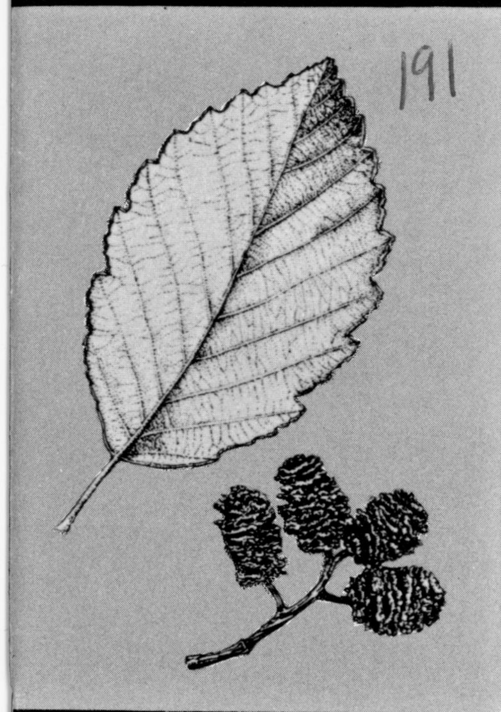
RED ALDER



its Management and Utilization

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RED ALDER

Its Management and Utilization

By Norman P. Worthington, Robert H. Ruth, and Elmer E. Matson
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CONTENTS

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Red Alder—Its Management and Utilization

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INTRODUCTION

Since World War II, attention of Pacific Northwest forest industries has been increasingly drawn to the comparatively untapped native hardwood resources of the region. This interest in the commercial possibilities of hardwood management and utilization is neither accidental nor transitory. It is a permanent outgrowth of diversification and expansion throughout the Nation's wood-using industries.

Red alder, the most important hardwood in Oregon and Washington, comprises about two-thirds of the hardwood timber resource in the two-State region. About 11¾ billion board feet are available in commercially operable stands, nearly all of which occur west of the Cascade Range.

Several factors have prompted an accelerating industrial demand for red alder: (1) technological advances in alder pulping, chiefly over the past 10 years, have expanded this use to the point of exceeding all other uses combined; (2) a decline in hardwood quality on the national scale, particularly in the East and South, has stimulated a growing recognition of alder as a wood possessing both high quality and value; (3) expansion of local markets on the west coast, particularly in California, has substantially favored locally grown hardwoods in railroad shipping costs; (4) long recognized as a versatile wood in furniture manufacture, red alder has continued to meet the expanding requirements of the furniture industry; and (5) effective promotion by an association of hardwood producers and landowners, both in establishing new markets and further exploiting current manufacturing outlets, has stressed the species' desirable qualities.

The unprecedented industrial demand for red alder has stimulated interest in its management and utilization. Because considerable new information has come to light since the most recent comprehensive account of red alder management and utilization was published (Johnson *et al.*, 1926),[2] this booklet has been prepared to consolidate past and present knowledge.

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[1] Deceased.

[2] Author names accompanied by dates of publication refer to Bibliography, p. 40.

RANGE AND DISTRIBUTION

Red alder (*Alnus rubra*) is the largest and most numerous of all the alders. The species is so called because the freshly cut sapwood soon turns a reddish brown. Other common names include Pacific Coast alder, Oregon alder, and western alder. The genus name *Alnus* is derived from the classical Latin name for the tree (Little, 1953).

Stands of commercial value grow in southeastern Alaska (Yakutat Bay), British Columbia, Washington, northern Idaho, Oregon, and the Santa Ynez mountains of California (Sargent, 1933), extending from 60° southward to latitude 34° (fig. 1). Although it is found

FIGURE 1.—Range of red alder.

along streams in northern Idaho, ordinarily it occurs no farther inland than 100 miles from the Pacific Ocean. It is uncommon above elevations of 2,500 feet (Collingwood and Brush, 1955).

The tree grows best along borders of streams and in adjacent bottom lands, or in moderately well-drained soils in areas where annual precipitation exceeds 40 inches. In such areas, red alder often forms pure stands varying in size and shape from a narrow stringer of only a few acres to continuous stands several hundred acres in extent (fig. 2). Scattered trees occur in varying degrees of mixture throughout the coniferous types of the coastal plains, the interior valleys, and the lower slopes of the Cascade and Coast Ranges and Olympic Mountains.

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FIGURE 2.—A typical pure stand of mature red alder growing in a moderately well-drained bottom land; trees vary from 10 to 16 inches d.b.h. Note understory of Sitka spruce and western hemlock.

Recent Forest Service estimates indicate that about 892,000 acres of commercial forest land in Oregon and Washington are occupied by stands predominantly red alder; the area on which the tree is intermingled in stands predominantly conifer is far greater. The area suitable for growing alder is being gradually reduced, however, by land clearing for agricultural and industrial development in the lower river valleys and coastal plains.

Red alder attains maximum yield and tree size in western Oregon and western Washington. In southwestern Washington it is sufficiently abundant to be classed as a major commercial type. The largest concentrations in western Oregon are in the coast counties of Clatsop, Columbia, Tillamook, Lincoln, Lane, Douglas, and Coos. All counties in western Washington have important commercial volumes. Most of the present supply is on privately owned lands.

SPECIES CHARACTERISTICS

General Appearance

The tree is straight, clear boled for 50 to 60 percent of its height when grown in relatively dense stands, and it has rather slim branches, which droop in a narrow, long, domelike crown. Heights of 65 to 100 feet are normal for mature trees, with maximum heights to 130 feet. Diameter at breast height is commonly 18 to 24 inches, but sizes up to 34 inches are found. The trunk bark on most mature trees is thin (rarely exceeding three-fourths of an inch), smooth, and mottled light gray to whitish. The bark on large trunks is very shallow seamed, with thin, flat, narrow ridges, and often covered with green moss. Twigs are clear, shiny, reddish, and sometimes slightly hairy, especially near their ends. Mature leaves are oval or elliptical, smooth and deep yellow green above, paler and coated with short rust-colored hairs underneath. Leaves are ordinarily 3 to 6 inches long and their toothed borders are very slightly curled toward the under surface (Sudworth, 1908). The seed consists of a small, compressed, narrow-winged nutlet, without endosperm and is borne in pairs at the base of each cone scale.

The most striking features of the tree are its clear gray-to-white trunk, its smooth bark, and its domelike crown. It occurs characteristically in groups.

Ecology

Alder grows both in pure stands and in mixture with native conifers and hardwoods. When growing in mixture, it is nearly always in a dominant or codominant position. Stands are predominantly even aged, whether pure or mixed, since alder is usually the first tree to originate in openings. Because of its intolerance, it rarely fills in after a stand has been established. Mixtures occur only in young-growth coniferous stands less than 100 years old; however, alder may occur in openings in older stands. Only on sites best suited for alder growth does it succeed itself.

Characteristic tree associates are Douglas-fir,[3] western redcedar, western hemlock, grand fir, Sitka spruce, bigleaf maple, vine maple, Pacific willow, bitter cherry, and black cottonwood. Given time, conifers will often attain dominance as the alder canopy breaks up because of age, disease, or insects.

Associated shrubs and prominent herbs are elder, salmonberry, western thimbleberry, American devilsclub, whortleberry, osoberry, salal, trailing blackberry, western swordfern, and nettle.

On poor alder sites, the tree commonly grows in mixture with Douglas-fir. The latter, although slower in initial height growth, survives when not directly overtopped and about the 20th year begins to equal or exceed alder's annual height development. Hence, the Douglas-fir and alder develop on a competitive basis until approximately the 40th year. Thereafter, Douglas-fir usually attains a dominant position, and few alders remain by the 60th year. This

[3] Scientific names of species mentioned are included in the appendix, p. 43.

association of the two trees often results in a smoother boled, smaller limbed Douglas-fir, and an improved soil and moisture condition due to formation of a mull humus layer and buildup of nitrogen from alder leaves. Alder may occur in a groupwise mixture, occupying small areas (½ acre or larger) where soil moisture is too high for best development of Douglas-fir.

Alder is common along streams and adjacent moist bottoms. In addition, it is usually the first tree to appear on the moist, rich soils of benches or gentle slopes after a coniferous forest has been removed by cutting or burning. On such sites it is frequently associated with willow, cherry, and bigleaf maple, which are slower growing. Whether or not it will persist to form the major component of the new stands depends on the occurrence of coniferous reproduction. Apparently, within a certain range of soil and moisture conditions, alder will win; outside that range, the conifers will gain ascendancy, if present.

Alder frequently becomes established on sites that are more valuable for production of conifers. With a small head start, it may prevent conifer reproduction from becoming established, and so may dominate the area. In such cases, it often forms a stand characterized by a great number of stems, few of which reach merchantable size.

Alder occupies two or three times more growing space per tree than native conifers. This is due to its wider crown and intolerance of shade. However, it is a relatively short-lived tree, giving way in many instances to the indigenous conifers. During its life it enriches the soil and under certain conditions may provide a nurse crop for the Douglas-fir, hemlock, redcedar, and grand fir that succeed it.

Generally speaking, alder is a pioneer type, succeeded by conifers except in extra-moist soils of high organic-matter content, where it is usually the climax type.

Site Requirements

Alder requires abundant soil moisture and is prevalent on soils of restricted internal drainage. However, it is not found in bottom lands subject to overflow of long duration. Deep, well-drained soils produce the best trees, but alder also does well on coarse sands and gravels if moisture is adequate.

Although alder roots do not penetrate deeply, windthrow is not common. This is due in part to intermingling of the trees with taller coniferous associates and to absence of foliage during the winter and early spring when winds are severe and soils are saturated with moisture.

Red alder seeds naturally wherever bare mineral soil is exposed by logging, fire, windthrow, or road construction.

Silvical Features

Red alder flowers are borne in the spring, both sexes on the same tree, and are produced in catkins, which were formed the preceding season and expand before or with the leaves. Staminate catkins occur in small tassel-like clusters 5 to 6 inches long and ¼ inch thick. They

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are naked and erect during winter but elongated and pendulous at maturity. Pistillate aments, also erect and usually naked during the winter, enlarge but slightly at flowering and develop into ovid strobiles or conelets. The dark-brown conelets are ½ to 1 inch long and ⅓ to ½ inch thick at maturity. They contain 50 to 100 small, flattened nutlike seeds. Leaves are shed in the late fall and winter while still green, leaving the fruit very prominent.

Red alder is a prolific seeder. Seed dispersal begins shortly after ripening in late summer and continues until early the following spring. Wind, the chief dispersal agent, often carries the seed for considerable distances. Good seed crops occur about every fourth year, with light crops in intervening years. Optimum seed-bearing age is from 25 years to tree maturity. Seed yield is approximately 1.1 pounds per bushel of cones, with 675,000 seeds per pound (U.S. Forest Service, 1948).

Germination, which takes place in the spring following seed dispersal, is best on moist mineral soil. Initial growth is rapid—heights of 8 to 10 feet in 3 years and 30 to 35 feet at 10 years are common. Such growth enables alder to assume dominance over competing trees and shrubs at an early age. On better sites, the tree reaches heights of 100 to 120 feet in 50 years, and diameters up to 24 inches are common.

In fully stocked stands, trees are eliminated rapidly by suppression until approximately 150 stems per acre remain at 50 years. The tree has a tendency to develop water sprouts or epicormic branches if the stand is opened up by heavy thinning or partial cutting. Otherwise, limbs are shed rapidly until only the upper 30 to 40 percent of the crown retains branches; the rest of the bole is limb free.

Alder contributes both to physical and chemical improvement of soil. Its litter decomposes rapidly, forming a mull humus layer, with subsequent improvement in soil structure. And it contributes to improved soil fertility through symbiotic fixation of nitrogen by organisms contained in the root nodules. The role of such organisms has been conclusively demonstrated with European alder (Bond, 1956).

