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Hardwood Supply in the Pacific Northwest: A Policy Perspective

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Abstract

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The policy framework for the hardwood resource and hardwood industry in western Oregon and Washington is examined. Harvesting trends, harvesting behavior of public and private landowners, and harvesting regulation are presented to complete the analysis of factors affecting short-run hardwood supply. In the short term, the supply of hardwoods is generally favorable, but in the long term, the supply is uncertain and cause for concern. Hardwoods need to be recognized in forest management in the Pacific Northwest.

Keywords: Supply, demand, hardwoods, red alder, *Alnus rubra*, Pacific Northwest.

Summary

The Policy framework for the hardwood resource and industry in western Oregon and Washington is examined. A detailed summary of the existing inventory was assembled with an emphasis on those characteristics related to the short-run supply of hardwoods. Current inventory in Pacific Northwest forests is 36 billion board feet of hardwood sawtimber. Over two-thirds of the inventory is red alder and most is on private lands in stands of sawtimber size. Harvesting trends, harvesting behavior of public and private landowners, and harvesting regulations are presented to complete the analysis of factors affecting short-run hardwood supply. Annual harvest of hardwoods in the Pacific Northwest is currently about 600 million board feet, most of which comes from privately owned forests. Long-run supply is addressed with a comprehensive evaluation of hardwood management. A historical summary and a review of the current institutional and biological dimensions of hardwood forestry in the Pacific Northwest are included. A comprehensive overview of the hardwood industry in the Pacific Northwest is used to assess the demand for the hardwood resources and the contribution of the hardwood industry to the Northwest's rural economies. Markets and marketing of hardwood products and the economic impact of the 7,000 hardwood related jobs are used to put the hardwood demand information into an economic development perspective. Overall major conclusions and recommendations are the the short-run supply of hardwoods is generally favorable; the long-run supply picture is uncertain and cause for concern; hardwoods need to be explicitly recognized in forest management in the Northwest; opportunity exists for expanding the usage of hardwood other than red alder; and opportunities exist for expanding value-added manufacturing of all hardwoods, including red alder.

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Background and Purpose

Until recently the hardwood manufacturing industry and associated hardwood forest resources in the Pacific Northwest have played a relatively minor role in the timber economy of that region.¹ With forests dominated by softwoods, the various hardwood species were generally underused, and the surplus of growth over harvest gave the region the high hardwood inventories present today. Due to this past surplus and to softwood timber supply problems in the region, interest has increased in the potential for new or expanded industries and in increased employment and income from value-added manufacturing based on the hardwood resource. Interest has intensified with the adjustments occurring in Federal timber supply and the changes in public land management policies. This study is part of a larger program of related research and demonstration projects that explores the possibilities for encouraging hardwood forestry and hardwood industry in the rural areas of the region.²

Interviews with representatives of the hardwood industry confirm widespread concern for hardwood supplies. This concern is, at first, surprising, because within the forestry community there has been a persistent image of hardwoods as an overabundant resource, and foresters have viewed hardwoods as economically undesirable competitors of the preferred and better recognized softwood species. Along with the image of overabundance in the woods has come the image of low-valued manufactured products and underuse of available raw materials by the hardwood industry. Neither image is consistent with current conditions. Decades of surplus growth have produced substantial hardwood timber inventories that support a growing hardwood industry, but supply problems related to diminishing quantity and quality of raw material recently have developed. Immediate and long-run hardwood supply prospects, therefore, are in doubt. Concern for supply is both ironic and unfortunate, because strong domestic and international markets have been developed for wood products from western hardwoods, particularly red alder (*Alnus rubra* Bong.).

The purpose of this paper is to evaluate the policy situation affecting hardwood supply. Included are detailed evaluations of the principle elements of hardwood policy, including hardwood resource conditions, nonregulatory and regulatory institutions, harvesting trends and behavior, forest management strategies, markets for manufactured products, and the contribution that the industry makes to the Pacific Northwest and the Nation. The need for this policy analysis is apparent—planning and management for sustainable hardwood resources is in its infancy when compared to the impressive level of attention given the softwood resources in the region.

We divide the paper and approach the problem of hardwood policy in three parts: (1) an overview of the hardwood resource conditions in western Oregon and western Washington, including analyses of inventories, regulatory and nonregulatory institutions affecting supply, harvesting trends, and harvesting behavior; (2) a comprehensive discussion of hardwood management, including its historical basis and current state of practices affecting hardwoods; and (3) an evaluation of the hardwood manufacturing industry, including its markets and its contribution to the Pacific Northwest

¹ Hardwood species include all nonconiferous tree species; generally synonymous with broad-leaved tree species.

² USDA Forest Service. 1993. The red alder/value added research and demonstration program. Unpublished report. 31 p. On file with: Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

Conditions, Influences, and Trends

economy. The first section, concentrating on hardwood resources and harvesting, is the foundation for understanding short-run supply. The second section, concentrating on forest management, is the foundation for understanding long-run supply. The last section, concentrating on the industry and its markets, is the foundation for understanding hardwood demand, the importance of the hardwood industry to the region and the Nation, and the prospects for the industry's future.

Hardwood availability is determined by the physical characteristics of the resource, the objectives and intentions of landowners, management practices carried out by landowners, nonregulatory institutions such as universities and research organizations, and the regulatory environment that defines acceptable harvesting practices. Availability, together with market conditions, determines supply, and supply and demand determine harvesting. We discuss each of these topics, and finish with a discussion of the factors that have influenced harvesting of privately owned hardwood and softwood stands in western Oregon and western Washington in the recent past. These discussions lead to a comprehensive evaluation of the supply outlook for hardwoods over the next 20 years.

Overview of Resource Conditions

This overview evaluates the conditions of Federal and non-Federal forests in western Oregon and western Washington. Although hardwoods are found in eastern Oregon and eastern Washington, those data are not included here.

The data for non-Federal forests were collected by the Inventory and Economics Research, Development and Application Program of the USDA Forest Service Pacific Northwest Research Station. Data for Oregon were collected in 1984-86 and estimates of area and volume are current as of January 1, 1986, and January 1, 1987 (Gedney and others 1986a, 1986b, 1987). Data for Washington were collected in 1988-90, and information on area and volume is current as of January 1, 1991 (MacLean and others 1992). Non-Federal data are presented, when available, for industrial, other private, and other public ownership categories. Industrial lands are lands owned by companies that grow timber for industrial use. This ownership class includes firms that own wood processing plants and firms that do not process wood. The category "other private lands" includes all private lands not owned by forest industry. Data for Native American forest resources are included in the "other public" category for western Oregon and the "other private" category for western Washington.

Volume data are reported, when available, in both board feet of sawtimber and cubic feet of growing stock. Sawtimber volume is measured in board feet net of defect for live hardwoods at least 11 inches in diameter at breast height and containing at least one 8-foot saw log, and for live conifers at least 9 inches in diameter at breast height and containing at least one 12-foot saw log. Growing stock volume is measured in cubic feet net of defect for commercial hardwood and softwood species between a 12-inch stump height and a 4-inch top outside the bark for trees at least 5 inches in diameter at breast height.

Inventory data for National Forests and lands managed by the U.S. Department of the Interior, Bureau of Land Management, were collected by the respective agencies. Because of differences in the inventory processes among and within the agencies, and recognizing the difficulty of updating the inventory to account for dramatic changes in land allocations and management strategies, the inventory information for Federal lands in both Oregon and Washington should be interpreted with caution. Data for Federal lands in Washington are current as of January 1, 1991, and for Oregon are current as of January 1, 1977 (Gedney 1982).

Regional volumes by ownership and species—Sawtimber and growing stock volumes for all species—hardwood and softwood alike—are substantial in western Oregon and western Washington (table 1). The largest volumes, representing some 57 percent of the total in the two States, are found in Federal forests; industrial forests, with approximately 21 percent, are the next largest ownership; other public and other private ownerships make up the balance, with 12 and 10 percent, respectively.

