimeters

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Resources-Oriented Outline of California's History--Continued

30-40 Hoover Dam and San Francisco's Hetch-Hetchy water development built.

25 reservoirs were built with 10,000 acre-feet capacity.

Devastating forest fires; extensive damage to resources and property.

Bankhead-Jones Farm Tenant Act of 1937 provided for purchase of lands to protect, improve, and develop natural resources.

40 Population in California reached 7 million.

41-45 World War II goaded the economy.

Massive shift of wealth and people to southern California.

State's funds for forest fire protection increased and a fire plan was developed which improved fire control.

Smog damage to pines in southern California first reported; cause was unknown at the time.

Lumber produced by 330 sawmills totaled 2.3 billion board feet.

45 Timber harvest approached 3 billion board feet, mostly from private lands.

California Forest Practices Act. Two premises central to this Act (1) promoted continuous production of forest products from private lands, and (2) entrusted regulation as much as possible to the forest industry.

47 Plywood boom began. First plants of the period were California Veneer Co., at Klamath, and Humboldt Plywood Corp., at Arcata. This opened a market for California Douglas-fir, which had been used very little previously.

48 California's first major pulpmill built – Fibreboard Products at East Antioch.

Lumber produced by 984 sawmills totaled 3.97 billion board feet.

49 Lake Shasta built, California's largest manmade lake, with 4.5 million acre-feet capacity.

50 Population of California reached 12 million, a 71-percent increase since 1940.

Lumber production topped 4 billion board feet.

Plywood production reached 300 million square feet.

From 1950 to mid-1960s, hardboard and particle plants were built; four large pulpmills were also built.

55 Total timber harvest peaked at 6 billion board feet, 85 to 90 percent from private lands. Much of the increase since 1945 was in the north coast.

57 Smog confirmed as cause of pine decline in southern California.

59 Lumber production peaked at nearly 6 million board feet.

60 Population in California reached 16 million.

Irrigated croplands totaled 8 million acres.

Multiple-Use Sustained Yield Act directed National Forest management.

60-61 Numerous forest fires occurred.

62 Columbus Day windstorm in northern part of State damaged forests extensively.

63 State legislation tightened forest fire laws and amended 1945 Forest Practices Act to obtain greater compliance.

64 Heavy rains in the north coast following large-scale logging and roadbuilding resulted in extensive erosion, flooding and stream sedimentation.

National Wilderness Act passed.

Plywood production peaked at 1.3 billion square feet.

Lumber production reached 5 billion board feet.

64-65 Tussock moth infestation, worst recorded in history of California.

68 Redwood National Park, the Nation's 34th National Park, was dedicated.

69 Smog damage in southern California spread to three-county area.

National Environmental Policy Act passed.

70 California Environmental Quality Act passed.

71 California Forest Practices Act declared invalid on grounds that the Board of Forestry was industry-dominated.

73 Z'Berg-Nejedly Forest Practice Act passed, setting forth standards aimed at maintaining forest productivity. A new Board of Forestry was appointed.

Budworm outbreak in northern California – worst recorded epidemic of a forest defoliator.

74 Smog damage spread northward to several National Forests and Sequoia and Kings Canyon National Parks.

75 Provisions of Forest Practice Act declared subject to requirements of California Environmental Quality Act in January 1975. A year-long battle between timber interests and environmentalists followed. Better rules and more workable guidelines resulted.

75-77 Severe drought, combined with insect and disease epidemics, killed millions of trees.

76 Z'Berg-Warren-Keene-Collier Forest Taxation Act designed to discourage premature timber cutting and to encourage landowners to keep land in forestry use.

77 California Forest Resource Assessment and Policy Act directed the Department of Forestry to assess and analyze the State's forest resources as basis for formulating forest policy.

United States
Department of
Agriculture

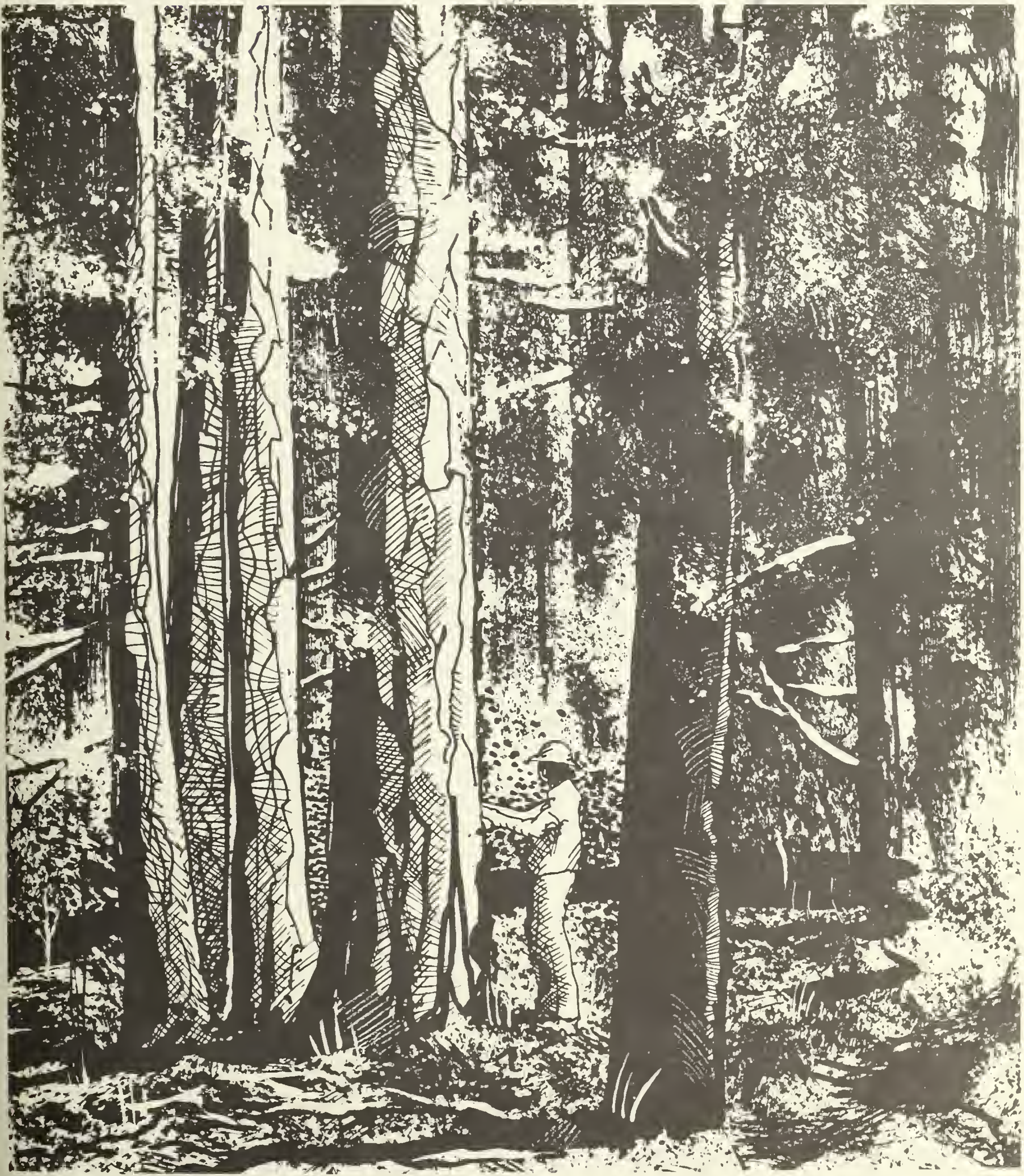
Pacific Northwest
Forest and Range
Experiment Station

Resource Bulletin
PNW-89

August
1980

California Forests: Trends, Problems, and Opportunities

Charles L. Bolsinger



Resources-Oriented Outline of California's History

1542	California discovered by Cabrillo.
1579	Sir Francis Drake landed; he recorded the site as lat. 36° N.
1769-1823	Pueblos, presidios, and missions constructed. The Spanish influence preserved in place names, people and cultures, highway routes, and in the annual grasses and forbs introduced by the Spanish which replaced much of the native vegetation on foothills and in valleys.
1812	Russian colony established at Fort Ross.
1826	Jedediah Smith, Peter Skene Ogden, and other fur-seekers came to California.
1839	John Sutter established his colony, New Helvetia, on the Sacramento River.
1842	First water-powered sawmill constructed – Santa Cruz.
1846-48	Mexican War. California came under U.S. ownership on February 2, 1848.
1848	Gold discovered at Coloma.
1848-52	Gold rush. Population in California increased by a factor of 17 from 15,000 to 250,000. Extensive timber cutting and burning in the foothills of the Sierra Nevada. Annual sheep and cattle drive from the valleys to mountain summer ranges began. Cities of Stockton, Sacramento, and San Francisco were developed. California gained Statehood in 1850. Crude water development for mining and irrigation and first recorded reservoir construction Emery Lake, Upper Lake, and White Rock Lake.
1849	California lumber production first reported 10 mills produced 5 million board feet.
1851-69	Numerous reservoirs built, including French Lake, the first with a capacity of 10,000 acre-feet.
1859	Lumber produced by 279 sawmills totaled 196 million board feet.
1860	Severe drought. Irrigation began in valleys; agriculture began to diversify. Livestock relocated to foothill and mountain ranges where the increasing numbers of animals began to deplete the grazing resources.
1861	Yosemite Valley and Mariposa Grove of big trees granted to the State of California by Congress.
1869	Railroad connected California with Eastern United States. Lumber produced by 251 sawmills totaled 354 million board feet.
1870-1900	In three decades the Nation experienced two major and five minor economic contractions. Over 70 reservoirs built in California, 11 with a capacity of 10,000 acre-feet or more. Irrigated agriculture expanded. Large investments made in southern California citrus industry. Real estate boom began in southern California. Range wars. Much of the grazing land was badly deteriorated by 1890. Sequoia National Park established in 1890, and the 4-square mile area surrounding General Grant tree established as "General Grant National Park." Forest Reserves authorized by Creative Act of 1891 and held by Department of the Interior. These reserves included much of the mountain rangelands, thus controlled grazing began. Organic Administration Act of 1897 provided that Forest Reserves be managed to protect forests, to yield water, and to furnish timber to U.S. citizens.
1904	Lumber produced by 247 sawmills totaled 1.1 billion board feet. California ranked 13th in U.S. lumber production.
1905	U.S. Forest Service established; Forest Reserves transferred to Department of Agriculture.
1906	San Francisco earthquake and fire.
1913	Los Angeles aqueduct built from Owens Valley, a distance of 238 miles.
1900-29	Over 300 reservoirs built, including 60 with a capacity of 10,000 acre-feet or more.
1920	Population in California approached 4 million.
1923-29	About 170 sawmills produced 2 billion board feet of lumber per year. California ranked sixth in U.S. lumber production.
1924	Clarke-McNary Act provided for cooperative forest management and protection on State and private lands.
1930	Irrigated cropland in California totaled 4 million acres.
1930-40	Great Depression curtailed development. Dust bowl immigrants arrived. Lumber production dropped to between 700 and 900 million board feet per year from 140-150 mills; yet California became 3d ranking lumber producer in U.S.

California Forests: Trends, Problems, and Opportunities

Reference Abstract

Bolsinger, Charles L.

1980. California forests: trends, problems, and opportunities. USDA For. Serv. Resource Bull. PNW-89, 138 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

The most recent information on forest area in California, volume of timber, ownership of forest resources, and rate of use and replenishment is summarized. An analysis of physical opportunities to increase timber production is presented, along with a discussion of problems relating to timber production. Also included are detailed statistical tables; a brief historical sketch of California forestry; a profile of the State's forest industry; a discussion of past, present, and future timber harvest; and a brief summary of nontimber forest resources.

Keywords: Timber resources, resources (forest), forest products industries, statistics (forest), California.

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Research Summary

RESOURCE BULLETIN PNW-89
1980

California ranks second in the United States in total forest area. Its 40 million acres of forest, including chaparral, oak woodlands, pinyon-juniper, and vast areas of pine, fir, and redwood occupy 40 percent of the State. Included in these forests are the world's most massive tree, the tallest tree, and the oldest known living tree.

Demand for forest resources – both products and amenities – has increased markedly during recent years, yet the area of California forests has decreased and will continue to decrease in the future as forest land is converted to nonforest use.

Timberlands occupy 16.3 million acres, over half of which is National Forest or other public land. Productive forests in parks, Wilderness Areas or deferred areas being studied for inclusion in Park or Wilderness systems amount to 1.6 million acres. National Forest and National Park systems each contain about 750,000 acres of these productive reserved and deferred forests; the balance is in State, county, and municipal parks, and a small amount of private land purchased by The Nature Conservancy. Unproductive forests, those incapable of producing 20 cubic feet of wood per acre per year, occupy 22.2 million acres. About 6.2 million acres are in National Forests or Parks. The remaining 16 million acres include large areas in private ownership and land administered by the State, Bureau of Land Management, military establishments, and other government agencies.

More than three-fifths of the softwood sawtimber volume is on public lands. Since 1953, softwood volume has declined 30 percent, mostly because of logging. Volumes of redwood and Douglas-fir declined the greatest amount. Sawtimber volume on private lands declined 44 percent compared with 12 percent on National Forest lands.

California contains some of the most productive forest land in the world. The State has only 3 percent of the Nation's timberland, yet 13 percent of the area is capable of growing 120 or more cubic feet per acre per year. Despite the high, innate productivity of California forests, current yields are less than half the land's potential. At least 5 million acres are non-stocked, inadequately stocked, or are occupied by commercially undesirable trees. If the 1.2 million acres classified as productive land were converted to conifer stands now, in 70 years there would be a prospective increase in mean annual yield of 700 million board feet. This amount represents 15 percent of the recent total annual timber harvest in California.

Forest losses to insects, disease, fire, weather, and other damaging agents continue to plague forest managers. If intensive forestry investments are to pay off, integrated pest management, continuing research, and better fire control measures are needed.

The intensity of forest management has increased dramatically in recent years. For example, timber companies were planting and seeding about 7,000 acres per year in the early 1960's. They planted and seeded 24,000 acres in 1976 and 37,000 acres in 1977. These investments will increase future yields of timber, but the benefits will not be realized until well after the year 2000. Before then, timber shortages are likely, especially in the northern part of the State. Supply problems are already evident, indicated by the steady decline in private timber harvest in the face of rising real prices of forest products.

For all ownerships the total timber harvest in California in recent years has been 4.3-4.9 billion board feet, compared with a high of about 6 billion board feet in the early 1950's. Timber harvest in the National Forests increased for many years while timber harvest in private ownership declined. Recently harvests in National Forests have more or less stabilized.

Forest industries employ from 85,000 to 90,000 persons in California, about 55,000 of whom are dependent on California-grown timber for jobs. Although these forest industries account for a small part of total employment, they are extremely important to many communities, especially in the northern part of the State and in the Sierra Nevada Mountains. Forest industry employment has declined in several counties and can be expected to decline even more in some areas as timber becomes scarce and as forest lands are converted or dedicated to nontimber use.

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Introduction

California is the third largest State in the United States, with 156,328 square miles of land. It ranks first in population with 21.5 million people, and first in the value of its agricultural produce, retail trade, and aerospace industry. The population and economy of California continue to expand as indicated by the 220,000 new houses authorized in 1976, 17 percent of the Nation's total (U.S. Department of Commerce 1977; State of California, Documents Section 1973-76).

In sharp contrast to California's teeming cities and economy are its vast wildlands — forests, brushlands, grasslands, deserts, marshes, and rocky barrens — covering about 132,000 square miles, or 85 percent of the total land area. Nearly 63,000 square miles are forest, 40 percent of the State. Alaska is the only State with a greater area of forest.

California forests include the world's oldest known tree (bristlecone pine),[1] the world's most massive tree (giant sequoia), the world's tallest tree (coast redwood), the world's tallest pine (sugar pine), and the world's heaviest pine cone (Coulter pine) (Harlow and Harrar 1958). Some of the most productive forest land in the world is found in the coastal redwood belt of California, where the greatest accumulations of biomass ever reported have been measured (Franklin and Dyrness 1973).

More important to forest resource managers is the extreme variability in the productivity and composition of California forests. Within San Bernardino County, for example, are forests as diverse as those found over large areas of the United States. Among the native trees in the county are palm, acacia, mesquite, oaks, laurel, ash, sycamore, walnut, aspen, maple, juniper, ponderosa pine, lodgepole pine, cedar, and white fir.

Failure to recognize diversity has led to problems. In northern California, for example, blanket treatment of extensive areas containing various conditions — level land; steep, erodable land; harsh, rocky soils; and hot south-facing slopes — has sometimes resulted in inadequately stocked land, invasion by undesirable trees, adverse effect on several resources, and deterioration of forest productivity. On the positive side, the diversity of California forests offers a wide range of opportunities for supplying various human needs.

Forest products from California are used throughout the Nation and the world. California forests contribute modestly to the State's economy and substantially to the economy of several counties (State of California, Employment Development Department 1960-75).

As populations grow and national and world demand for all resources increases, forests will be expected to furnish a greater supply of commodities and amenities. Planning will be necessary if demands are to be met, and planning requires information. In recognition of this, the California State Legislature enacted the Forest Resources Assessment and Policy Act of 1977, Assembly Bill No. 452, signed by the Governor on September 30, 1977 (State of California 1977). The Legislature found and declared, in part: "Better use of forest resources can result where there is good information as to anticipated needs and constraints and the potentials for meeting such needs. . . ."

The information in this report was gathered by the Renewable Resources Evaluation Research Unit at the Pacific Northwest Forest and Range Experiment Station (figs. 1 and 2). Renewable Resources Evaluation (formerly called Forest Survey) is a nationwide project, authorized by the McSweeney-McNary Forest Research Act of 1928 and subsequent amendments, and the Renewable Resources Planning Act of 1974. Included in this report are recent estimates of forest area and timber volume, growth, and mortality in California. It is presented for the use of policymakers, legislators, and others who need to make decisions now, as California's new forest law is being implemented. This report should also be useful to public and private forest managers, timber users, educators, and others concerned with forest resources.

Some of the information in this report has been published in regional timber resource reports (Bolsinger 1976 and 1978a; Oswald 1968, 1972, and 1979; Oswald and Walton 1966; Wall 1978). New information includes: recent inventory data for several National Forests; revised data to account for ownership changes, and the creation and expansion of parks and other reservations; updated statistics for the north coast resource area (see fig. 3); an analysis of silvicultural opportunities to increase timber production; and data from various sources on forest industry consumption, employment, forestation, and other forest-related activities.

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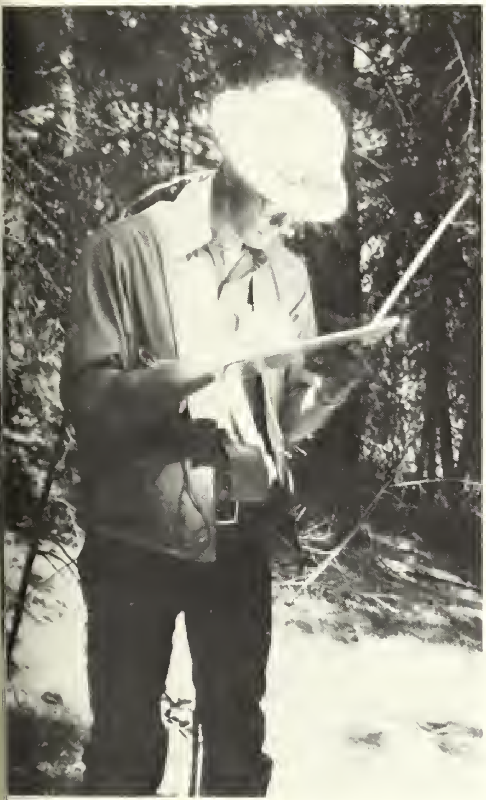
[1] See appendix, page 136, for scientific names of plants.

Figure 1. – Training forest resource inventory crev at Weaverville, California.

Detailed data are shown by ownership, and by geographic area. Area of timberland,[2] timber volume, and growth are shown by National Forest (fig. 4), a by resource area for lands outside National Forests. Area and volume for lands outside National Forests are also shown by county (see tables in the appendi .

[2] The term "timberland" is synonymous with "com mercial forest land" in previous Forest Service repo s on the timber resource. See definition, page 131.



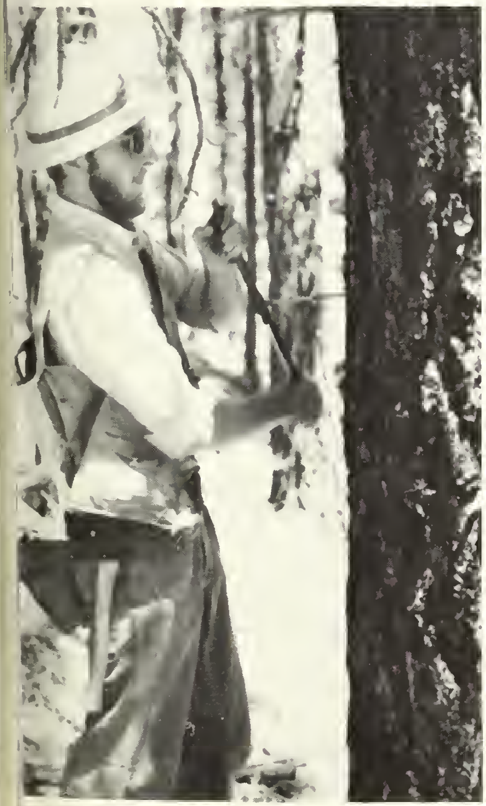


Figure 2. – Forest Service field crews established about 5,400 permanent plots and gathered information on over 225,000 trees in California forests.

Figure 3. – Resource areas in California.

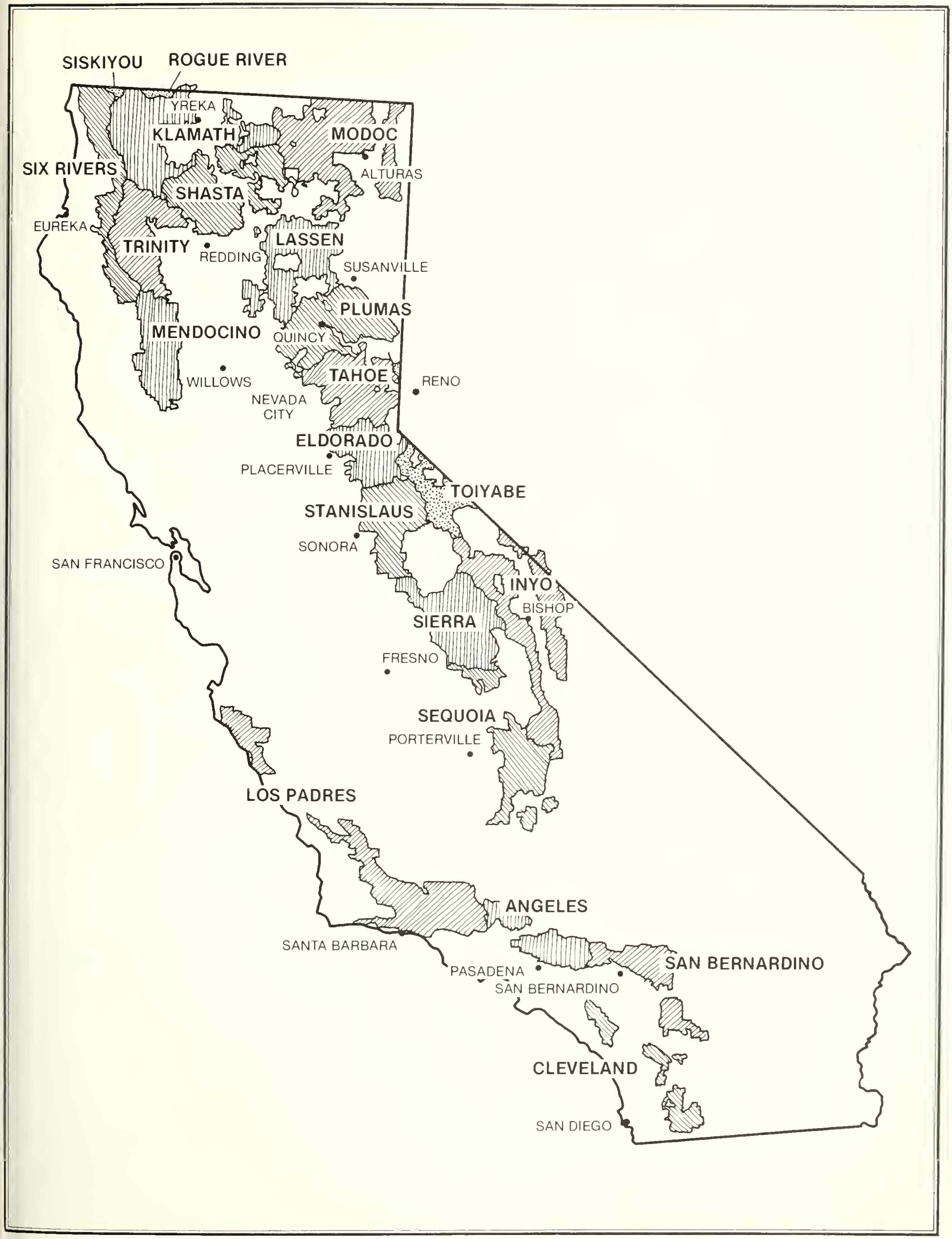


Figure 4. – National Forests in California.

Renewable, Forest-Related Resources of California in Brief

Water

"Water development has done more to enhance the economy . . . of California than any of man's activities."[3] In 1970, the fresh water consumption in California amounted to 25 percent of the Nation's total (U.S. Department of Commerce 1977). About 85 percent of all developed water used in 1974 was for agriculture. California agriculture ranks 1st in the Nation in value of products sold, though acreage in farms ranks only 11th (U.S. Department of Commerce 1972-77). Over two-thirds of all California cropland and 90 percent of harvested cropland is irrigated (State of California, Department of Water Resources 1974).

About 85 percent of the water currently used in California originates in the forests and rangelands of the State. Of the total runoff, 70 percent comes from timberland in areas remote from the place of use (fig. 5).

All land management activities have some effect on water quality and quantity (State of California Legislature, Assembly Committee on California Natural Resources, Planning and Public Works 1967). Though water quality is critical in some areas, such as the anadromous fish streams of the north coast (Citizens Advisory Committee on Salmon and Steelhead Trout 1975), the most crucial problem in the future will be the availability of water, which may be the limiting factor affecting the State's growth and may dictate the direction of other resource uses. Projections show demand in 2020 to exceed supplies from known and prospective sources (State of California, Department of Water Resources 1974).

Additional water supplies will be difficult to obtain because of the scarcity of sites, prior appropriation of water, and conflict with various other resource uses (Coppock 1974). Studies are underway or are planned to determine how to improve quantity and timing of water yields through vegetation management while also enhancing other resource values.

Figure 5. – Most of California's water originates in t forested mountains. Upper Yuba River, Sierra Count

Outdoor Recreation

In 1970, about 19 percent of the Nation's outdoor recreation took place in California.[4] National Fores in California represent 9 percent of the total area in the United States in National Forests, yet in 1972 th bore 25 percent of the total visitor use. Recreationa pursuits include camping (27 percent), recreational vehicle use (23 percent), hunting and fishing (16 pe cent), picnicking (4 percent), winter sports (4 percen recreational residence use (4 percent), and others.

[3] John R. Teerink, in foreword to the California Water Plan (State of California, Department of Water Resources 1974).

[4] U.S. Department of Commerce 1972-77, and unpu lished data from California Department of Parks an Recreation.

Use of off-road vehicles (ORV) has increased dramat-ically since the mid-1950's. In 1973, ORV visitor-days on lands administered by the Bureau of Land Management approached 12 million (U.S. Department of the Interior, Bureau of Land Management 1974). An estimated 1.5 million motorcycles, dune buggies, snow-mobiles, and four-wheel drive vehicles were in use in California in 1973 (State of California, Department of Parks and Recreation 1975).

The National Parks and Monuments in California attract many people. Although these parks represent about 16 percent of the total in the Nation in terms of area, they carry over 20 percent of the use (U.S. Department of Commerce 1972-77).