Indirect evidence of nitrogen fixation by red alder is also available. Alder foliage contains much greater amounts of nitrogen than leaves of other indigenous tree species (Tarrant *et al.*, 1951), and soil nitrogen, nitrogen content of fir foliage, and growth rate of fir all increased significantly in mixed plantings of alder and Douglas-fir (Tarrant, 1961). The mean annual accumulation rate for nitrogen in these plantings was about 56.5 pounds per acre. Studies of a recently deglaciated area in Alaska show the mean annual accumulation rate for nitrogen to have been 55 pounds per acre during the period of plant succession in which Sitka alder was becoming established (Crocker and Major, 1955).

Alder is useful for erosion control on steep slopes or where soil has been disturbed, especially along roadbanks. The heavy cover, including the litter layer that is created within 3 to 5 years, effectively protects the soil.

ACREAGE AND VOLUME

Pure red alder type in western Oregon and western Washington occupies 891,700 acres, compared with 1,490,800 acres of all other hardwood types (table 1). However, this acreage does not represent the entire area on which the tree occurs, for it has been estimated that two-thirds of the total alder volume grows in stands of which it is a minor component. This tendency to grow in mixture with softwoods and other hardwoods complicates management of the species, as will be discussed later (fig. 3).

The most recent estimate of alder sawtimber volume in the Pacific Northwest is 11,829 million board feet (Scribner rule), of which 6,052 million board feet is in western Washington and 5,777 million board feet in western Oregon (table 2). It represents 67 percent of the total hardwood sawtimber stand in the two half-State areas. Other principal species are bigleaf maple (17 percent) and black cottonwood (5 percent). The remainder (1,974 million board feet) consists largely of oaks. The relative supply of hardwoods is generally believed to be holding up better than that of softwoods. Probably the volume of hardwoods is increasing in some areas. Removal of the virgin conifer stand tends to favor the hardwoods by giving them an opportunity to grow in the open conditions most favorable to their development.

Recent estimates of softwood volumes for western Oregon and western Washington total 636 billion board feet, Scribner rule. Thus the hardwood volume (17,545 million board feet, two-thirds of which is alder) is approximately 2¾ percent of the softwood volume. Although its volume is relatively small, red alder is of growing importance in localities where concentrated volumes are easily accessible to manufacturing facilities. As the remaining old-growth softwood timber is harvested, alder and other hardwoods can be expected to provide an increasing share of total timber supplied in the region.

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FIGURE 3.—Red alder in mixture with Douglas-fir on an old burn. Alder grows more commonly in mixture than in pure stands.

TABLE 1.—*Extent of red alder and other hardwood types on commercial forest land in western Oregon and western Washington*[1]

(In thousands of acres)

Location, by county	Sawtimber		Seedlings, saplings, and poletimber		Total	
	Red alder	Other hardwoods	Red alder	Other hardwoods	Red alder	Other hardwoods
Western Oregon:						
Clatsop	4.8	0.2	7.1	0.4	11.9	0.6
Columbia	.5	11.2	1.6	12.1	2.1	23.3
Coos	19.1	4.2	40.1	5.9	59.2	10.1
Curry	.3	9.4	5.9	84.9	6.2	94.3
Douglas	2.0	2.3	.6	1.1	2.6	3.4
Hood River	------	.2	------	1.4	------	1.6
Jackson	------	2.3	------	------	------	2.3
Josephine	------	.7	------	12.1	------	12.8
Lane	5.4	41.0	8.1	51.7	13.5	92.7
Lincoln	3.8	52.4	6.7	34.2	10.5	86.6
Tillamook	1.5	37.6	13.9	48.2	15.4	85.8
All others	3.5	193.1	29.6	356.2	33.1	549.3
Total	40.9	354.6	113.6	608.2	154.5	962.8
Western Washington:						
Clark	1.1	------	1.4	12.4	2.5	12.4
Cowlitz	2.9	2.7	19.4	3.0	22.3	5.7
Grays Harbor	13.3	9.1	32.4	3.9	45.7	13.0
Island	5.4	------	8.0	------	13.4	------
King	34.9	23.9	105.2	------	140.1	23.9
Kitsap	23.5	5.9	14.7	2.9	38.2	8.8
Lewis	3.0	12.9	27.6	21.5	30.6	34.4
Mason	4.8	3.9	18.0	4.2	22.8	8.1
Pacific	3.2	------	12.1	.2	15.3	.2
Pierce	34.9	13.7	53.5	4.1	88.4	17.8
Skagit	9.1	41.9	34.2	78.1	43.3	120.0
Skamania	.1	.4	1.5	2.5	1.6	2.9
Snohomish	27.7	63.5	68.8	82.3	96.5	145.8
Thurston	.4	1.3	4.3	18.5	4.7	19.8
Wahkiakum	6.7	.9	4.8	.7	11.5	1.6
Whatcom	7.8	32.4	18.2	75.0	26.0	107.4
All others	46.7	5.0	87.6	1.2	134.3	6.2
Total	225.5	217.5	511.7	310.5	737.2	528.0
Both States	266.4	572.1	625.3	918.7	891.7	1,490.8

[1] To classify as a red alder type, more than 50 percent of the stems (in young stands) or volume (in older stands) must be hardwood, and the plurality of stems or volume must be red alder.

Source: Statistics for named counties from Forest Survey reports, 1947 to 1960; for all others from Forest Survey unpublished estimates, 1932 to 1946, adjusted for changes in area as occurring in named counties. U.S. Forest Serv. Pacific Northwest Forest and Range Expt. Sta., Portland, Oreg.

TABLE 2.—*Estimated sawtimber volumes (Scribner rule): Red alder and other hardwoods in western Oregon and western Washington*

(In million board feet, Scribner rule)

Location, by county	Red alder	Bigleaf maple	Black cottonwood	Other	Total
Western Oregon:					
Clatsop	323	23	------	------	346
Columbia	179	60	------	26	265
Coos	498	203	------	93	794
Curry	124	110	------	1,004	1,238
Douglas	333	56	------	200	589
Hood River	------	------	3	------	3
Jackson	1	2	------	57	60
Josephine	41	8	------	398	447
Lane	1,093	549	2	17	1,661
Lincoln	1,713	126	------	------	1,839
Tillamook	1,109	15	------	------	1,124
All others	363	366	6	46	781
Total	5,777	1,518	11	1,841	9,147
Western Washington:					
Clark	87	38	44	4	173
Cowlitz	428	148	25	2	603
Grays Harbor	663	15	------	------	678
Island	102	3	------	------	105
King	325	14	56	1	396
Kitsap	277	138	------	------	415
Lewis	295	312	77	3	687
Mason	178	19	60	5	262
Pacific	507	21	------	------	528
Pierce	277	58	47	52	434
Skagit	434	154	54	1	643
Skamania	117	33	159	------	309
Snohomish	671	139	183	23	1,016
Thurston	97	72	------	26	195
Wahkiakum	193	15	2	------	210
Whatcom	297	194	30	16	537
All others	1,104	39	64	------	1,207
Total	6,052	1,412	801	133	8,398
Both States	11,829	2,930	812	1,974	17,545

Source: Statistics for named counties from Forest Survey reports, 1947 to 1960; for all others from Forest Survey unpublished estimates, 1932 to 1946 adjusted for changes in volume as occurring in named counties. U.S. Forest Serv. Pacific Northwest Forest and Range Expt. Sta., Portland, Oreg.

GROWTH AND YIELD

Until recently there has been little interest in the management of red alder, since available supplies appeared to be sufficient for all present requirements and little thought was given to future needs. For these reasons, reliable data on growth and yield of the species was almost nonexistent. The need for more information, however, has led government and private foresters to join in producing new, comprehensive yield tables that make more satisfactory estimates possible (Worthington *et al.*, 1960).

TABLE 3.—*Examples of red alder mean annual increment and total yield in western Oregon and western Washington*

(Per-acre basis)

Location	Age of stand	Yield: Cubic volume[1]	Yield: Scribner volume	M.A.I.: Cubic volume[1]	M.A.I.: Scribner volume	Basis
	Yrs.	*Cu. ft.*	*Bd. ft.*	*Cu. ft.*	*Bd. ft.*	
Western Oregon and western Washington.[2]	47	4, 500	21, 663	103	480	16 selected fifth-acre plots, pure alder type.
Siuslaw National Forest (Lane County, Oreg.).[3]	60	-------	10, 510	-------	175	Inventory of 2,000 acres of 60-year-old stands.
Snohomish County, Wash.[4]	32	4, 388	-------	137	-------	4 selected 1-acre plots, pure alder type.
McCleary Experimental Forest (Grays Harbor County, Wash.).[5]	45	4, 650	20, 395	103	453	Inventory of 100-acre stand with 31 percent conifer mixture.
Large private land holdings, southwestern Washington.[6]	50	2, 660	-------	53	-------	150 fifth-acre plots mechanically spaced within hardwood types.

[1] All trees larger than 4.9 inches d.b.h. to a minimum 4-inch top (inside bark).
[2] Johnson *et al.*, 1926.
[3] Aufderheide, Robert. Some notes on alder management. 1950. (Unpublished report on file at the Pacific Northwest Forest and Range Expt. Sta.)
[4] Lloyd, 1955.
[5] Worthington, Norman P. Fourth annual supplement to McCleary Experimental Forest Management Plan. 1953. (Copy on file at the Pacific Northwest Forest and Range Expt. Sta.)
[6] Data on file at the Pacific Northwest Forest and Range Expt. Sta.

It is not easy to measure increment of volume of alder stands, since the tree grows in restricted areas and most of the volume is contained in small groups scattered through the coniferous forests. For example, a 55-year-old mixed stand on the 340-acre McCleary Experimental Forest (site II) in Grays Harbor County, Wash., contained 3,300 board feet per acre of alder, or 12 percent of the stand. The periodic annual increment of the alder alone was 90 board feet. On the 220-acre Voight Creek Experimental Forest (site III) in Pierce County, Wash., however, alder volume in a 40-year-old stand was only

700 board feet per acre (6.7 percent of stand), with periodic annual increment of 20 board feet. These examples illustrate the variability in growth and yield of alder in the great majority of stands.

Estimates of growth and yield are given in table 3. Mean annual cubic-foot increment per acre (4-inch minimum top diameter) ranges from 53 to 137; board-foot increment (Scribner), from 175 to 480. The Siuslaw National Forest example of 175 board feet is for a 2,000-acre area and thus alder is undoubtedly a component of "nonalder" types. The other examples of 453 and 480 board feet represent small areas of pure stands.

Where alder grows in pure or nearly pure well-stocked stands on average sites, mean annual growth rates of 400 to 500 board feet per acre are possible. This means a yield of 20,000 to 35,000 board feet per acre on a 50- to 70-year rotation. Cubic-foot growth may equal 90 to 100 cubic feet per acre per year, with final yields of up to 6,150 cubic feet (table 4). These yields may be exceeded by 15 to 20 percent on small areas of very favorable sites.

TABLE 4.—*Examples of yield tables for red alder*

(Per-acre basis)

PACIFIC NORTHWEST YIELD TABLES[1]

Age (years)	Board-foot yield[2]: Average net volume	Board-foot yield[2]: Mean annual increment	Cubic-foot yield[3]: Average net volume	Cubic-foot yield[3]: Mean annual increment
10	-------	-------	120	12
20	100	5	1, 620	81
30	6, 800	227	2, 930	98
40	13, 700	342	4, 030	101
50	20, 600	412	4, 940	99
60	27, 300	455	5, 640	94
70	33, 800	483	6, 150	88

BRITISH COLUMBIA F. S. YIELD TABLES[4]

Age (years)	Board-foot yield[2]: Average net volume	Board-foot yield[2]: Mean annual increment	Cubic-foot yield[3]: Average net volume	Cubic-foot yield[3]: Mean annual increment
10	-------	-------	1, 520	152
20	3, 400	170	2, 850	142
30	12, 750	425	3, 950	132
40	23, 500	588	4, 675	117
50	30, 750	615	5, 200	104
60	35, 000	583	5, 600	93

[1] Worthington *et al.*, 1960. Site index is 90 feet (50 years).
[2] PNW table: Scribner rule for all trees larger than 9.5 inches d.b.h. to a fixed top diameter of 8 inches (inside bark). Scaled in 8-foot logs.
BC table: BC rule for all trees larger than 6.5 inches d.b.h. to an average top diameter of 8 inches (outside bark). Scaled in 8-foot sections.
[3] PNW table: All trees larger than 5.5 inches d.b.h. to a minimum 4-inch top (inside bark).
BC table: All trees larger than 0.9 inch d.b.h.
[4] British Columbia Forest Service (1947). Site index is 96 feet (50 years).