The hardwood resource is substantial in the two States (fig. 1). The region's hardwood sawtimber inventory of about 36 billion board feet is 9 percent of the total sawtimber volume, and the hardwood growing stock inventory of 11.9 billion cubic feet is 12 percent of the region's total growing stock volume. Red alder is by far the most important hardwood species, comprising almost two-thirds of the hardwood sawtimber and growing stock volumes (fig. 2). Bigleaf maple (*Acer macrophyllum* Pursh.) and black cottonwood (*Populus trichocarpa* Torr. & Gray) are the next most abundant species, and together with red alder account for 87 percent of the total volume of hardwood species. The balance of the hardwood volume is accounted for by various of species, including Pacific madrone (*Arbutus menziesii* Pursh), Oregon white oak (*Quercus garryana* Dougl. ex Hook), paper birch (*Betula papyrifera* var. *commutata* (Regel) Fern.), Oregon ash (*Fraxinus latifolia* Benth.), bitter cherry (*Prunus emarginata* Dougl. ex Eaton), California black oak (*Quercus kelloggii* Newb.), California-laurel (*Umbellularia californica* (Hook. & Arn.) Nutt.), tanoak (*Lithocarpus densiflorus* (Hook & Arn.) Rehd.), giant chinquapin (*Castanopsis chrysophylla* (Dougl.) A. DC.), and canyon live oak (*Quercus chrysolepis* Liebm.). Some of these species are locally important, such as tanoak and Pacific madrone in southwestern Oregon and Oregon white oak in the Willamette Valley.

Table 1—Pacific Northwest total growing stock and sawtimber volume for all species by ownership^a

State	Owners				
	Federal ^b	Other public	Forest industry	Other private	All owners
<i>Million cubic feet</i>					
Growing stock:					
Washington	12,580	8,812	12,840	7,089	41,321
Oregon	37,675	3,510	11,199	5,210	57,594
Total	50,255	12,322	24,039	12,299	98,915
<i>Million board feet, Scribner rule</i>					
Sawtimber:					
Washington	59,714	35,483	47,187	26,277	168,660
Oregon	178,096	13,856	38,823	16,251	247,027
Total	237,810	49,339	86,010	42,528	415,687

^a Washington volume is estimated as of January 1, 1991. Oregon non-Federal volume is estimated as of January 1, 1986 and 1987. Federal volume in Oregon is estimated as of January 1, 1977. Totals may be off because of rounding.

^b Includes inventory on lands managed by the Bureau of Land Management and the USDA Forest Service.

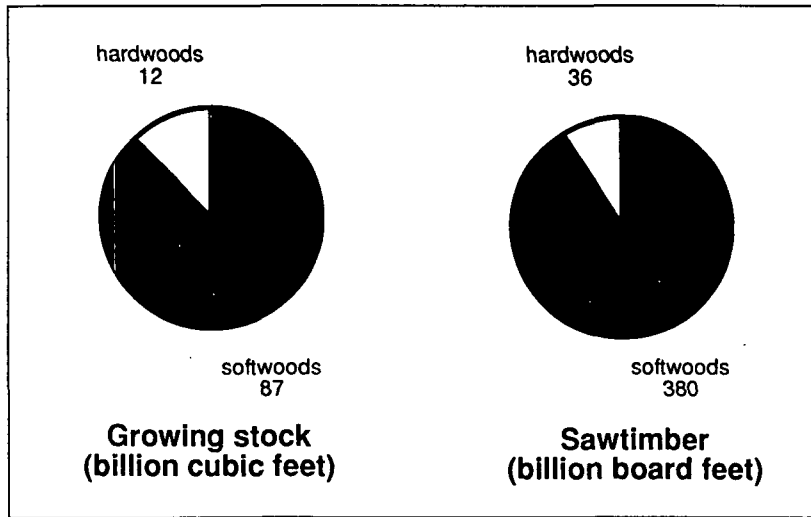


Figure 1—Pacific Northwest growing stock and sawtimber inventory (see table 1 for dates of volume estimates).

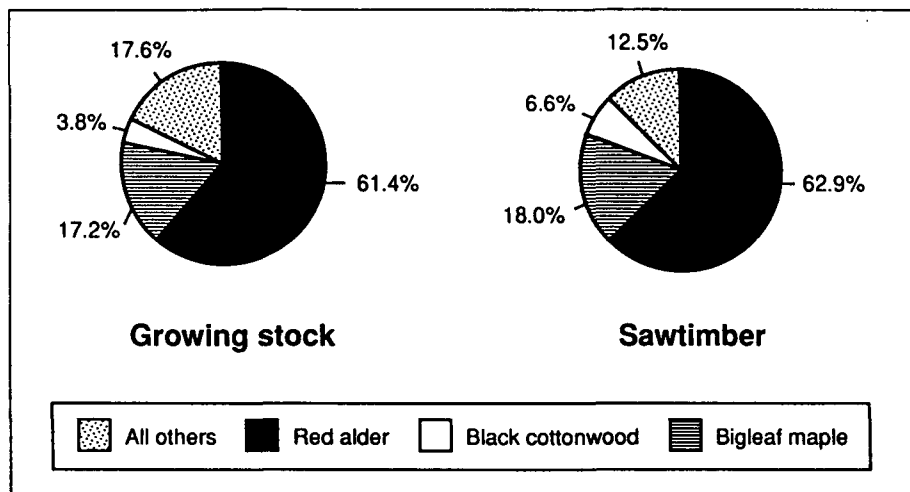


Figure 2—Species distribution of the Pacific Northwest hardwood sawtimber and growing stock inventory (see table 2 for dates of volume estimates).

Hardwood volumes by ownership—Hardwoods occur predominantly on private lands (fig. 3), where some 70 percent of the hardwood sawtimber (and growing stock) is found. Most of the hardwood timber found on public lands in Washington is on lands managed by State and local governments, while National Forest and Bureau of Land Management hardwood resources are of greater importance in Oregon.

In the region as a whole, privately owned hardwoods are evenly split between industrial and other private ownerships. In Washington, hardwood volumes on the other private ownership are of greater importance than industrial volumes, and in Oregon the situation is reversed (tables 2 and 3). In both States, the red alder resource is more concentrated on industrial ownerships, and bigleaf maple is found in greater abundance on other private ownerships.

Volume by survey unit and county—There are important subregional and ownership differences in the distribution of hardwoods. Non-Federal forest inventory data, which are collected and reported by subregional survey units (fig. 4), show that in Washington, forest industries own proportionately most of the hardwood inventory for both sawtimber (table 4) and growing stock (table 5) in the Olympic Peninsula and southwest Washington survey units. In contrast, the other private ownership has a large proportion of its share of the hardwood inventory in the Puget Sound survey unit. In Oregon, the greatest concentration of hardwood sawtimber (table 6) and growing stock (table 7) is in the Northwestern survey unit, which has the largest proportion of the hardwood inventory owned by both the other public and other private ownerships and the largest concentration of red alder. Other hardwood species become progressively more important in survey units farther south in Oregon.

County-level hardwood sawtimber and growing stock volumes, their associated confidence intervals (68 percent probability), and hardwood volume-per-acre averages for non-Federal timberland by State are reported in the appendix. The reliability of the estimates for some counties is low because of small sample size, and confidence intervals for those counties are correspondingly large.

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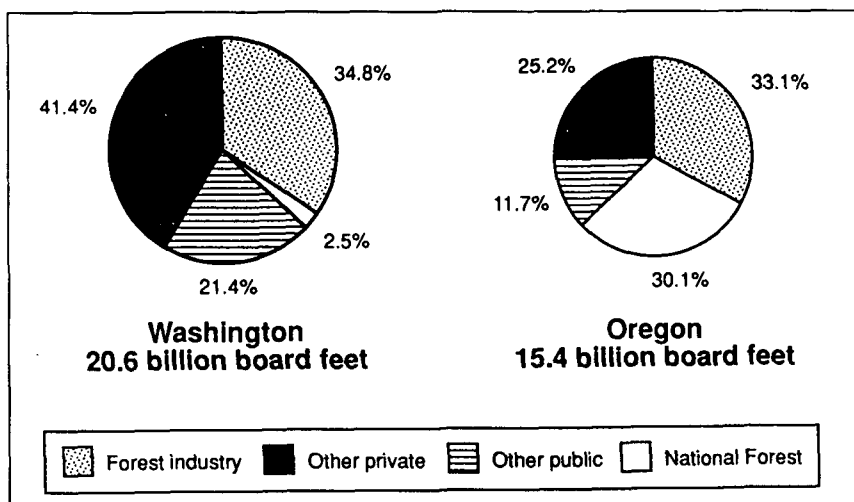


Figure 3—Hardwood sawtimber inventory by State and owner (see table 3 for dates of volume estimates).