Demand for outdoor recreation in California has been projected to increase from 2.9 billion participation-days in 1970 to 5 billion in 1990 (fig. 6) (State of California, Department of Parks and Recreation 1974).

Fish and Wildlife

California's diverse climate, vegetation, and topography support a variety of fish and wildlife, including species found nowhere else (State of California, Department of Fish and Game 1966).

The total revenue from the fishing and hunting licenses sold in California in 1975 was $22.4 million, 8 percent of the total in the Nation (U.S. Department of Commerce 1972-77). California issued 2.3 million fishing licenses (fig. 7), over twice the number issued by all other States except Michigan, Minnesota, Texas, and Wisconsin.

Nonconsumptive uses of California's fish and wildlife, such as bird-watching and photography, are extensive and are increasing.

The most pressing problems regarding fish and wildlife in California are related to habitat. The riparian habitat type, the most important in terms of numbers of species that depend on it, is the most threatened. Already reduced greatly from its original acreage, it faces further reduction of 15 percent in the next 10 years, primarily by water development. Other critical habitats include certain wintering areas, wetlands, and special areas supporting rare and endangered species (State of California, Department of Fish and Game 1974). Other problems include streamflow levels too low to support fish, water quality degradation, and poor public access to fishing and hunting areas.

A

B

Figure 6. — What effect will the projected increase in outdoor recreation have on timber and other forest resources? A, John Muir Wilderness; B, Sand Flat Campground, Eldorado National Forest.

A

B

Figure 7. – Most California fishermen pursue their sport in crowds: A, Upper Kings River; B, Lower Kings Rive

Range

Demand for livestock grazing on rangelands of the United States is projected to increase considerably by 2020 (USDA Forest Service 1975b). The growing demand for food worldwide has been diverting grain away from livestock feeding yards and also has caused the conversion of some of the better rangelands to crop lands. In some areas housing development has also usurped rangeland grazing. A smaller area of range will be expected to support more animals in the future.

In 1977, California farms and ranches supported 4.8 million cattle and 1 million sheep, placing the State seventh in the United States in cattle production and third in sheep production (U.S. Department of Commerce 1972-77). About 83 percent of all cattle in the State are beef stock and 65 percent of these graze largely on nonirrigated range. The total forest-range area in California is 66.7 million acres (USDA Forest Service 1972). Some of the better grazing lands in the San Joaquin and Sacramento Valleys and benches are being converted to cropland, but an extensive area of chaparral is amenable to development for grazing use (State of California, Division of Forestry 1961-74).

An assessment of rangelands under the jurisdiction of the Bureau of Land Management (BLM) in the We showed that the 10 million acres in the California region (which includes a small piece of Nevada) are in somewhat poorer condition than the average for the West (U.S. Department of the Interior, Bureau o Land Management 1975).

A goal of the BLM is to reverse the trend of deteriorating range conditions through a comprehensive pro gram of management. The proposed program could increase the productivity of the California region fro the existing 463,000 animal unit months[5] to 691,00

National Forests are important locally in supplying grazing area to ranchers (fig. 8). Currently the Fores Service is involved in land use planning which incorporates livestock grazing as one of many uses of lan

The situation on private lands, which comprise 65 percent of the natural range in California, is not so well known, and the future there is less predictable (Reed 1974).

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[5] An animal unit month is the amount of feed necessary to maintain 1 mature cow or 5 sheep for 30 da

Figure 8. – Cattle drive at Kirkwood Meadows, Eldorado National Forest. Forests in California are important as summer livestock range.

Figure 9. – Current timber yields in California forests are about half of the land's potential, because of the condition of many stands.

Timber

In the face of rising demand for forest products (USDA Forest Service 1975a), California's output has declined and is expected to decline over the next 20 years. Much of the accessible old-growth timber on private lands has been harvested. Though reforestation has generally kept pace with logging in recent years, extensive areas that were logged in the past, or burned, are inadequately stocked with desirable trees. A large proportion of the adequately stocked young stands will not be of harvestable size for 10-40 years. Over 200,000 acres of this young-growth timber in private ownership are being developed for nontimber uses. Much of the timber volume and growth on these lands will not be available for industrial use.

Most of the remaining old-growth timber is in National Forests. Less volume is available for harvesting than forest industries would like. These public lands are managed for many purposes and therefore yield less timber than would be available if timber production were the only objective. National Forests contain over 60 percent of the softwood volume, but large areas in the mountains are on harsh sites that are judged unable to produce continuous timber crops. Forest Service policy is to log only where timber yields can be sustained. Land use planning, litigation, and limited funds have caused short-term delays in preparing timber sales on National Forests; these delays compound the timber supply problem.

Current yields on all ownerships are only half of the land's potential (fig. 9) because of the condition of many stands. These areas amount to over 5 million acres. They hold the potential for increasing the State's timber yields. To capitalize on these opportunities investments in forestry practices are needed. Research is also needed to cope with the many problems that come between the manager and his goal of capturing the land's potential.

Recent legislation related to forestry practices on private lands (State of California 1974, 1976, 1977), and intensified efforts in timber management by public agencies and private timber companies are reasons to expect some improvement in the outlook for California's timber supply.

Much of the material in this report deals with timber resource problems and opportunities for increasing future timber supplies from California timberland.

Forest Area

Ownership

Total land area in California is about 100 million acres, of which 40 million acres are forest (see table 1). Productive forest land capable of growing 20 cubic feet of industrial wood per acre per year (see definitions, page 131) amounts to 17.9 million acres. About 8 percent of the productive forest land is in parks, Wilderness Areas, and other reserves; 1 percent is National Forest land being studied for possible Wilderness classification, and 91 percent is classified as timberland. About 1 million acres of the timberland are in roadless areas of the National Forests being studied by the USDA Forest Service under the second Roadless Area Review and Evaluation program (RARE II). This is 17 percent of the 6.2 million acres, including nonforest and unproductive forest land, designated for study. About 770,000 acres, or 12 percent of the total, have been recommended for Wilderness classification as of January 1979, including 226,000 acres of productive forest.

Timberland ownership is shown below:

Ownership[6]	Thousand acres	Percent
Public:		
National Forest	8,168	50.1
Bureau of Land Management	239	1.4
Other Federal	40	0.2
State	79	.5
County and municipal	27	.2
Indian	114	.7
Total public	8,667	53.1
Private:		
Forest industry	2,688	16.5
Other private timber growers	1,348	8.3
Farmer	1,646	10.1
Miscellaneous private	1,950	12.0
Total private	7,632	46.9
All ownerships	16,299	100.0

[6] See definitions, page 133.

Productive-reserved and deferred[7] forest ownership is shown in the following tabulation:

Ownership	Thousand acres	Percent
National Forest:		
Reserved	479	29.1
Deferred	268	16.3
National Parks	747	45.4
State parks	125	7.6
County and municipal[8]	23	1.4
Private[9]	3	0.2
Total	1,645	100.0

Unproductive forest area by ownership group inside and outside reservations is shown below:

Ownership	Thousand acres	Percent
National Forest:		
Wilderness and other reservations	742	3.3
Outside reservations	4,824	21.7
National and State parks and other reservations	659	3.0
Private and other public outside reservations	15,991	72.0
Total	22,216	100.0

[7] Productive-reserved forest land is withdrawn from timber utilization through statute, ordinance, or administrative order. Productive-deferred forest land is designated for reserved status but has not yet been dedicated.

[8] Includes parks and certain watersheds where timber cutting is prohibited.

[9] The Nature Conservancy lands at the time ownershi was determined.

Table 1--Land area by use or major vegetation type, California, 1975

Land use or vegetation type[1]	Thousand acres	Percent
Forest:		
Productive forest	17,944	17.9
Unproductive forest	22,216	22.2
Total forest	40,160	40.1
Non-forest:		
Coastal sagebrush	2,300	2.3
Inland sagebrush	3,800	3.8
Desert	23,900	23.9
Grassland	12,000	12.0
Riparian, marsh, tidelands	700	0.7
Barren	1,800	1.8
Agriculture	11,000	11.0
Urban, industrial, roads, and other	4,390	4.4
Total non-forest	59,890	59.9
All types	[2]100,050	100.0

[1] Sources:
a. Aerial photo and ground classification data collected by the Pacific Northwest orest and Range Experiment Station at Portland, and the Intermountain, Pacific outhwest, and Pacific Northwest Regions of the U.S. Forest Service, 1966-75, on file n the various offices.
b. Wieslander and Jensen (1946), and their basic data.
c. U.S. Forest Service, Pacific Southwest Region, Area Guides (1975b, 1976a, 1976b).
d. State of California Department of Fish and Game (1966)(includes wildlife habitat ata and projections).
e. State of California, Division of Forestry (1961-74).
f. Cross-checking was done for different portions of the State using information from ureau of Land Management, National Park Service, Bureau of Indian Affairs, Soil onservation Service, Southern California Association of Governments, and other ganizations.

[2] Source: United States Bureau of the Census. 1971. Land and water areas of the nited States. Revised to account for new water areas reported by the California epartment of Water Resources.

Trends in Forest Area

Forest area statistics were published for 1953 in Forest Statistics for California (USDA Forest Service 1954). The inventory procedures used for the current inventory differ from those used in 1953, but a comparison of the estimates gives a fair picture of land class changes:

Land class	1953	1975	Difference	
	Thousand acres			Percent
Timberland	17,317	16,299	-1,018	-5.9
Productive reserved	1,202	1,377	+175	+14.6
Deferred		268	+268	--
Unproductive	24,022	22,216	-1,806	+7.5
Total	42,541	40,160	-2,381	+5.6

The differences in timberland area by ownership class between the 1953 and current inventories are shown below:

Ownership Class	1953	1975	Difference	
	Thousand acres			Percent
Public:				
National Forest	8,573	8,168	405	-4.7
Bureau of Land Management	324	329	85	-26.2
Other Federal	40	40	0	0
Indian	133	114	19	14.3
State	186	79	107	-57.5
County and municipal	8	27	+19	+237.5
Total public	9,264	8,667	597	-6.4
Private:				
Farmer	1,586	1,646	+60	+3.8
Industrial and other	6,467	5,986	481	7.4
Total private	8,053	7,632	+421	-5.2
All ownerships	17,317	16,299	1,018	5.9

Much of the decrease in timberland area was caused by land clearing, refinement in site classification, an Park and Wilderness expansion as shown in the tabu- tion on page 13. Considerable shifting in ownershi has occurred, complicating the picture. The Bureau of Land Management sold many parcels of public domain land until the mid-1960's. The State of Cali fornia sold many parcels of State Land Board lands. Forest industries have steadily acquired land from various ownerships. The miscellaneous private owne ship has decreased through sales, development, and subdivisions.

Figure 10 shows the trends in forest area from 1953 to 1975. The greatest change was in unproductive fore, which declined by 7½ percent. Reported clearings of chaparral and oak (fig. 11) for grazing amounted to about 1.7 million acres (State of California, Division of Forestry 1961-74), accounting for most of the change. Sample-derived estimates indicate that timb- land declined about 6 percent. Documented refine ment in site classification accounted for 80 percent of the net difference. In National Forests, closer inspection of forest lands (fig. 12) and experience in managing problem sites provided a basis for reducin the area classified as timberland. On lands outside National Forests, an improved method of estimatin forest productivity (MacLean and Bolsinger 1973b was used in estimating timberland area (figs. 13 and 14). Physical conversions for reservoirs, roads, resi dential areas, agriculture, and other nonforest use amounted to an estimated 202,000 acres. These changes in forest area are summarized in the following tabulation:

Cause of change	Area changed from 1953 to 1975 [10] (Thousand acres)	Percent of 1953 acres
	Timberland	
Conversion – reservoirs, roads, powerlines, residential, grazing, etc.[11]	–202	–1.2
Refinement in site classification	–812	–4.7
Park and Wilderness expansion	–175	1.0
Deferred areas	–268	–1.5
Other[12]	+439	+2.5
Net change	–1,018	–5.9
	Unproductive forest	
Grazing clearings	–1,704	7.1
Reservoirs, roads, and all other sources[12]	–102	0.4
Net change	1,806	7.5

Sources of information include records of reservoir tate of California, Department of Water Resources 972) and road construction, forest conversion affiavits, records of park dedications, National Forest nd records, forest inventory field records, aerial iotographs, soil vegetation maps (Colwell 1974), and ushland reclamation records (State of California, ivision of Forestry 1961-74).

The total area of timberland conversion docuented by the California Department of Forestry om 1953 to 1975 is 814,089 acres (Arvola 1976). uch of this area was either not completely converted nonforest according to U.S. Forest Service definins or was reverted to forest after conversion.

Other causes of change may include sampling error, fferences in definitions, differences in personal dgment, and undetected real changes.

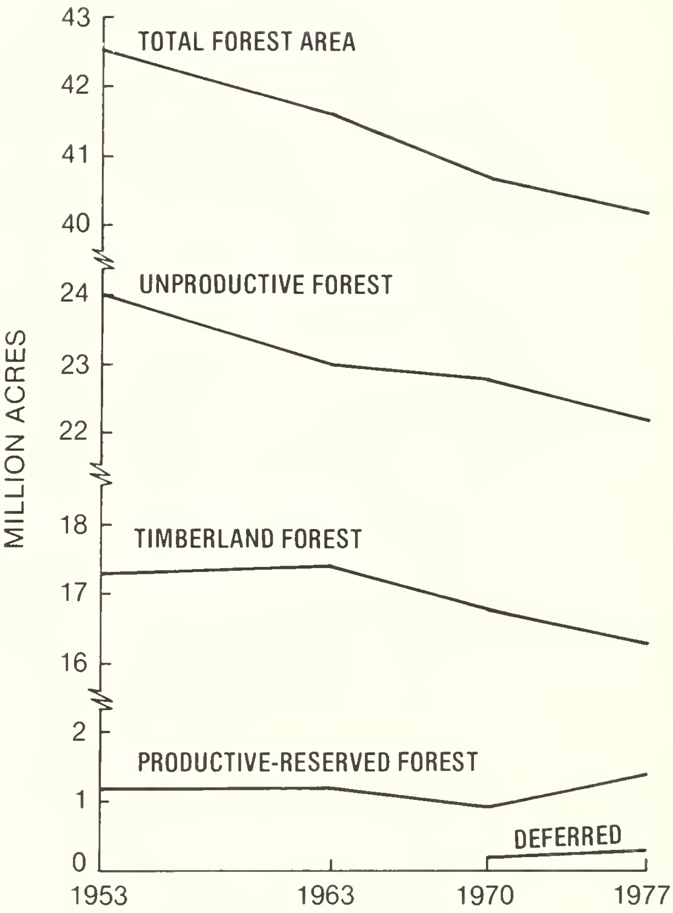


Figure 10.— Trends in forest area in California, 1953-77. (Deferred acreage does not include RARE II study areas.) Sources: (1) USDA Forest Service (1954). (2) Oswald and Hornibrook (1966). (3) Determined by adjusting the 1953 area by the reported clearings for grazing (State of California, Division of Forestry 1961-74). (4) USDA Forest Service (1973a). (5) This figure was determined from new inventory data for all lands except those outside National Forests in southern California. Records of range clearings, reservoirs, etc. were used along with the acreage estimate of California Department of Fish and Game Habitat to approximate unproductive forest area outside National Forests in southern California.

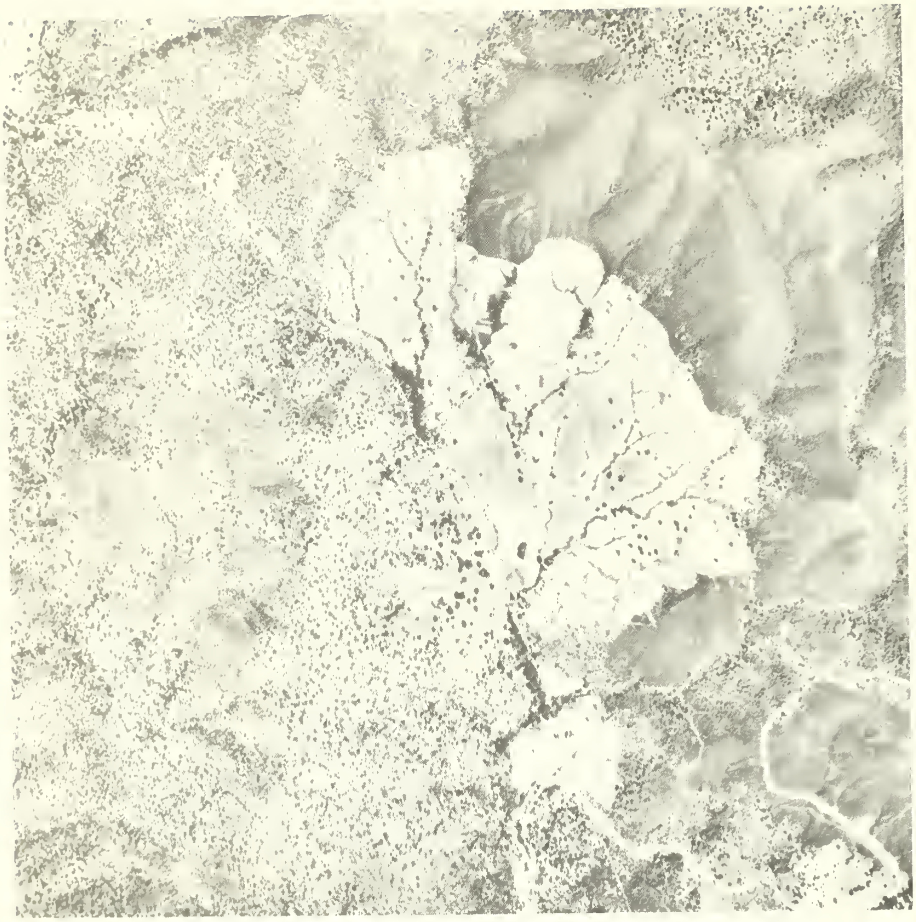


Figure 11. – Clearings in chaparral and oak woodland types between 1953 and 1975 amounted to about 1.7 million acres. Shown is an aerial view of a chaparral and oak clearing in Mariposa County.

Figure 12. – Previous forest inventories, based on type maps, often included small areas of unproductive land as part of the timberland. Recent inventories have removed many of these areas.

Figure 13. – Jeffrey pine stand on soil derived from serpentine rock, Trinity County. Serpentine soils are naturally low in productivity. In earlier surveys, some areas like this were classified as poorly stocked. In fact, stocking is close to the site's capacity. The dense timber in the background is on soil derived from schistose rock.

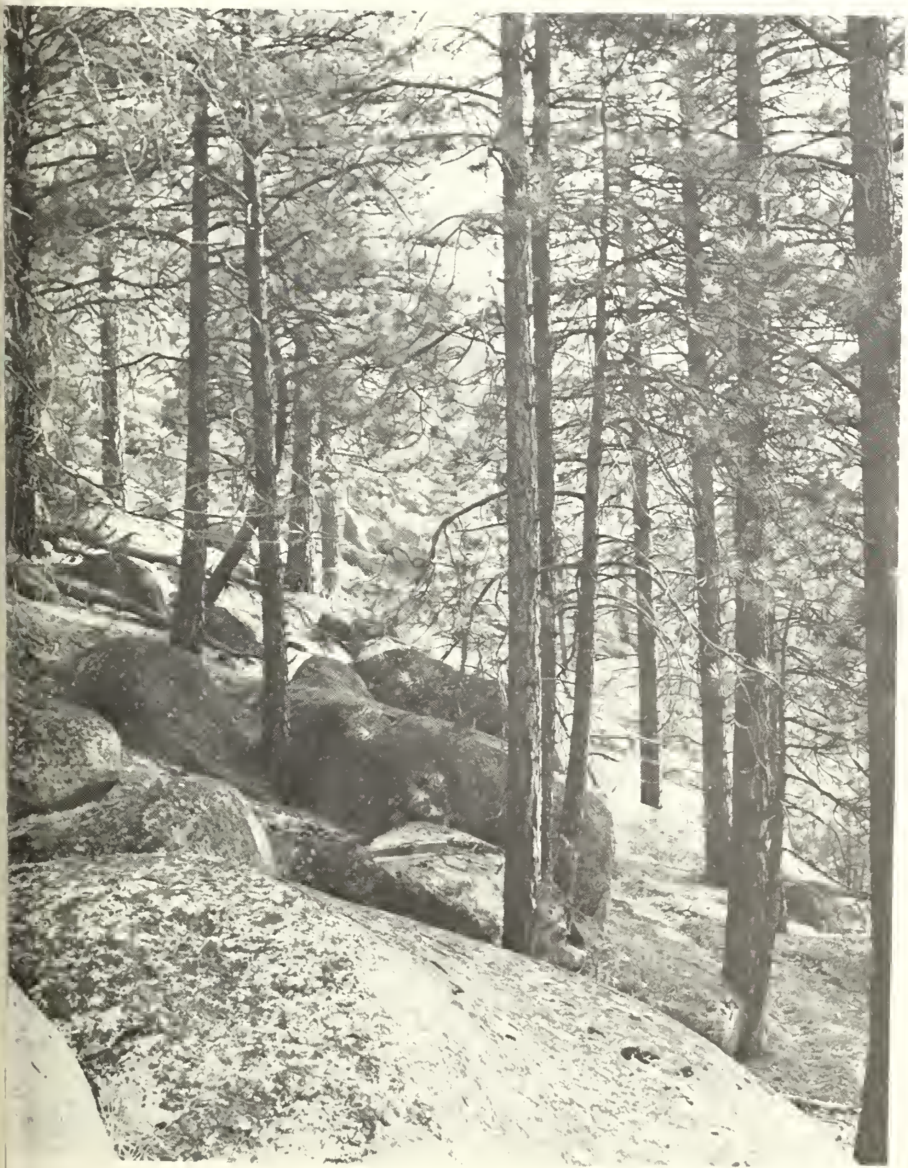


Figure 14. – Rocky lands such as this in Plumas County can support only a fraction of full tree stocking, and they are difficult to log and reforest. In earlier surveys based on type maps, areas like this were often included as timberland. In the recent survey they were classified as unproductive forest.

Forest Types

Forest Types on Timberland

All forest land has been classified into single-species forest types (fig. 15) based on plurality of current tree stocking. Table 2 shows area of timberland by these forest types. The forest type currently present on a given site is not always the most desirable type in terms of timber production. For example, hardwoods occupy some sites that could be growing more valuable conifers (see discussion on silvicultural opportunities, page 39). In much of California's interior, forests are not managed as single-species types.[13] A stand having a mixture of Douglas-fir, ponderosa pine, white fir, and incense-cedar, for example, will be managed as a "mixed conifer" stand (fig. 16) regardless of which species has the plurality of stocking. Coastal redwood is a special case. There is widespread interest in this unique species, not only in the volume and area of redwood type by standard definition, but also in the total area in which the species occurs, regardless of type. In recognition of these situations, the inventory data for lands outside National Forests were recast into special "timber management types" that are more in line with California forest management practices and current interests (table 3).

[13] See USDA Forest Service (1973b, p. 23-33), for a detailed description of California's major forest types and management considerations.

Table 2--Area of timberland by forest-type group and ownership, California, 1975
(In thousand acres)

Forest type group1/	National Forest	Other public	Forest industry	Other private timber growers	Farmer and miscellaneous private	All ownerships
Douglas-fir	1,542	90	2/ 400	198	501	2,731
Ponderosa and Jeffrey pines3/	3,098	46	368	232	587	4,331
Lodgepole pine	189	--	10	33	29	261
True firs4/	2,575	29	524	386	237	3,751
Incense-cedar	5/	6/ 28	199	266	158	651
Redwood	7/ 21	8/ 20	9/ 308	9/ 10	9/ 291	650
Hardwoods	426	222	588	151	1,452	2,839
Nonstocked	317	34	111	72	224	758
North coast areas logged since inventory	--	30	180	--	117	327
All groups	8,168	499	2,688	1,348	3,596	16,299

1/ Based on plurality of stocking.

2/ Includes small amounts of western hemlock and Sitka spruce in Del Norte and Humboldt Counties.

3/ Includes sugar, Coulter, knobcone, Monterey, and Bishop pines; and incense-cedar in National Forests.

4/ Includes white, grand, California and Shasta red firs, western white pine, and mountain hemlock stands intermingled with true fir stands in high mountain forests.

5/ Combined with ponderosa and Jeffrey pines.

6/ Includes small amounts of western red and Port-Orford-cedars in Del Norte and Humboldt Counties.

7/ Includes 16,000 acres of coastal redwood in coastal areas and 5,000 acres of giant sequoia in the Sierra Nevada Mountains.

8/ Includes 18,000 acres of coastal redwood and 2,000 acres of giant sequoia.

9/ Coastal redwood.

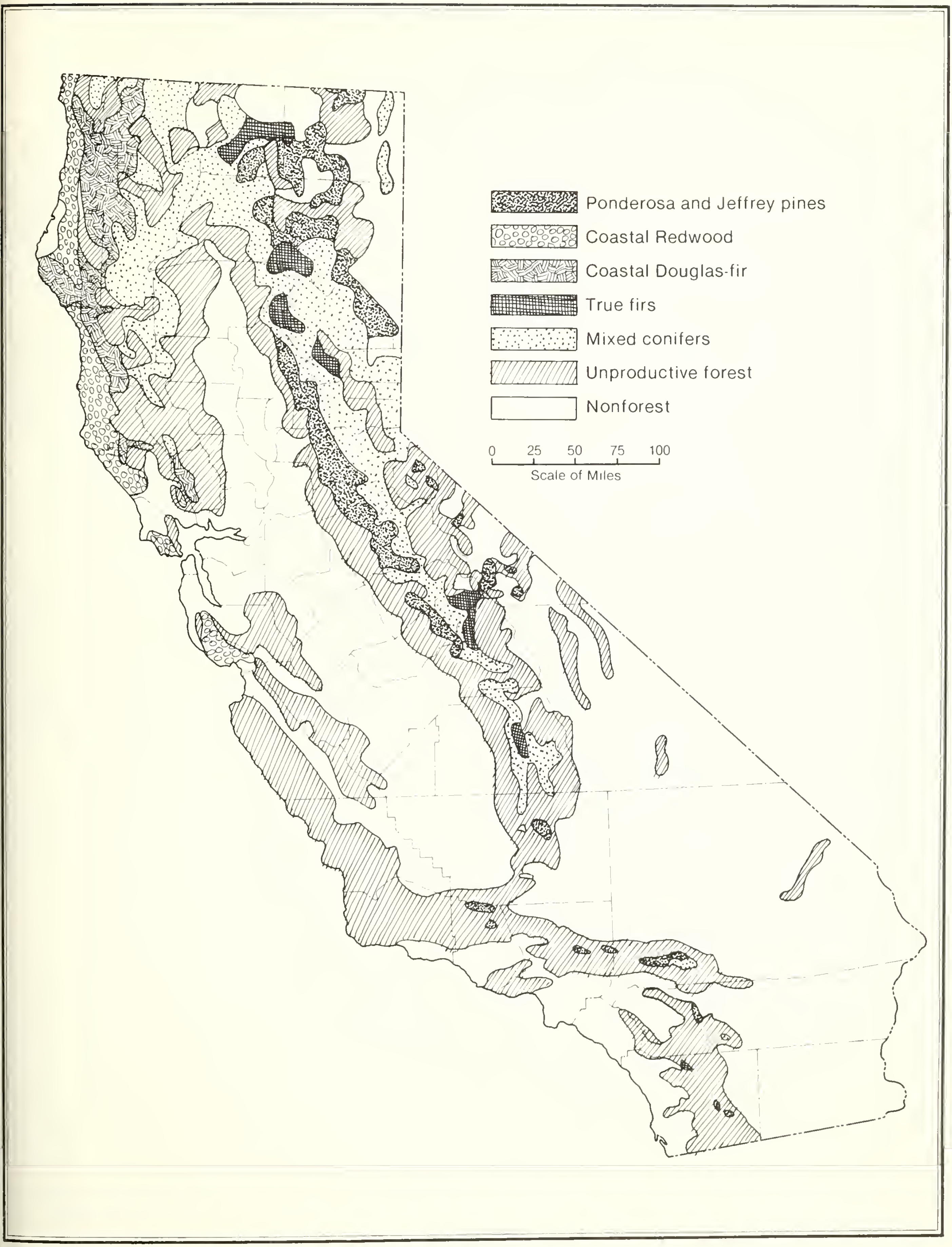


Figure 15. — Forest types and associations in California.