Comparison With Conifer Yields

Yields of alder on average sites are normally less than those of conifers. As shown in table 5, alder increments are roughly one-half to three-fourths those of hemlock and Douglas-fir. Chief reasons for this are (1) alder has a much larger crown area per tree, hence the number of trees per acre is less; (2) alder has a shorter merchantable tree height—40 to 50 feet at 50 years, compared with 65 to 90 feet for conifers.

TABLE 5.—*Yields of red alder, western hemlock, and Douglas-fir at rotation age* [1]

Species and rotation age (years)	Scribner volume		Cubic volume	
	Yield	Mean annual increment	Yield	Mean annual increment
	Bd. ft.	*Bd. ft.*	*Cu. ft.*	*Cu. ft.*
Douglas-fir: [2]				
70			9, 650	138
110	69, 400	631		
Western hemlock: [3]				
60			13, 800	230
80	93, 000	1, 162		
Red alder: [4]				
40			4, 030	101
70	33, 800	483		

[1] Yields attained on sites assumed to be average for each species and to specified utilization standards as follows (site index for Douglas-fir and western hemlock is based on height at age 100, while alder site index is based on height at age 50):

	Douglas-fir	*Hemlock*	*Alder*
Site index (feet)	140	150	90
Minimum d.b.h. (inches)	5. 0	6. 5	5. 6
Minimum top diameter (inches)	4. 0	Entire stem	4. 0

[2] McArdle *et al.*, 1949.
[3] Barnes, George H. Yield of even-aged stands of western hemlock. 1953. (Unpublished report on file at the Pacific Northwest Forest and Range Expt. Sta.)
[4] Worthington *et al.*, 1960.

Average diameter growth of alder is somewhat higher than that of Douglas-fir, at least for the first 40 years. The Soil Conservation Service, working with a 30-year-old alder stand in Snohomish County, Wash., found 6-year diameter growth of 1.33 inches on thinned plots and 0.91 inch on unthinned plots for all trees larger than 7.9 inches d.b.h. (Lloyd, 1955). This latter figure compares with 0.70 inch for fully stocked stands of Douglas-fir of comparable age and site. Johnson *et al.* (1926) gave average breast-high diameter at age 50 years as 16.0 inches for alder; McArdle *et al.* (1949) reported 12.3 inches for Douglas-fir of the same age. However, the Douglas-fir figure included many intermediate and suppressed trees, whereas the alder average was based on dominants and codominants only.

Rotation

Alder is a short-lived tree, maturing in most instances at 60 to 70 years of age. Hence, sawtimber rotations of about 70 years on the better sites and 60 years on poorer ones appear to be appropriate for pure stands. Often these rotations are extended in mixed coniferous stands, where rotations are set by the more slowly maturing conifers. However, alder harvest can seldom be delayed past 90 years. Cordwood or cubic-foot volume rotations would appear to range from about 35 to 40 years.

FOREST PRACTICES ON COMMERCIAL SITES

Harvest Cuttings

Few red alder stands are intensively managed. This is the result of unstable markets; low stumpage values; relatively low volumes per acre; and the scattered distribution of merchantable sawtimber stands, which requires high initial road investments in relation to saw-log volume. Most merchantable alder is in small ownerships, few owners having acquired areas large enough for sustained-yield management. The expanding market for alder pulpwood, however, is changing this situation. A trend toward blocking up of ownership and more intensive alder management is apparent.

To be commercially operable under present utilization practices in most areas, alder sites must produce mature trees with a minimum breast-high diameter of 12 inches and at least two relatively clear 8-foot logs. In western Oregon and western Washington, except where soils are of glacial origin, such sites occur most frequently in narrow strips along streams. These strips may be several miles in length but seldom exceed 1,500 feet in width. Many are less than 600 feet wide.

Site varies greatly over short distances. Within only 500 feet of a creek bottom, site classes on a hillside may encompass the entire range, varying from the best site to the poorest.[4] Stands on upper slopes generally do not attain commercial size or quality. Some high-quality stands, however, are found on moist flats and benches. In the Puget Sound area of Washington, most deep, medium-textured glacial soils will support commercial stands if average annual precipitation exceeds 50 inches.

Red alder is well adapted to even-aged management and should be harvested by clear cutting. A typical harvest cutting for the saw-log market removes all trees 13 inches d.b.h. and over, and many of the more accessible and better quality 12-inch trees. This results in practically clear cutting the area in the stream bottoms and leaving an increasingly heavier residual stand as logging progresses up the hillsides. Eight- to ten-inch minimum top diameter requirements are

[4] Aufderheide, Robert. A plan of management for red alder in the Nestucca working circle. 1940. (Copy on file, U.S. Forest Serv. Siuslaw National Forest.)

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common. A recently developed alder pulp market, however, is fostering improved utilization in stands tributary to pulp plants.

Logging Methods

Most alder is logged by small operators who buy stumpage from private landowners or public agencies. Some is harvested by ranchers or farmers who supplement their income by logging, often on their own lands. A considerable volume of alder adjacent to conifer stands or mixed with conifers is logged with the conifers.

One-man chain saws are generally used for felling and bucking red alder. The wood is more brittle than that of the softwoods, and care must be taken to minimize breakage. Many trees lean heavily, necessitating side notching to prevent splitting of the butt log. Also, in mixed stands, large softwood trees falling on alder logs cause considerable breakage. To avoid this, the alder is often logged first.

Yarding is usually done with a small tractor, but horses are frequently used. On steep topography, cable yarding and high-lead systems are employed. Because of low volumes per acre and the usual occurrence of merchantable alder in narrow strips along streams, portable yarding equipment adapted to frequent moves from landing to landing is most efficient. On some operations, trees are yarded whole and then bucked into logs at the landing.

Most loading is done with an "A-frame." Methods range, however, from hand loading at a rollway to use of shovel loaders with air tongs. Logs are hauled in 16-foot lengths on short log trucks or in 8-foot lengths loaded crosswise on flatbed trucks. A considerable volume is rough-sawed at the logging site with a portable or semiportable mill.

Alder loggers often have difficulty in obtaining suitable winter logging shows. Annual precipitation averages more than 40 inches and sometimes exceeds 100 inches. Heaviest rainfall occurs from November to June, making surfaced roads a necessity for winter logging. With merchantable alder in long, narrow strips and only small volumes available in any one drainage, alder alone does not justify high road-construction costs. As a result, alder loggers usually restrict their operations to the dry season. This seasonal operation has led to an oversupply of logs in the summer and scarcity in the winter, thus contributing to fluctuations in log prices. Cutting alder logs in the summer and storing them for winter use is not practical because they are highly susceptible to decay.

Most Douglas-fir loggers have a low regard for alder. Usual practice has been to leave it on the area whenever possible. Reasons for this attitude include high costs of logging alder with heavy equipment, difficulty of separating alder from conifer logs, and unstable market conditions. Some operators, required by contract to take the alder, have yarded it to a landing only to find no market available for the logs.

A general change in the situation is underway, however. A few alder remanufacturing plants equipped with dry kilns have helped to stabilize the market. Also, rapidly increasing stumpage prices for Douglas-fir and other conifers have caused many loggers to turn to alder, which they have found can be logged profitably without large, expensive equipment.

Slash Disposal

Alder slash is usually left unburned because of low fire hazard on alder sites, rapid decay of slash, and the danger of killing residual alder trees below merchantable size. Where brush is a problem and sufficient fuel is present, however, broadcast burning is recommended as a control measure.

Broadcast burning is difficult because of moist conditions, green underbrush, and the nonresinous, light slash. When slash in the creek bottoms becomes dry enough to burn, adjacent south slopes and ridges are often too dry for safe burning. After a year, alder slash is usually shaded by green brush and becomes virtually impossible to burn except during extremely dry weather when burning is hazardous.

Regeneration

Red alder is an abundant and regular seed producer, and most commercial alder sites are ideally situated for natural regeneration. Clearcut strips along streams receive a shower of seed from stands on adjoining hillsides. Failure of this species to regenerate naturally is usually attributable to factors other than seed supply.

Alder will regenerate under a wide range of soil and seedbed conditions. Dense stands become established on areas of exposed mineral soils, such as skidroads and landings. Alder also establishes itself alongside truck roads, where it sometimes becomes a major maintenance problem. It often grows in the middle of rock-surfaced logging roads, and many operators have returned to areas logged but 5 years previously to find the road blocked by a dense stand of alder 2 to 4 inches in diameter. Alder also seeds in readily and makes fair growth in small openings if direct overhead light is available. Road right-of-way clearings through a tall conifer stand and tractor landings in a thinned conifer stand are examples of modified shade conditions that alder will tolerate. Alder will not grow in dense shade.

Regeneration problem areas are those dominated by brush, herbs, or a medium-to-dense residual timber stand. Brush is particularly a problem on the better alder sites, which are also good brush sites. Major brush species competing with alder regeneration are salmonberry, western thimbleberry, and salal. Other important competitors include vine maple, American devilsclub, elder, and whortleberry. Important herbaceous plants include trailing blackberry and nettle—both prevalent in Washington but less common in Oregon—and western swordfern, which is particularly common on north slopes.

Brush is usually present under alder stands, and it increases in density as the alder matures (fig. 4). When the overstory is removed in logging, brush is exposed to full sunlight but usually is otherwise little disturbed. Even when knocked down and defoliated, the shrubs are seldom killed. They sprout from stem and root crown and soon form a dense cover that effectively prevents seedling establishment. Regeneration on some of the best alder sites is limited to exposed mineral soil on skidroads, truck roads, and landings, where brush has been destroyed.

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FIGURE 4.—A 50-year-old alder stand with brush understory typical of the Oregon coastal area.

Coppice reproduction is not effective for merchantable red alder. Forty-eight alder trees averaging 14.1 inches d.b.h. were cut on the Cascade Head Experimental Forest in western Oregon in 1940. Cutting was done during all four seasons and in four locations. By the fall of 1941, only 54 percent of the stumps had live sprouts. All but one or two sprouts were then cut from some stumps, as might be done under the coppice method, and all sprouts were left on other stumps as a check. Of 20 stumps reexamined in 1945, only 1 had living sprouts, and in this case root grafting was suspected because of proximity to a living alder tree.[5] In contrast to trees of merchantable age, young alders often sprout vigorously following cutting.

Experience in the Coastal Area Near Hebo, Oregon

One of the first attempts to manage red alder was made on the Hebo Working Circle of the Siuslaw National Forest in Oregon. Here, early harvest cuttings in 55- to 65-year-old stands took all trees 14 inches d.b.h. and over. Later observations showed that diameter growth of residual trees averaged only 1 inch in 10 years, height growth after cutting was negligible, and released alder developed side branches that reduced bole quality. In addition, heavy underbrush and shade from the residual stand prevented alder regeneration. As a result of these observations, diameter-limit cutting was abandoned and the logger encouraged to take every tree that would pay its way.[6]

[5] Munger, Thornton T. Final report on red alder sprout study at Cascade Head Experimental Forest. 1945. (Unpublished report on file at the Pacific Northwest Forest and Range Expt. Sta.)