Table 2—Pacific Northwest hardwood sawtimber inventory by State and ownership^a

Area and species	Ownership				All owners
	Federal ^b	Other public	Forest industry	Other private	
Million board feet, Scribner rule					
Washington:					
Red alder	270	3,344	5,471	4,519	13,605
Bigleaf maple	92	713	900	2,500	4,204
Cottonwood	144	288	718	908	2,057
All others	1	52	66	579	698
Total Washington	507	4,397	7,155	8,505	20,564
Oregon:					
Red alder	2,174	1,390	3,536	1,904	9,005
Bigleaf maple	381	353	687	843	2,264
Cottonwood	3	—	21	301	325
White oak	2	18	69	322	411
All others	2,069	33	781	506	3,389
Total, Oregon	4,629	1,794	5,095	3,876	15,394
Pacific Northwest:					
Red alder	2,444	4,734	9,007	6,423	22,610
Bigleaf maple	473	1,066	1,587	3,343	6,468
Cottonwood	147	288	739	1,209	2,382
White oak	2	18	69	322	411
All others	2,070	85	847	1,085	4,087
Total, Pacific Northwest	5,136	6,191	12,250	12,381	35,958

^a Washington volumes are estimated as of January 1, 1991. Oregon non-Federal volumes are estimated as of January 1, 1986 and 1987. Federal volume in Oregon is estimated as of January 1, 1977. Totals may be off because of rounding.

^b Includes inventory on lands managed by the Bureau of Land Management and the USDA Forest Service.

Table 3—Pacific Northwest hardwood growing stock inventory by State and ownership^a

Area and species	Ownership				All owners
	Federal ^b	Other public	Forest industry	Other private	
<i>Million cubic feet</i>					
Washington:					
Red alder	96	962	1,714	1,455	4,226
Bigleaf maple	38	190	286	623	1,138
Cottonwood	27	58	140	170	395
All others	1	33	58	198	290
Total, Washington	163	1,243	2,198	2,448	6,051
Oregon:					
Red alder	624	455	1,278	733	3,090
Bigleaf maple	120	109	313	367	909
Cottonwood	1	—	6	53	60
White oak	1	8	37	254	300
All others	744	29	398	345	1,512
Total, Oregon,	1,490	600	2,032	1,750	5,872
Pacific Northwest:					
Red alder	720	1,417	2,992	2,188	7,316
Bigleaf maple	158	299	599	990	2,047
Cottonwood	28	58	146	223	455
White oak	1	8	37	254	300
All others	745	62	456	543	1,802
Total, Pacific Northwest	1,653	1,843	4,230	4,198	11,923

^a Washington volume is estimated as of January 1, 1991. Oregon non-Federal volume is estimated as of January 1, 1986 and 1987. Federal volume in Oregon is estimated as of January 1, 1977. Totals may be off because of rounding.

^b Includes inventory on lands managed by the Bureau of Land Management and the USDA Forest Service.

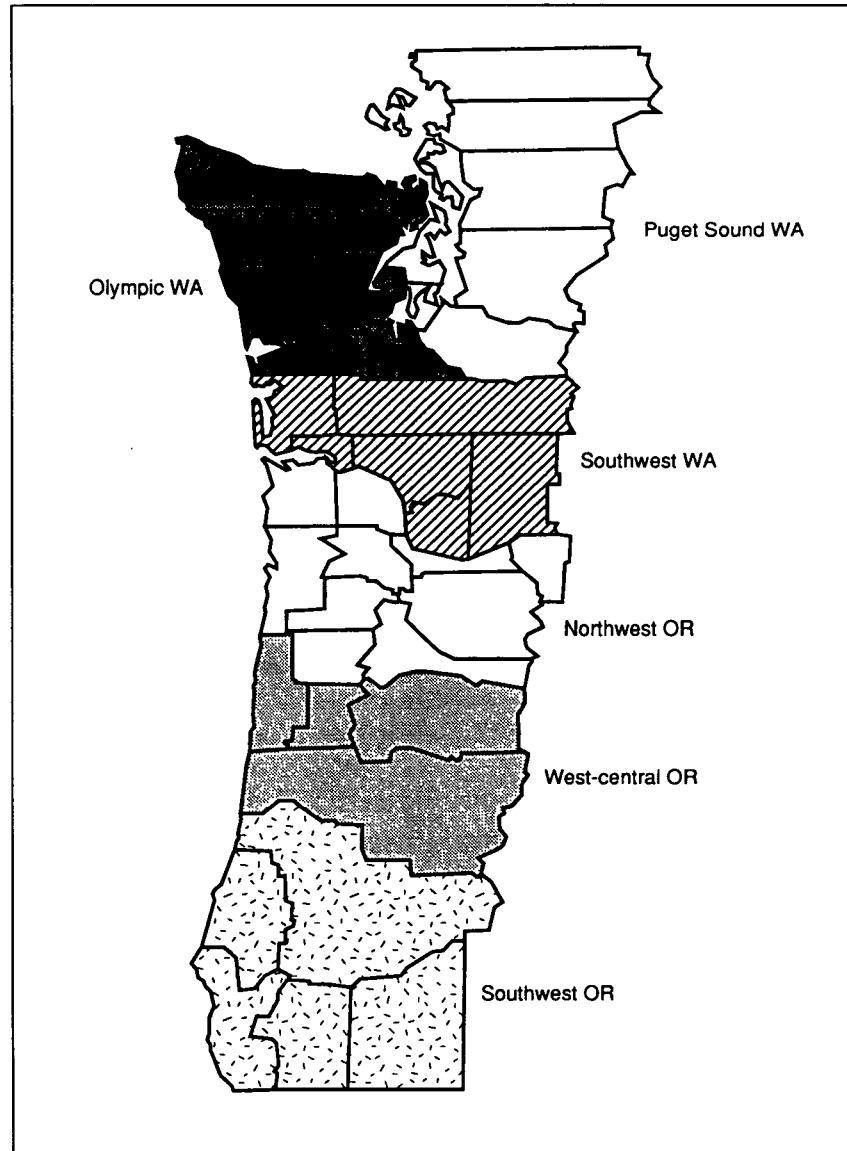


Figure 4—Forest survey units in Washington and Oregon.

Table 4—Washington hardwood sawtimber inventory on non-Federal lands by survey unit and ownership, January 1, 1991^a

Area and species	Ownership			
	Other public	Forest industry	Other private	All owners
<i>Million board feet, Scribner rule</i>				
Olympic:				
Red alder	1,039±203	2,141±299	896±134	4,076±384
Bigleaf maple	102±55	355±81	512±112	969±149
Cottonwood	9±6	153±83	111±73	273±111
All others	29	26	93	149
Total, Olympic	1,179±230	2,675±331	1,612±217	5,466±454
Puget Sound:				
Red alder	1,262±170	1,334±182	2,650±249	5,245±349
Bigleaf maple	391±89	364±95	1,363±169	2,118±213
Cottonwood	279±116	349±82	737±208	1,365±252
All others	23	25	326	373
Total, Puget Sound	1,955±245	2,071±238	5,077±399	9,103±520
Southwest:				
Red alder	1,044±206	1,996±245	973±161	4,013±356
Bigleaf maple	220±85	182±63	625±138	1,026±174
Cottonwood	—	216±71	60±29	276±76
All others	—	15	159	174
Total, Southwest	1,264±241	2,409±266	1,817±218	5,489±416

^a Totals may be off due to rounding.