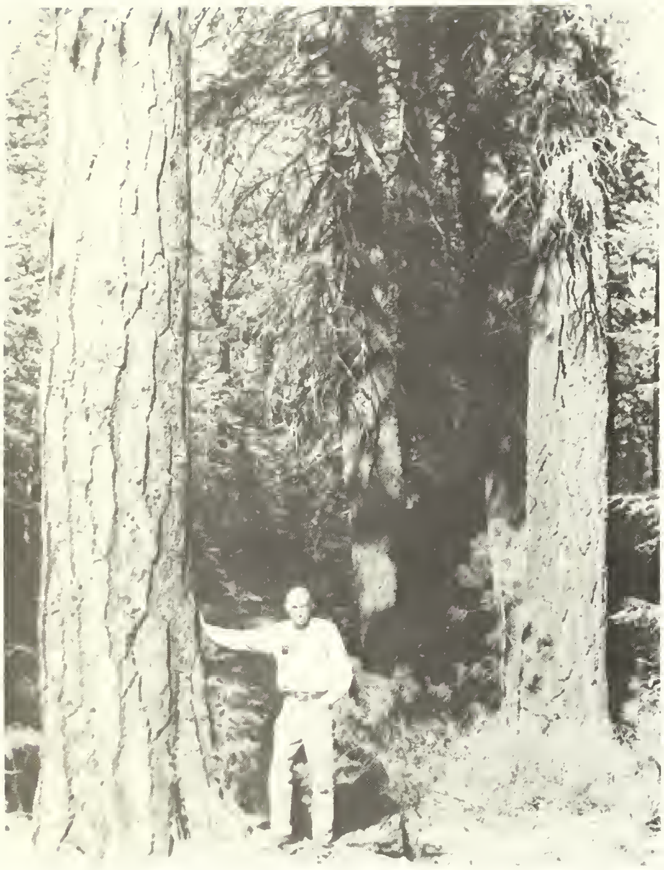


Figure 16. – Three to six tree species can be found in this stand in Plumas County belonging to a timber company. The company's management activities are perpetuating these species.

Table 3--Area of timberland outside National Forests by timber management type, California, 1975

Timber management types	Thousand acres	Percent
Coastal redwood1/	1,482	18.2
Coastal Douglas-fir2/	1,698	20.9
Ponderosa and Jeffrey pines3/	982	12.1
Mixed conifer--Douglas-fir and/or sugar pine present4/	2,350	28.9
Mixed conifer--Douglas-fir and/or sugar pine absent5/	825	10.1
True firs6/	548	6.7
Other conifers	193	2.4
Hardwoods on hardwood sites7/	53	0.7
All types	8,131	100.0

1/All timberland areas having at least one redwood tree per acre, or one redwood stump in recently logged areas.

2/Includes hardwood stands and nonstocked areas in north coast and central coast counties, and in Napa County, if Douglas-fir trees or stumps are present, unless redwood is present.

3/Stands that are 80 percent or more stocked with ponderosa or Jeffrey pine.

4/Stands in which a single species makes up less than 80 percent of the stocking. Douglas-fir and/or sugar pine are always present. Usually present are ponderosa or Jeffrey pine, white fir, and incense-cedar.

5/Same as footnote 3 except Douglas-fir and sugar pine are absent. This type typically occurs on the east slopes of the Sierra Nevada and Cascade Ranges. Usually consists of ponderosa and/or Jeffrey pine and white fir. Incense-cedar is present in many areas.

6/Stands that are 80 percent or more white fir and/or California or Shasta red fir.

7/Includes north coast upland hardwood stands with no evidence of past conifer stocking; riparian hardwood stands such as cottonwood, alder, and ash; and eucalyptus (exclusive of southern California eucalyptus stands).

A Closer Look at Coastal Redwood

The 1975 estimate of coastal redwood forest type[14] on timberland is 643,000 acres, 60 percent less than the 1,588,000 acres reported in 1953 (USDA Forest Service 1954). Although logging, fires, and land clearing for nonforest purposes have reduced the area of coastal redwood type, the actual change is much less than the 1953 and 1975 estimates indicate. Part of the difference is in definition. In 1953, stands in which 20 percent of the sawtimber volume was redwood were classified as redwood type. In 1975, only stands in which the plurality of stocking of all trees was redwood were classified as redwood type.[15]

[14] This discussion concerns coastal (coast) redwood *Sequoia sempervirens* which occurs naturally along California's coast from Oregon to Monterey County. Coastal redwood is an important commercial tree species in California. California's big tree, *Sequoiadendron giganteum*, goes by several names including redwood, Sierra redwood, and giant sequoia. It is confined to a few groves in the Sierra Nevada Range, and is valued mainly for its majestic beauty.

[15] For example, a stand fully stocked with small, low-volume tanoak trees but having two or three large redwood trees per acre would have been classified as redwood type in 1953; in 1975 the same stand would have been classified as tanoak.

Redwood trees still occur on an estimated 1,415,000 acres. From 1965 to 1975, about 211,000 acres of redwood type were logged. Most of this acreage is likely to have redwoods either residual trees or stump-sprouts. The total area in which redwood is likely to occur exceeds 1,600,000 acres, as shown in the following tabulation:

Forest type category	Acres
Timberland in redwood type	643,000
Other forest types on timberland containing redwood trees[16]	658,000
Redwood types in parks[17]	114,000
Total estimated area in which redwood trees are known to occur	1,415,000
Redwood type logged 1965-75[18]	211,000
Total forest area in which redwood trees are likely to occur[19]	1,626,000

Public agencies hold 11 percent of the area in which redwood occurs; private owners, 89 percent. Of the total redwood area, 7 percent is set aside in parks (table 4 and fig. 18).

Figure 17. — Houses in young-growth redwood stands effectively remove the land from timber use.

Figure 18. — Of the total redwood area in California, 7 percent is set aside in Parks. Some of the very best redwood sites are in these Parks. Jedediah Smith State Park, Del Norte County.

[16] Includes 5,000 acres of unproductive forest.

[17] May exclude as much as 21,000 acres of other types with redwood present. Does not include the 1978 additions to the Redwood National Park. Total area in the additions was about 48,000 acres; details on type, condition, and volume are not available. Most of the 48,000 acres is assumed to be redwood type.

[18] About 60 percent is estimated to have been clear-cut and 40 percent partially cut. Residual or stump-sprout redwood trees are likely to be present in most of the area.

[19] Excludes residential developments and other "non-forest" lands where redwood trees are still growing (fig. 17).

Table 4--Area of forest land containing coastal redwood by land class and ownership, California, 1975
(In thousand acres)

Land class and category	National Forest[1]	National Park	Other public	Forest industry	Other private timber growers	Farmer and miscellaneous private	All ownership
Timberland:							
Plurality of stocking	16	--	18	308	10	291	643
Redwoods logged 1965-75	0	--	14	152	0	45	211
Other types containing redwood	0	--	17	315	17	304	653
Total	16	--	49	775	27	640	1,507
Productive reserved	2	23	89	[2]	0	0	[3]114
Unproductive	0	0	0	0	0	5	5
Total all classes	18	23	138	775	27	645	1,626
Percent of total area	1.1	1.4	8.5	47.6	1.7	39.7	100

[1]National Forest redwoods occur as stringers in steep canyons in Monterey County at the southern extremity of the species range.

[2]A number of timber companies have established demonstration forests and public parks in the redwoods, estimated to cover less than 1,000 acres totally. They are not permanently reserved from timber cutting; hence, they are included as timberland.

[3]May exclude as much as 21,000 acres of other types containing redwood.

Noncommercial Forest Types

Productive reserved. — The 1,377,000 acres of productive forest in Parks, Wilderness, and other reservations vary from superlative redwood stands in stream bottoms near the coast to sparse stands of pines and firs near upper timberline in the mountains (fig. 19).

Figure 19. — True fir and lodgepole pine forests in the Caribou Wilderness, Lassen National Forest. Though classified as "productive," these high-elevation forests have low timber yield potential. True fir and lodgepole pine make up about half of the productive forest in California's wilderness. About 23 percent of National Forest Wilderness is productive forest, 36 percent is unproductive forest, and 41 percent is nonforest.

They include about 7 percent of the total forest are containing redwood, 7 percent of the total producti Douglas-fir type, 11 percent of the productive true f type, 8 percent of the ponderosa pine group, and most of the giant sequoia. Table 5 shows these area by forest type group and ownership; table 6 show the acreage of deferred areas in National Forests bei considered for possible Wilderness designation.

Unproductive. — Unproductive forests in the high mountains (fig. 20) and in arid forest zones (figs. 2 and 22) that are incapable of growing 20 cubic feet of industrial wood per acre per year or are too rock (fig. 23) or steep to manage for timber products amount to 22,216,000 acres. These forests are valu able as wildlife habitat, watershed protection, and scenery. Large areas are grazed by livestock. Curren y, very little of the wood growth on these lands is bei used. Some fuelwood and fenceposts are cut from t oak woodland[20] (fig. 24), and saw logs are occasio ally cut from the pine or fir types. In the future so of these lands, especially the chaparral and hardwo types, may be used as a source of energy. Table 7 shows the area of unproductive forest, by type and ownership group.

[20] For example, about 1.5 million cubic feet of fue wood was harvested by timber operators in 1976 (State of California, Department of Forestry 1947-7, 1977 issue), and 48,000 fuelwood cutting permit were issued by the USDA Forest Service. Some o this fuelwood was cut in the oak woodland.

Table 5--Area of productive-reserved forest land by forest type group and ownership, California[1]
(In thousand acres)

Forest type group[2]	National Forest	National Parks	State Parks	County and municipal	Private	All ownerships
Douglas-fir[3]	94	86	22	3	--	205
Redwood	2	23	79	10	--	114
Giant sequoia	--	7	[4]	--	--	7
True firs[5]	210	255	9	--	--	474
Ponderosa pine[6]	149	228	11	4	1	393
Lodgepole pine	15	109	1	--	--	125
Noncommercial conifers	--	1	1	--	--	2
Hardwoods	9	33	2	[4]	--	44
Unclassified	--	5	--	6	2	13
All groups	479	747	[7]125	23	3	1,377

[1]Information for National Forests is as of January 1, 1977; for other areas, 1975.
[2]Based on plurality of stocking.
[3]Includes bigcone Douglas-fir.
[4]Less than 500 acres.
[5]Includes white, California red, and Shasta red firs; also includes small amounts of western white pine and mountain hemlock.
[6]Includes Jeffrey, sugar, knobcone, Coulter, and Monterey pines; and incense-cedar.
[7]A small amount of productive-reserved forest land in southern California is combined with unproductive-nonreserved.

Table 6--Area of productive-deferred forest land[1] in National Forests by forest type group, California, January 1, 1977

Forest type group[2]	Thousand acres
ouglas-fir	51
onderosa pine	108
rue firs	81
odgepole pine	21
ardwoods	7
All groups	268

/Areas under study for possible ilderness classification as of anuary 1, 1977. Does not include study reas in the Roadless Area Review and valuation program (RARE II) of the USDA orest Service.
/Based on plurality of stocking.

Figure 20.– Unproductive forest on granitic soil in the Desolation Valley Wilderness, Eldorado National Forest. The vegetation in this high elevation site includes Jeffrey pine, lodgepole pine, California red fir, huckleberry oak, and mountain white thorn.

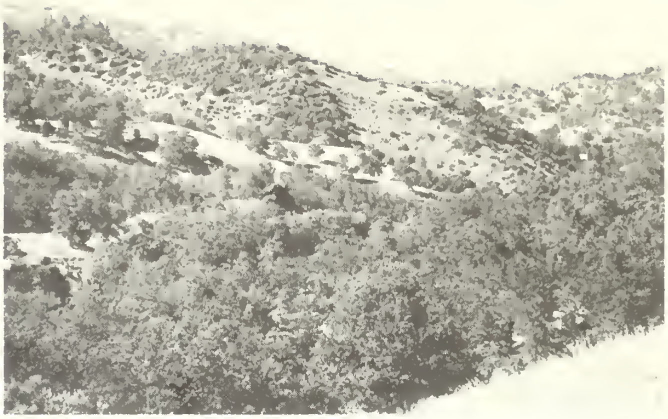
Figure 21. – Pinyon-juniper forest in Mono County. This type covers 2.7 million acres in California, mostly near the Nevada border.

A

B

Figure 22. – A, MacNab cypress trees and chaparral consisting of manzanita and ceanothus, Colusa County; and B, chaparral grading into oak woodland, Lake County. Chaparral, consisting of many species of brush and short trees, covers 7.6 million acres in California.

Figure 23. – Ponderosa pine and western juniper gro in pockets of soil in scabrock in the lava-flow count of Modoc County. Such areas produce less than 20 cubic feet of wood per acre per year and are considered unmanageable for continuous timber crops. About 2.3 million acres of ponderosa pine type is classified as unproductive forest.



'igure 24. — *Oak woodland, consisting of California blue oak and interior live oak, with scattered Digger pine, ccurs as a belt 450 miles long in the western foothills of the Cascades and Sierra Nevada and in the interior 'oast Ranges. The total area of oak woodland, including several tree species, is 5.8 million acres. A, Shasta 'ounty; B, Mendocino County.*

ıble 7--Area of unproductive forest by forest type group and ownership, California, 1975
(In thousand acres)

Forest type group	National Forest Wilderness and other reservations	National Forest outside reservations	National, State, and other parks, and reservations	Outside National Forests, parks and reservations	All areas
uglas-fir	18	227	1	29	275
nderosa and Jeffrey pines1/	206	1,382	89	637	2,314
ue firs2/	315	1,148	42	96	1,601
dwood	--	--	--	5	5
dgepole pine	49	179	225	188	641
mmercial hardwoods	4	613	3	699	1,319
aparral	132	761	177	6,516	7,586
nyon-juniper	8	350	48	2,290	2,696
k woodland	10	164	74	5,531	5,779
All groups	742	4,824	659	3/15,991	22,216

1/Includes sugar, Coulter, knobcone, Monterey, and Bishop pines; and incense-cedar in National Forests.
2/Includes white, grand, California and Shasta red firs, western white pine, and mountain hemlock stand ıtermingled with true fir stands in high mountain forests.
3/Includes a small amount of productive reserved in southern California.

Timber Volume

California timberlands contain an estimated 49.7 billion cubic feet of wood in sound growing stock trees, 5-inch d.b.h. and larger, and 235.6 billion board feet (Scribner rule) in sound sawtimber trees, 11-inch d.b.h. and larger. The State ranks third in the Nation in the amount of standing softwood sawtimber, with 13 percent of the total on only 3 percent of the Nation's timberland. Over 60 percent of the softwood volume is on National Forest lands (see table 8).

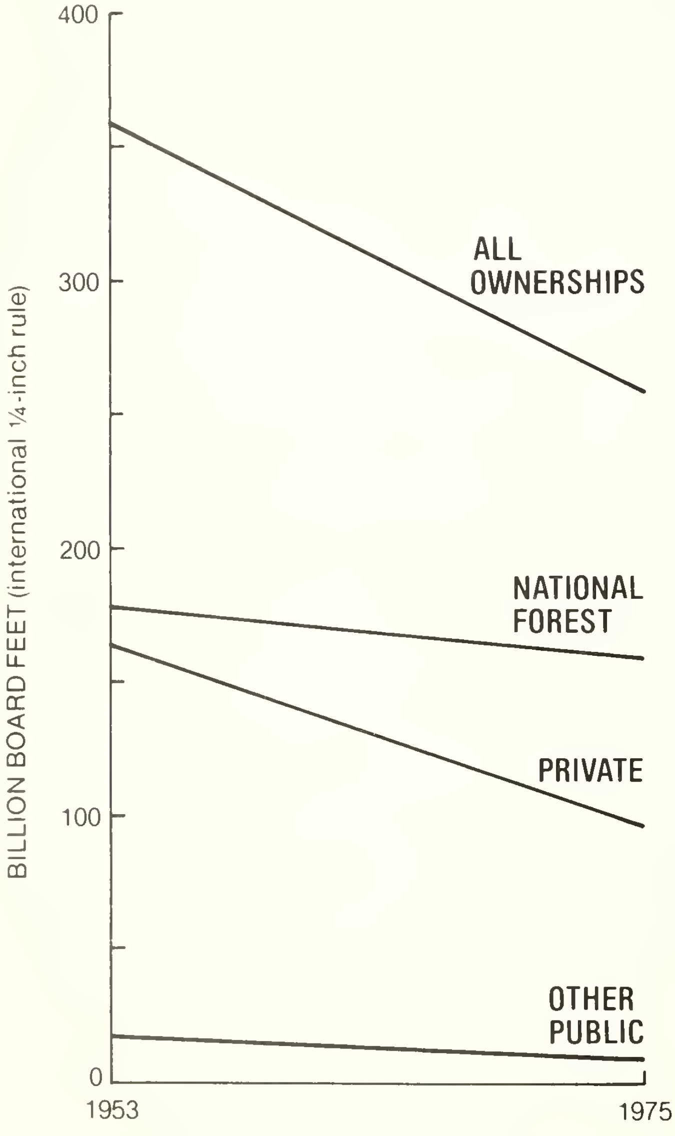


Figure 25.—Trends in sawtimber volume on California timberland by ownership, 1953-75.

Timber volume on California timberland has decline during the past two decades. A comparison of 1975 volume estimates with those published for 1953 (USDA Forest Service 1954) shows a net reduction in softwood sawtimber of 101 billion board feet (fig. 25 and table 27, appendix). Reported timber harvest during that period was 117 billion board fee and estimated growth was about 60 billion. Roughly 5-10 billion board feet were set aside in parks, Wilde ness, and deferred areas. The remaining difference includes volume lost or unaccounted for in land clea ings, fires, storms, and epidemics, and in sampling errors in both inventories.

Redwood and Douglas-fir volume declined the greate amount—41 percent and 38 percent respectively. Incense-cedar and minor conifers (mostly lodgepol pine, knobcone pine, and hemlocks) remained nearl constant. Hardwood volume increased by 35 percen (fig. 26 and table 28, appendix).

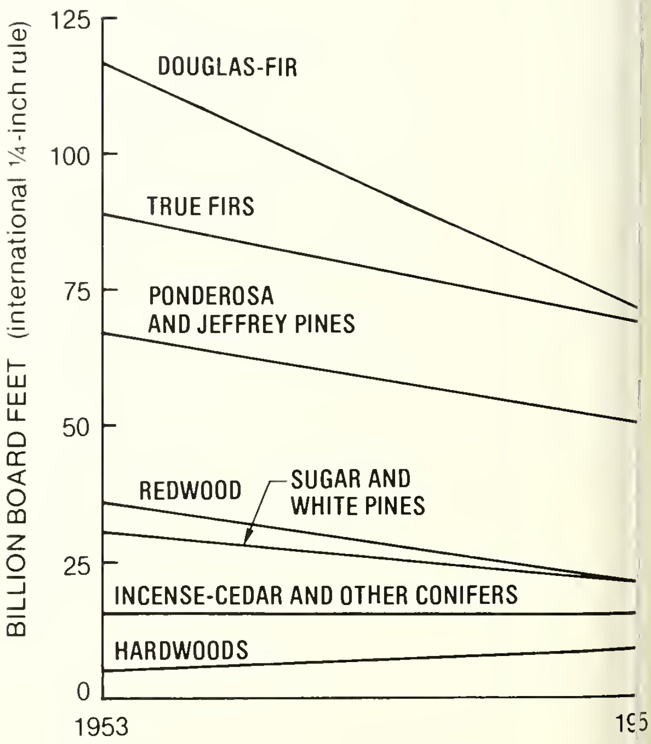


Figure 26.—Trends in sawtimber volume on California timberland by species, 1953-75.

Table 8--Net volume of growing stock and sawtimber on timberland by ownership, California, 1975

Ownership	Growing stock			Sawtimber					
	Softwoods	Hardwoods	Total	Softwoods	Hardwoods	Total	Softwoods[1]	Hardwoods[2]	Total
	- - - Million cubic feet - - -			Million board feet (Scribner rule)			Million board feet (Internatonal 1/4-inch rule)		
National Forest	28,072	1,134	29,206	142,883	2,814	145,697	157,958	2,955	160,913
Other public	1,108	283	1,391	5,668	560	6,228	6,356	572	6,928
Forest industry	7,457	679	8,136	35,940	1,181	37,121	40,883	1,206	42,089
Other private timber growers	3,068	121	3,189	15,091	177	15,268	3/	3/	3/
Farmer and miscellaneous private	6,269	1,476	7,745	28,246	3,090	31,336	50,397	3,342	53,739
All ownerships	45,974	3,693	49,667	227,828	7,822	235,650	255,594	8,075	263,669

1/Includes trees 9.0-inch d.b.h. and larger.
2/Includes trees 11.0-inch d.b.h. and larger.
3/Included with farmer and miscellaneous private.

The decline in volume has been concentrated in large trees. In 1953, 89 percent of the softwood sawtimber volume was in trees 21-inch d.b.h. and larger compared with 78 percent in 1975. Percent of hardwood volume in trees 21-inch d.b.h. and larger also declined, though total hardwood volume increased. Two factors caused this: small hardwood trees restocked several hundred thousand acres of logged and burned land (fig. 27), and many of the large hardwoods standing in 1953 were killed when associated softwoods were logged, or were damaged and became cull trees.

About 60 percent of the current softwood sawtimber volume in trees 21-inch d.b.h. and larger, and 67 percent in trees 29-inch d.b.h. and larger are in National Forest ownership.

In addition to the 49.7 billion cubic feet of sound growing stock trees, there is an estimated 2.3 billion cubic feet of wood in rough and rotten cull trees and in dead trees (fig. 28 and table 29, appendix). This volume is widely scattered, usually in broken, rotten, crooked, or forked trees that are costly to handle. It is a potential resource that could be used for many purposes. Cull and dead trees contain about 4 percent of the total sound wood volume in National Forests, averaging 135 cubic feet per acre and 6 percent of the total sound wood volume outside National Forests averaging 147 cubic feet per acre.

Figure 27. – Small hardwood trees have stocked several hundred thousand acres of logged and burned land in California.

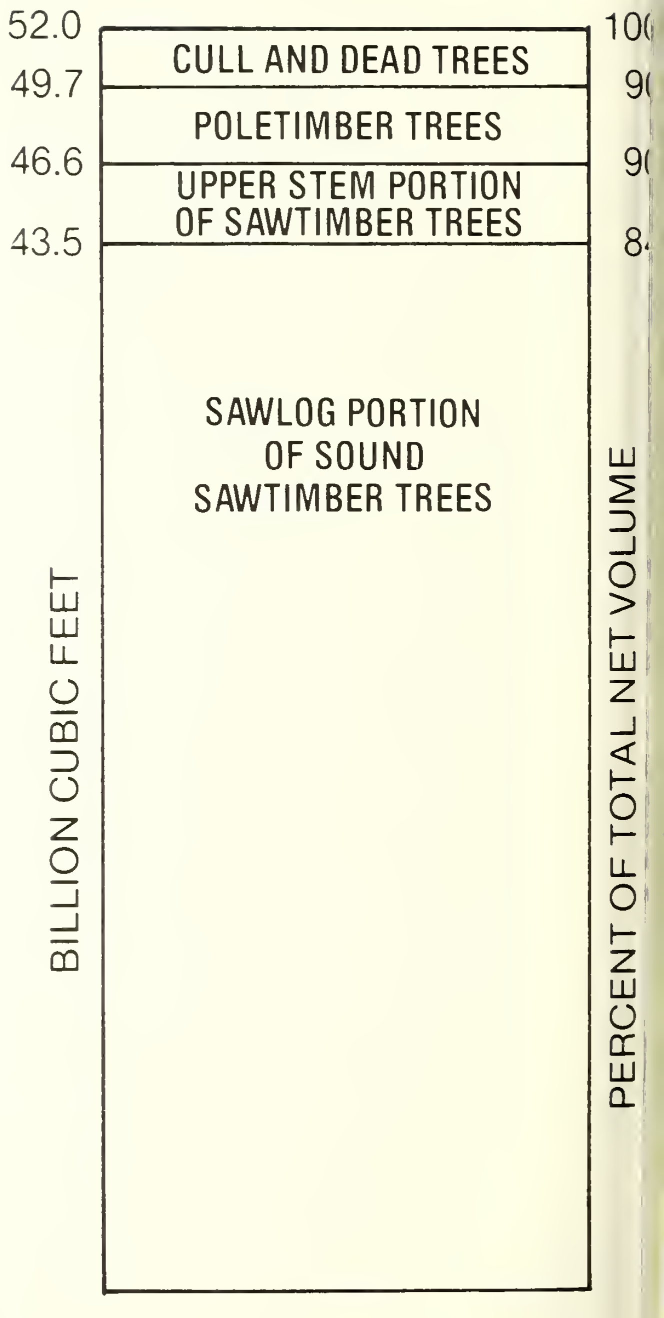


Figure 28. – Net volume of timber on California timberland by class of timber, 1975.

'imber Productivity ınd Growth

'roductivity

'he amount of wood that a forest produces depends ›n several factors, including climate, soil, tree species, nd stocking condition. The productive capacity of imberlands in California is extremely variable. Some lluvial soils in the mild, rainy north coast area are apable of growing 400 or more cubic feet per acre er year if well stocked with healthy redwood trees fig. 29). These same soils can grow 200 or 250 cubic ›et of Douglas-fir, or as much as 150 cubic feet of ardwoods. At the other extreme are serpentine and eridotite soils in the Coast Ranges and western opes of the Sierra Nevada and granitic and volcanic ›ils in the arid interior that will barely grow 20 cubic ›et of Jeffrey pine or ponderosa pine (fig. 30). 'hroughout the State are extensive areas capable of ›owing at least 85 cubic feet of wood per acre per ›ar if well stocked with productive coniferous ›ecies such as ponderosa pine, sugar pine, Douglas- ›, and white fir (table 9 and fig. 31).

'igure 29.— The best redwood sites in the north coast ›e capable of growing 400 or more cubic feet of wood ›r acre annually. This well stocked young-growth ›dwood stand is on Simpson Timber Company land, 'umboldt County.

Figure 30. – Stands near arid timberline may produce less than 20 cubic feet of wood annually. This ponderosa pine stand is in the Modoc National Forest.

Table 9--Area of timberland by biological potential (site class) and ownership, California, 1975
(In thousand acres)

Biological potential (site class)	National Forest	Other public	Forest industry	Other private timber growers	Farmer and miscellaneous private	All ownerships
Cubic feet						
165 or more	533	44	686	100	501	1,864
120-164	824	72	633	151	721	2,401
85-119	1,918	99	502	255	792	3,566
50-84	3,576	199	542	436	1,033	5,786
20-49	1,317	85	325	406	504	2,637
All classes	8,168	499	2,688	1,348	[1]3,551	16,254

[1]Excludes 6,000 acres in central coast and 39,000 acres in southern California for which information is not available.

Figure 31. – Two-story ponderosa pine and white fir stand capable of growing 120 cubic feet per acre annually, Plumas County.

California contains 3 percent of the Nation's timberland and has about 9 percent of the area capable of growing 120 or more cubic feet per acre annually. California has 13 percent of the Nation's timberland capable of growing 165 or more cubic feet. The estimated biological potential (site class)[21] for all of California's timberland averages 97 cubic feet per acre compared with 75 for the entire United States (USDA Forest Service 1973a). These estimates are based on yield tables developed for fully stocked even-aged stands of single species. The estimates of biological potential do not necessarily indicate the yield potential of stands currently occupying the land and are considered to be less than the potential of intensively managed stands on the more amenable sites. They do provide a rough gage for monitoring forest management success. They also are useful in ranking the potential of lands for allocating funds for forest intensification and for setting priorities.

Growth

On all ownerships combined, the net annual growth on timberland in 1975 was 0.8 billion cubic feet and 3.6 billion board feet (table 10). Net annual softwood growth averaged 46 percent of the land's estimated potential. Gross annual growth, which includes wood grown each year in trees that die, averaged 54 percent of the land's potential. National Forests have the highest growth rate relative to the land's potential while forests owned by forest industry have the highest absolute growth rate (table 11).

[21] See definition, page 132.