Subsequently, alder was harvested on a clear-cutting basis, including trees down to 11 inches in diameter. At first natural regeneration was relied upon, but rapid brush development indicated that natural regeneration had little chance except on exposed mineral soil, where brush had been destroyed. Planting to conifers was tried next. The plantations survived well the first year or two but then were overtopped by brush. Current practice on the Hebo Working Circle is to clear cut, broadcast burn to retard brush development, and then plant to conifers.

Cultural Practices

Very little cultural work is being done in red alder stands. The recent trend toward more intensive utilization, however, will result in more work of this type. Some research on cultural practices has been completed.

Thinning

Under conditions favorable for regeneration, young red alder stands may contain several thousand stems per acre, few of which can grow to merchantable size. Although natural thinning starts at an early age, many stands remain too dense, a few tending to stagnate as early as the 15th year. Dense 20- to 30-year-old stands have remarkably even crown canopies, with only slight variations in tree heights (Haddock, 1948). Thinnings are desirable in such stands to concentrate volume growth on high-quality stems. Commercial thinnings will probably become standard silvicultural practice as soon as markets are available for the small stems that would be removed.

Several thinning experiments in red alder have been started in recent years, but few have been established long enough to yield conclusive results. Consensus of foresters working in dense alder stands on good sites is that light and frequent stand improvement thinnings, begun early in the life of the stand, are desirable. Priority should be given to removing dying, defective, poor-quality, and leaning trees. If a single, heavy thinning is all that can be undertaken, it should be made when the stand is 15 to 20 years old (Warrack, 1949). In addition to encouraging epicormic branching, heavy thinnings in some areas may stimulate brush development under stands. The latter would hinder establishment of a new stand following clear cutting of the overstory.

Available thinning data are from relatively heavy precommercial thinnings made in stands where stagnation was not a serious problem. They do not show appreciable benefits from the thinnings. In one study on the Cascade Head Experimental Forest near Otis, Oreg., an 11-year-old alder-conifer stand was treated by removing all conifers and thinning the alders to a spacing of about 8 by 8 feet. At age 31 the volume for trees 5.5 inches d.b.h. and over was 3,539 cubic feet.

[6] Aufderheide, Robert. Some notes on alder management. 1950. (Unpublished report on file at the Pacific Northwest Forest and Range Expt. Sta.)

This was 13 percent less than an adjacent unthinned alder stand. The individual trees released in thinning showed negligible accelerated growth, partly because spacing was emphasized in their selection and they may not have been the best crop trees. In the unthinned stand the dominant and codominant trees appeared to be little affected by the presence of the suppressed and intermediate trees (Berntsen, 1961a).

In a second study established in 21-year-old red alder on the same experimental forest, the thinning treatment was to girdle a scattered overstory of 80-year-old Douglas-fir trees and thin heavily in the alder stand by removing 36 percent of the cubic volume (trees 5.5-inches d.b.h. and larger). A nearby stand had the overstory girdled but was left unthinned. Both alder stands had a net growth of 111 cubic feet per acre per year during the subsequent 20-year measurement period. In the thinned stand, however, this growth was concentrated on 17 percent fewer trees. Their average d.b.h. at age 41 was 9.5 inches compared with 8.9 inches in the unthinned stand. This difference was probably not enough to have justified the cost of the precommercial thinning 20 years previously. But had there been a market for the thinned material, the operation would have yielded an intermediate return, concentrated growth on larger stems, and yet caused no reduction in annual growth.[7]

A third study was established in a 26-year-old stand near McMurray, Wash., in 1947. Fifty-five percent of the number of trees (40 percent of the basal area) was removed from two plots, and two plots were left unthinned. Growth measurements from the second to the eighth year following thinning showed that gross growth was about the same but that net growth was best on the thinned plots (Lloyd, 1955):

	Average annual growth per acre	
	Thinned stand	*Unthinned stand*
Cubic-foot volume: [1]		
Gross	133	128
Net	133	93
Board-foot volume (net) [2]	916	366

[1] Trees 5.6 inches d.b.h. and over to a 4-inch top.
[2] Trees 11.6 inches d.b.h. and over to an 8-inch top, Scribner rule.

The difference in net cubic-foot growth was largely due to natural mortality of intermediate and suppressed trees in the unthinned stand. These were the same type of trees which, in the treated stand, were removed in the precommercial thinning.

Pruning

Artificial pruning of red alder is not a common cultural practice. Results of one experimental pruning project on the Oregon coast indicate no substantial increase in wood quality, due to formation of epicormic branches. These branches usually originate on the clear bole at points where the original branches have been pruned. Sectioning of the study trees 22 years after pruning showed rot to be present in every dead branch stub, whether artificially or naturally pruned. The rot rarely extended beyond the extremities of the knot, however, and only the occurrence of epicormic branches prevented increment of clear wood (Berntsen, 1961b).

[7] Berntsen, Carl M. A 20-year growth record for 3 stands of red alder. 1961. (Unpublished report on file at the Pacific Northwest Forest and Range Expt. Sta.)

Seeding and Planting

Red alder can be successfully seeded or planted, but very little of either has been done. Alder was sown successfully on the Olympic National Forest in Washington in 1932–33 (fig. 5): of 5 plots examined in 1936, 3 had 3,270, 3,800, and 5,560 trees per acre, 1 heavily grazed by elk had 700 trees per acre, and 1—seeded on heavy marsh grass—was a failure. Planting stock was grown successfully at the Wind River Nursery, Carson, Wash., from 1932 to 1934. Several plantations were established on the Olympic National Forest, and an alder firebreak was planted around part of the Wind River Experimental Forest.

Demand for red alder seed or planting stock has not been great, and nursery production of alder planting stock does not seem warranted at this time. If artificial regeneration should be desired, it probably could best be accomplished by direct seeding.

Damaging Agents

Insects

Red alder is host to insects of many kinds, but in general they cause little damage. Several species are abundant, however, and under intensive management some may become sufficiently important to warrant control or preventive measures.

The western tent caterpillar (*Malacosoma pluviale* (Dyar)), the forest tent caterpillar (*M. disstria* Hbn.), the striped alder sawfly (*Hemichroa crocea* (Fourc.)), and the alder flea beetle (*Altica ambiens* (Lec.)) sporadically defoliate alder stands. Severe out-

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FIGURE 5.—Red alder in July of the second growing season following seeding on an abandoned, gravel-surfaced railroad grade in northwestern Washington. Seeding rate was 1 pound per acre.

F-475336

FIGURE 6.—A young red alder stand in mid-July, completely defoliated by the western tent caterpillar.

breaks—particularly of tent caterpillars—reduce tree growth for a year or two but kill only trees that have been severely weakened by other causes (fig. 6). No attempt has been made to control any of these insects in the forest. Aerial spraying might be effective if warranted.

The alder bark beetle (*Alniphagus aspericollis* (Lec.)) bores between bark and wood of the main stem and large branches of weakened, dying, and recently felled red alder throughout the tree's range. Apparently the beetle does not attack vigorous trees; hence, no special control measures are needed.

Three species of ambrosia beetles (*Gnathotrichus alni* Blkm., *Trypodendron cavifrons* (Mann.), and *Xyleborus arbuti* Hopk.) commonly bore into the boles of weakened and recently felled alder trees. Lumber cut from attacked trees is degraded by the small entry holes and accompanying stain. Prompt removal of logs from the woods during spring, summer, and fall will prevent this type of damage.

Disease

Red alder stands below age 50 are relatively free from decay, although even young alder will decay readily following injury from logging or other causes. Stands more than 50 years old become progressively more defective, with the heartwood of some trees rotted out completely. Diseases attacking red alder include cankers, leaf curl, leaf spot, and one in which the scales of the fertile catkins are deformed. One canker disease has killed many small trees over an

extensive area. No data are available on the extent of losses or how losses might be minimized by management practices. However, if stands are harvested at 50 years of age or younger, and if care is taken to avoid injury during thinning operations, the economic loss from decay and diseases should be minor.

Decay of alder logs is a serious problem. They often show signs of incipient decay within a few weeks after felling and bucking and sometimes become unuseable within a few months.

Ice

Red alder is readily susceptible to ice damage. One experimental plot in a 36-year-old alder stand on the Oregon coast had a basal area of 126 square feet per acre in 1941, with a conifer understory of 19 square feet per acre. A severe ice storm early in 1942 killed 31 alder trees but only 1 conifer. By 1946 the alder stand was reduced to 104 square feet in basal area and the understory conifers, having been partially released, had increased to 26 square feet. The alder canopy, however, again closed over the conifers and in 1956 averaged 22 feet taller.[8]

In areas of repeated ice damage, alder may be killed or its growth restricted enough to favor competing conifers less susceptible to this type of injury.

Fire

Fire hazard is generally so low in alder stands that they may be used as firebreaks. An alder stand with a closed canopy that has shaded out brush and other ground cover has a low fire hazard during the season when it is in full leaf, about April 15 to October 20. Dead fuel is scarce and sufficiently moist to be of low flammability, and the canopy shields fuels from the sun and any fire from wind. Thin litter permits easy construction of firelines.

During moderately dry weather with moderate wind, fires spreading rapidly on the ground in such fuels as logging slash, conifer seedlings, dead weeds, and brush may be checked by strips of alder 40 feet tall and several hundred feet wide. Control with a fireline is then relatively easy. If the alder strip is in a moist gully, the fire often goes out. If the wind is sufficient to carry embers over an alder strip the fire will continue, leaving the alder unburned. In the coastal fog belt and in other places where the canopy is broken or thin, underbrush is dense and fireline construction may be difficult. Litter may burn readily on occasional dry, windy days when alder is not in leaf.

Control of Alder on Coniferous Sites

Red alder often encroaches on sites being managed for conifer production, at low elevations generally and particularly along creeks on the exposed soil of skidtrails, truck roads, and landings. Because of rapid initial height growth, it readily overtops both natural and planted conifer seedlings. It greatly retards their growth and causes

[8] Berntsen, Carl M. Effect of ice damage on development of a 51-year-old red alder stand with a conifer understory. 1959. (Unpublished report on file at the Pacific Northwest Forest and Range Expt. Sta.)

many of them to drop out of the stand. All degrees of mixture occur, varying from almost pure alder to almost pure conifer.

On many sites, however, alder is destined to temporary occupancy. Many young stands in the region appeared to be alder for their first 15 to 20 years, then became coniferous stands as the conifers accelerated and the alders decelerated in height growth. Many conifers eventually overtopped and crowded out nearby alders (fig. 7). The resulting stand, however, was often understocked with conifers, and their growth had been retarded during the struggle up through the alder canopy. Also, many were deformed by wind-whipped alder branches, which repeatedly killed back the conifer leaders. Much of the alder that encroaches on conifer sites is limby, rough, and short boled. When this is the case and there is enough alder to reduce conifer stocking below a desirable level, some reduction in the alder component of the stand is needed.

Several methods of alder control are used. These include slashing with hand axes, usually followed by chemical treatment of the stumps; chemical basal treatment of the stems (Ruth and Berntsen, 1956); and foliage spray applied from the air. Spraying from the air with 1 to 3 pounds acid equivalent of 2, 4–D (2, 4-dichlorophenoxyacetic acid) per acre is the generally accepted method of releasing young conifer stands from alder competition. About 2 pounds per acre in a water carrier is a common treatment.