Table 5—Washington hardwood growing stock inventory on non-Federal lands by survey unit and ownership, January 1, 1991^a

Area and species	Ownership			
	Other public	Forest industry	Other private	All owners
<i>Million cubic feet</i>				
Olympic:				
Red alder	343±59	673±81	321±44	1,337±109
Bigleaf maple	26±11	109±23	136±31	271±40
Cottonwood	2±1	29±16	21±13	52±20
All others	13	18	35	66
Total, Olympic	384±64	829±87	512±63	1,725±124
Puget Sound:				
Red alder	338±40	411±45	807±65	1,556±88
Bigleaf maple	103±21	97±22	323±39	523±49
Cottonwood	55±25	70±15	138±36	264±46
All others	19	28	115	162
Total, Puget Sound	516±57	607±58	1,383±92	2,506±121
Southwest:				
Red alder	280±50	629±64	327±47	1,237±93
Bigleaf maple	61±20	80±22	164±35	305±46
Cottonwood	—	41±13	11±5	53±14
All others	—	11	50	62
Total, Southwest	343±59	761±70	553±57	1,657±107

^a Totals may be off due to rounding.

Table 6—Oregon hardwood sawtimber inventory on non-Federal lands by survey unit and ownership^{a b}

Region and species	Ownership			
	Other public	Forest industry	Other private	All owners
Million board feet, Scribner rule				
Northwest:				
Red alder	773±196	1,516±319	1,132±209	3,421±428
Bigleaf maple	248±102	222±77	523±104	993±165
Cottonwood	—	—	279±208	279±208
White oak	—	12±12	154±70	167±71
All others	4	29	50	83
Total, Northwest	1,025±232	1,779±356	2,138±327	4,942±534
Southwest:				
Red alder	439±275	1,131±229	302±65	1,872±363
Bigleaf maple	8±8	163±35	51±20	222±41
White oak	18±16	45±31	29±12	93±37
All others	29	713	374	1,118
Total, Southwest	495±277	2,053±279	756±95	3,304±403
West-central:				
Red alder	178±36	889±250	470±190	1,538±315
Bigleaf maple	96±49	303±81	268±73	667±119
Cottonwood	—	21±20	23±23	44±31
White oak	—	11±11	139±52	150±53
All others	—	38	82	121
Total, West-central	274±53	1,263±269	982±212	2,519±346

^a Totals may be off due to rounding.

^b Northwest and southwest volume estimates as of January 1, 1986. West-central volume estimate as of January 1, 1987.

Table 7—Oregon hardwood growing stock inventory on non-Federal lands by survey unit and ownership^{a b}

Region and species	Ownership			
	Other public	Forest industry	Other private	All owners
<i>Million cubic feet</i>				
Northwest:				
Red alder	318±70	521±85	367±43	1,206±124
Bigleaf maple	79±29	104±29	243±57	426±59
Cottonwood	—	—	49±36	49±36
White Oak	—	7±5	110±38	117±39
All others	5	13	46	65
Total, Northwest	403±77	646±100	815±85	1,863±151
Southwest:				
Red alder	93±58	410±71	194±40	697±100
Bigleaf maple	4±4	93±20	22±6	118±21
White Oak	8±7	24±16	25±8	57±19
All others	18	357	251	624
Total, Southwest	123±58	884±94	490±55	1,497±123
West-central:				
Red alder	43±11	346±79	172±56	562±97
Bigleaf maple	26±14	117±25	103±27	245±39
Cottonwood	—	6±6	4±4	10±7
White Oak	—	6±5	119±57	124±57
All others	6	28	46	79
Total, West-central	75±18	502±85	445±81	1,022±119

^a Totals may be off due to rounding.

^b Northwest and southwest volume estimates as of January 1, 1986. West-central volume estimate as of January 1, 1987.

Washington has several counties with a large inventory of hardwoods. Grays Harbor, Lewis, and Snohomish counties each have over 2 billion board feet of hardwood sawtimber inventory. Nine of the 19 counties in western Washington have more than a billion board feet of hardwood sawtimber (fig. 5). When the hardwood resource is considered from the viewpoint of sawtimber volume-per-acre of timberland in each County, the highest concentrations are found in the Puget Sound survey unit and adjacent Thurston County (table 27).

In western Oregon, Clatsop-Columbia, Coos-Curry, and Lincoln Counties have more than a billion board feet of hardwood sawtimber and together have 34 percent of the State's combined Federal and non-Federal hardwood inventory. On a volume-per-acre of timberland basis (table 29), the highest concentrations of hardwood in Oregon are found in the coastal counties and the central and northern counties of the Willamette Valley.

Urbanization, including the application of land use restrictions and the effect of urban values on the use of surrounding rural land, is not reflected in the timber volume data. Effects of urbanization are most likely to occur around Seattle, where 9.6 billion board feet of the hardwood sawtimber inventory (47 percent of the total hardwood sawtimber inventory in the State and 27 percent of the hardwood sawtimber inventory in the Pacific Northwest) is found on non-Federal lands in the counties adjacent to the Puget Sound, from Thurston County on the south to Whatcom County on the north. Volume removed in conjunction with land conversion and from lands influenced by urbanization may be both unpredictable and difficult to obtain as raw material by the hardwood industry in the short run; over the long run, such resources may disappear or become completely unavailable for industrial use.

Area by forest type and management type—Most of the hardwood sawtimber volume, 73 percent in Washington and 66 percent in Oregon, occurs in stands classified as belonging to one of the hardwood forest types (table 8, fig. 6). Such stands are not necessarily composed exclusively of hardwoods—indeed, a stand need have only 50 percent or more of its live trees in hardwood species at the time of inventory to be assigned to the hardwood type. The percentage of hardwood volume in the hardwood type is comparable across ownership classes in both States except for the other private ownership in Washington, where almost 85 percent of the hardwood sawtimber is found in the hardwood type.

Very little of the hardwood volume occurs in stands composed exclusively of hardwood species. In Washington and Oregon, less than 9 percent and 17 percent, respectively, of the two States' total hardwood sawtimber inventories occurs in stands composed exclusively of hardwood species. In Oregon, the other public ownership has the largest proportion of the hardwood volume in stands composed exclusively of hardwood species; in absolute terms the volume on the other public ownership rivals the volumes occurring in the same type of stands on other ownerships.