'able 10--Net annual growth of growing stock and sawtimber on timberland by ownership, ;alifornia, 1975

Ownership	Growing stock	Sawtimber
	Million cubic feet	Million board feet (Scribner rule)
ational Forests	379.7	1,663.0
ther public	21.9	90.1
'orest industry	162.5	748.3
ther private timber growers	56.5	245.9
armer and miscellaneous private	181.0	835.0
All ownerships	801.6	3,582.3

ıble 11--Average biological potential (site class), growth, and mortality of softwoods on timberland by ınership, California, 1975

Ownership	Biological potential (site class)	Gross growth	Mortality	Net growth	Net growth as percent of biological potential	Gross growth as percent of biological potential
	Cubic feet per acre per year				Percent	
ıtional Forest	86	54	9	45	52	63
(ıer public	92	40	10	30	33	43
F̦rest industry	115	61	8	53	46	53
(ıer private timber growers	82	46	7	39	48	56
F-mer and miscellaneous private	101	47	6	41	41	47
All ownerships	97	52	8	44	46	54

ı:asurable growth on National Forests is generally ı;her relative to the land's potential than on private l.ds for three reasons:

ı Most of the very productive private land in the north c ıst area has been logged. Extensive areas are either o:upied by stands too young to have measurable g wth, or are inadequately stocked with desirable tı:s. Growth can be expected to increase on these lads as young stands develop and as the inadequately stcked areas are reforested. Reforestation efforts o private lands have increased in recent years and p mise better forest yields in the future (see table 3 appendix).

2. National Forest lands have lower innate productivity, but most are stocked by trees of measurable growth size. Extensive areas are occupied with stands near the age of maximum growth, especially in the Sierra Nevada.

3. Most of the private lands in the interior have been selectively logged one to several times. These areas still support sawtimber stands, but about 2 million acres are occupied with trees that are diseased, damaged, suppressed, or of undesirable species (see the section on treatment opportunities, regeneration cutting, pages 35,36).

Opportunities for Silvicultural Treatment

Growth varies by geographic area because of differences in the yield potential of the land and the species, age, and condition of forest stands. National Forest growth ranges from a high of 87 cubic feet per acre per year on the Stanislaus National Forest to a low of 6 cubic feet on the Angeles. The Stanislaus is a Sierra Nevada National Forest with extensive areas of healthy stands on productive land managed for timber use, while the Angeles is one of five National Forests in southern California with limited timber resources on relatively unproductive sites managed primarily for watershed, recreation, and wildlife habitat (see table 30, appendix). The central coast resource area has the fastest growing timber stands in private ownership, with average growth ranging from 96 to 129 cubic feet per acre. This area is generally well stocked with redwood and Douglas-fir stands approaching the age of maximum growth. Private lands in the northern interior have the lowest growth in the State, ranging from 28 to 36 cubic feet. This area has extensive areas of unproductive land and some heavily cutover stands in poor growing condition (see table 31, appendix).

Private lands in the north coast have the lowest growth relative to their potential. Much of the cutover area is stocked with trees too small to have measurable volume and growth,[22] and a substantial area is occupied with brush and hardwoods.

[22] Growth estimates for the north coast have been updated to account for cutting, ingrowth, and changing growth rates in uncut stands since the mid-1960's inventory.

Demand for timber products is expected to grow rapidly (USDA Forest Service 1977b). California's timberland is producing only half its estimated poten tial. These two facts lead to the question: How can California's forest productivity be increased?

One way that future timber yields can be increased is by intensifying forest management activities now. Proven silvicultural techniques can be applied to fores stands that are in poor timber producing condition ir order to improve forest yields. In the following section information on stand condition, past and presen silvicultural accomplishments, planned activities, and opportunities for additional silvicultural treatments are summarized and discussed.

Some silvicultural treatment has been done for many years (fig. 32), and a considerable area is now being treated annually. In 1977, 83,000 acres in California were planted or seeded to trees (table 32, appendix). Forest industries planted and seeded 37,449 acres, the greatest on record and a five-fold increase since the mid-1960's when about 7,000 acres were plantec and seeded. The total area of silvicultural activities, counting timber harvesting and salvaging timber kille by the 1975-77 drought and pest epidemics, is abou 1 million acres (table 12).

Nurseries in California (fig. 33) in fiscal year 1977 produced about 63 million seedlings as shown in the following tabulation:

Nursery owner	October 1, 1976 - September 30, 1977 (Thousand trees)	Percer
National Forest	20,016	32
State	3,420	5
Other public	227	trac
Forest industry	39,833	63
Total	63,496	100

The silvicultural treatments considered in this repor are based strictly on the physical condition of timbe stands and site quality. A cost-benefit analysis migh show that some physical opportunities cannot be justified economically. Some areas may be unavailat for intensive management because of concern for nontimber values, local ordinance, or other factors for which information was not gathered.

A

B

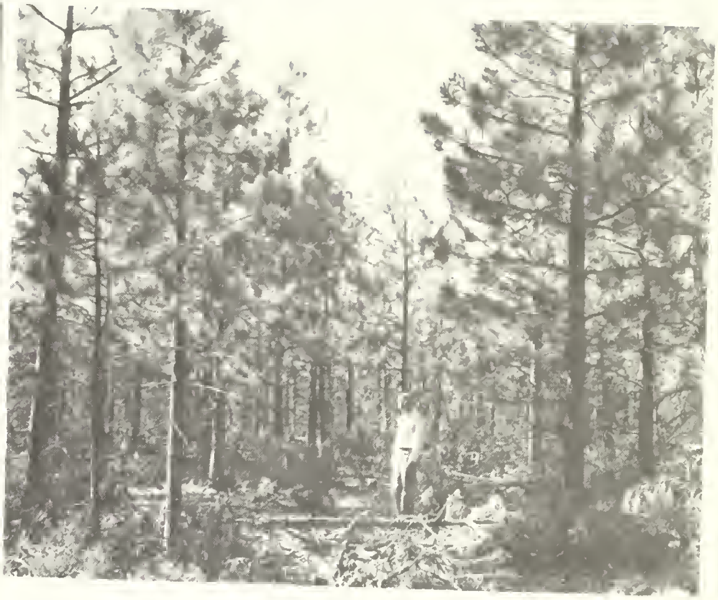


Figure 32. – Trees have been planted in or thinned from public and private forests for many years: A, Tree planters in the Deer Hollow Project, Lassen National Forest, 1961; B, Thinned ponderosa pine plantation, Collins Pine Co., 1977.

igure 33. – Masonite Corporation's tree nursery in endocino County.

Table 12--Approximate area of timberland in annual management activities by silvicultural treatment and ownership[1], California, 1977-78

(In acres)

Silvicultural treatment	National Forest	Other public	Forest industry and other private timber growers	Farmer and miscellaneous private	Total of available data
Treatments not involving timber harvest:					
Planting and seeding	33,719	2,202	42,582	4,557	83,060
Site preparation for planting	25,581	NA	NA	NA	25,581
Site preparation for natural regeneration	14,024	25	20,394	72	34,515
Treatment for releasing	8,909	45	13,455	8,453	[2]55,124
Precommercial thinning	24,262				
Pruning	315	NA	NA	NA	315
Fertilizing	409	NA	NA	NA	409
Prescribed burning to control understory	1,914	NA	NA	NA	1,914
Total no-harvest treatments	109,133	2,272	76,431	13,082	200,918
Timber harvest treatments:			Ownerships combined[3]		
Clearcutting	19,600	NA	15,700		35,300
Selective cutting[4]	22,800	NA	286,100		308,900
Shelterwood and seed tree cutting	73,200	NA	46,900		120,100
Intermediate cutting (includes commercial thinning)	52,100	NA	42,400		94,500
Sanitation-salvage cutting	164,600	NA	92,300		256,900
Other	--	NA	84,800		84,800
Total harvest treatments	[5]332,300	--	568,200		900,500
All treatments	441,433	2,272	657,713		1,101,418

NA = not applicable.

[1]These data are presented to indicate the approximate area being treated annually in California forests. Sources: U.S. Forest Service, State summary, reforestation and stand improvement report 24.24s, compiled a Fort Collins, Colorado, January 1979; USDA Forest Service (1964-78, 1978 issue); State of California fores practice report, 1977, Sacramento, California, 1978; and U.S. Forest Service, Pacific Southwest Region dat on file, 1978.

[2]Reported as timber stand improvement for owners other than National Forests.

[3]Timber harvest plans as filed for 1977, presented as the best indicator of acres actually treated. Includes nonfederal public lands and all private lands.

[4] Includes all partial cutting not reported as other harvest treatments.

[5]Actual accomplished treatments, fiscal year 1977.

Treatment Opportunities Examined

nformation on stand condition was examined to determine treatment opportunities.[23] Specific treatments identified, by stand condition, are:

Stand Condition	Treatment Opportunity[24]
Conifer sawtimber with 5,000 or more board feet per acre:	
Low growth, stocked with understory conifers	Overstory removal
Low growth, not stocked with understory conifers	Regeneration cutting
High growth	Commercial thinning or no treatment[25]
Poletimber or young sawtimber conifers with less than 5,000 board feet per acre:	
Without cull trees or hardwoods	Precommercial thinning or no treatment[25]
With cull trees or hardwoods	Improvement cutting
Poletimber or sawtimber hardwoods without understory conifers	Stand conversion
Conifer seedlings and saplings:	
Without overtopping brush or hardwoods	Precommercial thinning or no treatment[25]
With overtopping brush or hardwoods	Cleaning or releasing
Nonstocked or inadequately stocked	Planting

ctivities that would be expected to increase yields herever applied, such as fertilization, genetic tree provement, using large planting stock, mycorrhiza oot inoculation, or irrigation, were not considered.

eatment Opportunities utside National Forests

ost of the 8.1 million acres of timberland outside tional Forests have been logged. Some uncut oldowth stands can still be found, mainly in remote ountain regions, and considerable residual volume been left in many logged stands. Volume in some ung-growth stands on land logged decades ago is as at as the volume in many uncut old-growth stands . 34). Much of the more recently logged area is w forested with seedling, sapling, or poletimber nds. Older logging, mining, fires, insect and disease demics, storms, and unsuccessful attempts to vert forest to pasture have left extensive areas of productive land stocked with low value hardwoods, rotten and damaged conifers, and brush. Because of the longer history of disturbance on private lands than on National Forests and the various objectives pursued by the many owners, opportunities for silvicultural treatment on these lands are more extensive and varied (fig. 35).

[23] Detailed information for National Forests was not available. Treatment opportunities for National Forests shown on pages 45-46 are based on region-wide resource summaries and statements of expected treatment acreages.

[24] See appendix, p. 134 for criteria used in assessing treatment opportunities.

[25] Thinning may or may not be an opportunity depending on age of trees, site characteristics, species mix, and objectives of the forest manager.

Figure 34. – Young-growth redwood trees surround the stump of a redwood tree logged several decades ago. Young stands like this may contain 70,000 to 100,000 board feet of timber per acre. Simpson Timber Company land, Humboldt County.

Figure 35. – Private lands offer a variety of forest treatment opportunities. This forestscape in Mendocino County includes conifer thinning opportunities, nonstocked areas, and low value hardwoods.

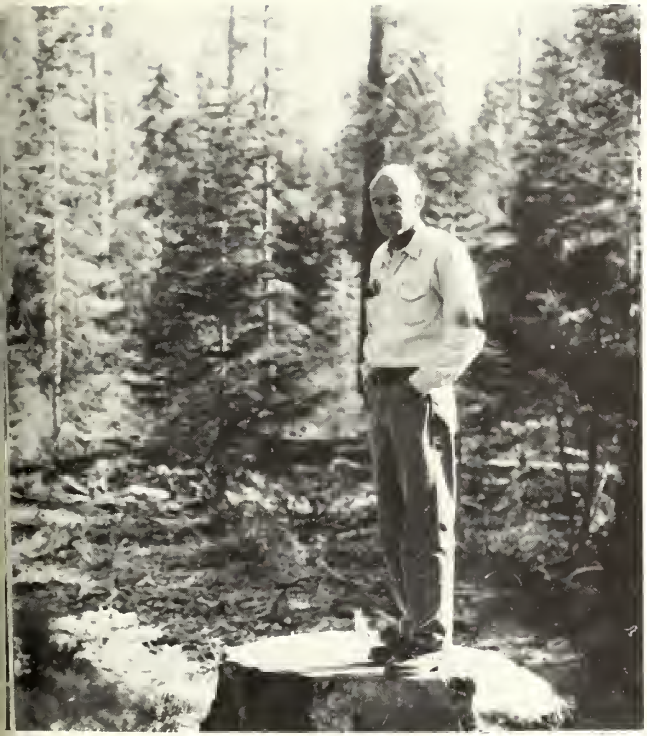
Area by stand condition and treatment class is shown for the major ownerships outside National Fo ests in table 51, appendix. These estimates are based on inventories conducted from 1965 to 1972. The north coast resource area was inventoried first – in 1965-67. The data for this area were updated using aerial photographs, cutting records, and reforestatio records. Data for the rest of California are considere recent enough to reflect the general situation currently. See appendix, p. 134, for the criteria used to assess treatment opportunities.

A discussion of the treatment opportunities identifie for ownership outside the National Forests follows:

Treatment: Overstory removal

Stand condition: Sawtimber stands with 5,000 or more board feet per acre in merchantable conifers, having low cubic-foot growth (less than 60 percent c the site's capacity), and 30 percent or more stocking in desirable understory conifers.

Remarks: Careful removal of slow-growing overstory trees will give undamaged young trees more light, space, moisture, and nutrients to increase their growt (fig. 36). In all ownerships outside National Forests,



gure 36. — *Large old trees have been removed from is mixed conifer stand on timber company land in umas County. Young trees already present in the derstory are now free to grow.*

the estimated area suitable for overstory removal is 272,000 acres (see the following tabulation and detailed tables in the appendix).

Area	Forest industry and other private timber growers		Farmer and miscellaneous private	
	Acres	Percent of ownership [26]	Acres	Percent of ownership
North coast	50,000	4	26,000	2
Other areas	125,000	4	71,000	4
State total	175,000	4	97,000	3

Treatment: Regeneration cutting

Stand condition: These stands are similar to those described in overstory removal above, except they have no understory.

Remarks: Net growth in these stands is low, sometimes negative, because of mortality. Removing the slow-growing trees and restocking with desirable trees would increase future yield. The total estimated area of these stands outside National Forests is 1,926,000 acres (see the following tabulation and detailed tables in the appendix).

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous private	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent of ownership
North coast	93,000	41	277,000	23	254,000	16
Other areas	76,000	28	855,000	30	371,000	19
State total	169,000	34	1,132,000	28	625,000	18

[26] Percent of ownership figures, based on the sample data, indicate how much of the total timberland in the given ownership is in this treatment opportunity class. For example, 4 percent of all other stands sampled in forest industry and other private timber growers ownership were opportunities for overstory removal.

Three general categories of these slow-growing sawtimber stands exist. Some stands may fit in two or all three categories:

1. Old stands that have lived well beyond the age of cubic-foot growth culmination. These are the least common.

2. Residual cutover stands with major components of hardwoods or incense-cedar.

3. Residual cutover stands consisting of damaged or diseased trees (fig. 37).

Categories 2 and 3 above are the most common, occupying 1.9 million acres. An examination of cutover stands in mixed conifer type in private ownership in Shasta and Tuolumne Counties showed that the proportion of basal area in hardwoods and incense-cedar was 15-30 percent more after stands were selectively logged. In Shasta County almost half of all privately owned forests consisted of cutover stands in which 30 percent or more of the basal area was in hardwoods and/or incense-cedar. In many stands, the only trees

Figure 37. – Forest industry-owned stand in Butte County after three selective cuttings which removed sugar pine, ponderosa pine, and Douglas-fir and left the white fir. Decay has entered many trees damaged by logging, and most trees are infected with dwarf mistletoe. Dense brush has prevented seedling establishment. The stand is growing about 20 cubic feet of wood annually, yet the land could produce over 100 cubic feet. Low-growth sawtimber stands like this cover about 2 million acres outside National Forests. Growth potential on these lands can be realized only if the stands are removed and new stands are established.

left that were over 20-inch d.b.h. were hardwoods and/or incense-cedar. These trees compete with smaller trees of more desirable species and become the primary seed bearers that restock the forest.

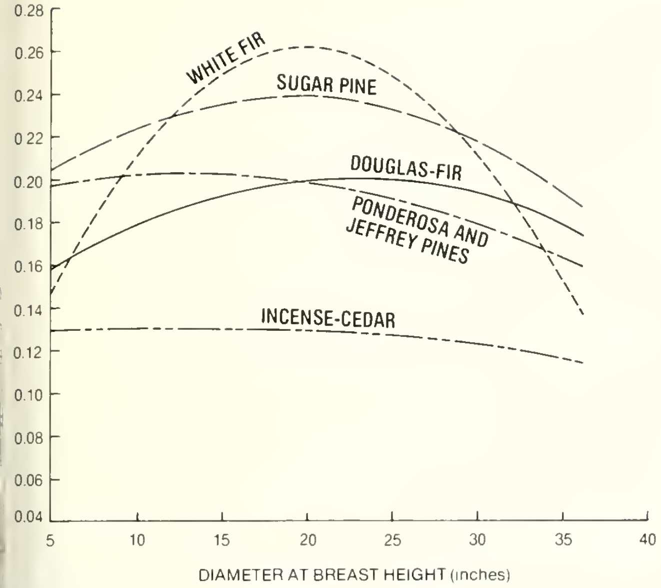
Although hardwoods and incense-cedar are importar to wildlife, add to the beauty of California forests, and have increased in value in recent years, the trees of these species that currently stock much of the cut over forests are poor timber producers. About two-thirds of the hardwoods are rotten culls or species that have no market value other than for firewood. Many of the incense-cedars are defective and most a slow-growing (figs. 38, 39, and 40). If these species are to contribute to the commercial timber supply ir the future, considerable research on their silvical characteristics will be necessary, and markets must develop for the small trees produced in the short rotations planned.

Treatment: Commercial thinning or no treatment.

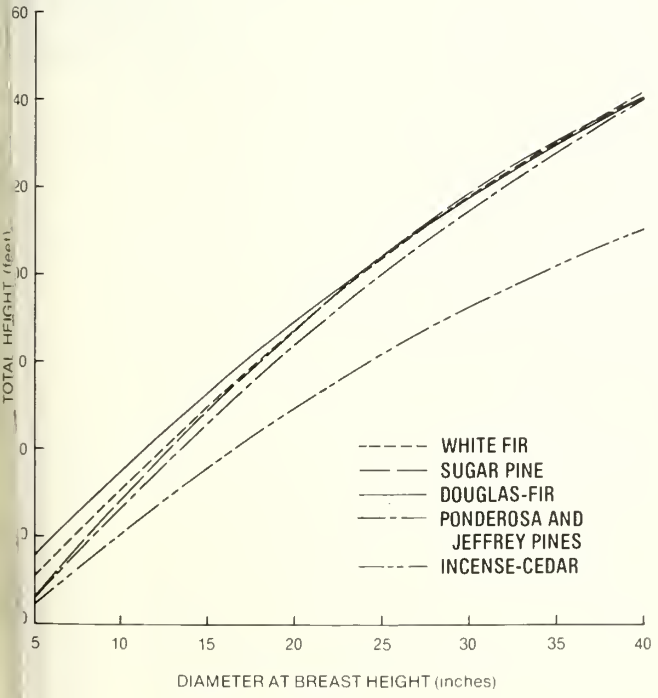
Stand condition: Sawtimber stands with 5,000 or more board feet per acre in merchantable conifers with high cubic-foot growth (60 percent or more of the site's capacity).

Remarks: These stands are in good condition (see fig. 29, for example). They are contributing most of the current wood growth on lands outside National Forests in the State. Many could be thinned comme cially. Studies conducted in various parts of the wor indicate that thinning generally does not increase total fiber yields; it does yield wood and income at early date and by concentrating the fiber on fewer trees, thinning results in greater recovery for some products.[27] Whether or not a given stand in this category should be thinned depends more on the owner's objectives than on the condition of the star.

[27] Lang et al. (1978) found that dense stands of wes side Sierra Nevada mixed conifers were more suscep tible to bark beetle attack than open stands. Thinni may reduce insect-caused mortality.



gure 38. — *Current annual diameter increment by ecies in selectively logged stands in private owner-ip, cubic-foot site classes 4, 5, and 6, Shasta County, lifornia.*



Fi ire 39. — *Total height over d.b.h. by species in se ctively logged stands in private ownership, cubic-fo site classes 4, 5, and 6, Shasta County, California.*

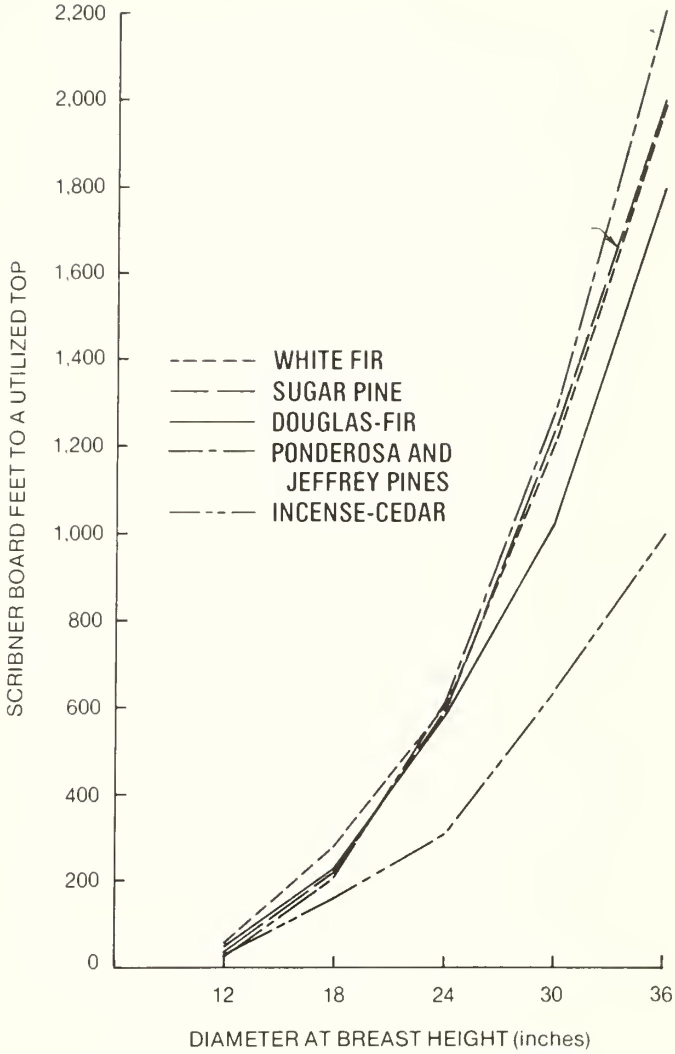


Figure 40. — *Gross board-foot volume in the five major species in selectively logged stands in private ownership, cubic-foot site classes 4, 5, and 6, Shasta County, California.*

In all ownerships outside National Forests, fast-growing young sawtimber stands cover 1,831,000 acres (see the following tabulation and detailed tabl in the appendix).

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous private	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent o ownersh
North coast	30,000	13	235,000	20	217,000	14
Other areas	59,000	22	785,000	28	505,000	26
State total	89,000	18	1,020,000	25	722,000	20

Treatment: Precommercial thinning or no treatment

Stand condition: Moderately to well-stocked poletimber or young sawtimber conifers with less than 5,000 board feet per acre, or conifer seedlings and saplings (fig. 41).

Remarks: These stands are stocked with enough well-distributed trees to utilize the site's potential over a 70- to 100-year rotation. For shorter rotations, some of these stands may not have enough trees to utilize the site's full potential. Little can be done about this, however; the lower yields will have to be accepted. About 60 percent of the poletimber stands and 70 percent of the seedling and sapling stands (stands in which 30 percent or more of the area is in overstocked thickets) are candidates for precommercial thinning.

Figure 41. – Well-stocked stand of young Douglas-fi and redwood on forest industry property. Most stan like this have over-dense thickets that could be thinned. About a million acres outside National For ests in all forest types are moderately to well-stocke with young conifers.

For the entire State outside National Forests, these stands occupy 1,038,000 acres, including 565,000 acres of poletimber and young sawtimber conifers and 473,000 acres of sapling and seedling conifers[28] (see the following tabulation and detailed tables in the appendix).

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous privat	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent ownersh
North coast	1,000	–	48,000	4	40,000	3
Other areas	30,000	13	632,000	22	287,000	15
State total	31,000	6	680,000	17	327,000	9

[28] Does not include seedling or sapling stands that have been established on north coast lands logged since 1965-67.

Treatment: Improvement cutting

Stand Condition: Moderately to well-stocked pole-imber or young sawtimber conifers with less than ,000 board feet per acre, and 30 percent or more of he stand occupied by cull conifers or large hardwood rees (fig. 42).

Remarks: Removing "weed" trees that compete with desirable trees in most cases will increase growth of usable wood. On lands outside National Forests, 318,000 acres are suitable for improvement cutting (see the following tabulation and detailed tables in the appendix).

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous private	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent of ownership
North coast	—	—	48,000	4	84,000	5
Other areas	21,000	8	57,000	2	108,000	6
State total	21,000	4	105,000	3	192,000	5

reatment: Stand Conversion

tand condition: Poletimber or sawtimber hardwoods ith understory conifers on less than 30 percent of e area.

emarks: Some hardwood species may indirectly enefit timber production. Red alder, for example, n fix nitrogen in the soil and may thwart the spread *Phellinus weirii*, a conifer root-rotting fungus. On rsh sites, especially south-facing slopes in the in-rior Coast Ranges, a light overstory of hardwood ay promote establishment of conifer seedlings.

terms of industrial timber production, hardwoods ve been a liability. Though they make up 9 percent the State's timber volume and account for 10 per-nt of the total cubic-foot annual growth, they nount to less than one-quarter of 1 percent of the ate's log consumption by forest product mills oward 1974, Howard and Hiserote 1978). The rdwoods are an untapped resource that could be ed many ways.

lifornia hardwood trees are often crooked, forked, a sprawling (figs. 42, 43, and 44). They are difficult a costly to log and process, and they usually get d naged in partial cutting. Wood-rotting fungi enter w unds in hardwoods more readily than in associated p chy conifers.

Figure 42. – Large cull hardwoods are restricting the development of young Douglas-firs in this privately owned stand in Mendocino County.

Figure 43. – Tanoak and madrone stand in Humboldt County. Less than 30 percent of this stand contains understory Douglas-fir.

Figure 44. — California black oak in Shasta County with a scattered understory of ponderosa pine, sugar pine, and Douglas-fir.

Over 20 species of hardwoods grow in California forests, but only 2 or 3 species have been used to an degree. Inventory data show that about 30 percent of the hardwood trees on timberland are of species or form used by forest industries, and many of these have but one usable 8-foot log. Of the total hardwood cubic-foot volume in all species, 28 percent is in sound sawlogs, compared with 89 percent for softwoods.

Although some of the better hardwood stands are manageable for timber products, removing hardwoods and establishing conifer stands in most cases could substantially increase the amount of usable wood produced. Of hardwood stands outside National Forest in California, 866,000 acres were on sites capable of growing conifers, including 518,000 acres (60 percent on land capable of growing 85 or more cubic feet of conifer timber per acre per year (see the following tabulation and detailed tables in the appendix).

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous privat	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent ownersh
North coast	50,000	22	149,000	12	396,000	25
Other areas	29,000	11	81,000	3	161,000	8
State total	79,000	16	230,000	6	557,000	16

Figure 45. – Timber company forester examining deer-browsed Douglas-fir seedling that is being crowded out by hardwood saplings and ceanothus brush, Mendocino County.

Treatment: Cleaning or releasing

Stand condition: Moderately to well-stocked sapling and seedling conifers with competing or overtopping brush or hardwoods (fig. 45) on 30 percent or more of the area.