WOOD PROPERTIES

Wood from freshly cut red alder is nearly white, with no clear distinction between heartwood and sapwood. Shortly after being

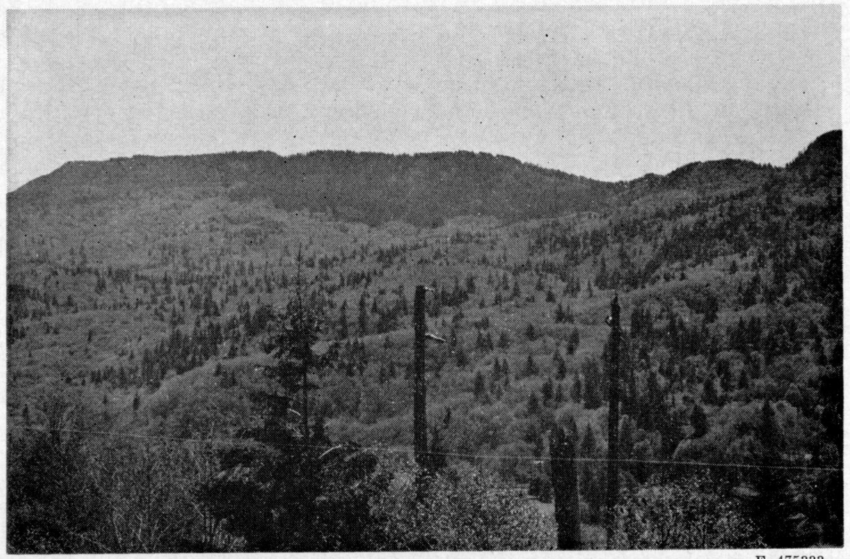

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FIGURE 7.—This high-site conifer land on the Oregon coast was dominated by red alder following fire. Scattered conifers are now pushing through the alder canopy, but quality and stocking are poor.

sawed, the wood turns to reddish brown and may further change to light yellowish brown when thoroughly dried. The color of alder wood is determined to some extent by the temperature used in drying, but it presents little problem since in use much of the wood is stained to imitate walnut or mahogany.

Red alder has a fine, even texture and is characteristically straight grained. The wood has no characteristic odor or taste. Although each year's growth ring is marked by a thin whitish or brownish line at the outer margin, there is virtually no distinction between springwood and summerwood.

A distinct characteristic of red alder is the scattered occurrence, on the face of flat-grained lumber, of narrow brown streaks called ray flecks. These run parallel to the grain and may be as much as an inch long.

Red alder's physical properties make it well suited for furniture manufacture. It is moderately light in weight and moderately hard. It machines well, takes finish well, and is easily glued. The wood does not split readily when nailed, and when properly seasoned does not shrink, check, or warp appreciably.

Physical properties of red alder may be judged further by comparing them with those of nine commonly used woods (tables 6 and 7). It will be noted that for the properties shown, alder is similar to yellow-poplar and ponderosa pine. Yellow-poplar is the standard for use as furniture core stock, whereas ponderosa pine is the leading species used for millwork and containers. Red alder is also similar to yellow-poplar and ponderosa pine in many other woodworking characteristics.

TABLE 6.—*Comparative values for five properties important in the processing and use of red alder and nine other common woods* [1]

Species	Ease of kiln-drying [2]	Ability to stay in place [2]	Ease of working with hand-tools [3]	Ease of gluing [3]	Ability to hold paint (outside use) [4]
Alder, red	2	3	1	2	3
Yellow-poplar	2	2	1	1	3
Pine, ponderosa	1	2	1	2	3
Douglas-fir	1	3	3	2	4
Sweetgum	2–4	4	2	2	4
Cherry, black	4	3	3	3	4
Walnut, black	4	2	2	3	5
Birch, yellow	2	4	3	4	4
Maple, sugar	3	4	3	4	4
Oak, white	4–5	4	3	3	5

[1] Species rated relatively high in the property listed are assigned the lowest numbers; species rated low in the property are assigned the highest numbers. For some properties the woods are divided into five groups; for other properties, into three or four groups.

[2] From "Strength and Related Properties of Wood" (Markwardt and Wilson, 1935).

[3] From "Wood Handbook" (U.S. Forest Service, 1955).

[4] From "Wood Properties and Paint Durability" (Browne, 1947) and supplementary data.

TABLE 7.—*Comparative values for several physical properties of red alder and nine other common woods*

Species	Weight per cubic foot at 12-percent moisture content [1]	Comparative values [2]				
		Volumetric shrinkage	Bending strength	Hardness	Stiffness	Shock resistance
	Pounds					
Alder, red	28	100	100	100	100	100
Yellow-poplar	29	99	100	92	109	106
Pine, ponderosa	28	80	84	85	81	79
Douglas-fir	34	99	118	121	133	119
Sweetgum	36	130	112	127	106	147
Cherry, black	36	92	122	150	108	156
Walnut, black	38	94	146	181	120	174
Birch, yellow	43	135	139	181	125	239
Maple, sugar	44	120	150	240	128	190
Oak, white	46	124	134	225	110	176

[1] Based on average specific-gravity values in "Wood Handbook" (U.S. Forest Service, 1955).
[2] Based on values in "Standard Terms for Describing Wood" (U.S. Forest Products Laboratory, 1956).

MACHINING PROPERTIES

The suitability of alder for furniture, millwork, wood turnings, and similar products is indicated by results of machining tests performed recently at the U.S. Forest Products Laboratory (Davis, 1960). Both red alder and bigleaf maple were evaluated in planing, shaping, turning, boring, and mortising, and the quality of machining was judged by the smoothness of cut. In general, machinability was evaluated by determining the proportion of defect-free pieces and comparing the results with those of previous tests on other hardwoods.

Overall, red alder did not compare as favorably with other well-known hardwoods as did bigleaf maple, but alder's specific machining properties are generally satisfactory, as shown by results of individual tests.

Planing

A knife cutting angle of 10° proved best for alder at 6-percent moisture content. A 20° cutting angle was almost as good but a 30° cutting angle gave poor results. Comparative results from planing several hardwoods are based on an average of the three best cutting angles for each species and are not the results achieved with the best cutting angle:

Species:	*Defect-free pieces (percent)*
Yellow birch	63
Red alder	61
Hard maple [1]	54
Bigleaf maple	52
Sweetgum	51

[1] Commercial name for lumber cut from black maple and sugar maple.

The chief defects in planing either alder or bigleaf maple were chip marks and chipped grain.

Shaping

Tests made with a double-spindle shaper on hardwoods at 6-percent moisture content have shown that 25 eastern hardwoods yielded an average of 25 percent of good to excellent shapings. Shaping properties of red alder as compared with four other hardwoods are:

Species:	*Good to excellent shapings (percent)*
Hard maple [1]	62
Bigleaf maple	56
Red gum [2]	21
Red alder	20
Yellow-poplar	12

[1] Commercial name for lumber cut from black maple and sugar maple.
[2] Commercial name for lumber cut from sweetgum.

Turning

Twenty-five eastern hardwoods previously tested in turning at 6-percent moisture content yielded 58 to 91 percent of good to excellent turnings, with an average of 79 percent. As indicated in the following tabulation, red alder is well above the average:

Species:	*Good to excellent turnings (percent)*
Black walnut	91
Red alder	88
Hard maple [1]	82
Yellow birch	80
Bigleaf maple	80
Soft maple [2]	76

[1] Commercial name for lumber cut from black maple and sugar maple.
[2] Commercial name for lumber cut from red maple and silver maple.

Boring

The 25 eastern hardwoods previously tested yielded from 62 to 100 percent of good to excellent holes. Red alder was near the low end of this range and compared with five other hardwoods as follows:

Species:	*Good to excellent borings (percent)*
Hard maple [1]	99
Yellow-poplar	87
Bigleaf maple	80
Soft maple [2]	80
Cottonwood	70
Red alder	69

[1] Commercial name for lumber cut from black maple and sugar maple.
[2] Commercial name for lumber cut from red maple and silver maple.

Mortising

Mortising tests on eastern hardwoods yielded from 18 to 100 percent of fair to excellent mortises, the average being 70 percent. Red alder is below average in this property, as indicated by a comparison with five other hardwoods:

Species:	Fair to excellent mortises (percent)
Mahogany	100
Bigleaf maple	100
Hard maple [1]	95
Red gum [2]	58
Red alder	52
Cottonwood	52

[1] Commercial name for lumber cut from black maple and sugar maple.
[2] Commercial name for lumber cut from sweetgum.

SEASONING

Because of its low density, moderate moisture content, high permeability, generally uniform wood structure, and the moderate difference between radial and tangential shrinkage, red alder is one of the easiest hardwoods to season. However, it requires somewhat more care than the softwoods. Kiln-drying is the best way to season alder, at least in the ordinary thicknesses, and it has been dried this way commercially for many years at temperatures ranging from 120° to 200° F. For stock more than 2 inches thick, preliminary air-drying may be desirable.

Air-Drying

Since the sapwood of red alder is susceptible to stain, mold, and decay, alder lumber should be piled with stickers as soon as possible after sawing. Use of an antistain chemical dip before piling may be desirable during periods of warm, humid weather (Verrall and Scheffer, 1949).

Rapid and uniform drying and straight lumber will result if the following practices are observed when piling alder for air-drying: good yard layout; a substantial pile foundation, 12 to 18 inches high; vertical alinement of stickers, spaced not more than 3 feet apart; and roofing of the piles (Peck, 1956). Stickers should be placed close to the ends of the boards to minimize end checking, and stock more than 2 inches thick should be treated with a wax emulsion end-coating or, if necessary, a more highly water-resistant material (McMillen, 1956). In laying out an air-drying yard, there should be several feet between the sides of the piles, and somewhat wider spaces between rows of piles. In a yard where the piles are built by hand, a space at the front ends of the piles is provided by the main alley, but there should also be a rear alley of about 6 feet.

In a study by the Oregon Forest Products Laboratory (Anderson and Frashour, 1954), a high-humidity treatment before air-drying eliminated sticker stain. The treatment also resulted in a desirable and uniform shade of color when the lumber was finally kiln-dried. Best results were obtained by preconditioning the lumber for 18 hours at 140° F. with a 4° F. wet-bulb depression.

Except in periods of very low humidity, air-drying will not reduce red alder's moisture content enough for use in furniture manufacture. Small quantities can be dried in a room heated 15° to 20° F. above the outdoor air temperature (Rasmussen, 1946), but kiln-drying is more practical for large-scale operations. Also, conditioning in a kiln is needed if casehardening is of consequence.

Lumber producers state that it is more difficult to obtain the light honey color desired by furniture manufacturers when alder lumber is air seasoned before kiln-drying. Generally, best color results when green lumber is sent directly from the saw to the dry kiln.

Kiln-Drying

Alder is dried best in a kiln with forced-air circulation and automatic temperature control. Recommended kiln schedules are T10–D4 for 4/4 (1-inch) to 6/4 stock and T8–D3 for 8/4 (2-inch) stock (U.S. Forest Products Laboratory, 1960). These schedules, shown in table 8, like those used for other hardwoods are based on average moisture content of the lumber, as determined by kiln samples. Recommended procedures in the use of kiln samples are described in U.S. Forest Products Laboratory Report 1607 (1954). The schedules can be simplified (Espenas, 1951) or reduced to time schedules after experience is gained. For 10/4 and thicker stock, hardwood schedule T6–C3 is suggested.

TABLE 8.—*Recommended kiln schedules for seasoning red alder*

SCHEDULE T10–D4 (4/4 TO 6/4 STOCK)

Treatment or moisture content at start of step (percent)	Dry-bulb temperature	Wet-bulb temperature	Relative humidity
Drying:	*Degrees F.*	*Degrees F.*	*Percent*
50+	140	133	82
50	140	130	75
40	140	125	64
35	140	115	46
30	150	110	28
25	160	110	21
20	170	120	24
15	180	130	26
Equalizing	180	145	41
Conditioning	170	160	78

SCHEDULE T8–D3 (8/4 STOCK)

Treatment or moisture content at start of step (percent)	Dry-bulb temperature	Wet-bulb temperature	Relative humidity
Drying:			
50+	130	125	86
50	130	123	81
40	130	119	71
35	130	111	54
30	140	105	31
25	150	100	18
20	160	110	21
15	180	130	26
Equalizing	180	145	41
Conditioning	170	160	78

Although the same schedule is recommended for 4/4 and 6/4 stock on a moisture-content basis, and 4/4 and 6/4 stock could be included in an 8/4 charge using schedule T8–D3, it is well to segregate different sizes because the thinner stock dries more rapidly. Drying times of 5 to 6 days have been reported for 4/4, and 14 to 16 days for 8/4 lumber.