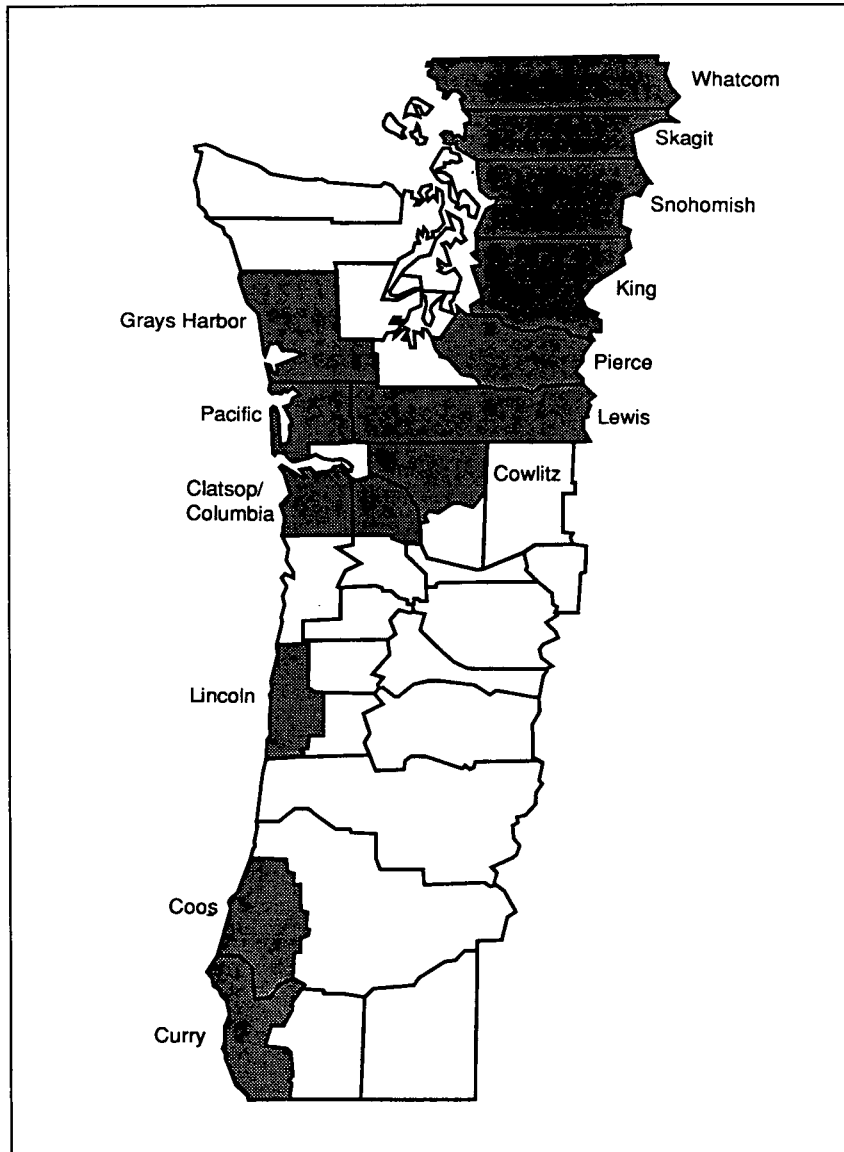


Figure 5—Counties in Oregon and Washington with over 1 billion board feet of hardwood inventory on non-Federal timberlands as of most recent inventory.

Table 8—Hardwood sawtimber volume by stand type for non-Federal ownerships by State

Stand type by State	Ownership			All owners
	Other public	Forest industry	Other private	
Washington:				
Hardwood type—				
Exclusively				
hardwood species	152 (3.5)	615 (8.6)	938 (11.0)	1,705 (8.5)
Mixed hardwood and conifer species	2,792 (63.5)	4,270 (59.7)	6,237 (73.4)	13,299 (66.3)
Conifer type—				
Mixed conifer and hardwood species	1,453 (33.0)	2,270 (31.7)	1,330 (15.6)	5,053 (25.2)
Total, Washington	4,397	7,155	8,505	20,057
Oregon:				
Hardwood type—				
Exclusively				
hardwood species	552 (30.8)	597 (11.7)	674 (17.4)	1,823 (16.9)
Mixed hardwood and conifer species	688 (38.3)	2,608 (51.2)	2,014 (52.0)	5,130 (49.3)
Conifer type—				
Mixed conifer and hardwood species	554 (30.9)	1,890 (37.1)	1,188 (30.6)	3,632 (33.8)
Total, Oregon	1,794	5,095	3,876	10,765

^a Percentages are shown in parentheses.



Figure 6—A typical stand of mature red alder in western Washington. The stand regenerated naturally after harvesting and burning in the 1930s.

Stands of mixed species, including stands of the hardwood type, can be managed to favor softwood species, hardwood species, or both. Less than one-half of the non-Federal hardwood sawtimber volume is found in stands classified as having a hardwood management type (fig. 7), where management type indicates the potential for managing an existing stand. In Oregon, more hardwood sawtimber volume is in stands with a softwood management type than in stands with a hardwood management type. Management type, of which there are four in Oregon and five in Washington, is assigned to each non-Federal ground plot based on current stocking by species group and condition of the trees making up the stand.³

Volume by diameter class—Diameter at breast height, a measure of tree size, is closely related to timber quality (Plank 1992, Plank and others 1990) and the size of red alder is widely used in the industry as a proxy for quality, with larger trees being of higher quality than smaller trees. There are differences in the way that volume is proportionally distributed across broadly defined diameter classes of sawtimber (table 9) and growing stock (table 10) by species and State. Although the differences are not great, more of the inventory of red alder in Oregon is in the smallest size class than in Washington. For species other than red alder, the situation is modestly reversed, and a larger proportion of the volume appears in the larger diameter classes in Oregon than in Washington. The black cottonwood resource is almost exclusively in large trees in both States.

³ Management types are conifer, high-valued hardwoods, mixed conifer/high-valued hardwoods, management stand absent from the site, and, in Washington, low-valued hardwoods.

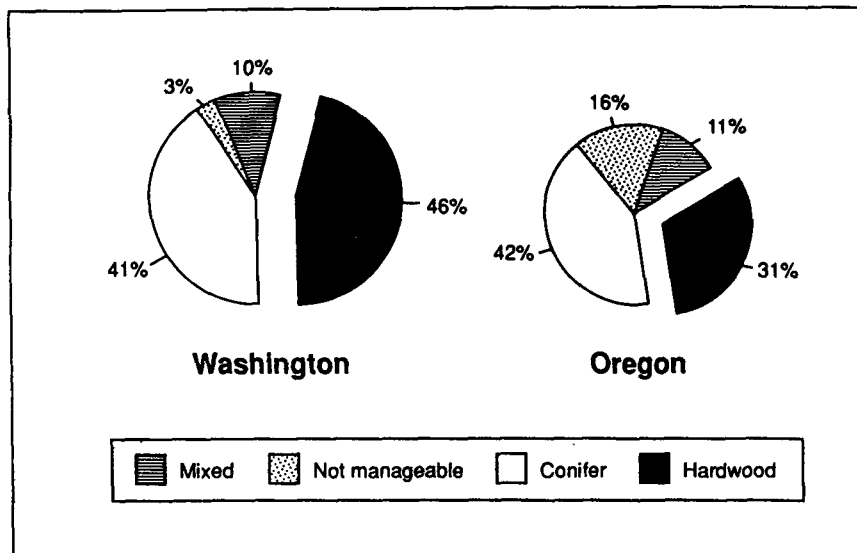


Figure 7—Distribution of hardwood sawtimber volume on non-Federal timberlands by management type (see table 1 for dates of volume estimates).

Table 9—Diameter distribution of hardwood sawtimber by State and species^{a b}

State and species	Total volume by diameter class		
	11.0-12.9 inches	13.0-16.9 inches	Over 17.0 inches
	<i>Percent</i>		
Washington:			
Red alder	23.2	45.0	31.8
Bigleaf maple	11.5	26.6	61.9
Cottonwood	3.7	9.7	86.6
All others	22.0	37.4	40.6
All species, Washington	19.1	37.4	43.6
Oregon:			
Red alder	24.8	38.9	36.3
Bigleaf maple	15.7	28.4	55.8
Cottonwood	—	9.1	90.9
White oak	16.2	34.9	48.9
All others	18.8	27.7	53.6
All species, Oregon	21.4	34.6	44.0

^a Estimated as of January 1, 1991, for Washington and January 1, 1986, for southwest and northwest Oregon. West-central Oregon estimate is as of January 1, 1987.

^b Washington data include volume for all Federal and non-Federal owners. Oregon data include volume only on non-Federal lands.

Table 10—Diameter distribution of hardwood growing stock by State and species^{a b}

States and species	Total volume by diameter class			
	5.0-8.9 inches	9.0-12.9 inches	13.0-16.9 inches	Over 17.0 inches
	<i>Percent</i>			
Washington:				
Red alder	13.6	36.4	30.5	19.5
Bigleaf maple	11.9	22.5	20.8	44.8
Cottonwood	2.5	9.4	10.1	78.0
All others	27.3	34.7	18.9	19.2
All species, Washington	13.2	31.9	26.8	28.1
Oregon:				
Red alder	21.1	35.2	23.4	20.3
Bigleaf maple	12.2	21.5	20.5	45.8
Cottonwood	—	3.4	6.8	89.8
White oak	12.9	26.9	17.0	43.2
All others	16.6	26.4	19.1	37.9
All species, Oregon	17.8	30.7	21.4	30.1

^a Estimated as of January 1, 1991, for Washington and January 1, 1986, for southwest and northwest Oregon. West-central Oregon estimate as of January 1, 1987.

Area by site productivity class—Hardwoods occupy sites that are generally quite productive. In Washington, slightly more than 80 percent of the hardwood forest types on non-Federal forest lands occur on sites capable of producing more than 120 cubic feet per acre per year (fig. 8). In Oregon, slightly less than 70 percent of the hardwood forest types on non-Federal forest lands occur on sites capable of producing at least 120 cubic feet per acre per year (fig. 9); most of the hardwoods on the less productive sites are found in southwestern Oregon and are in the Pacific madrone, tanoak, and oak forest types.