Remarks: Cleaning or releasing accomplishes the same thing as improvement cutting – it releases desirable trees from competition by undesirable vegetation. On lands outside National Forests, 176,000 acres were identified as suitable for cleaning or releasing (see the following tabulation and detailed tables in the appendix).[29]

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous private	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent of ownership
North coast	5,000	2	13,000	1	57,000	4
Other areas	1,000	–	22,000	1	78,000	4
State total	6,000	1	35,000	1	135,000	4

[29] Does not include opportunities for cleaning or releasing in stands established on north coast lands logged since 1965-67.

Treatment: Planting

Stand condition: Nonstocked and inadequately stocked land (less than 30 percent of the area stocked with sapling or seedling conifer trees).

Remarks: Most of these areas are occupied by vegetation and/or slash. Some kind of site preparation will usually be necessary before they can be planted (fig. 46). At the dates of inventory, there were 1,331,000 acres of planting opportunities outside National Forests, including 616,000 acres in the north coast and 715,000 acres in the rest of the State.

Figure 46.—Most forest areas in California restock to brush if not reforested soon after logging or burning. Site preparation is usually necessary before trees can be planted. This burned area in Siskiyou County is covered with dense manzanita, ceanothus, and bitter cherry brush.

The data for the north coast were collected during 1965-67. Events and natural processes since then have altered the condition of the forest in this area of high growth potential, heavy logging, and intensified forest management. Available information was combined with some assumptions to approximate the area of planting opportunities in the north coast in 1975. For 1975, the approximated area of planting sites is 374,000 acres. This figure is speculative but is considered a more reasonable statement of forest conditions on which to base forestry programs than the 1965-67 estimate of 616,000 acres. The approximate area of planting opportunities in the north coast for 1975 was determined as follows:

Item	Acres
Planting opportunities in 1965-67	616,000
Logging (clearcuts only)[30] 1964-75	+196,000
Redwood sprouting in areas clearcut 1964-75[31]	–126,000
Planting and seeding 1964-75[32]	–157,000
Assumed natural increase in stocking[33]	–155,000
Approximated area of north coast planting opportunities in 1975	374,000

[30] Sixty percent of the logged area was estimated to have been clearcut.

[31] Total redwood area logged in each ownership multiplied by 0.6. See USDA Forest Service (1965, p. 666) for a discussion on the ability of redwood to sprout after logging.

[32] This assumes that all planting and seeding resulted in stands at least 30 percent stocked with desirable conifers and that none of the reported acreage was planted or seeded more than once. Reforestation rates varied by ownership—132,000 out of 157,000 acres were on forest industry lands.

[33] Inadequately stocked areas of seedlings and saplings in each ownership were assumed to increase in stocking at the rate of 7 percent per decade. McArdle, Meyer, and Bruce (1961) showed that understocked Douglas-fir stands increase in stocking at the rate of 4 percent per decade; Lindquist and Palley (1963) stated that redwood sprouts occupy the site and increase in size more rapidly than associated species during the first few years following the harvest of old-growth trees (see fig. 47).

Figure 47. — Redwood stump sprout less than two full growing seasons after logging. Simpson Timber Company land, Humboldt County.

For the rest of the State, the data are newer and are ccepted as representing current conditions. Outside National Forests, the State has 1,089,000 acres conidered to be suitable for planting, including 454,000 cres or 42 percent that is capable of growing 85 or nore cubic feet of conifer timber per acre per year see the following tabulation and detailed tables in he appendix).

For all private and other public lands, the reforestation situation is similar to that on National Forests: the acreage reforested annually is only slightly greater than the area deforested by logging and burning (fig. 48).

Area	Other public		Forest industry and other private timber growers		Farmer and miscellaneous private	
	Acres	Percent of ownership	Acres	Percent of ownership	Acres	Percent of ownership
orth coast	22,000	10	23,000	2	329,000	21
ther areas	53,000	20	281,000	10	381,000	19
State total	75,000	33	304,000	8	710,000	20

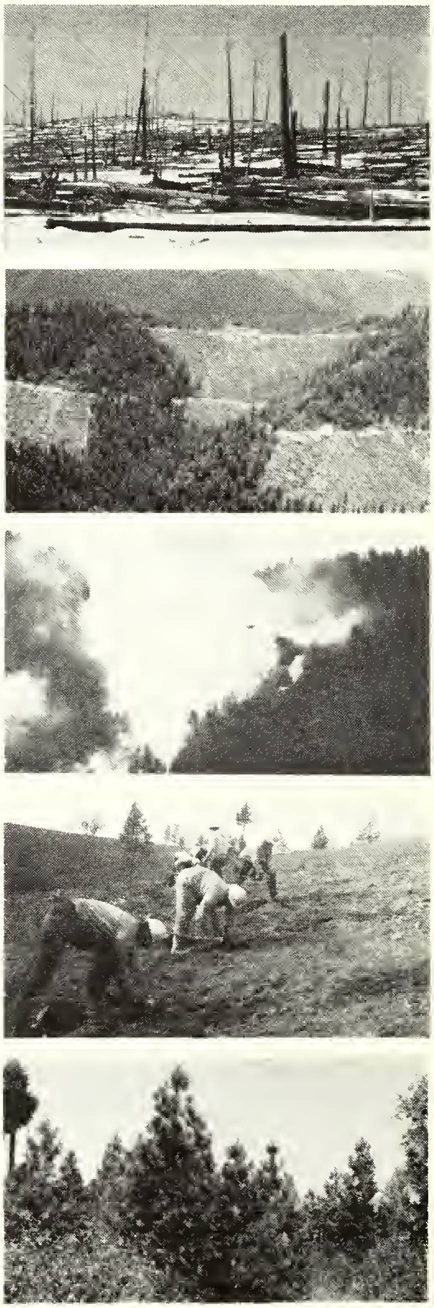


Figure 48. – The reforestation equation. The current rate of reforestation is just keeping up with the areas logge and burned annually on all ownerships. Extra effort will be necessary to reforest the older nonstocked areas.

Forest industries and other private timber growers have greatly increased reforestation efforts on their lands during the past few years; reforestation on farmer and miscellaneous private lands has increased but little (see the following tabulation and details in table 32, appendix).

Ownership	Acres planted and seeded per year	
	1964-65	1976-77
Forest industries and other private timber growers	7,900	30,691
Farmer and miscellaneous private	2,900	4,903

On other public lands, over three-fourths of the area that could be planted is classified as low site. Much of this is in hot, steep, rocky country in and near the chaparral-oak-conifer forest transition zone (see the following tabulation and details in tables 51-69, appendix).

Ownership	Percent of planting opportunities by cubic-foot site class		
	High 165+	Medium 85-164	Low 20-84
Other public	3	21	76
Forest industry and other private timber growers	17	34	49
Farmer and miscellaneous private	10	36	54

Nearly 60 percent of the planting opportunities on sites capable of growing 85 or more cubic feet of wood per acre are on farmer and miscellaneous private lands.

Treatment Opportunities in National Forests

National Forest lands are stocked mainly with softwood sawtimber stands (softwood sawtimber trees are 9-inch d.b.h. or larger). By stand size, timberland in National Forests is distributed as follows:

Stand Size	Thousand acres	Percent
Sawtimber	6,367	78
Poletimber	993	12
Sapling and seedling	491	6
Nonstocked	317	4
Total	8,168	100

The predominant treatment opportunity in sawtimber stands is regeneration cutting — removing the trees and restocking. This is done in conformance with land use plans that incorporate various resource values. Timber harvesting in National Forests is scheduled as much as possible in older stands, insect- or disease-infested stands, high mortality areas, and other areas where cutting will yield timber as well as promote increased future growth.

In 1977, treatments in National Forests of the Pacific Southwest Region that involved timber harvesting were accomplished on 332,300 acres (see table 12). About 88 percent of the harvest treatments were in the standard component,[34] 9 percent were in the special component, and 3 percent were in the marginal component.

Other major treatment opportunities on National Forest lands are discussed below.

Stand conversion. — Hardwood stands are important as watershed protection and habitat, and they add to the diversity of forest scenery. They occupy 426,000 acres of timberland in the National Forests. Most of this area is capable of growing more valuable softwoods, though it is predominantly on sites of low productive potential in the foothills and forest fringes where softwood stands are usually difficult to establish. The hardwoods on sites capable of growing at least 85 cubic feet of softwood per acre per year occupy 153,000 acres (see table 13); 273,000 acres of hardwood type are on sites with lower productive capacity.

[34] See pages 64,65 for a discussion of National Forest commercial forest components.

Precommercial thinning. – In many stands, overcrowding slows tree growth, thereby lengthening the time required for trees to reach merchantable size. Precommercial thinning early in the life of such stands can "weed out" diseased and deformed trees and undesirable species, and can create growing space for "crop" trees. Though such thinning produces no immediate revenue, it can greatly increase yields over time.

About 134,000 acres of seedlings, saplings, and poletimber stands in National Forests have been identified as precommercial thinning opportunities.

Releasing. – In many areas, brush and low-value hardwood trees grow up and around desirable conifers, thereby restricting conifer development and curtailing yields. Removal of these undesirable plants will "release" the conifers from competition. About 122,000 acres of adequately stocked conifer seedlings, saplings, and poletimber in National Forests have been identified as releasing opportunities.

Planting nonstocked areas. – Nonstocked timberland in California National Forests in 1975 totaled 317,000 acres.[35] About 85,000 acres are areas recently logged or burned; the balance is older nonstocked areas and forest lands recently purchased by the U.S. Forest Service that are nonstocked. Nearly 400,000 acres of National Forest land have been planted[36] since 1961.

An average of about 30,000 acres per year have been reforested during the past 5 years, slightly more than the area clearcut during that period and about 10,000 acres more than the planned area to be clearcut in the future. About 10,000 acres per year of stocked timberland burned in wildfires from 1964 to 1975;[37] 63,000 acres burned in 1977, one of California's worst fire years.

The recent rate of reforestation is just keeping up with the area being deforested. Nonstocked areas do reforest naturally, but the process is often slow and dependent on the right combination of weather conditions, favorable seedbed, a good seed crop, and a low population of seed-eating animals. The better forest sites often restock first to brush unless planted soon after logging. Tree stocking builds up very slowly once the brush is established. The Forest Service is planning to accelerate reforestation efforts with the intent of eliminating the nonstocked backlog as soon as possible.[38] Nursery capacity is being expanded to provide additional planting stock. A considerable proportion of the 317,000 acres of nonstocked land is on relatively unproductive sites, often in remote areas (fig. 49). Table 13 shows that 194,000 acres or 61 percent of the nonstocked area is capable of growing less than 85 cubic feet of wood per acre per year.

Figure 49. – Much of the nonstocked forest land in National Forests is on relatively unproductive sites in the high mountains. Tahoe National Forest near Donner Pass.

[35] Excludes areas burned by wildfire in 1977.

[36] Includes about 30,000 acres that were seeded and may also include some areas seeded or planted more than once.

[37] USDA Forest Service (1964-75) wildfire statistics show that 127,180 acres of timberland in National Forests burned over the 12-year period 1964-1975, or 10,598 acres per year; 95 percent is assumed to have been stocked when burned: 10,598 acres x 0.95 = 10,068 acres.

[38] Alternate program directions that are being considered under the Resources Planning Act (USDA Forest Service 1978) include a range of reforestation goals depending on the mix of resource values to be produced and funding. The most intensive reforestation alternative would eliminate the nonstocked areas by 1985, if all projected planting were successful.

Table 13--Area of timberland in poletimber, seedling and sapling conifers, hardwoods, and nonstocked condition in National Forests, by biological potential (site class), California, 1975

(In thousand acres)

Stand condition	Biological potential (site class)			Total
	High 165+ cubic feet	Medium 85-164 cubic feet	Low 20-84 cubic feet	
Poletimber conifers	96	180	664	940
Seedling and sapling conifers	32	155	260	447
Hardwoods	3	150	273	426
Nonstocked	10	113	194	317

The Best Opportunities for Increasing Timber Yields

The preceding section discussed the broad stand conditions that exist in California forests. Table 14 shows the net annual growth by these stand conditions. Of the eight conditions listed, four are not apparent problems. These are: (1) cut since inventory, (3) high-growth sawtimber, (4) conifer poletimber and young sawtimber in good condition, and (7) seedling and sapling stands. These four conditions account for 45 percent of the area and 77 percent of the current softwood growth. The remaining four conditions account for 55 percent of the area and 23 percent of the current softwood growth. These are the major underproductive forest conditions in California.

Table 15 shows the area in the four major underproductive stand conditions by ownership class for lands outside National Forests and includes available information for National Forests. Table 16 shows current and potential growth in the four major underproductive stand conditions.

The first two unproductive conditions — hardwood stands and nonstocked and inadequately stocked areas — can be dealt with now. Although some areas may be difficult to rehabilitate because of environmental factors such as slope and aridity, hardwood stands in general, could be replaced with conifers; nonstocked areas, landowners willing, could be reforested, with adequate funding, personnel, equipment, and planting stock. The current softwood growth on the 2.7 million acres in these conditions averages about 4 cubic feet per acre. If these areas were at least 60 percent stocked with healthy conifers, their average growth 70 years after planting, would be 189 million cubic feet. This is 70 cubic feet per acre, 17 times the current growth rate in these areas (table 17). This amounts to 23 percent of the current softwood growth and 12 percent of the estimated potential in all ownerships in California.

Table 14--Net annual growth on all timberlands outside National Forests, by stand condition, California, 1975[1]

Stand condition	Area	Softwood growth	Current softwood growth per acre
	Thousand acres	Million cubic feet	Cubic feet per acre per year
1. Cut since inventory (north coast)[2]	326	5.2	16.0
2. Low-growth sawtimber	2,198	60.1	27.3
3. High-growth sawtimber	1,831	225.5	123.2
Conifer poletimber and young sawtimber:			
4. In good condition	565	32.7	57.9
5. Improvement cutting needed	318	13.2	41.5
6. Hardwoods on conifer sites	866	7.2	8.3
Saplings and seedlings:			
7. Growth on stand at time of inventory	891	9.9	16.5
Ingrowth (north coast only)[3]	--	4.8	
8. Non- and inadequately stocked	1,089	1.4	1.1
Total	8,084	360.0	44.5

[1]Growth for stands in the north coast that were not logged since inventory and were larger than sapling size was updated to 1975 by stand-growth models.

[2]Growth on residuals: 2,000 cubic feet per acre X 0.02 growth rate X 130,000 acres partially cut = 5.2 million cubic feet.

[3]Growth on sapling and seedling stands was projected on a stand-by-stand basis starting with the stand at time of inventory and moving it ahead to 1975 at normal yield table rates. These acres are not to be added to the total.

Table 15--Area of timberland in major underproductive condition by stand condition and ownership, California, 1975

(In thousand acres)

Stand condition	National Forest	Other public	Forest industry	Other private timber growers	Farmer and miscellaneous private	Total
Hardwood stands	426	79	179	51	557	1,292
Nonstocked areas and inadequately stocked sapling and seedling stands	[1]317	75	148	156	710	1,406
Moderately to well-stocked conifer poletimber or young sawtimber stands with less than 5,000 board feet per acre and 35 percent or more stocked with hardwoods or cull conifers	No data	21	75	30	192	318
Low-growth conifer sawtimber stands with 5,000 or more board feet per acre	No data	169	881	426	722	2,198
Total of available data	743	344	1,283	663	2,181	5,214

[1]Nonstocked only.

Table 16--Potential growth of timberland in major unproductive condition by stand condition, treatment opportunity, ownership group, area of timberland, and current growth, California, 1975

Stand condition	Treatment opportunity	Ownership	Area	Current softwood growth	Potential growth1/	Potential increase in growth	Potential increase as a percent of potential growth
			Thousand acres	- Million cubic feet	per year	-	Percent
Hardwood stands	Remove hardwoods and plant conifers	National Forest	426	2/4	28	24	86
		Other lands	866	7	61	54	88
Nonstocked areas and inadequately stocked sapling and seedling stands	Prepare site and plant conifers	National Forest	3/317	0	22	22	100
		Other lands	1,089	1	58	57	98
Moderately to well-stocked conifer poletimber or young sawtimber stands with less than 5,000 board feet per acre and 35 percent or more stocked with hardwoods or cull conifers	Improvement cutting	National Forest	No data	--	--	--	--
	Remove hardwoods and cull conifers	Other lands	318	13	18	5	28
Low-growth conifer sawtimber stands with 5,000 or more board feet per acre	Regeneration cutting	National Forest	No data	--	--	--	--
		Other lands	2,198	60	273	213	78
Total of available data			5,214	85	460	375	81

1/Potential annual growth shown in this column for hardwood stands and non- or inadequately stocked areas is the mean annual growth over 70 years that could be realized if the areas were at least 60 percent stocked with healthy conifers. For the other conditions, it is the potential growth at the mean age of these stands if they were at least 60 percent stocked with healthy conifers.

2/Estimated by using the per-acre growth rates from hardwood stands outside National Forests.

3/Nonstocked only; data not available on inadequately stocked sapling and seedling stands.

Table 17--Area and prospective annual yield of timberland suitable for hardwood stand conversion and planting opportunities by ownership group, and biological potential (site class), California, 1975

Ownership group, treatment and biological potential (site class)	Treatable area	Prospective mean annual yield 70 years after planting	
	Thousand acres	Million cubic feet	Cubic feet per acre
National Forest:			
Hardwood stand conversion, medium and high sites	153	17	111
Hardwood stand conversion, low sites	273	11	40
Total hardwood stand conversion	426	28	66
Planting, medium and high sites	123	14	114
Planting, low sites	194	8	41
Total planting	317	22	69
Total National Forest	743	50	67
Outside National Forest:			
Hardwood stand conversion, medium and high sites	518	57	110
Hardwood stand conversion, low sites	348	14	40
Total hardwood stand conversion	866	71	82
Planting,[1/] medium and high sites	456	51	112
Planting,[1/] low sites	635	12	27
Total planting	1,091	68	62
Total outside National Forest	1,957	139	71
All ownerships:			
Hardwood stand conversion	1,292	99	77
Planting	1,408	90	64
Total	2,700	189	70

[1/]North coast planting opportunities as determined from mid-1960's data were adjusted from 616,000 to 374,000 acres to account for changes due to logging, redwood sprouting in logged areas, planting and seeding, and the assumed natural increase in stocking.

If only the stand conversion and planting opportunities on sites capable of growing at least 85 cubic feet per acre were treated, the total area covered would be 1,248,000 acres, or 46 percent of the total; but the prospective harvest in 70 years would be 9.8 billion cubic feet, or 82 percent of the total. In other words, 80 percent of the potential increase in yields could be realized by treating less than half of the land in these conditions (fig. 50). About 22 percent of the stand conversion and planting opportunities on sites capable of growing 85 cubic feet per acre (high and medium sites) are in National Forests and 78 percent are outside National Forests (table 18). By ownership, the area on these sites is distributed as follows:

Ownership	Percent of treatable area on medium and high sites
National Forest	22
Other public	4
Forest industry	15
Other private timber growers	5
Farmer and miscellaneous private	54
Total	100

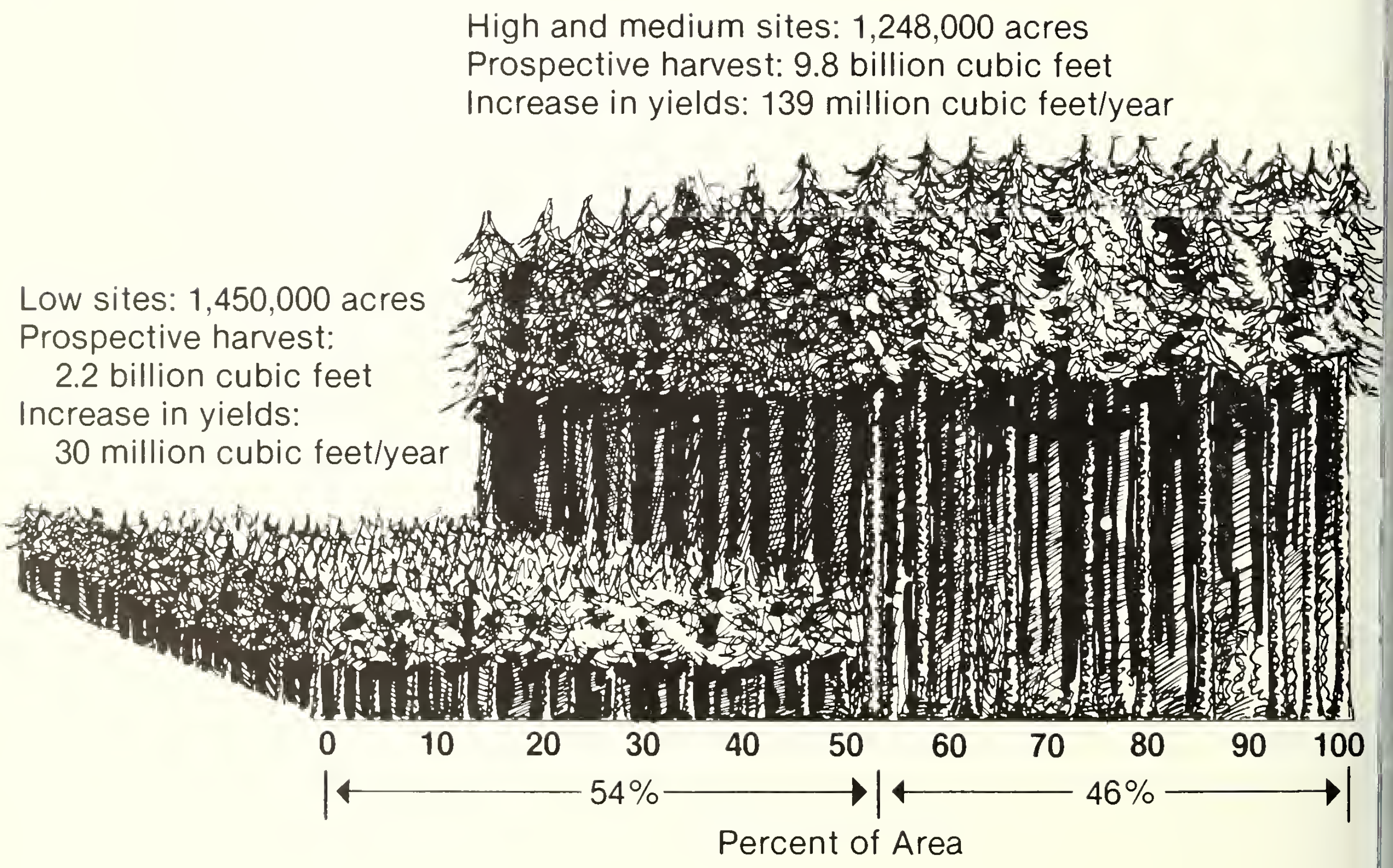


Figure 50.—About 80 percent of the potential increase in timber yield from planting understocked land and replacing hardwoods with conifers could be realized by treating less than half of the area in these conditions.

United States
Department of
Agriculture

Forest Service

Pacific Northwest
Forest and Range
Experiment Station

Resource Bulletin
PNW-90

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Opportunities for Silvicultural Treatment in Western Oregon

Colin D. MacLean

Metric Equivalents

1,000 acres	= 404.69 hectares
1,000 cubic feet	= 28.3 cubic meters
1 cubic foot per acre	= 0.0700 cubic meter per hectare
1 square foot basal area per acre	= 0.2296 square meter per hectare
1 foot	= 30.48 centimeters
1 inch	= 2.540 centimeters

Opportunities for Silvicultural Treatment in Western Oregon

Reference Abstract

MacLean, Colin D.
1980. Opportunities for silvicultural treatment in western Oregon. USDA For. Serv. Resour. Bull. PNW-90, 35 p., illus. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

A recent Forest Survey inventory of western Oregon has been analyzed to determine the extent of physical opportunities to increase wood production through silvicultural treatment. Results are presented by owner group and by geographic unit.

Keywords: Silvicultural treatments, intensive management, timber resources, Oregon (western).

Research Summary

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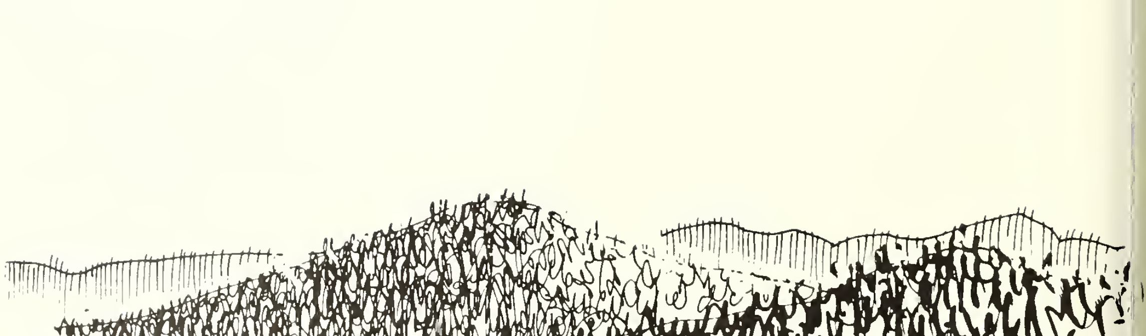
1980

Almost 6 million acres of private forest holdings and over 7 million acres of public forest lands in western Oregon are potentially capable of growing continuous crops of conifer timber. Production of conifers on many of these acres could be increased through silvicultural treatment. The objective of this analysis was to determine how many acres of timberland in western Oregon are physically suited for silvicultural manipulation of growing stock and competing vegetation to increase timber production.

The analysis identified almost 1.4 million acres of young conifer stands on private lands that would be more productive if silviculturally treated by thinning, cleaning, improvement cutting, or reinforcement planting. Another 1.5 million acres lack adequate conifer stocking for management; 40 percent of this land is nonstocked, and the remainder is stocked with either hardwoods, scattered residual conifers, or a mixture of the two. Almost 2 million acres of private forest land--about one-third of the western Oregon total--support productive young conifer stands that offer no substantial opportunities for treatment and another 900,000 acres of timberland that support harvestable conifer stands over 70 years old.

Unlike private forests, public forests are still predominantly mature and offer relatively few opportunities for investment in silvicultural treatments that will increas future yields. Over 4 million acres of public timberland support harvestable conifer stands that exceed 70 years of age and an additional 1.3 million acres suppor young conifer stands not currently in need of silvicultural treatment. There are almost 1 million acres of young conifer stands available for treatment and another 250,000 acres of functionally nonstocked cutover land. In addition, fires and other natural catastrophes have created 700,000 acres of hardwood and brush types that could be converted to conifer production if other resource considerations permit.

Contents



Introduction

Now that much of western Oregon's privately owned, old-growth timber has been logged, harvesting activity is shifting to young stands growing in old clearcuts. Future supplies of conifer timber will come increasingly from lands that now support young conifer stands, hardwood trees, and, in some cases, brush and weeds. Current management practices on these lands will have a substantial impact on future supplies of timber.

In recent years, there has been widespread interest in programs to encourage silvicultural activity that will increase future yields of conifer timber. Thus, planners and legislators need information on the area available for treatment and kinds of treatment possible. A recent inventory of western Oregon timberlands was designed to provide this kind of information. The findings of that inventory are reported here. They are intended to provide information on (1) the condition of forest lands in western Oregon and (2) the physical opportunities to increase timber production on those lands through silvicultural treatment. Not all treatment opportunities identified in this report are likely to be undertaken. Some will conflict with objectives of the landowner and others may not be cost effective. However, neither landowner objectives nor cost effectiveness were analyzed for this report.

The Survey

A Renewable Resources Evaluation[1/] inventory of private, State, and municipal forest lands in western Oregon was recently completed. Statistical reports of the findings have already been published (Bassett 1979, Jacobs 1978, Mei 1979). As part of that inventory, additional data were collected to permit plot-by-plot analysis of the opportunities to increase timber production through silvicultural treatment. The findings of that analysis are reported here. The field design and data analysis procedures are those described by MacLean (1979).

The Renewable Resources Evaluation inventory was based on a 3.4-mile grid of field plots covering all private, State, county, and municipal timberlands[2/] in western Oregon. At each of these 958 grid locations and at 127 locations in southwestern Oregon, special plots were laid out for the express purpose of identifying opportunities for silvicultural treatment--particularly treatments dependent on the manipulation of tree stocking: planting, thinning, weeding, and harvesting. Although Federal lands administered by the USDA Forest Service and the U.S. Department of the Interior Bureau of Land Management (BLM) were not included in the inventory, treatment opportunities on those lands were identified by analysis of data from over 5,000 inventory plots furnished by the two agencies.