When previously air-dried, 4/4 stock can be kiln-dried in 3 days and 8/4 stock in 7 days. For material that has been air-dried, kiln-drying can start at the appropriate step of the standard schedule corresponding to the moisture content of the samples. If the stock has been subjected to a prolonged period of high-humidity weather just before kiln-drying, it may be desirable to predry it 1 day for each inch of thickness at a higher relative humidity than called for in the schedule.

For some exacting uses, such as for furniture, it is desirable that alder lumber be uniformily dry and free of casehardening stresses in order to avoid later distortion of wood parts and loosening of assembly joints. Moisture content of individual boards or items can be made uniform through use of an equalizing treatment, and uniform moisture content throughout the thickness of each board and relief from casehardening stresses can be obtained with a high-temperature, high humidity conditioning treatment (U.S. Forest Products Laboratory, 1960). Casehardening stresses develop when lumber is dried, because the surfaces become dry before the interior and cannot shrink normally. These stresses in dry lumber cause resawn pieces to cup badly and machined pieces to distort, often rendering them unsuitable for use. In a conditioning treatment following equalization of moisture content, the wood is plasticized so that the casehardening stresses are relieved. Following such treatment, dry lumber can be resawed and worked to pattern without the risk of distortion.

The equalizing and conditioning treatments shown in the schedules in table 8 apply to lumber dried to an average moisture content of 7 percent. In this case, equalizing should be started when the driest sample is down to 5-percent moisture content, and conditioning when the wettest sample is down to 7-percent moisture content. Conditioning will require 16 to 24 hours for 4/4 stock and 32 to 48 hours for 8/4 stock.

Although the surface of alder turns reddish brown soon after cutting, the interior may stay almost white or take on considerable color, depending on drying conditions. Schedules T10–D4 and T8–D3 are designed for rapid drying with a minimum of seasoning defects and should produce a moderate amount of coloration. If a darker or lighter colored product is desired, the drying schedules can be modified: High-temperature, high-humidity kiln-drying is believed to give most coloration and—conversely—low-temperature, low-humidity kiln-drying to give least coloration. It is suggested, therefore, that hardwood schedule T11–D3 be used if deep coloration is desired and that hardwood schedule T5–D5 be used for least coloration. Both schedules are included in U.S. Forest Products Laboratory Report 1900–5 (U.S. Forest Products Laboratory, 1960).

MAJOR USES

Accurate figures are not available, but it is estimated that approximately 200 million board feet of red alder was logged in Oregon and Washington in 1959. The logs were manufactured into the following products:

	Volume of logs used	
	(M board feet)	(Cords)
Pulp	150, 000	300, 000
Lumber and miscellaneous products [1]	50, 000	100, 000
Total	200, 000	400, 000

[1] Miscellaneous products include paper plugs, veneer, and novelties.

Pulp

Although commercial pulping of alder is a relatively new development, it now exceeds all other uses for this species. In 1959, five pulp companies were using substantial volumes of alder, and two other companies used limited amounts on a trial basis. Since plans are underway to construct a new mill on the Oregon coast to use alder exclusively, consumption of the species for pulp should continue to expand.

Alder is being pulped by the standard sulfate and sulfite processes and is the one species in the Pacific Northwest being pulped by the neutral sulfite semichemical process. In addition, pulping of alder by the soda, cold soda, groundwood, and chemigroundwood processes has been successfully demonstrated.

Neutral Sulfite Semichemical Pulping

The neutral sulfite semichemical process was developed by the U.S. Forest Products Laboratory to encourage use of available hardwood timber. Increase in demand for corrugated board and insulation board since World War II led to commercial adoption of the process in the Lake States and Southern States and, more recently, to its use with alder in the Pacific Northwest (fig. 8). Production of neutral sulfite semichemical pulp in the United States was about 2 million tons in 1959.

Because of relatively high chemical and fiberizing requirements, red alder is somewhat more difficult to pulp by the neutral sulfite semichemical process than many eastern and southern hardwoods used commercially. Alder's chemical and fiberizing requirements are not impractically high, however.

Red alder semichemical pulps are suitable for use in container board and in bleached papers, according to the results of trials at the Forest Products Laboratory. Also, corrugating boards of excellent strength and resistance to flat-crush were prepared from neutral sulfite pulp cooked to yields as high as 80 percent of the original wood. Stronger pulps made in a yield of 70 percent showed promise for use in linerboard, although the low tearing and folding values characteristic of short-fibered pulps were evident and indicated the desirability of blending with long-fibered pulps. Pulps made in yields of 65 to 70 percent were bleached to high white values in a conventional three-

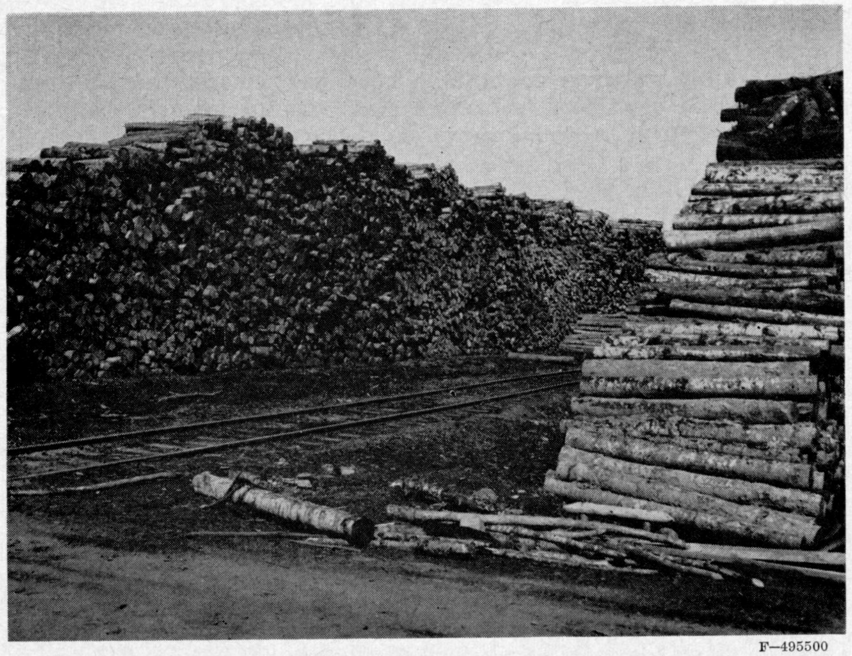

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FIGURE 8.—Alder cordwood in storage for Weyerhaeuser Company's neutral sulfite pulpmill at Longview, Wash. Each pile contains 400 to 500 cords.

stage process with economical amounts of chlorine to give final yields slightly below 55 percent of the original wood.

Greaseproof paper made from red alder semichemical pulp has good formation and strength equal or superior to that of a standard high-quality, commercial, softwood sulfite product. Alder semichemical pulp is now being used by a paper company in western Washington for the production of greaseproof paper.

Because of its nature and properties, bleached semichemical pulp from red alder could probably be used successfully in bond and book papers; much as this kind of pulp is used in the Eastern United States. Many of the pulp products now made from western softwoods could be improved by adding alder semichemical pulp.

Sulfite Pulping

One hardwood pulpmill in the Pacific Northwest is pulping alder by the ammonia-base sulfite process. Alder pulp produced at this plant is blended with softwood sulfite pulps to make high-grade tissues. The short, soft fiber produced from alder is well suited for this use.

Sulfate and Soda Pulping

Red alder pulped by the sulfate and soda processes at the U.S. Forest Products Laboratory gave relatively high yields—about 50 percent and 47 percent, respectively. Both types of pulp had strength values falling in the range of those for eastern and southern hardwoods, which are pulped in large quantities by these two processes.

Experimental yields of sulfate semichemical pulps from alder were in the range of those ordinarily obtained for other hardwoods pulped under the same conditions; namely, 60 to 75 percent. These pulps decreased in strength with increase in yield. The pulp with highest yield was considerably lower in bursting strength and tearing resistance than pulp of similar yield made by the neutral sulfite semichemical process. At lower yields the differences were not so great.

Red alder sulfate and soda pulps should find the same uses as other hardwood alkaline pulps, that is, in products where a short-fibered pulp is desirable and high strength is not required. Products of this type include book and other printing papers and tissue and toweling papers. Actually, only a small amount of red alder sulfate pulp is used in this way. These products generally require that the pulps be bleached. Red alder sulfate pulps can be bleached by practical procedures only slightly modified from those now used to give acceptable semibleached and fully bleached hardwood pulps. A resinous substance, which sometimes appears as dark, reddish-orange threads in the alkaline process pulp, can be eliminated in the multistage bleaching process if the proper conditions are maintained.

Douglas-fir is the primary species used by western sulfate pulpmills. This species has the largest and coarsest fiber of the western softwoods and gives a bulky sheet with a relatively poor finish. Experiments have shown that bond and magazine papers and milk-carton stock containing Douglas-fir bleached sulfate pulp can be improved by adding short-fibered red alder sulfate pulp.

Cold Soda Pulping

The cold soda process, which was first announced by the U.S. Forest Products Laboratory in 1949, is still in the experimental stages but is now undergoing commercial development. It is simple to operate as a batch system, and the possibilities for continuous processing are very promising. It is an excellent process for producing pulps from hardwoods in a yield range above 85 percent. In the batch process, chips are steeped in a solution of sodium hydroxide at room temperature. The time varies from ½ to 2 hours, depending on the pressure applied. The treated chips are then fiberized in an attrition mill.

Optimum conditions for pulping red alder by this process were found to be similar to those used for the more easily pulped hardwoods, such as aspen and paper birch. The energy required to fiberize the treated alder chips was about 50 percent greater than that needed for chips from an average eastern or southern hardwood treated under the same conditions. Yields ranged from 87 to 92 percent.

The reaction of the caustic soda upon the wood during the process resulted in a slightly darkened, reddish pulp that was easily semibleached in a single-stage calcium hypochlorite bleaching treatment.

Strength of the red alder cold soda pulps increased with a decrease in pulp yield within the limits of the experiments. Another finding was that strength could be increased by adjusting fiberizing conditions. The strength values of the cold soda pulps were in a range only slightly lower than the best that have been obtained from other hardwoods. Also, strength values were not so high as those of red alder pulps made by the neutral sulfite semichemical process, but they were somewhat above those of the strongest softwood groundwood pulp.

The strength properties of corrugating boards made from 100-percent red alder cold soda pulps compared favorably with those of commercial hardwood semichemical corrugating boards. The high resistance to flat-crush shown in tests on these boards was especially promising.

A newsprint-weight paper made from 40-percent red alder semibleached cold soda pulp and 60-percent western hemlock groundwood pulp was about the same in strength, brightness, and opacity as a commercial grade of newsprint made from 20-percent western hemlock sulfite and 80-percent western hemlock groundwood pulps.

Groundwood and Chemigroundwood Pulping

Though groundwood pulp made experimentally from red alder has a reddish color, it is easily semibleached by a single-stage hypochlorite bleaching treatment, making it satisfactory from this standpoint for use in groundwood book paper. However, its strength is only about half that of a book grade of aspen groundwood, so the amount that could be used in a paper furnish would be limited. A paper made from a furnish containing 35-percent red alder semibleached groundwood, 45-percent subalpine fir groundwood, and 20-percent Douglas-fir bleached sulfate pulps is comparable in strength and color to a commercial paper.

Pulps with greater strength and other improved properties can be made by pressure treating the wood with an approximately neutral solution of sodium sulfite before grinding (chemigroundwood). Chemigroundwood from red alder tested stronger than any softwood groundwood and approached red alder neutral sulfite semichemical pulp in strength and other properties. Chemigroundwood pulp, however, lacks bulk and certain other properties possessed by groundwood pulp, and so it is not wholly a substitute for softwood groundwood in papers in which those properties are needed. Like semichemical pulp, it can be used in mixtures with hardwood groundwood to provide the strength generally lacking in that product.