Area by stand-size class—The distribution of acres by stand-size class in the hardwood types is not the same in Oregon as in Washington (fig. 10). Oregon has a smaller proportion of its acreage in the sawtimber stand-size class, a larger proportion in the poletimber stand-size class, and a roughly comparable proportion in the seedling/sapling stand-size class. Seedling/sapling stands are those with a basal area-weighted mean diameter less than 5 inches; hardwood poletimber stands have a basal area-weighted mean diameter between 5 and 11 inches; and hardwood sawtimber stands have a basal area-weighted mean diameter larger than 11 inches.

Changes in hardwood volumes and area by type and size-class—Hardwood sawtimber volumes reported in the latest inventories in both Oregon and Washington have generally increased over the volumes reported in previous inventories (table 11). There were increases in reported volumes for all ownership classes in the two States combined, including increases of 31 percent for the other public ownership class, 23 percent for the industrial ownership, and 13 percent for the nonindustrial ownerships.

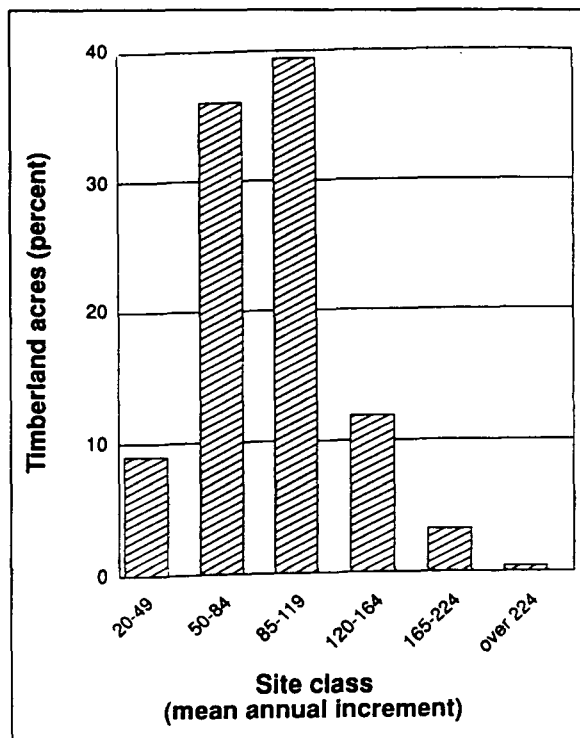


Figure 8—Distribution of timberland acres by site class in western Washington for all non-Federal owners, January 1, 1991.

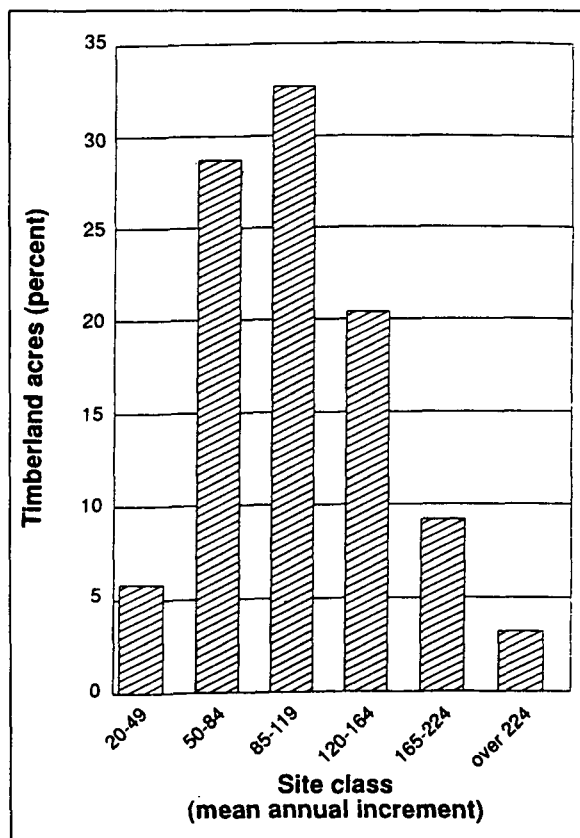


Figure 9—Distribution of timberland acres by site class in western Oregon for all non-Federal owners, January 1, 1986 and 1987.

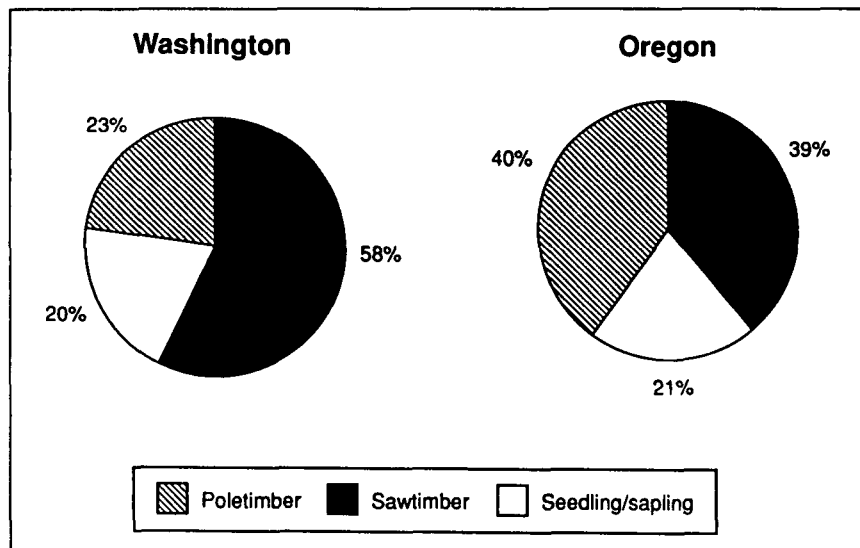


Figure 10—Size class distribution of hardwood types in Oregon and Washington (see table 1 for dates of volume estimates).

Table 11—Pacific Northwest hardwood sawtimber inventory changes by State and owner^a

Inventory and State	Owner				All owners
	Federal ^b	Other public	Forest industry	Other private	
Million board feet, Scribner rule					
Current inventory: ^c					
Washington	507	4,397	7,155	8,505	20,564
Oregon	—	1,803	5,107	3,888	10,799
Total, current inventory	507	6,200	12,262	12,393	31,363
Previous inventory: ^d					
Washington	360	3,235	6,829	7,456	17,879
Oregon	4,630	1,497	3,150	3,476	12,753
Total, previous inventory	4,990	4,732	9,979	10,932	30,632

^a Totals may be off due to rounding.

^b Includes data for lands managed by the USDA Forest Service and the Bureau of Land Management. Current data not available for Federal lands in Oregon.

^c Volume as of January 1, 1991, for Washington. Oregon volume as of January 1, 1986 and 1987.

^d Washington volume estimates are as of January 1, 1979, and January 1, 1980. Oregon volume estimates are as of January 1, 1975, January 1, 1976, and January 1, 1977.

The comparison across forest conditions reported for inventories at different points in time must be interpreted with caution. The stand-related factors of growth, mortality, and harvesting affect the reported inventory volumes and acres in the different categories for stage of stand development. Other factors affect both reported volumes and reported acreages, including land use changes, ownership changes, utilization standard changes, and inventory sampling and design changes. MacLean and others (1992) report how all factors, stand and nonstand related, contributed to the change in softwood and hardwood volumes between 1978 and 1988 in Washington; they report that growth and harvest dominated the volume changes during the interval.

There has been a 19-percent decrease in the total reported acreage of the hardwood forest types in western Washington on non-Federal lands between the two inventories and a 21-percent decrease for Oregon (table 12). All the reported decrease in western Washington has occurred on forest industry lands, and the reported total hardwood forest type acreage on other public and other private ownerships has actually increased slightly between the two inventories. In western Oregon, the reported hardwood forest type acreage has decreased for all ownerships, but the largest decrease, both absolutely and proportionately, has been in the other private ownership class.