1/ Renewable Resources Evaluation inventories (formerly called the Forest Survey) are conducted in the Pacific Coast states by the Pacific Northwest Forest and Range Experiment Station as part of a nationwide project of the USDA Forest Service.

2/ Timberland is forest land capable of producing 20 ft^3 per acre per year of industrial wood and not withdrawn from timber production. Timberland was formerly called commercial forest land.

The Treatments

Renewable Resources Evaluation plots consist of 10 sample points distributed over approximately 10 acres. At each point, trees over 35-inches in d.b.h. were sampled on a 55.6-foot-radius plot, trees 7 to 35 inches were sampled with a 30-factor prism, and trees under 7 inches were sampled on an 11.1-ft-radius plot. Plots on BLM lands and National Forests consisted of 10 points distributed over approximately 1 acre. At each point, trees over 5 inches in d.b.h. were sampled with an 80-factor prism and trees under 5 inches were sampled with either a 300th-acre or a 580th-acre fixed-radius point. Extensive data on nontree competition (shrubs, grasses, ferns, and other plants) were collected at each plot location; but this type of data was usually not available for the BLM and National Forest plots.

In western Oregon, most forest managers practice some form of even-aged management. The Resources Evaluation analysis assumes a long-range objective of even-aged management for conifer wood production, even for stands that are presently of mixed species or uneven age. Thus, for treatment identification purposes, all merchantable stands are sorted into two species groups--conifer and salable hardwoods (with or without a conifer component), and conifer stands are further sorted into three maturity classes--mature, intermediate, and regeneration. An additional category--"no manageable stand present"--describes areas where trees are lacking or where the stocking of potentially salable trees is not sufficient to fully utilize the site.

The treatments identified are those that are expected to increase conifer timber production through manipulation of growing stock. Two other common treatments--fertilization and genetic improvement--are omitted, but potential fertilization opportunities may be identified by combining treatment opportunity class with site index and cost information. Genetic improvement, of course, is possible wherever a planting opportunity exists.

The treatments identified in this analysis are described and defined in this report. The definitions were written after consultation with silviculturists and forest managers in the Pacific Northwest; they represent the silvicultural conventional wisdom of today, adapted to fit the variable stocking commonly found on inventory plots. The analytical procedure used to identify the treatment opportunities are described in a previous paper (MacLean 1980).

Mature Conifer Stands

Mature stands have a density of at least 20 percent of normal (MacLean 1979) on at least 60 percent of the area and exceed the age when mean annual increment of cubic-foot volume culminates. Since the exact age of culmination of each stand is not known, we use the normal yield table age--70 years (McArdle et al. 1961):

1. Shelterwood removal cut.--This is the final stage of a shelterwood cut, when the regeneration is well established and the remaining overstory can be removed. Overstory density should be less than 50 percent of normal and understory density should be at least 35 percent. Natural stands with a composition that resembles this description will be treated the same.

2. Clearcut.--This is the prescription for stands that fail to qualify for a shelterwood removal cut because of excessive overstory or inadequate understory, unless environmental or land use restrictions make clearcutting undesirable.

3. Shelterwood seed cut.--This is the proper prescription for mature, dense (at least 50 percent of normal density) stands on sites where clearcutting is inappropriate.

4. Shelterwood with harvest delayed until after underplanting.--Some mature stands lack an adequate understory but have too little overstory (less than 50 percent of normal density) to permit a shelterwood seed cut. If such a stand occurs on a site that is unsuitable for clearcutting, then it must be regenerated before the overstory can be removed. Usually site preparation is necessary, and sometimes cull trees must be removed.

Intermediate Conifer Stands

Intermediate conifer stands are below the age of culmination of mean annual increment, have a quadratic mean diameter of at least 8 inches, and have at least 25 percent of normal density on at least 60 percent of the area. Although normally such stands are not harvested until maturity, they may be candidates for one of the following treatments:

1. Commercial thinning.--An intermediate harvest in which excess growing stock is removed for sale. Stands that exceed the "maximum" percent of normal density (Reukema and Bruce 1977) on at least 60 percent of the area are potential candidates for this treatment.

2. Improvement cutting.--The removal of unsalable material to free crop trees from competition. Improvement cutting differs from commercial thinning in that the material removed is not marketable. Stands are candidates for this treatment if the density of competition from unmarketable trees exceeds 20 percent of normal over at least 60 percent of the area.

3. Sanitation salvage cutting.---The removal of salvable dead trees and trees expected to die within 10 years (high risk trees). When the merchantable volume in salvable dead and high risk conifer trees over 8 inches in d.b.h. exceeds 1,000 cubic feet per acre, the stand is a candidate for sanitation salvage cutting.

Conifer Regeneration Stands

These immature stands of growing stock conifers have a quadratic mean diameter of less than 8 inches and a density expected to reach 25 percent of normal on at least 60 percent of the area by the time the quadratic mean diameter of the stand is 8 inches. Such stands may be candidates for one of the following treatments:

1. Precommercial thinning.--Regeneration stands qualify for precommercial thinning: (a) if the average height of the dominant and codominant trees is between 10 and 30 ft and (b) if, on at least 60 percent of the area, the stand density is expected to exceed 75 percent of normal by the time the quadratic mean diameter of the stand reaches 8 inches. At 8 inches, normal density varies from 390 to 540 trees per acre, depending on species. The standard for smaller trees is slightly higher to account for anticipated mortality.

2. Precommercial thinning of clumps.--Stands qualify for the precommercial thinning of clumps if their density exceeds the density standard on at least 30 percent but less than 60 percent of the area and the stand otherwise qualifies for precommercial thinning.

3. Cleaning or release.--A cleaning is called for when a regeneration stand is partly stocked with brush or hardwoods. If this competition is overtopping the conifers, the treatment is called a release. The usual treatment has been with herbicidal sprays. Stands are candidates for cleaning or release when field records indicate substantial competition from brush or hardwoods on at least 60 percent of the area.

4. Preparing site and planting holes.--Sometimes regeneration stands contain nonstocked holes. If these holes make up one-third or more of the area and if competition from trees over 5 feet is absent, the nonstocked patches are suitabl[e] for spot planting, after site preparation.

5. Improvement cutting.--Regeneration stands qualify for improvement cutting when they are overtopped by hardwood and cull conifer trees that exceed 8 inches in d.b.h., and when the density of that overstory exceeds 20 percent on at least 60 percent of the area. These stands resemble stands that are candidates for overstory removal except that the overstory is composed of nonsalable material.

High-Value Hardwood Stands and High-Value Hardwood-Conifer

Mixed Stands

These stands fail to qualify as manageabl[e] conifer stands but have at least 25 percen[t] of normal density of red alder (*Alnus rubra* Bong.), black cottonwood (*Populus trichocarpa* Torr. & Gray), and conifers on at least 60 percent of the area. Although these stands are treated as opportunities to convert to conifer production, they are identified separately to identify alternative opportunities to manage for hardwo[od] production. The opportunities currently identified are the same as those listed under "Manageable Stand Absent."

Results

Manageable Stand Absent

Areas that fail to qualify as mature, intermediate, or regeneration stands are assumed to not have a manageable stand and are candidates for the following regeneration treatments:

1. Harvest cutting (clearcutting).--Stands that average at least 1,000 cubic feet per acre in conifer and high-value hardwood trees over 8 inches in d.b.h. are candidates for clearcutting.

2. Stand conversion.--Stand conversion is the removal of all existing trees and their replacement with desirable growing stock. Stands qualify for stand conversion (a) if no manageable stand is present, (b) if the volume per acre is less than 1,000 cubic feet, and (c) if at least 60 percent of the area is stocked to a density of at least 20 percent with trees that exceed 8 inches in d.b.h.

3. Site preparation and planting.--Site preparation and planting is the removal of competing vegetation and the planting of desirable conifer growing stock. Areas qualify for this treatment if they lack a manageable stand and if the density of trees over 8 inches in d.b.h. is insufficient for stand conversion.

Since the area covered by this study encompasses a wide range of climatic, topographic, and geologic conditions and has a varied fire and cutting history, the findings are presented separately for three geographic strata--northwestern, west-central, and southwestern Oregon. In addition, five owner-groups--forest industry, other private, National Forest, Bureau of Land Management, and other public--are identified.

The acres of timberland in western Oregon that are suitable for silvicultural treatment are itemized in this report. The reader should be aware, however, that these are opportunities only in the physical sense. Some treatments suggested may be too costly to be justified under today's market conditions. The economic feasibility of the treatments identified by this study cannot be determined without further screening.

Reliability of the data.--Silvicultural prescription is, of necessity, a subjective process. The procedures (MacLean 1980) are an attempt to objectify the process, but judgment still plays an important part. The readers may reject the basic assumptions listed earlier or they may accept them and still disagree with some of the prescriptions. If, however, they accept the plot prescriptions as correct, the acreages presented here are still subject to sampling errors that vary inversely with the size of the estimate. The approximate size of those sampling errors can be estimated from table 1 (see appendix).

The treatment opportunities identified in this study are as of the date of inventory. Renewable Resources Evaluation inventories were conducted in southwest Oregon in 1973-74, in west-central Oregon in 1975, and in northwest Oregon in 1976. National Forest and BLM inventories were either taken or updated between 1973 and 1976.

NORTHWEST OREGON (Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Polk, Tillamook, Washington, and Yamhill Counties)

Northwest Oregon has a cool, moist climate that is excellent for growing timber. Although well-stocked, immature stands of conifers predominate overall, mature conifer stands are extensive on Federal lands. Thus, silvicultural opportunities differ substantially between owner groups.

Figure 1.--In northwest Oregon, most forest industry-owned lands support thrifty young stands of conifers.

Forest industry lands.--Most of the lands owned by forest industry were logged during the period 1900-60, and now support thrifty young conifer stands (fig. 1). About 8 percent (fig. 2) of the area is occupied by stands that are mature by the definition used in this study, and another 6 percent could be harvested if rotation age were 50 years. About half the remaining area is well stocked with intermediate conifer stands (over 8 inches in average diameter). Because rapid growth permits relatively short rotations, many of these stands will be harvested within 20 years.

Although some opportunities for commercial thinning exist, most intermediate stands are moderately well stocked and will do well without further treatment. Productivity within the intermediate stands is high; over 80 percent of the area is devoted to conifer production. The occasional clumps of hardwood seldom are extensive enough to warrant improvement cutting.

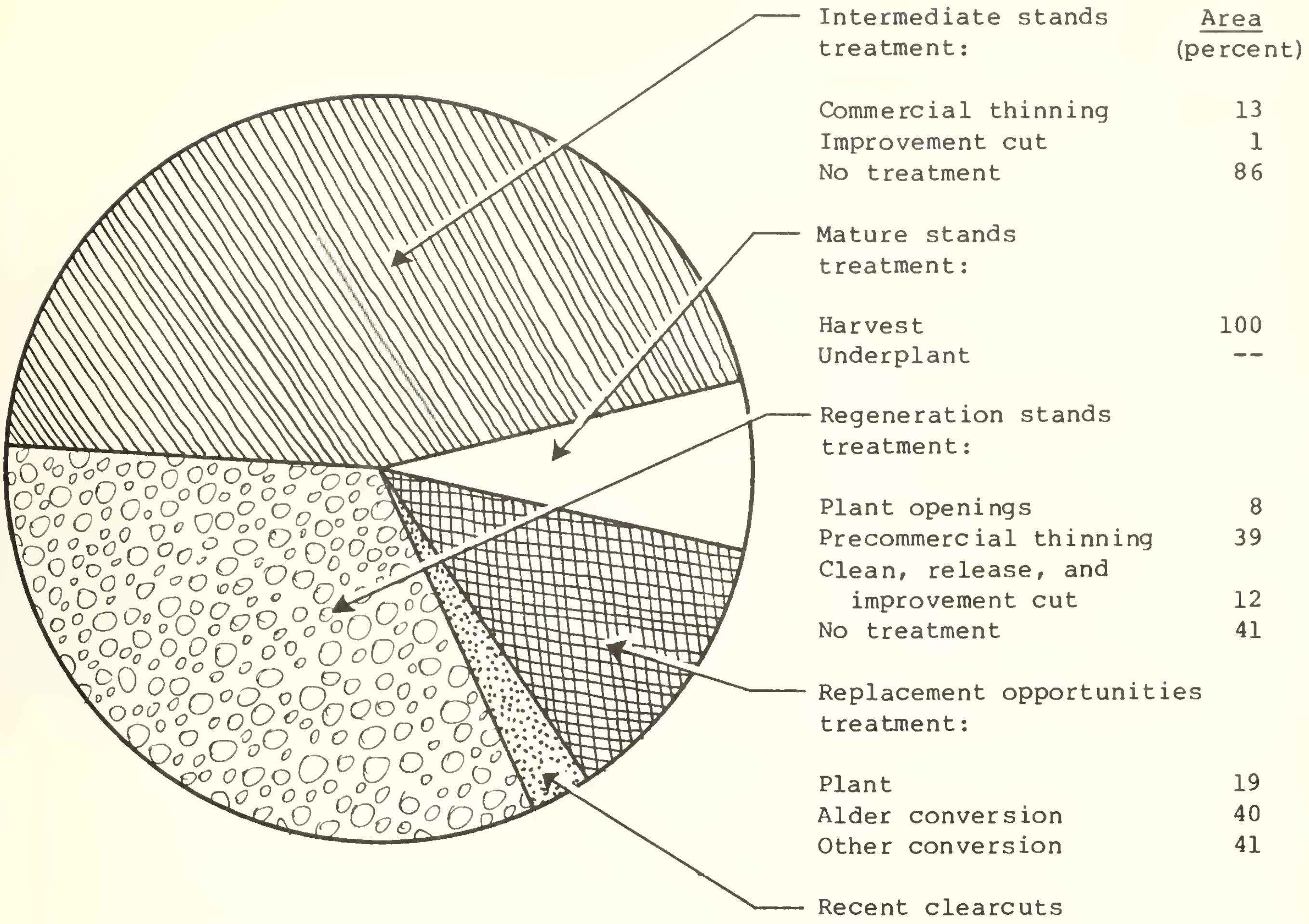


Figure 2.--Treatment opportunities on forest industry land in northwest Oregon.

Figure 3.--Red alder sometimes replaces conifers after clearcutting.

Most of the opportunities for silvicultural treatment are in the regeneration-sized stands and on areas where conifer stocking is either lacking or so poor that replacement is indicated. Generally, high-site lands where trees grow rapidly seem more likely to need precommercial thinning. On the other hand, regeneration failures are more common on the lower sites where clearcutting has occasionally converted conifer forest to hardwood type or brushland (fig. 3). The opportunities for silvicultural treatment on forest industry-owned lands in northwest Oregon are:

Treatment	Thousand acres*	Conifer occupancy (Percent)
INTERMEDIATE STANDS		
Commercial thinning	60 ± 23	90
Improvement cut	6 ± 6	70
No treatment needed	409 ± 45	74
Total and average	475 ± 45	76
MATURE STANDS		
Harvest: Clearcut	75 ± 27	84
Shelterwood: Removal cut	6 ± 6	100
Total and average	81 ± 28	85
REGENERATION STANDS		
Plant openings	28 ± 14	49
Precommercial thinning	45 ± 17	97
Improvement cut	16 ± 11	90
Precommercial thinning of clumps	93 ± 23	93
Clean and release	29 ± 13	66
No treatment needed	146 ± 27	84
Total and average	357 ± 34	84
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	20 ± 16	27
Alder conversion	43 ± 16	17
Other conversion	44 ± 19	35
Total and average	107 ± 27	26

Conifer occupancy is the percent of the area occupied by growing stock conifer trees. When conifer occupancy is less than 100 percent, the remaining area is bare ground or is growing hardwoods, brush, cull conifers, or other vegetation.

*Confidence intervals at the 0.68-probability level.

In addition to the acres available for treatment, there were 23,000 acres of recent clearcuts (cut within 5 years).

Lands owned by forest industry in northwest Oregon are generally well managed, and inventory crews found considerable evidence of recent silvicultural activity. Although study data were inadequate to determine the exact level of current activity, many treatable acres identified in this study are undoubtedly scheduled for treatment.

Other private lands.--Like forest industry lands, about 8 percent of the other private lands support mature timber (fig. 4) and another 10 percent could be harvested under a 50-year rotation. In other respects, however, the ownerships are dissimilar. Unlike forest industry lands, other private lands are frequently understocked. Overall, only 44 percent of the area available for conifer production is occupied by conifer trees, with the remaining area shared by hardwoods, brush, herbs, and grasses. While some of the hardwoods and brush patches are scattered within manageable conifer stands, almost half of the nonindustrial private acres lack the minimum conifer growing stock needed for reasonable management (fig. 5).

Although only 8 percent of the other private land is nonstocked, another 40 percent has been high graded repeatedly and now supports a scattered mixture of sawtimber-size conifers, red alder, other hardwoods, and brush. Merchantable volumes in these stands are less than 5,000 board feet per acre. These stands are currently producing only a fraction of their potential. Extensive site preparation will be needed before they can be replaced by new conifer stands.

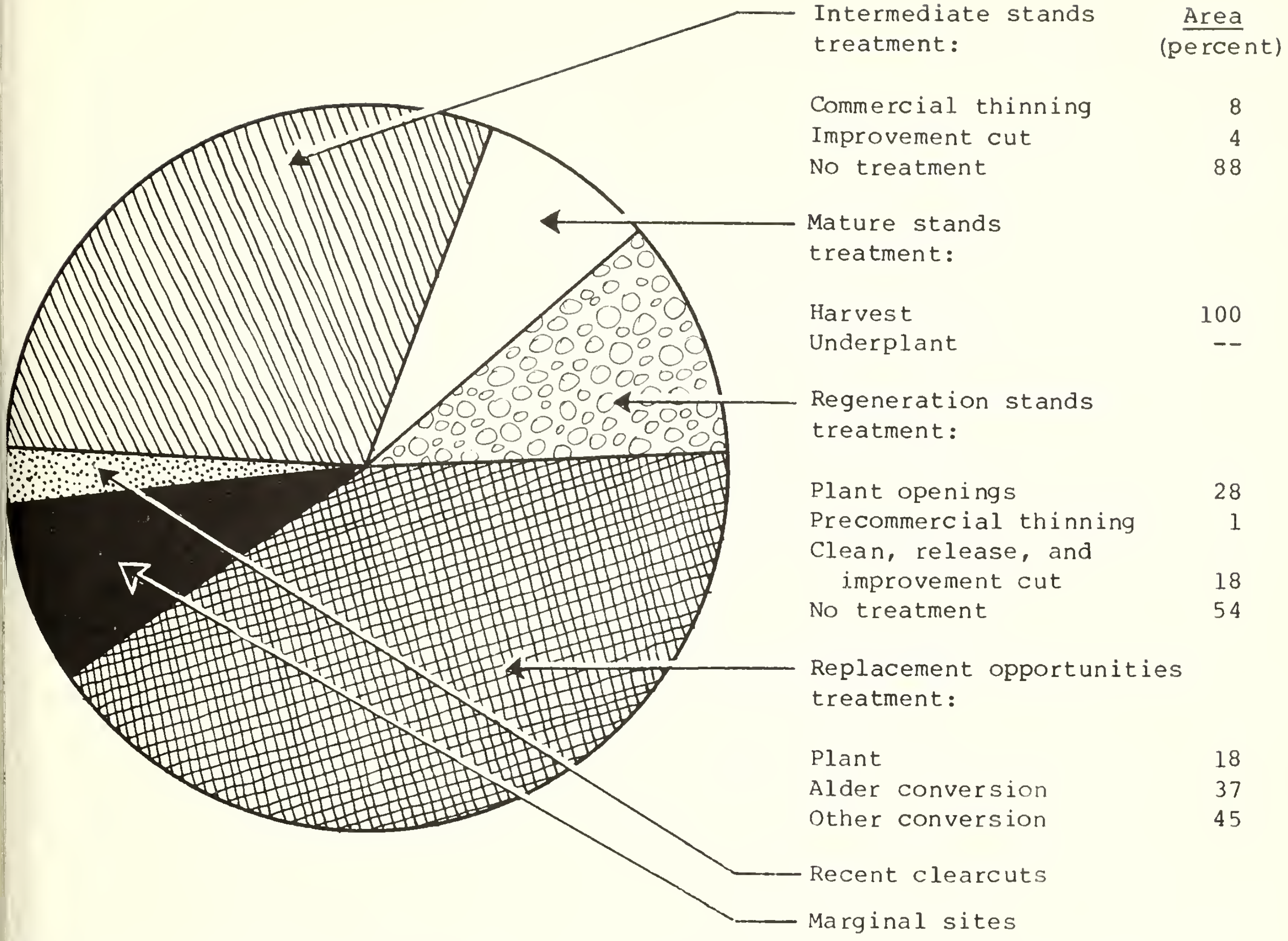


Figure 4.--Treatment opportunities on other private lands in northwest Oregon.

Figure 5.--Almost half the nonindustrial private land in northwest Oregon lacks the minimum conifer growing stock needed for reasonable management.

The opportunities for silvicultural treatment are:

Treatment	Thousand acres*	Conifer occupancy (Percent)
INTERMEDIATE STANDS		
Commercial thinning	19 ± 11	95
Improvement cut	9 ± 9	41
No treatment needed	201 ± 33	68
Total and average	229 ± 34	69
MATURE STANDS		
Harvest: Clearcut	57 ± 18	46
Total and average	57 ± 18	46
REGENERATION STANDS		
Plant openings	22 ± 13	50
Precommercial thinning	1 ± 1	100
Improvement cut	7 ± 7	54
Clean and release	7 ± 7	62
No treatment needed	43 ± 17	68
Total and average	80 ± 23	62
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	57 ± 20	17
Alder conversion	118 ± 27	12
Other conversion	141 ± 30	29
Total and average	316 ± 40	20

*Confidence intervals at the 0.68-probability level.

An additional 62,000 acres are wet bottomlands unsuitable for growing conifers; 23,000 acres are recent cutovers, assumed to be scheduled for planting.

State, county, and municipal lands.--After the devastating Tillamook fires in the 1930's and 1940's, the State of Oregon acquired title to large tracts of burned-over forest land. After burned timber was salvaged, a massive regeneration effort was undertaken. Although study results do not specifically identify the Tillamook burn, the State owns all but 50,000 acres of the non-Federal public lands in northwest Oregon, and much of that land is in the Tillamook burn (now known as the Tillamook Forest). It is evident from the study results (fig. 6) that the regeneration effort has mainly been successful; over three-quarters of the State, county, and municipal lands are growing manageable stands of conifer.

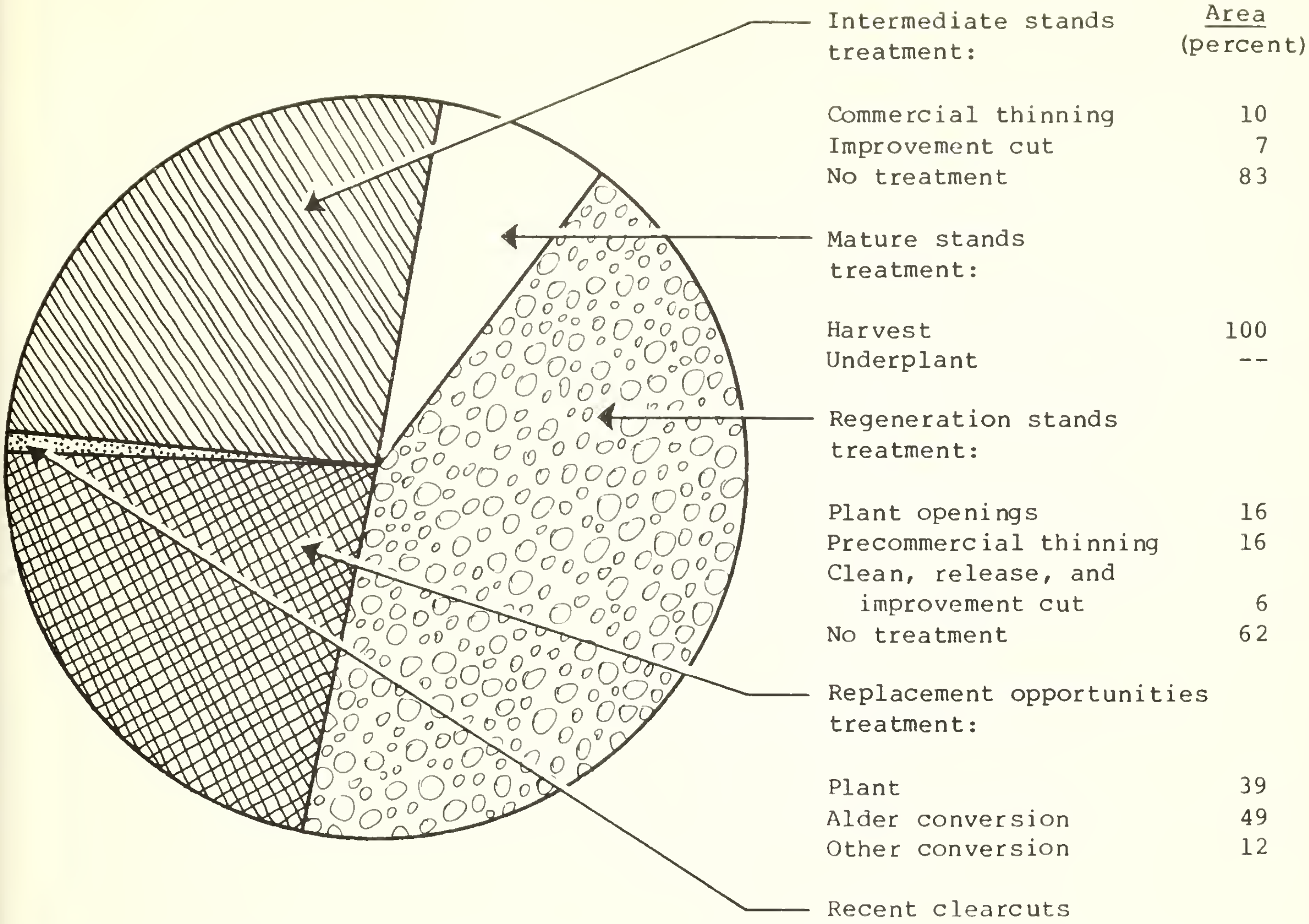


Figure 6.--Treatment opportunities on State, county, and municipal lands in northwest Oregon.

The opportunities for treatment on State, county, and municipal lands are:

Treatment*	Thousand acres**	Conifer occupancy (Percent)
INTERMEDIATE STANDS		
Commercial thinning	16 ± 12	93
Improvement cut	11 ± 11	38
No treatment needed	127 ± 31	77
Total and average	154 ± 34	76
MATURE STANDS		
Harvest: Clearcut	42 ± 15	92
Total and average	42 ± 15	92
REGENERATION STANDS		
Plant openings	38 ± 17	48
Precommercial thinning	20 ± 12	87
Improvement cut	15 ± 11	60
Precommercial thinning of clumps	20 ± 12	92
Clean and release	--	--
No treatment needed	149 ± 30	82
Total and average	242 ± 32	77
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	51 ± 19	20
Alder conversion	63 ± 21	10
Other conversion	16 ± 12	39
Total and average	130 ± 25	17

*Neither economic feasibility nor practical operational considerations, such as poor access and adverse topography, have been considered in assigning these treatments. The Oregon State Department of Forestry has completed an intensive rehabilitation program on the Tillamook forest. They believe that most of the opportunities identified here are infeasible because of cost, operational difficulty, or environmental restraints.

**Confidence intervals at the 0.68-probability level.

Only one field plot (representing 7,000 acres) was in a recent clearcut.

Federal timberlands.--Although only about one-third of the timberland in northwest Oregon is owned by the Federal Government, that land includes 80 percent of the mature timber in the area (fig. 7). National Forest land, in particular, is characterized by older stands: 63 percent of the area is in mature timber, and another 20 percent is occupied by intermediate stands. As a result, silvicultural treatment opportunities other than harvest cut are limited, primarily to commercial thinning.

About 200,000 acres of Federal land have been clearcut and two-thirds of these have been successfully regenerated. The remaining one-third are evenly divided between recent cutovers scheduled for planting and regeneration failures.