Red alder groundwood and chemigroundwood pulps are too dark colored to use in printing papers without semibleaching. A newsprint-weight paper made from 40-percent red alder semibleached chemigroundwood and 60-percent subalpine fir groundwood pulps was above average for newsprint in strength and color, and the opacity, porosity, and ink receptivity were satisfactory. A good-quality groundwood book paper was made from 40-percent alder semibleached chemigroundwood, 40-percent subalpine fir groundwood, and 20-percent Douglas-fir sulfate pulps.

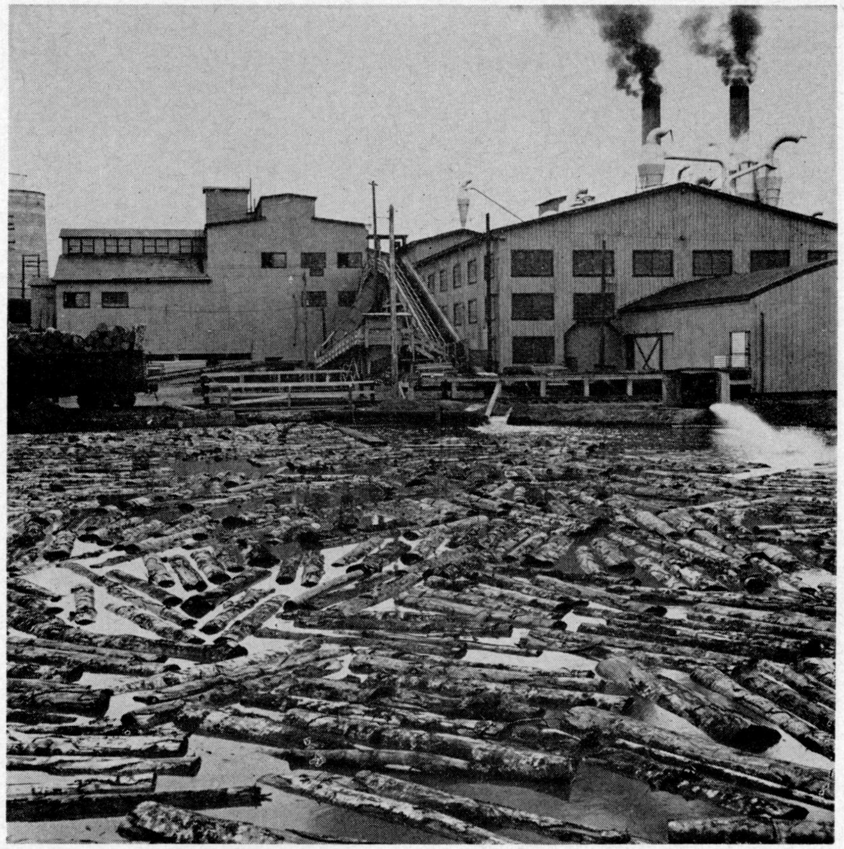
Alder groundwood or chemigroundwood pulps should be suitable for softboard or hardboard production. Experiments at the U.S. Forest Products Laboratory have shown that red alder, steam treated by the Asplund Defibrator Process to a yield of about 85 percent, can be made into hardboard that meets class I specifications.

Lumber and Miscellaneous Products

Lumber

One of the most important uses for alder is the production of lumber. Most of the lumber is cut in small stationary or portable

mills. Logs are ordinarily 8 feet long, although a few companies find it advantageous to produce lumber in longer lengths. In the past, much alder lumber was sold on a rough, green, mill-run basis. Production was geared to maximum volume and much poorly manufactured lumber was put on the market. This practice gave alder a bad reputation that has been difficult to overcome. In recent years the trend has been to cut more of the lumber at mills equipped to produce accurately manufactured, kiln-dried, and surfaced lumber (fig. 9).

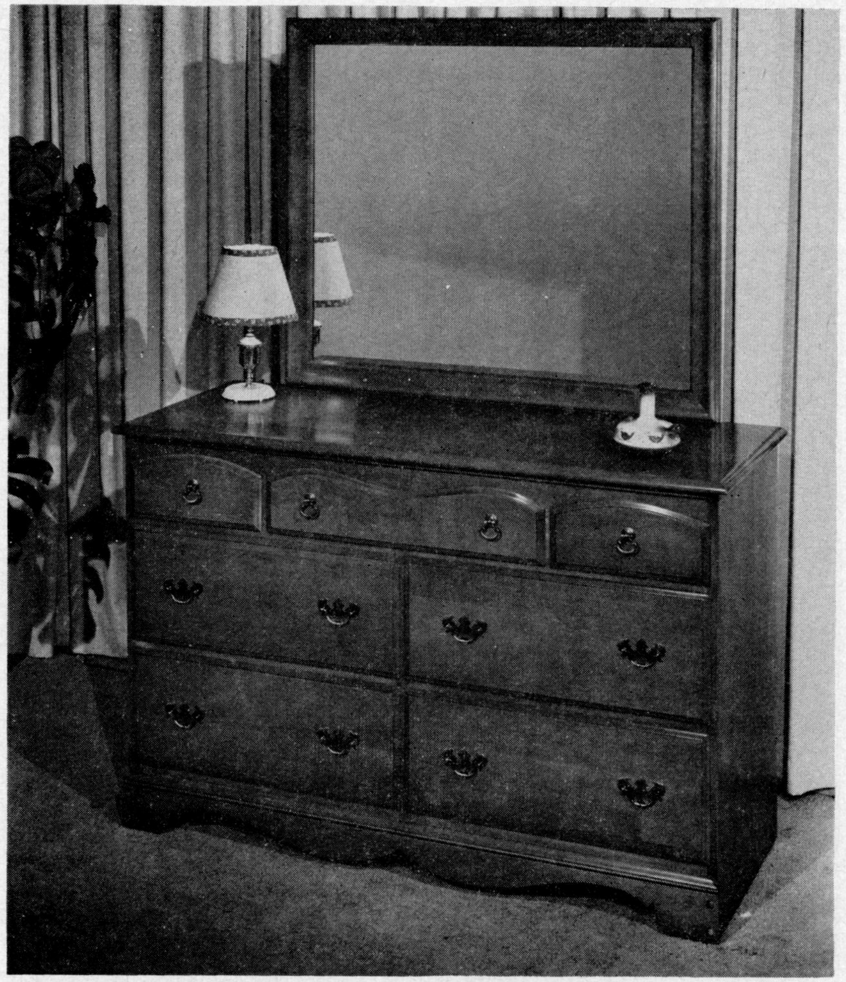


(Photo courtesy Weyerhaeuser Company.)

FIGURE 9.—Alder saw logs customarily are stored or sorted in log ponds.

Most of the alder lumber produced is used by the furniture industry. During 1959, furniture plants in Oregon and Washington used approximately 28 million board feet of alder. It is estimated that another 20 million feet was shipped from Oregon and Washington to out-of-State furniture plants, primarily in the Los Angeles area, where it competes with eastern hardwoods.

Because of its physical properties, described in a previous section, alder is suited for core stock as well as for turned and exposed parts of many types of furniture. In solid form, it is used for medium-priced dining room, kitchen, and bedroom furniture (fig. 10). It is also used for bottoms and sides of drawers in more expensive furni-



(Photo courtesy B. P. John Furniture Corp.)

FIGURE 10.—A double dresser of solid red alder.

ture. Better grades of unpainted furniture—such as chairs, cabinets, tables, dressers, and beds—also are made of alder. It is well suited for this use since it can be painted or enameled readily.

A small amount of alder lumber is used for production of wall paneling, molding, and interior trim. Some of the panels are one-piece boards in 8- or 10-inch widths, and some are made by gluing narrow pieces into 12-inch widths. Alder paneling and molding have a pleasing appearance, can be easily nailed, and do not warp and twist in use. Use of these products will probably increase.

Veneer

A small amount of alder veneer is produced for the Northwest furniture industry. This veneer is used primarily for crossbands,

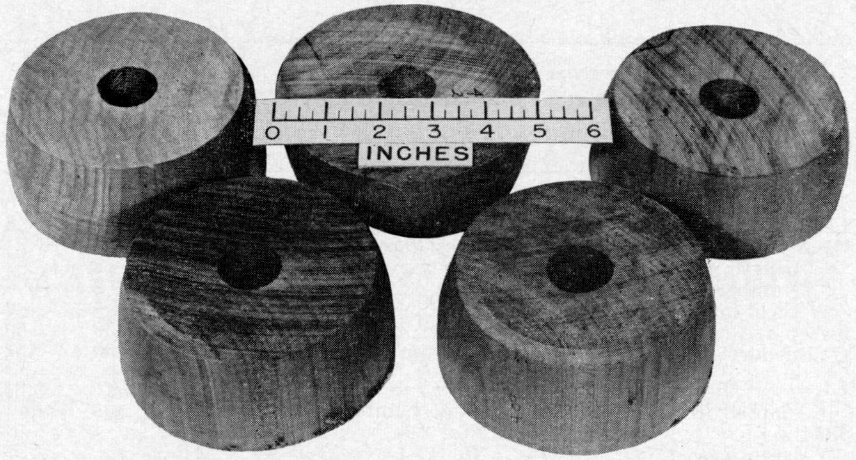
with minor amounts used for face stock. Experiments at the U.S. Forest Products Laboratory show that good alder veneer can be produced without heating the bolts (U.S. Forest Prod. Lab., 1950). However, quality was improved when the bolts were heated in water at a temperature of 140° F. To get adequate penetration, a 12-inch bolt 4 feet long should be heated at this moderate temperature for about 8 hours; a 16-inch bolt, for 15 hours.

Owing to its small size and the occurrence of knots and other defects, alder is at somewhat of a disadvantage for veneer production. However, integrating pulpwood cutting with veneer-bolt production offers a possibility for segregating the premium material for veneer use.

Paper Plugs

Practically all paper plugs made in the Pacific Northwest are alder. These plugs are inserted in the ends of paper rolls to facilitate handling and to keep the paper in place. Because of the ease with which it can be turned, bored, and dried, alder is well suited for this use.

Alder plugs are turned in various sizes from small poles or from sawed material (fig. 11). They are produced from green material and then dried and polished. With pulp production expanding, the demand for paper plugs should continue to increase. However, alder plugs probably will face increasing competition from molded plugs now being made from wood fiber.



(Photo courtesy Oregon Forest Research Center.)

FIGURE 11.—Nearly all paper plugs made in the Pacific Northwest are alder.

Novelties and Small Miscellaneous Products

Because of its good machining, gluing, and painting properties, and its ability to hold its shape with changes in moisture content, alder is well suited for the manufacture of novelties and small miscellaneous products. Toys, brush handles, shoe soles, trays, and numerous other small items are now made from alder.

LOG GRADES AND LUMBER RECOVERY

Until recent years, much of the alder lumber produced was sold ungraded. With increasing emphasis placed on lumber quality, however, it became important to have a set of log rules and to know the type of lumber that can be expected from the various log grades. A few mills developed their own grading rules, but there was a lack of standardization throughout the industry. Therefore, a cooperative project was undertaken in 1952–53 by the Oregon Forest Products Laboratory and the U.S. Forest Service to:

1. Determine whether the hardwood log-grading rules developed by the U.S. Forest Products Laboratory for eastern hardwoods could be applied to alder.
2. Ascertain the applicability of National Hardwood Lumber Association grading rules to this species.
3. Compare alder lumber recovery with that of commonly used eastern hardwood species.

A report on the study was published by the Oregon Forest Products Laboratory in cooperation with the U.S. Forest Products Laboratory (Pfeiffer and Wollin, 1954). A suggested set of log grading rules for alder was developed during the course of the study and is summarized in table 9.