Table 12—Pacific Northwest hardwood forest type acreage changes by State and owner^a

Inventory and State	Owner			
	Other public	Forest industry	Other private	All owners
<i>Thousand acres</i>				
Current inventory: ^b				
Washington	269	627	886	1,782
Oregon	209	834	872	1,913
Total, current inventory	478	1,461	1,758	3,695
Previous inventory: ^c				
Washington	263	1,059	878	2,199
Oregon	249	982	1,182	2,413
Total, previous inventory	512	2,041	2,060	4,612

^a Totals may be off due to rounding.

^b Acreage as of January 1, 1991, for Washington. Oregon acreage as of January 1, 1986 and 1987.

^c Washington acreage estimated as of January 1, 1979 and 1980. Oregon acreage estimated as of January 1, 1975, January 1, 1976, and January 1, 1977.

Changes in the reported acres by size class and owner for the hardwood types in western Washington have not been uniform (table 13). For all ownerships combined, there has been a large increase in the reported acreage of seedling/sapling-sized stands; a large drop in the reported acreages of poletimber-sized stands; and a modest decrease in the acreage in sawtimber-sized stands. The decrease in poletimber stands indicates potential problems with supplies of hardwoods in the future as existing sawtimber stands are harvested. Some of this potential impact could be offset by investment in the management of hardwood stands, because such investments accelerate growth. Comparable data were not available for Oregon.

All ownerships in western Washington show large increases in the reported acreage in the seedling/sapling size class in the hardwood forest types, with the increase being greatest on the industrial ownership. The implication of these increases for long-run timber supply is not readily discernible, because stands may include a softwood component that will be managed for, if not favored, over hardwood species. If this occurs, then hardwood seedling/sapling stands may contribute little, if any, to future hardwood supply.

All ownerships in western Washington show decreases in reported acreage for poletimber-sized stands in the hardwood forest types, with the largest and most dramatic decreases occurring in the industrial ownership. Such decreases cast serious doubt on long-run hardwood supply, because recruitment into the sawtimber-sized class (the size class in which hardwood harvest mainly occurs) is declining.

Table 13—Change in acres of hardwood forest type by size class and owner in western Washington^a

Size class and inventory	Owner			All owners
	Other public	Forest industry	Other private	
Acres				
Seedling/sapling:				
Current ^b	57,925	151,159	140,950	350,034
Previous ^c	31,155	81,552	94,816	207,522
Poles:				
Current	55,197	139,160	210,882	405,239
Previous	76,843	324,181	457,084	858,108
Sawtimber:				
Current	155,535	337,049	534,224	1,026,808
Previous	154,931	471,769	507,055	1,133,755

^a Totals may be off due to rounding.

^b Acreage estimate as of January 1, 1991.

^c Acreage estimate as of January 1, 1979 and 1980.

The industrial ownership shows a substantial reduction in the reported acreage in the sawtimber-sized classes in the hardwood types, and the other public and other private show modest increases. The combined effect across ownerships indicates increasing short-run supply stresses, because it is from these stands that the hardwood supply of the next decade will come.

Growth, mortality, and removal volumes—Current net annual growth of hardwood growing stock in Washington is about 183 million cubic feet per year; it is distributed by owner and species similarly to the 6 billion cubic feet of growing stock inventory (table 14). Current net annual growth of the growing stock on non-Federal lands in Oregon is 144 million cubic feet, which also is distributed similarly to the 4.4 billion cubic feet of growing stock inventory on non-Federal lands. Current net annual growth is the increment in net volume of sawtimber and poletimber trees alive at the beginning of the year and surviving to the end of the year, plus the net volume of trees reaching sawtimber and poletimber size during the year, minus mortality (net volume of trees that died from natural causes during the specified year).

Average annual mortality in the two States totals about 107 million cubic feet or about 33 percent of the current net annual growth (table 15). Average annual mortality relative to current annual net growth is high for the other public ownership; this is especially true for red alder, which indicates that a substantial portion of the other public red alder volume is approaching the age of decay and is vulnerable to being completely lost if not used.

The volume of average annual removals (includes trees removed in harvesting, silvicultural activities, and land clearing) exceeds the average annual net growth of growing stock for red alder and all hardwood species combined in western Washington but is less than the average annual net growth of sawtimber (table 16). Comparable data are not available for western Oregon.

Institutional Factors Affecting Availability

Nonregulatory and regulatory arrangements influence the availability of hardwoods as a source of industrial raw material, and a wide variety of public agencies and private groups are involved in those institutional arrangements. We separately discuss the institutional influences of regulatory and nonregulatory agents. Nonregulatory agents are typically involved in developing and disseminating information useful for hardwood forestry or for promoting the hardwood manufacturing industry. Regulatory agencies directly influence the behavior of forest landowners through the exercise of legislatively mandated regulatory authorities.

Nonregulatory influences on hardwood availability—Research institutions (including Oregon State University, University of Washington, Washington State University, and the USDA Forest Service Pacific Northwest Research Station) have a profound influence on the status of hardwood resources through research, teaching, and continuing education programs, all of which influence forestry professionals, forest landowners, and those involved in forest policy.

Table 14—Pacific Northwest current net annual hardwood growing stock growth by State, owner, and species^a

Species	Owner				All owners
	National Forest ^b	Other public	Forest industry	Other private	
<i>Thousand cubic feet</i>					
Washington:					
Red alder	2,221	25,484	48,812	48,614	125,131
Bigleaf maple	645	5,318	8,670	19,367	34,000
Cottonwood	184	2,187	5,484	7,513	15,368
All others	23	589	1,983	5,790	8,384
Total, Washington	3,073	33,578	64,949	81,284	182,884
Oregon:					
Red alder	—	17,360	49,004	26,329	92,693
Bigleaf maple	—	2,758	6,600	10,185	19,543
Cottonwood	—	—	306	1,160	1,466
White oak	—	335	472	3,826	4,633
All others	—	668	13,989	10,711	25,368
Total, Oregon	—	21,121	70,371	52,211	143,703
Pacific Northwest:					
Red alder	2,221	42,844	97,816	74,943	217,824
Bigleaf maple	645	8,076	15,270	29,552	53,543
Cottonwood	184	2,187	5,790	8,673	16,834
White oak	—	335	472	3,826	4,633
All others	23	1,257	15,972	16,501	33,752
Total, Pacific Northwest	3,073	54,699	135,320	133,495	326,587

^a 1990 estimates for Washington and 1986 and 1987 for Oregon. Totals may be off due to rounding.

^b Growth for Oregon Federal lands not included.

Table 15—Pacific Northwest average annual hardwood growing stock mortality by State, owner, and species^a

Species	Owner				All owners
	National Forest ^b	Other public	Forest industry	Other private	
Thousand cubic feet					
Washington:					
Red alder	496	12,826	23,607	17,327	54,256
Bigleaf maple	52	2,058	3,211	5,583	10,904
Cottonwood	69	521	1,221	1,177	2,988
All others	1	673	970	2,459	4,103
Total, Washington	618	16,078	29,009	26,546	72,251
Oregon:					
Red alder	—	3,563	10,216	5,838	19,617
Bigleaf maple	—	868	2,457	2,864	6,189
Cottonwood	—	—	49	409	458
White oak	—	161	308	1,919	2,388
All others	—	224	3,166	2,740	6,130
Total, Oregon	—	4,816	16,196	13,770	34,782
Pacific Northwest:					
Red alder	496	16,389	33,823	23,165	73,873
Bigleaf maple	52	2,926	5,668	8,447	17,093
Cottonwood	69	521	1,270	1,586	3,446
White oak	—	161	308	1,919	2,388
All others	1	897	4,136	5,199	10,233
Total, Pacific Northwest	618	20,894	45,205	40,316	107,033

^a 1990 estimates for Washington and 1986 and 1987 for Oregon. Totals may be off due to rounding.

^b Mortality for Oregon Federal lands not included.