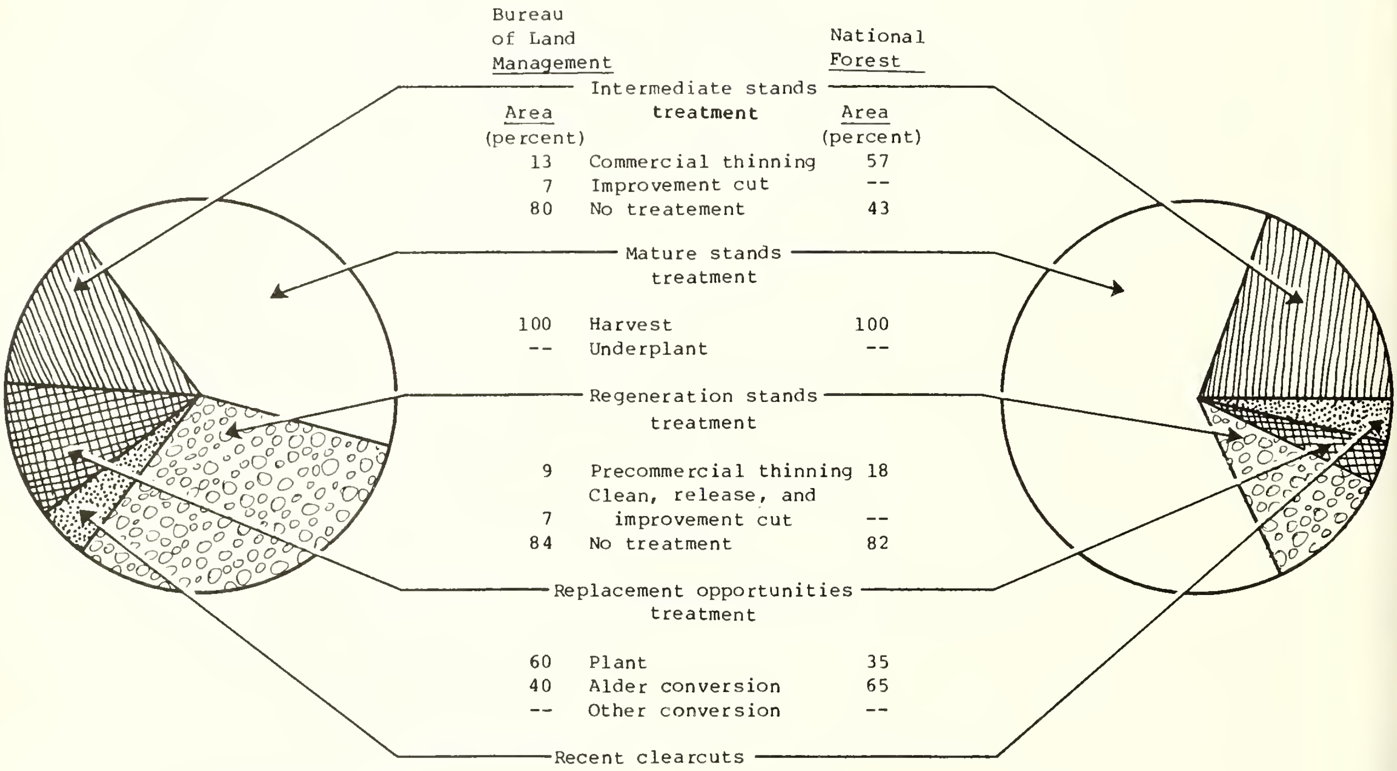


Figure 7.--Treatment opportunities on Federal land in northwest Oregon.

Treatment opportunities on Federal lands are:

	National Forest	Bureau of Land Management
	(Thousand acres*)	
INTERMEDIATE STANDS		
Commercial thinning	104 ± 14	4 ± 1
Improvement cut	--	2 ± 1
No treatment needed	78 ± 11	24 ± 3
Total	182 ± 16	30 ± 3
MATURE STANDS		
Harvest: Clearcut	552 ± 25	91 ± 5
Shelterwood: Removal cut	37 ± 17	--
Total	589 ± 25	91 ± 5
REGENERATION STANDS		
Precommercial thinning	18 ± 6	6 ± 1
Improvement cut	--	1 ± 1
Clean and release	--	4 ± 1
No treatment needed	3/ 82 ± 11	3/ 59 ± 4
Total	100 ± 14	70 ± 5
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	12 ± 5	15 ± 3
Alder conversion	22 ± 6	10 ± 2
Other conversion	--	--
Total	34 ± 8	25 ± 3

Data on conifer occupancy are unavailable for federally owned lands.

3/ Two treatments--"Plant openings" and "Precommercial thinning of clumps"--could not be identified because of the small size of the plot.

*Confidence intervals at the 0.68-probability level.

WEST-CENTRAL OREGON (Benton, Lane, Lincoln, and Linn Counties)

The climate of west-central Oregon is slightly hotter and drier than that of northwest Oregon, and the immature stands in the area are younger than those farther north--reflecting a more recent logging history. The area is potentially as productive as northwest Oregon and is less subject to hardwood incursion on conifer sites. The hotter climate, however, increases the risk of regeneration failure, particularly in the southern Willamette Valley.

Forest industry lands.--Lands owned by forest industry in west-central Oregon are predominantly conifer regeneration (figs. 8 and 9). Only one-third of the ownership supports stands larger than 8 inches in average diameter and 60 percent of that is less than 50 years old. About 70 percent of the remaining area has been regenerated successfully, and one-third of these regeneration stands would benefit from precommercial thinning.

There are still substantial opportunities to increase timber production through planting and stand conversion activities. Almost 200,000 acres of good timber-growing land is currently either unproductive or growing alder--a species that is both less productive and less marketable. The cost of putting these acres into production may be quite high, but the return is potentially more than 26 million cubic feet per year.

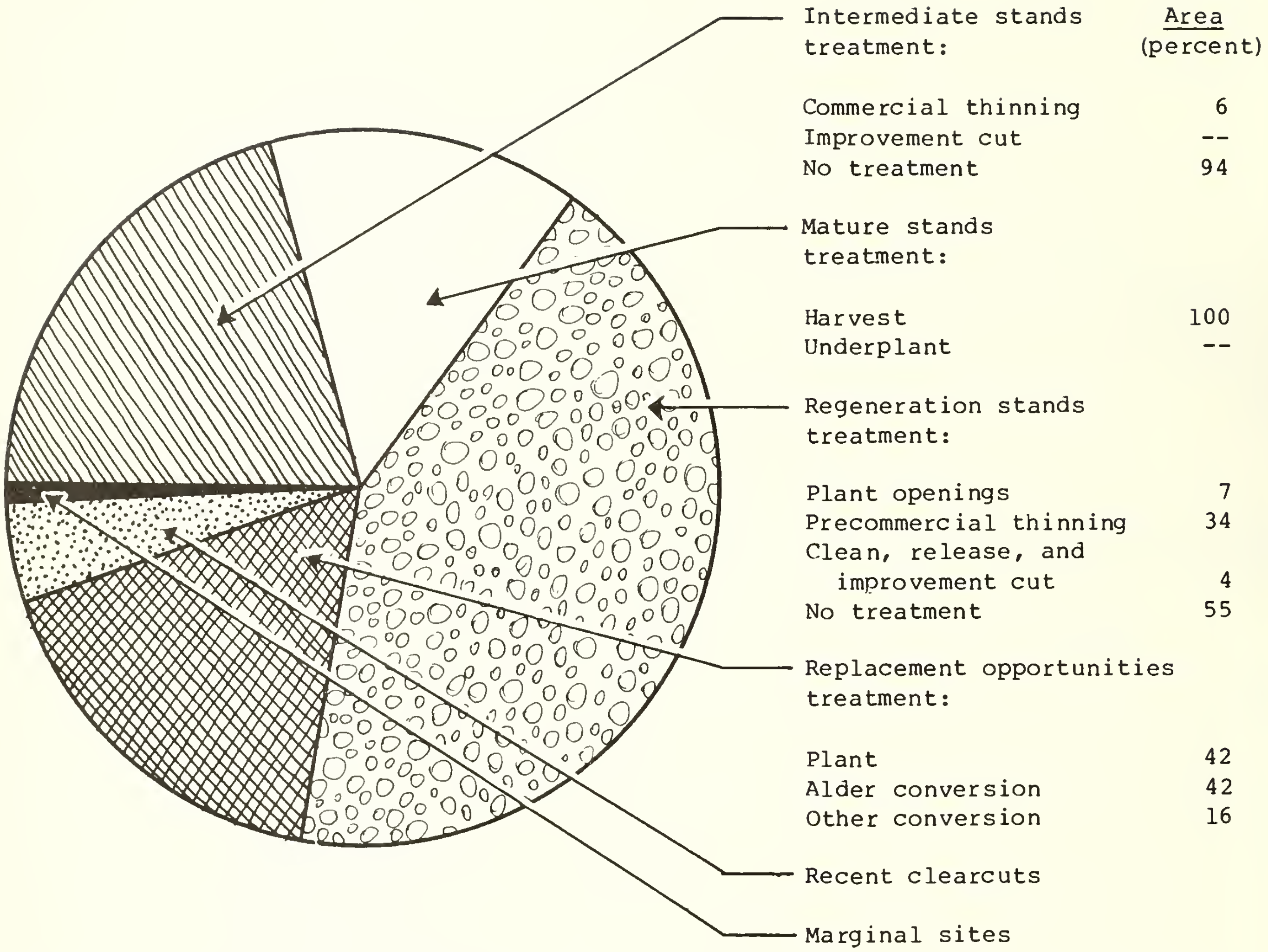


Figure 8.--Treatment opportunities on forest industry lands in west-central Oregon.

Figure 9.--Forest industry lands in west-central Oregon are predominantly stocked with conifer regeneration.

A detailed list of the opportunities for silvicultural treatment on lands owned by forest industry in west-central Oregon follows:

Treatment	Thousand acres*	Conifer occupancy
		(Percent)
INTERMEDIATE STANDS		
Commercial thinning	12 ± 12	100
Improvement cut	--	--
No treatment needed	205 ± 36	75
Total and average	217 ± 37	76
MATURE STANDS		
Harvest: Clearcut	150 ± 25	81
Shelterwood: Removal cut	6 ± 6	97
Total and average	156 ± 26	82
REGENERATION STANDS		
Plant openings	31 ± 16	51
Precommercial thinning	81 ± 25	79
Improvement cut	14 ± 10	64
Precommercial thinning of clumps	82 ± 28	86
Clean and release	7 ± 7	80
No treatment needed	258 ± 43	80
Total and average	473 ± 47	78
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	79 ± 23	17
Alder conversion	79 ± 20	14
Other conversion	30 ± 12	37
Total and average	188 ± 39	19

An additional 55,000 acres of recent clear-cuts are probably scheduled for planting. There are an estimated 6,000 acres of hardwood site that are unsuitable for growing conifers.

Other private lands.--Only 8 percent of the other private lands in west-central Oregon support mature timber stands. Intermediate stands account for 30 percent of the area; about one-quarter of these are over 50 years in age.

*Confidence intervals at the 0.68-probability level.

Conifer regeneration is somewhat more extensive on the other private lands of west central Oregon than on similar lands to the north (fig. 10). The reason, however, is not better management but an environment where hardwood encroachment on conifer sites is less common. Still, most of the opportunity for silvicultural activity lies in the planting of nonstocked areas and unproductive stands that theoretically could be growing 33 million cubic feet of wood per year. A list of the opportunities for silvicultural treatment on the other private lands of west-central Oregon follows:

Treatment	Thousand acres*	Conifer occupancy (Percent)
INTERMEDIATE STANDS		
Commercial thinning	12 ± 12	100
Improvement cut	5 ± 5	50
No treatment needed	191 ± 36	77
Total and average	208 ± 34	78
MATURE STANDS		
Harvest: Clearcut	58 ± 20	67
Total and average	58 ± 20	67
REGENERATION STANDS		
Plant openings	19 ± 14	53
Precommercial thinning	18 ± 13	90
Improvement cut	10 ± 7	70
Precommercial thinning of clumps	9 ± 9	71
Clean and release	--	--
No treatment needed	91 ± 28	75
Total and average	147 ± 35	73
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	106 ± 31	18
Alder conversion	58 ± 18	7
Other conversion	88 ± 25	33
Total and average	252 ± 39	21

*Confidence intervals at the 0.68-probability level.

An additional 37,000 acres of commercial forest land were classed as marginal. Typically, these marginal acres are: (1) hardwood bottomlands incapable of growing conifers; (2) hot, dry sites--frequently with shallow soil, where productivity is low, regeneration difficult, and management infeasible; or (3) serpentine soil types, where soil toxicity prevents establishment of productive stands.

State, county, and municipal lands.--These government agencies own only about 100,000 acres of timberland in west-central Oregon--about evenly divided between mature and intermediate stands. Opportunities for silvicultural treatment are too small to be accurately assessed from the relatively extensive sample taken for this study. The estimated acreages of treatment opportunities are listed below. From these statistics, the reader can infer that some opportunities for thinning and stand conversion exist; but little reliance should be placed on the exact acreage shown.

Treatment	Thousand acres*	Conifer occupancy (Percent)
INTERMEDIATE STANDS		
Commercial thinning	9 ± 9	93
No treatment needed	39 ± 18	81
Total and average	48 ± 20	83
MATURE STANDS		
Harvest: Clearcut	45 ± 21	76
Total and average	45 ± 21	76
REGENERATION STANDS		
Alder conversion	8 ± 8	27
Other conversion	8 ± 8	35
Total and average	16 ± 10	31

*Confidence intervals at the 0.68-probability level.

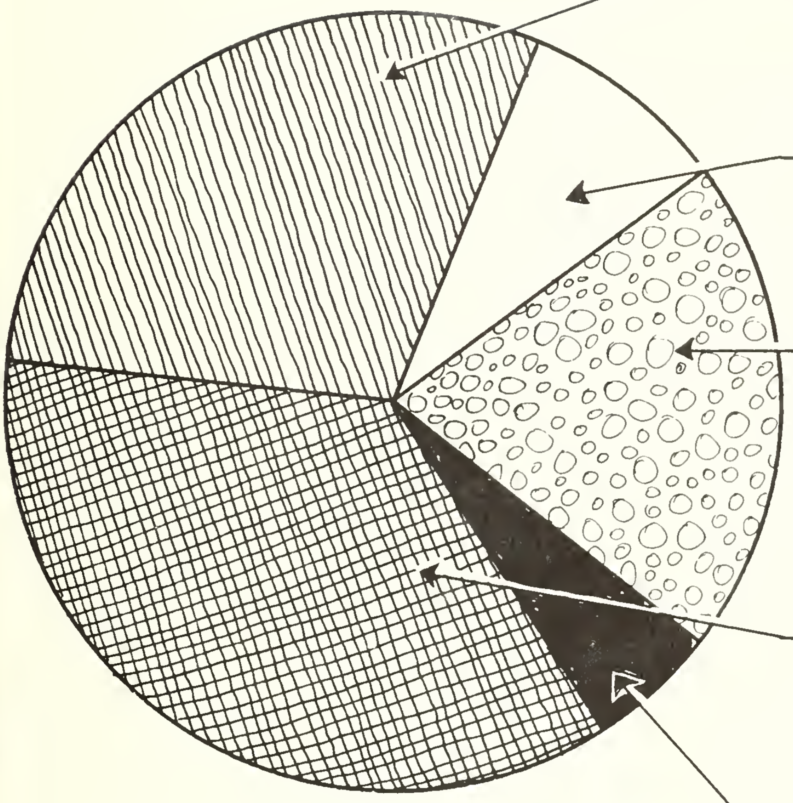


Figure 10.--Treatment opportunities on other private lands in west-central Oregon.

Federal timberlands.--National Forests contain 40 percent of the timberland in west-central Oregon, and the BLM administers another 10 percent (fig. 11). Two-thirds of the National Forest land and over 40 percent of the BLM land is occupied by mature forests (fig. 12) which offer little opportunity for silvicultural activity except scheduled harvest. Substantial opportunities for commercial thinning, however, were found on the 192,000 acres of intermediate forest land that is federally owned. These intermediate stands, unlike those on private land, originated almost entirely from fire and are quite densely stocked.

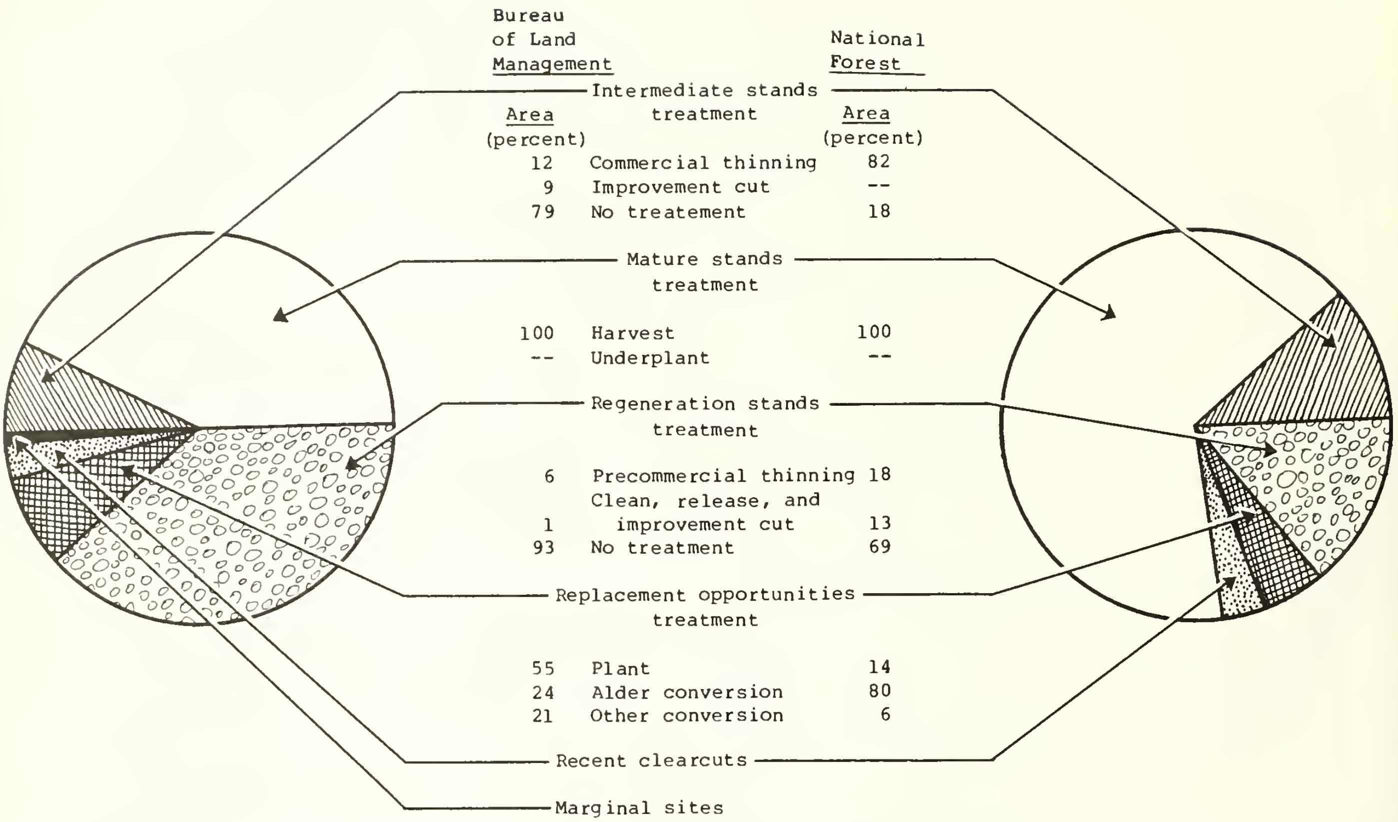


Figure 11.--Opportunities for treatment on Federal land in west-central Oregon.

Over 400,000 acres of the Federal forest land in west-central Oregon have been clearcut. If recent clearcuts are excluded over 90 percent of the area is now growing conifers. An additional 75,000 acres, mostly on National Forest land, are conife sites that are now growing intermediate and mature red alder. Although the alder stands on private lands usually originated after clearcutting, those on Federal land are nearly all of natural origin. Conversion would substantially increase timbe production, but conflict with nontimber use could restrict this activity.

Figure 12.--Mature forests predominate on Federal land.

Treatment opportunities on Federal forest land in west-central Oregon are as follows:

	National Forest	Bureau of Land Management
	(Thousand acres*)	
INTERMEDIATE STANDS		
Commercial thinning	134 ± 15	4 ± 2
Improvement cut	--	3 ± 2
No treatment needed	30 ± 7	27 ± 4
Total	164 ± 16	34 ± 5
MATURE STANDS		
Harvest: Clearcut	1,069 ± 25	
Shelterwood: Seed cut	6 ± 3	
Regenerate: underplant shelterwood	2 ± 2	186 ± 9
Total	1,077 ± 25	186 ± 9
REGENERATION STANDS		
Precommercial thinning	44 ± 9	10 ± 3
Improvement cut	23 ± 6	1 ± 1
Clean and release	9 ± 4	2 ± 2
No treatment needed	4/ 171 ± 16	4/ 155 ± 8
Total	247 ± 19	168 ± 5
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	12 ± 5	18 ± 3
Alder conversion	66 ± 10	8 ± 2
Other conversion	5 ± 3	7 ± 2
Total	83 ± 12	33 ± 5

4/ Two treatments--"Plant openings" and "Precommercial thinning of clumps"--could not be identified because of the small size of the plot.

*Confidence intervals at the 0.68-probability level.

An additional 76,000 acres that were recently clearcut are scheduled for planting.

SOUTHWEST OREGON (Coos, Curry, Douglas, Josephine, and Jackson Counties)

Southwest Oregon provides a transition between the cool, moist Douglas-fir forest of the Northwest and the more arid mixed-conifer forests of California. The forests of this region are generally less even-aged than those farther north and are more often of mixed species. In the Siskiyou Mountains, evergreen hardwoods form an important part of most stands and often provide shade for conifer seedlings. Douglas-fir seedlings, which thrive on bare clearcuts in northwest Oregon, cannot always survive without shade on the hotter and drier sites of southwest Oregon (fig. 13).

Figure 13.--Douglas-fir seedlings, which thrives on bare clearcuts in northwest Oregon, cannot always survive without shade on the hotter and drier of the southwest Oregon sites.

Logging began later in southwest Oregon than in other parts of the State, and clearcuts are of more recent origin. Thus, intermediate stands make up less than 8 percent of the total forest. Most stands are either mature or regeneration-size, and a substantial area of unregenerated clearcuts remains. Many owners have now switched to shelterwood cutting, in the hope of avoiding future regeneration failures.

Forty-five percent of western Oregon's commercial forest land lies in southwest Oregon. Potentially, the area could supply more than one-third of western Oregon's timber, but environmental problems will make that goal difficult to achieve.

Forest-industry-owned lands.--One-third of the lands owned by forest industry in southwest Oregon support mature or intermediate conifer stands. Almost 80 percent of these stands are over 70 years old, and another 8 percent are more than 50 years old. A high proportion of these lands in southwest Oregon, however, would benefit from silvicultural treatment. Many acres have been cutover for 20 years or more and are now completely occupied by hardwoods and brush. About one-quarter of the industry-owned lands will produce little conifer timber unless they are planted or converted to conifer type (fig. 14). Some of these lands were repeatedly burned by previous owners in the vain hope of encouraging grass for fodder (fig. 15). Rehabilitation may be costly and difficult, but the potential return could be as much as 55 million cubic feet per year. There is, of course, no guarantee that all treatments will succeed.

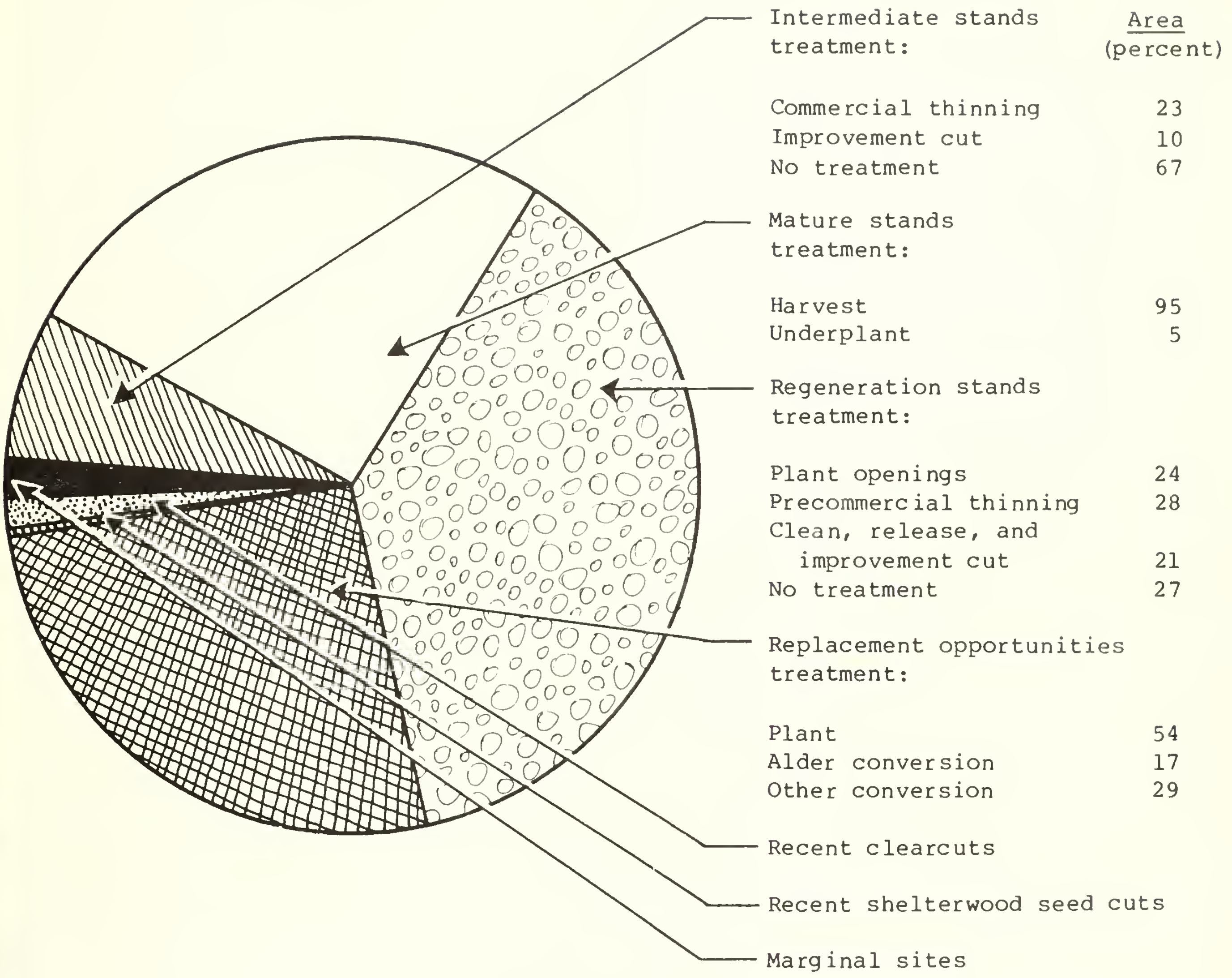


Figure 14.--Treatment opportunities on forest-industry-owned land in southwest Oregon.

Figure 15.--Some lands have been subjected to repeated fires to encourage grass for fodder.

Two-thirds of the regenerated stands have too many conifer trees, too many competing shrubs and hardwood trees, or large holes devoid of conifer reproduction. Treatment of these acres could substantially increase timber production. About 25 percent of the area was, at the time of inventory, still occupied by mature timber--mostly old growth. Care in the harvesting of this timber may reduce the cost of future treatments.