TABLE 9.—*Suggested log grades for 8-foot red alder factory-type logs* [1]

Log grade factors	Log grade [2] 1	2	3
Diameter, minimum ... inches	16	10	8
Length ... feet	8	8	8
Clear cuttings (on each of the three best faces):			
Length, minimum ... feet	3	2	2
Number on one log face, maximum	2	2	(3)
Yield in face length, minimum	5/6	4/6	3/6
Sweep and crook deduction, maximum ... percent	15	30	50
Cull deduction, including sweep, maximum ... percent	40	50	50

[1] Adapted from "Red Alder Log and Lumber Grading" (Pfeiffer and Wollin, 1954).
[2] Exceptions:
a. Logs classified as below the No. 3 grade when graded from the second from the poorest face will be admitted in the No. 3 log grade when two sides are of No. 2 log grade quality.
b. Grade 2, 10-inch diameter inside bark, must be of grade 1 surface quality.
c. Sound end defect (blue stain) in excess of 50 percent of the area on either end of the log will cause a one-step degrade.
[3] Unlimited.

Because it is the predominant practice to cut short (8-foot) logs in alder, the proposed rules for alder contain modifications to the hardwood log grading rules developed by the U.S. Forest Products Laboratory. The modifications, though few, could have a pronounced effect on lumber grade recovery. It was observed by those making the

TABLE 10.—*Lumber-grade recovery in red alder, log grade No. 1, by diameter* [1]

Log diameter (inches)	Lumber-grade recovery: FAS	Select	No. 1C	No. 2C	No. 3A	No. 3B	Basis (logs)
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Number*
16	10.7	11.3	33.8	30.5	9.7	4.0	7
17	14.0	9.1	39.0	25.8	7.0	5.1	3
18	16.3	7.9	42.9	22.0	5.0	5.9	6
19	17.5	7.8	45.7	19.1	3.6	6.3	4
20	17.8	8.7	47.4	17.1	2.7	6.3	1
21	17.1	10.6	47.8	16.0	2.4	6.1	4
22	15.4	13.5	47.1	15.9	2.7	5.4	2
23	12.8	17.5	45.2	16.6	3.5	4.4	2
All diameters	15.1	10.6	42.6	21.2	5.1	5.4	29

[1] Curved data, adapted from "Red Alder Log and Lumber Grading" (Pfeiffer and Wollin, 1954). Lumber graded by National Hardwood Lumber Association standard rules, but without limitation on the amount of 8-foot stock.

TABLE 11.—*Lumber-grade recovery in red alder, log grade No. 2, by diameter* [1]

Log diameter (inches)	Lumber-grade recovery: FAS	Select	No. 1C	No. 2C	No. 3A	No. 3B	Basis (logs)
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Number*
11	0.0	1.6	17.6	44.0	24.6	12.2	6
12	.6	2.4	20.9	43.9	22.2	10.0	21
13	2.4	3.0	23.8	43.2	19.7	7.9	51
14	4.0	3.6	26.5	42.3	17.4	6.2	37
15	5.3	4.0	29.1	41.3	15.5	4.8	43
16	6.4	4.3	31.5	40.2	13.8	3.8	33
17	7.2	4.5	33.7	39.1	12.3	3.2	28
18	7.8	4.6	35.8	37.7	11.2	2.9	25
19	8.1	4.6	37.7	36.3	10.3	3.0	13
20	8.2	4.5	39.5	34.8	9.6	3.4	12
21	8.1	4.3	41.1	33.1	9.2	4.2	5
22	7.7	4.0	42.5	31.4	9.1	5.3	2
23	7.0	3.5	43.8	29.6	9.3	6.8	3
24	6.1	3.0	44.9	27.6	9.8	8.6	1
25	---	---	---	---	---	---	---
26	3.6	1.6	46.6	23.4	11.4	13.4	1
27	2.0	.8	47.2	21.1	12.6	16.3	1
All diameters	5.7	3.9	31.8	39.1	14.4	5.1	282

[1] Curved data, adapted from "Red Alder Log and Lumber Grading" (Pfeiffer and Wollin, 1954). Lumber graded by National Hardwood Lumber Association standard rules, but without limitation on the amount of 8-foot stock.

study that the lumber grade yield from alder logs, graded by the modified rules, compared favorably with lumber yields from eastern hardwood logs of roughly equivalent grade, although no exact comparison is possible. Lumber grade yields as determined in the study of suggested log grades are reproduced in tables 10, 11, and 12 since there are no published lumber recovery data based on the log rules now in effect.

The Northwest Hardwood Association, which was formed in 1955, made it a first order of business to consider log grading rules for alder. In 1956 the association adopted a simplified set of log grading rules [9] which are still in use. Grading rules for alder lumber were adopted by the Northwest Hardwood Association in 1957 and incorporated as part of the National Hardwood Lumber Association rules that same year.

TABLE 12.—*Lumber-grade recovery in red alder, log grade No. 3, by diameters* [1]

Log diameter (inches)	Lumber-grade recovery						Basis (logs)
	FAS	Select	No. 1C	No. 2C	No. 3A	No. 3B	
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Number*
10	2. 3	0. 1	9. 1	38. 6	31. 7	18. 2	7
11	2. 1	1. 0	12. 6	39. 4	28. 9	16. 0	13
12	2. 0	1. 9	15. 9	40. 0	26. 2	14. 0	19
13	1. 9	2. 6	18. 9	40. 6	23. 7	12. 3	22
14	1. 9	3. 2	21. 6	41. 1	21. 4	10. 8	25
15	2. 0	3. 8	24. 1	41. 4	19. 3	9. 4	24
16	2. 1	4. 2	26. 3	41. 7	17. 4	8. 3	17
17	2. 3	4. 6	28. 3	41. 9	15. 6	7. 3	8
18	2. 6	4. 8	30. 0	41. 9	14. 1	6. 6	10
19	2. 9	5. 0	31. 4	41. 8	12. 8	6. 1	6
20	3. 3	5. 0	32. 6	41. 7	11. 6	5. 8	3
21	3. 8	5. 0	33. 5	41. 4	10. 6	5. 7	2
22	4. 4	4. 9	34. 2	41. 0	9. 8	5. 7	1
23	5. 0	4. 6	34. 6	40. 5	9. 3	6. 0	1
24	5. 6	4. 3	34. 8	39. 9	8. 9	6. 5	3
All diameters	2. 5	3. 6	24. 4	41. 0	18. 9	9. 6	161

[1] Curved data, adapted from "Red Alder Log and Lumber Grading" (Pfeiffer and Wollin, 1954). Lumber graded by National Hardwood Lumber Association standard rules, but without limitation on the amount of 8-foot stock.

STORAGE LOSS—LOGS AND PULPWOOD

Red alder is very susceptible to decay. Logs and pulpwood cut during summer months will show stain and incipient decay within a few weeks if not used. Therefore, the period between logging and milling should be held to a minimum. This is especially true for saw logs, since stain is a major defect in most lumber uses.

[9] Included in the appendix, p. 44.

Fresh-water storage for logs is recommended. Industry has found that alder logs placed in water deteriorate much more slowly than similar logs placed in cold decks. If water storage is not available, logs should be held for only short periods and decking should be done on well-drained areas with good air circulation.

The Pacific Northwest Forest and Range Experiment Station has studied the decay rate of alder pulp chips in outside storage (Wright, 1954). This pilot study on small piles of chips showed that even during the cool part of the year decay was evident after 5 months, although there is limited evidence that decay proceeds much slower in large piles.

FUTURE TRENDS IN UTILIZATION

Prospects for continued improvement in utilization of red alder are promising. The overall increase in markets for wood products and the decreasing per-capita timber supply are directing more attention to western hardwoods. Although alder use has increased markedly since the late 1950's, the species is still not harvested as fast as it is growing.

When properly manufactured, alder lumber can compete successfully with eastern hardwoods in western furniture plants. This market should continue to expand to keep pace with furniture needs for the rapidly growing western population. In addition, the recently developed market for pulpwood provides an important gain in utilization of alder, since only trees growing on moist sites reach saw-log size.

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APPENDIX

Common and Scientific Names of Botanical Species Mentioned

"Check List of Native and Naturalized Trees of the United States" (Little, 1953) is the authority for tree names used in this publication; "Standardized Plant Names" (Kelsey and Dayton, 1942) is the authority for names of shrubs and herbs. Approved common names not often used by foresters in the Pacific Northwest have the locally used name in parentheses.

Trees

Bigleaf maple	*Acer macrophyllum*
Bitter cherry	*Prunus emarginata*
Black cherry	*P. serotina*
Black cottonwood	*Populus trichocarpa*
Black maple	*Acer nigrum*
Black walnut	*Juglans nigra*
Cottonwood	*Populus* spp.
Douglas-fir	*Pseudotsuga menziesii*
European alder	*Alnus glutinosa*
Grand fir	*Abies grandis*
Mahogany	*Swietenia macrophylla*
Pacific willow	*Salix lasiandra*
Ponderosa pine	*Pinus ponderosa*
Red alder	*Alnus rubra*
Red maple	*Acer rubrum*
Silver maple	*A. saccharinum*
Sitka alder	*Alnus sinuata*
Sitka spruce	*Picea sitchensis*
Subalpine fir	*Abies lasiocarpa*
Sugar maple	*Acer saccharum*
Sweetgum	*Liquidambar styraciflua*
Vine maple	*Acer circinatum*
Western hemlock	*Tsuga heterophylla*
Western redcedar	*Thuja plicata*
White oak	*Quercus alba*
Yellow-poplar	*Liriodendron tulipifera*
Yellow birch	*Betula alleghaniensis*

Shrubs and Herbs

American devilsclub	*Oplopanax horridus*
Elder	*Sambucus* spp.
Nettle	*Urtica* spp.
Osoberry (Indian plum)	*Osmaronia cerasiformis*
Salal	*Gaultheria shallon*

Salmonberry	*Rubus spectabilis*
Trailing blackberry	*Rubus macropetalus*
Western swordfern	*Polystichum munitum*
Western thimbleberry	*Rubus parviflorus*
Whortleberry (huckleberry)	*Vaccinium* spp.

Official Grading Rules for Pacific Coast Hardwood Logs

(Applicable to Red Alder and Big-Leaf Maple)

General rules:

1. These rules, adopted by the Northwest Hardwood Association at its April 14, 1956 Quarterly Meeting at Vancouver, B.C., shall be the official grading rules to govern the measurement, sale and purchase of hardwood logs by Association members.
2. All logs shall be produced from live, standing trees, and shall be clean, free of metal and other foreign matter, and shall have all limbs trimmed flush with the bark surface.
3. No sweep or crook to exceed one-half the mid-diameter of the log in an 8-foot length shall be allowed in any grade.
4. Compound splits or "spider splits" which extend more than ⅓rd of the log length shall be allowed in pulp grade only.
5. Log diameters, unless otherwise specified, shall be measured at the average diameter of the smaller end of the log, inside the bark.
6. Discoloration of logs due to weather stain shall not be allowed in saw log grades.
7. All logs shall be cut with a minimum additional length of two inches over the specified length for each eight feet as an allowance for trimming in manufacture.
8. The Scribner Decimal "C" log rule shall be used in scaling all logs. The net scale of any log shall be the gross scale minus the volume of unsound and unusable wood, such as: red heart, hollows, large holes, rot, dote, windshake, large or excessive wormholes, damage in felling by splintering pulls, spider-splits, roughness and crooks. (This does not include adventitious bud clusters.) Standard cord measure of 128 cubic feet may be used.

Log rules for Pacific Coast Alder:

No. 1. SAWLOG: Each log shall have a minimum diameter of 15 inches. 75% of each log shall be free of knots and other defects. Not over 25% of the gross scale of any log may consist of stained wood or rot.

No. 2. SAWLOG: Each log shall have a minimum diameter of 10 inches. 75% of each log shall be free of knots and other defects. Not over 25% of the gross scale of any log may consist of stained wood or rot.

PULP GRADE: All logs which have a minimum diameter of less than 10 inches, or which otherwise do not qualify as No. 2 SAWLOG GRADE, shall be classified as unacceptable for manufacture into sawn products.

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