A detailed list of the opportunities for silvicultural treatment on forest-industry-owned lands follows:

Treatment	Thousand acres*	Conifer occupanc
		(Percent
INTERMEDIATE STANDS		
Commercial thinning	27 ± 12	81
Improvement cut	12 ± 9	46
No treatment needed	80 ± 19	69
Total and average	119 ± 25	69
MATURE STANDS		
Harvest: Clearcut	241 ± 30	78
Shelterwood:		
Removal cut	36 ± 15	80
Seed cut	111 ± 26	79
Regenerate:		
Underplant shelterwood	19 ± 10	72
Total and average	407 ± 40	78
REGENERATION STANDS		
Plant openings	152 ± 24	53
Precommercial thinning	153 ± 24	82
Improvement cut	44 ± 17	58
Precommercial thinning of clumps	25 ± 13	82
Clean and release	88 ± 20	67
No treatment needed	176 ± 30	82
Total and average	638 ± 38	71
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	228 ± 29	27
Alder conversion	73 ± 20	16
Other conversion	128 ± 23	34
Total and average	429 ± 38	26

*Confidence intervals at the 0.68-probability level.

There are 20,000 acres of recent clearcut. Another 26,000 acres were considered marginal because the poor site and hot dry climate or serpentine soils made management for timber production difficult or impossible.

Other private lands.--Other private lands in southwest Oregon typically have a moderate to low potential productivity and a deficiency of growing stock. Two-thirds of the area has been clearcut, and most of the remaining land has been partially cut (fig. 16). Although some land has restocked, half the clearcut area still lacks a manageable conifer stand (fig. 17).

Over 150,000 acres of other private land in southwest Oregon are "tough sites" that are difficult to regenerate and have a low productive potential. About two-thirds of this area has been logged and now supports only brush and grass. The hot, dry climate makes successful regeneration of these areas unlikely. The low productive potential--about 50 cubic feet per acre per year after successful regeneration--will probably discourage anyone from trying. I have classed these acres as marginal and excluded them from the list of opportunities for silvicultural treatment.

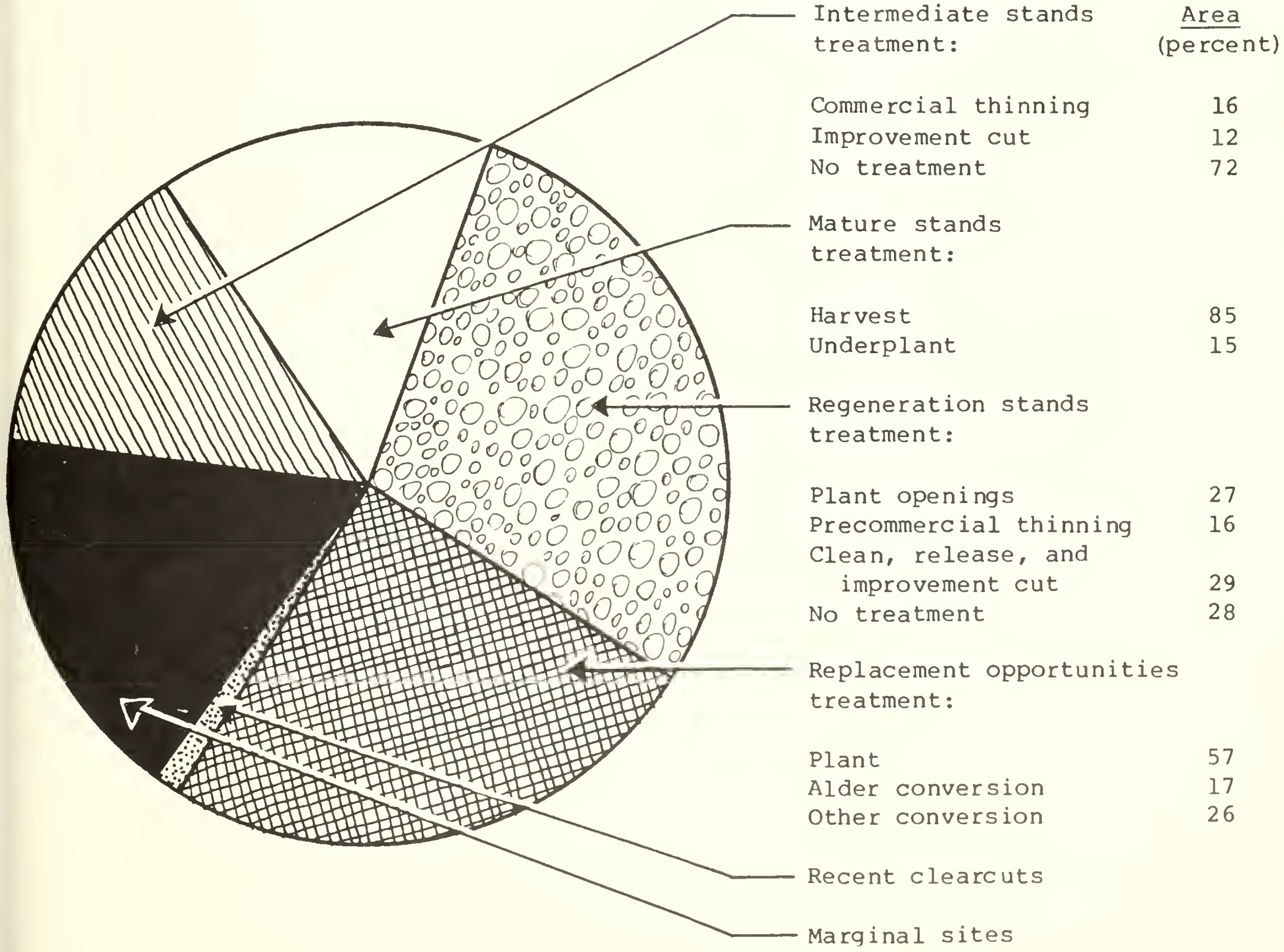


Figure 16.--Treatment opportunities on other private land in southwest Oregon.

Figure 17.--Half the clearcut area on other private lands in southwest Oregon lacks a manageable conifer stand.

After the tough sites are excluded, there remain 243,000 acres with a potential productivity of 25 million cubic feet per year that need planting or stand conversion. Another 74,000 acres of conifer reproduction intermixed with patches of brush are producing at half their capability. Finally, there are 21,000 acres of low-density residual mature stands growing on sites that are unsuited to clearcutting and should be underplanted before further harvest. In all these cases, treatment will be difficult and with substantial risk of failure.

A complete list of opportunities for silvicultural treatment on other private lands follows:

Treatment	Thousand acres*	Conifer occupanc
		(Percent
INTERMEDIATE STANDS		
Commercial thinning	9 ± 6	90
Improvement cut	25 ± 11	57
No treatment needed	88 ± 20	73
Total and average	122 ± 23	71
MATURE STANDS		
Harvest: Clearcut	68 ± 18	63
Shelterwood:		
Removal cut	18 ± 9	63
Seed cut	39 ± 13	66
Regenerate:		
Underplant shelterwood	21 ± 9	59
Total and average	146 ± 24	63
REGENERATION STANDS		
Plant openings	74 ± 18	49
Precommercial thinning	43 ± 18	88
Improvement cut	50 ± 16	54
Precommercial thinning of clumps	--	--
Clean and release	31 ± 13	61
No treatment needed	76 ± 18	77
Total and average	274 ± 32	65
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	144 ± 26	23
Alder conversion	42 ± 15	18
Other conversion	63 ± 15	24
Total and average	249 ± 31	23

*Confidence intervals at the 0.68-probability level.

In addition, there are 160,000 acres of marginal lands and 7,000 acres of recent clearcut.

State, county, and municipal lands.--These lands are quite diverse and the treatment opportunities reflect this diversity. Although most acres would benefit from some form of silvicultural treatment, the treatment needs vary greatly (fig. 18). About 10 percent of the area needs planting, and an additional 10 percent could produce substantially more conifer volume if nonstocked holes were planted. In addition, 15,000 acres of natural alder stands could be converted to conifer production, provided treatment does not conflict with other uses.

Opportunities for silvicultural treatment on State, county, and municipal lands in southwest Oregon are:

Treatment	Thousand acres*	Conifer occupancy (Percent)
INTERMEDIATE STANDS		
Commercial thinning	9 ± 8	98
Improvement cut	--	--
No treatment needed	21 ± 8	72
Total and average	30 ± 12	80
MATURE STANDS		
Harvest: Clearcut	40 ± 16	76
Shelterwood: Removal cut	4 ± 4	74
Regenerate:		
Underplant shelterwood	4 ± 4	29
Total and average	48 ± 18	63
REGENERATION STANDS		
Plant openings	17 ± 8	57
Precommercial thinning	15 ± 8	80
Improvement cut	11 ± 9	47
Precommercial thinning of clumps	--	--
Clean and release	9 ± 6	49
No treatment needed	6 ± 6	100
Total and average	58 ± 16	64
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	18 ± 8	9
Alder conversion	15 ± 10	22
Other conversion	--	--
Total and average	33 ± 14	15

In addition to the above, there were 8,000 acres of hardwood site.

*Confidence intervals at the 0.68-probability level.

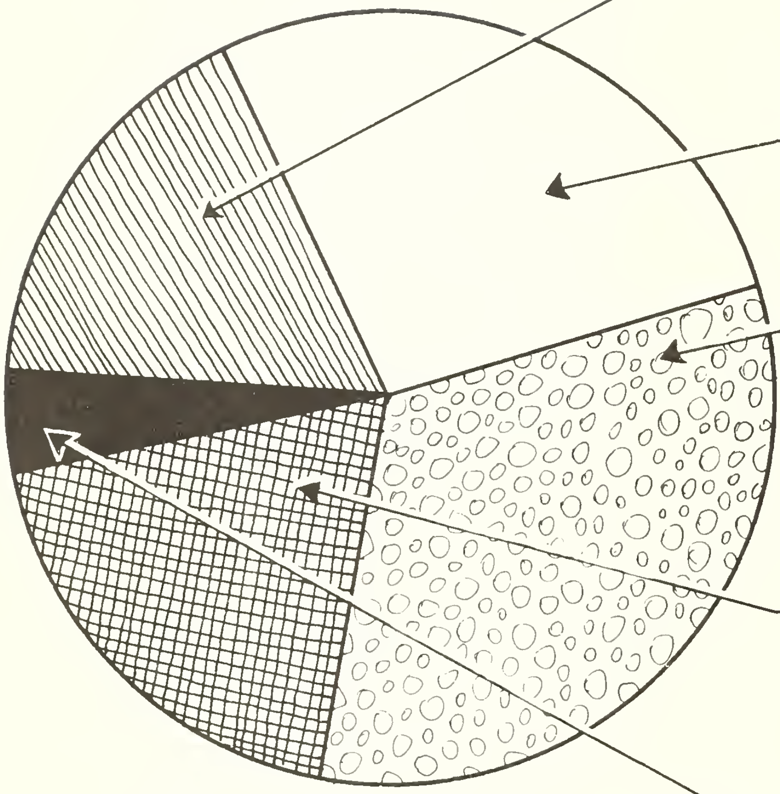


Figure 18.--Treatment opportunities on "other public" lands in southwest Oregon.

Federally-owned land.--Although about two-thirds of the federally owned timberland in southern Oregon supports mature timber (fig. 19), only slightly over one-half of it is suitable for clearcutting. The other half lies in the southern interior portion of the region where clearcutting often leads to regeneration failure.[5] Over 157,000 acres of BLM land is marginal for timber production because of low productive potential and extreme regeneration hazard. The BLM has excluded these acres from consideration as opportunities for silvicultural treatment because of low yield and high risk of treatment failure. I have assumed that the remaining 40 percent of the mature timber is suitable for shelterwood management--recognizing that the risk of regeneration failure is greater here than in other parts of western Oregon.

[5] Waring, R. H., K. N. Johnson, and W. H. Emmingham. 1974. Tough site management: A discussion of timber management on public land in southwestern Oregon. Unpublished manuscript on file at Oregon State University, Corvallis.

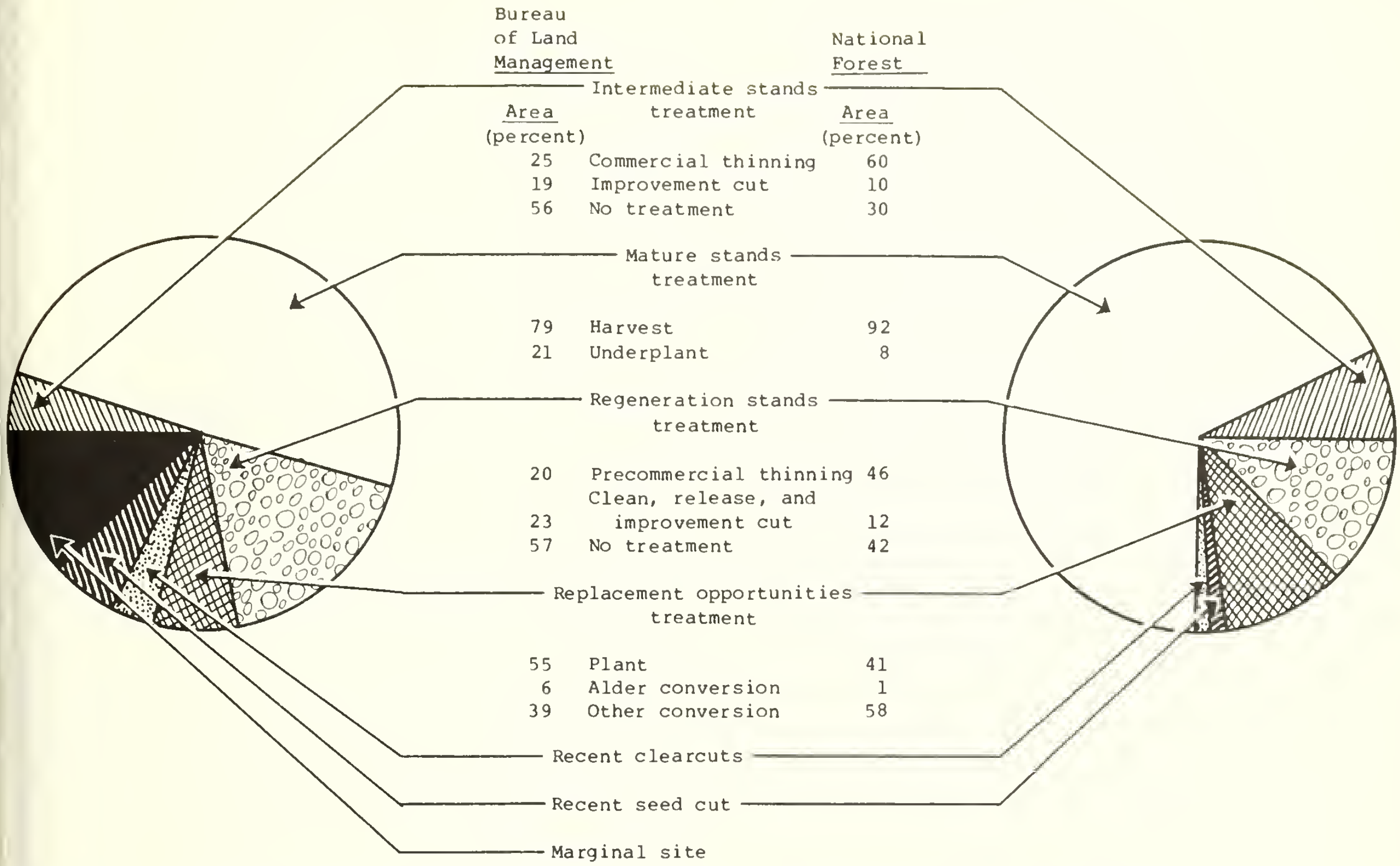


Figure 19.--Treatment opportunities on federally owned land in southwest Oregon.

Only two-thirds of the mature timber suitable for shelterwood management is available for immediate harvest. The remaining 350,000 acres are too lightly stocked with conifers to permit further cutting until adequate regeneration has been obtained. About 100,000 acres of this area has been recently logged and is omitted from the list of treatment opportunities. The remaining 250,000 acres should be underplanted before further harvest is attempted.

Intermediate stands are almost absent on Federal lands in southwest Oregon, but logging and fires have created almost 500,000 acres of regeneration-size stands and an additional 350,000 acres of stand conversion opportunities. An estimated 500,000 acres of Federal land has been clearcut; 80 percent of that area has restocked with conifer, the remainder growing either brush or hardwoods. An additional 127,000 acres of regeneration and 60,000 acres of planting opportunities probably are of fire origin. Finally, there are 112,000 acres of intermediate-size hardwood stands growing on sites that could support conifer. Conversion of these stands would increase timber production, but the impact of such conversion on other resource values is beyond the scope of this study.

Conclusions

Opportunities for silvicultural treatment on federally owned land areas are:

	National Forest	Bureau of Land Management
	(Thousand acres*)	
INTERMEDIATE STANDS		
Commercial thinning	92 ± 13	16 ± 4
Improvement cutting	15 ± 5	12 ± 3
No treatment needed	46 ± 9	36 ± 6
Total	153 ± 15	64 ± 8
MATURE STANDS		
Harvest: clearcut	840 ± 30	372 ± 18
Shelterwood:		
overstory removal cut	145 ± 15	28 ± 6
seed cut	283 ± 21	121 ± 11
Regenerate:		
underplant shelterwood	108 ± 14	139 ± 12
Total	1,376 ± 28	660 ± 20
REGENERATION STANDS		
Precommercial thinning	116 ± 14	48 ± 7
Improvement cutting	31 ± 8	11 ± 4
Clean and release	--	46 ± 7
No treatment needed	[6]105 ± 13	[6]140 ± 12
Total	252 ± 20	245 ± 15
REPLACEMENT OPPORTUNITIES		
Site preparation and plant	80 ± 12	48 ± 7
Alder conversion	2 ± 1	5 ± 2
Other conversion	112 ± 14	35 ± 6
Total	194 ± 19	88 ± 10

[6] Two treatments--"plant openings" and "precommercial thinning of clumps"--could not be identified because of the small size of the plot.

*Confidence intervals at the 0.68-probability level.

In the short run, timber supply in western Oregon will come from the 8 million acres of timberland that now support stands of mature and intermediate-size conifers. Although these stands present some opportunities for commercial thinning and improvement cutting, such practices can have only minor impact on yield. Thus, most of the opportunities to increase timber yields are found in the regeneration-size stands and in the nonstocked areas. The impacts of such treatments on timber supply are potentially large, but the direct effects will not be felt for at least three decades.

There are 13.5 million acres (table 6) of timberlands in western Oregon, and only 8 million of them support merchantable stands of conifers. The remaining 5.5 million acres will not contribute to timber supply for at least 30 years, but they will become increasingly important thereafter. The size of the timber yield from these young stands and nonstocked areas will depend on the silvicultural investment made during the next few years. The fate of 2.2 million acres of timber that do not now support a manageable conifer stand will be particularly important. These acres are not totally unproductive, since about 800,000 of them are growing hardwood stands and the other 1.4 million support scattered conifers and hardwoods. Still, the potential timber production from present growing stock is but a fraction of the 250 million cubic feet per year of timber that could be grown if the area were fully stocked with conifers.

I am not suggesting that all these acres can or should be treated. The bulk of the nonstocked area is in southwest Oregon where rehabilitation will be both difficult and expensive. Furthermore, the conversion of hardwood stands may not be environmentally desirable or even possible in all cases. Even so, the large areas of brushland, "junk conifer," and hardwoods in western Oregon represent a substantial opportunity to increase future timber supply (fig. 20) through investment in site preparation, stand conversion, and planting.

Figure 20.--Large areas of brushland and hardwoods represent a substantial opportunity to increase future timber supplies.

In the long run, timber supply will depend on regeneration success on the 300,000 acres of recent cutover and on the new cutover lands that are created each year. Present backlogs of unregenerated land attest to the inadequacy of past efforts. Declining timber supply, rising prices, and a new Oregon Forest Practices Act all have encouraged both public and private owners to increase their investment in regeneration. Better planting stock, new technology, and experience gained from past mistakes should all contribute to higher survival. The next Resources Evaluation inventory of western Oregon, scheduled for the mid-1980's, should provide a measure of the success of these efforts.

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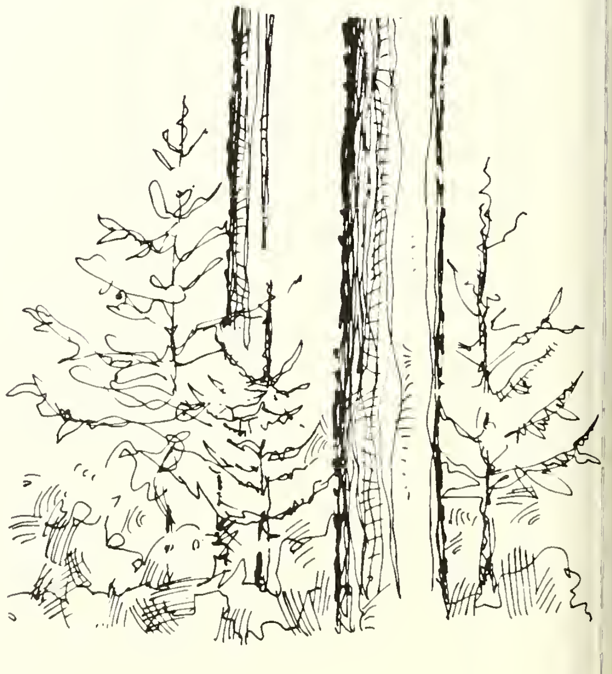

Appendix

Table 1--Approximate confidence intervals for estimates of various sizes in tables 3-6[1]

Area	Private and other public lands	National Forest	Bureau of Land Management
	Thousand acres (±)		
1,000	60	24	17
800	55	25	18
600	49	25	18
400	42	23	16
200	31	17	12
100	23	13	9
50	17	9	6
25	12	7	5
15	10	5	4
10	8	4	3

[1]Confidence intervals at the 0.68-probability level.

Table 2--Condition of clearcut lands in western Oregon, by owner group[1]
(Thousand acres)

Management condition	Forest industry	Other private	Other public	National Forest	Bureau of Land Management	Total
Manageable intermediate stand	533	314	100	7	21	975
Manageable regeneration stand	1,407	384	105	425	436	2,757
Manageable stand absent	720	707	74	73	105	1,679
Marginal land (manageable stand absent)	0	79	0	0	1	80
Recent clearcuts	105	24	7	113	69	318
Total	2,734	1,539	286	618	632	5,809

[1]Estimates are subject to sampling error. See table 1.

Table 3--Area of treatment opportunities on high sites[1] in western Oregon, by owner group[2]

(Thousand acres)

Type of stand and treatment	Forest industry	Other private	Other public	National Forest	Bureau of Land Management	Total
Mature:						
Harvest--clearcut	204	43	37	359	127	770
Shelterwood (cut)	10	0	4	24	9	47
Regenerate--shelterwood (underplant)	0	0	0	4	12	16
Total	214	43	41	387	148	833
Intermediate:						
Commercial thinning	48	0	0	43	5	96
Improvement cut	0	0	11	0	0	11
No treatment	168	95	44	11	6	324
Total	216	95	55	54	11	431
Regeneration:						
Plant openings	21	5	14	[3]	[3]	40
Precommercial thinning	27	6	0	36	4	73
Improvement cut	0	0	0	5	0	5
Precommercial thinning of clumps	71	0	0	[3]	[3]	71
Clean and release	22	5	0	0	5	32
No treatment	75	20	20	63	33	211
Total	216	36	34	104	42	432
Replacement opportunities:						
Site preparation and plant	18	32	6	3	11	70
Alder conversion	54	28	31	16	3	132
Other conversion	37	44	11	1	3	96
Total	109	104	48	20	17	298

[1] Sites capable of producing more than 165 cubic feet per acre per year.

[2] Estimates are subject to sampling error. See table 1.

[3] Treatment opportunities not identifiable because of the small size of the plot.

able 4--Area of treatment opportunities on medium sites[1/] in western Oregon, by wner group[2/]

(Thousand acres)

Type of stand and treatment	Forest industry	Other private	Other public	National Forest	Bureau of Land Management	Total
ature:						
Harvest--clearcut	175	87	81	785	349	1,477
Shelterwood (cut)	41	5	0	107	49	202
Regenerate--shelterwood (underplant)	6	0	0	27	36	69
Total	222	92	81	919	434	1,748
ntermediate:						
Commercial thinning	45	47	34	138	11	275
Improvement cut	6	19	0	0	8	33
No treatment	464	268	121	28	56	937
Total	515	334	155	166	75	1,245
egeneration:						
Plant opening	124	35	30	3/	3/	189
Precommercial thinning	161	23	26	26	20	256
Improvement cut	26	17	7	13	3	66
Precommercial thinning of clumps	76	0	20	3/	3/	96
Clean and release	88	12	4	0	14	118
No treatment	317	98	105	95	230	845
Total	792	185	192	134	267	1,570
eplacement opportunities:						
Site preparation and plant	176	154	47	24	35	436
Alder conversion	113	171	56	21	12	373
Other conversion	102	144	5	12	19	282
Total	391	469	108	57	66	1,091

1/Sites capable of producing between 120 and 165 cubic feet per acre per year.

2/Estimates are subject to sampling error. See table 1.

3/Treatment opportunities not identifiable because of the small size of the plot.

Table 5--Area of treatment opportunities on low sites[1] in western Oregon, by owner group[2]

(Thousand acres)

Type of stand and treatment	Forest industry	Other private	Other public	National Forest	Bureau of Land Management	Total
Mature:						
Harvest--clearcut	86	53	8	1,315	173	1,635
Shelterwood (cut)	108	52	0	341	91	592
Regenerate--shelterwood (underplant)	13	21	4	79	91	208
Total	207	126	12	1,735	355	2,435
Intermediate:						
Commercial thinning	5	4	0	149	9	167
Improvement cut	13	10	0	15	8	46
No treatment	61	117	22	115	25	340
Total	79	131	22	279	42	553
Regeneration:						
Plant openings	66	75	11	[3]	[3]	152
Precommercial thinning	91	33	9	116	39	288
Improvement cut	48	50	19	36	9	162
Precommercial thinning of clumps	53	9	0	[3]	[3]	62
Clean and release	14	21	5	9	34	83
No treatment	188	92	30	200	92	602
Total	460	280	74	361	174	1,349
Replacement opportunities:						
Site preparation and plant	133	120	15	77	35	380
Alder conversion	28	19	0	53	7	107
Other conversion	63	104	8	104	21	300
Total	224	243	23	234	63	787

[1] Sites capable of producing between 20 and 120 cubic feet per acre per year.

[2] Estimates are subject to sampling error. See table 1.

[3] Treatment opportunities not identifiable because of the small size of the plot.

Table 6--Area of treatment opportunities in western Oregon[1/]
(Thousand acres)

Type of stand and treatment	Forest industry	Other private	Other public	National forest	Bureau of Land of Management	Total
Mature:						
Harvest--clearcut	465	183	126	2,459	649	3,882
Shelterwood (cut)						
Regenerate--shelterwood	159	57	4	472	149	841
(underplant)	19	21	4	110	139	293
Total	643	261	134	3,041	937	5,016
Intermediate:						
Commercial thinning	98	51	34	330	25	538
Improvement cut	19	29	11	15	16	90
No treatment	693	480	187	154	87	1,601
Total	810	560	232	499	128	2,229
Regeneration:						
Plant opening	211	115	55	2/	2/	381
Precommercial thinning	279	62	35	3/178	63	617
Improvement cut	74	67	26	54	12	233
Precommercial thinning of clumps	200	9	20	2/	2/	229
Clean and release	124	38	9	9	53	233
No treatment	580	210	155	358	355	1,658
Total	1,468	501	300	599	483	3,351
Replacement opportunities						
Site preparation and plant	327	306	68	4/104	81	886
Alder conversion	195	218	87	90	23	613
Other conversion	202	292	24	117	42	677
Total	724	816	179	311	146	2,176

1/Estimates are subject to sampling error. See table 1.

2/Treatment opportunities not identifiable because of small plot size.

3/Includes 55,837 acres of precommercial thinning opportunities reported in the 1977 Needs Report of the Pacific Northwest Regional Office of the Forest Service as having a high probability of being treated by 1984.

4/Includes 79,240 acres of planting opportunities reported in the 1977 Needs Report of the Pacific Northwest Regional Office of the Forest Service as having a high probability of being treated by 1984. The balance--25,000 acres--have apparently been planted since the inventory on which this report is based.

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.

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