Table 16—Growth and removal of hardwoods from private lands in western Washington, 1990

Species	Growing stock		Sawtimber	
	Net growth	Removals	Net growth	Removals
	<i>Thousand cubic feet</i>		<i>Thousand board feet</i>	
Red alder	97,426	136,229	597,135	363,788
All hardwoods	146,233	157,031	739,744	550,444

A wide variety of species and topics are addressed by research programs. Much of the information developed on hardwoods pertains to controlling hardwoods to facilitate management favoring softwood species. There has been, however, an increasing amount of work on beneficial attributes of hardwoods and management techniques favoring hardwoods. This work is well represented in several major symposia on the biology and management of red alder (Briggs and others 1978, Hibbs and others, 1994, Trappe and others 1968). Researchers at the University of Washington, Washington State University, and the Olympia Forestry Sciences Laboratory (Pacific Northwest Research Station) have contributed to the science of hardwood forestry. There also has been concentrated private research on the culture of fast-growing hardwoods, including poplar (*Populus* sp.) and alder, for production of fuel or fiber in short rotations; research and development on this topic is expanding throughout the region. Thousands of acres of high-yield plantations (fiber farms) are now being cultivated.

Under the direction of the Hardwood Silviculture Cooperative, based in the Department of Forest Science at Oregon State University, representatives from the forest industries and forestry agencies are combining their efforts to learn more about hardwoods and develop successful techniques for management. The cooperative was formed in 1986 by David Hibbs, Department of Forest Science, Oregon State University. Cooperative research and development efforts are focused on red alder, with major topics of interest including plantation management, thinning, and managing for wood quality.

Agencies that provide forest management advice and information to landowners also influence forestry practices. These include the Cooperative Extension Service, USDA Forest Service State and Private Forestry, and State forestry organizations. Through a variety of programs, these agencies promote state-of-the-art practices to assist private landowners in managing their forest lands. Information offered by public advisors has tended to focus on softwood management, but interest in hardwood management has grown.

The Western Hardwood Association was formed in 1955 to promote the growth, management, and marketing of western hardwoods. The association has been active politically, has sponsored research, and has publicized the current and potential uses and values of western hardwoods.

The Washington Hardwood Commission was created by the 1991 Washington Legislature to promote the hardwood industry and address issues such as hardwood supply, marketing, research, and education. The commission was patterned after the commodity commissions in Washington, and it is financed through an assessment on hardwood processors based on their volume of production in Washington. The commission is administered by a seven-person board made up of members of the hardwood industry. The commission sponsors a number of ongoing research and education programs concerned with hardwoods in Washington.

The Oregon Hardwood Forest Products Resources Committee was formed by the Oregon Legislature in 1987 to examine issues pertaining to industries based on hardwood resources. A major goal of the committee was to assess the need for and feasibility of an Oregon Hardwood Commission, operating in a fashion similar to the Washington Commission. As yet, no decision has been made on forming the commission.

Regulatory influences on hardwood availability—Perhaps the most visible, if not the most influential, institutional arrangement affecting hardwoods is forest practices regulation in the two States. Forest practices laws enacted by the legislatures and carried out by the Oregon Department of Forestry and the Washington Department of Natural Resources regulate harvesting and management on private forest lands. The rules and regulations of the two States provide differing degrees of flexibility and are a political approach to achieving a multitude of public purposes, including sound resource conservation and stewardship, environmental protection, and economic and social benefits.

Governmental regulation of forest practices has both immediate and long-term impacts on hardwood resources. In both Oregon and Washington, rules are complex and subject to periodic revision to meet desired levels of environmental protection. Rules governing harvesting and management in riparian zones and wetlands have the potential for much greater effects on hardwoods than on softwoods because hardwoods often are the dominant species in these areas (fig. 11). Reforestation rules have long-term effects on hardwood resources and hardwood supply, because future supply must come from stands yet to be established.

The overview presented here covers proposed and existing rules and regulations and focuses on those having significant impact on hardwoods. The Washington Forest Practices Board completed an extensive revision of forest practices rules in 1992 (Washington Administrative Code 1993). The 1971 Oregon Forest Practices Act was amended by legislation in 1991 (Oregon Forest Practices Act, n.d.). The Oregon Board of Forestry is revising forest practices rules, OAR 629-24-101 through 1000, based on proposals being developed by the Oregon Department of Forestry.^{4 5} The new rules should be in effect by the end of 1994.

⁴ Oregon Department of Forestry. 1992. Draft rules for the water classification and protection project. December 15, 1992. Draft report. 119 p. On file with: Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.

⁵ Morman, David. March 12, 1993. Forest practices program reforestation rule revision issue paper. Draft report. On file with: Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.



Figure 11—Hardwoods are often the dominant tree species in riparian areas and wetlands.

Wetlands regulation—In Oregon, logging is permitted, subject to restrictions, in forested wetlands and adjacent to wetlands. Fifty percent of the original trees, by species and size-class, must be retained within wetlands and within a riparian management area surrounding significant wetlands. Significant wetlands are (1) wetlands larger than 8 acres, (2) estuaries, and (3) bogs. The width of the riparian area may range from 50 to 200 feet, depending on specific characteristics of the wetland. Lands are classified as wetlands if they are submerged or saturated by surface or ground water often enough and for a long enough time to support a prevalence of wetland vegetation.

Areas adjacent to wetlands of more than 8 acres are included in a “wetlands management area” subject to specific criteria. For nonforested wetlands, the wetland management area extends outward 100 feet from the wetland. Soil and hydrology protection, understory vegetation protection, snag and down-wood protection, and live-tree retention are required for both the wetland and wetland management area. For forested wetlands, the wetland management area also extends 100 feet from the wetland, and the same protection specified for nonforested wetlands applies. The rules for forested wetlands encourage the development of site-specific live-tree retention plans, and a written plan for significant wetlands is required to address reforestation.

In Washington, there are three categories of wetlands: forested wetlands and two categories of nonforested wetlands based on a specific set of criteria, including the times that the site is actually under water. The nonforested wetlands are surrounded by a “wetland management zone” that depends on the size and type of the wetland. Logging is permitted in wetland management zones, but there are specific requirements to leave designated quantities and sizes of trees, representative of the existing species composition.

Riparian regulation—In Oregon, the width of the riparian management area along streams depends on the size of the stream and its direct or indirect importance to fish, wildlife, or human uses. Proposed new rules would increase both the average width of riparian areas and the number of trees retained after logging. The portion of the trees that must be retained within the riparian management area depend on (1) minimum required levels of shade for the actual aquatic area, and (2) requirements for retention of live trees, specifying the minimum number of tree to be left. Proposed new rules specify total numbers of trees to be retained, including a minimum number of conifers.

A significant change proposed for the new rules in Oregon pertains to special management options for hardwood-dominated riparian areas. Under these options, all hardwoods may be removed to within 10 feet of the stream to facilitate reforestation with softwood species. Modification of shade requirements may be allowed, based on review by the State Forester. The intent of these options is to establish more softwood species along streams, because downed softwoods provide more durable woody debris than do hardwood species. These rules would increase the short-term availability of hardwood timber from riparian areas. In the longer run, such rules promote softwoods in riparian areas, and the favoring of softwoods may be achieved at the cost of a reduced hardwood component and availability in riparian stands.

In Washington, riparian areas have a special management zone; the size depends on the characteristics of the stream or body of water and its importance in providing fish and wildlife habitat. Leave-tree requirements for riparian areas of most significance call for the retention of trees “representative of the stand.” Riparian areas (zones) of most significance are those adjacent to type 1 water, which is water as inventoried in “shorelines of the State,” or type 2 water, which is water that has high fish, wildlife, or human use. For less significant riparian zones or those contributing to the water quality of more important zones, the rules call for retention of conifers and deciduous trees (according to designated ratios) to provide adequate shade for streams.

The new rules in Washington also provide some controls over cumulative effects of activities within watersheds (across ownerships) via a process of watershed analysis. Cumulative effects, as used in the Washington Administrative Code (WAC), refers to the environmental impact caused by the interaction of two or more forest practices. The analysis is done by a team of qualified field managers assembled by the Washington Department of Natural Resources (DNR) and by forest land owners in the watershed. Areas of resource sensitivity may be identified in particular watersheds. Forestry activities within these areas are constrained by special prescriptions developed by the analysis team.

In both Oregon and Washington, specific restrictions apply to the conduct of forestry activities in streamside or wetland riparian areas, including special techniques and great care that may be required for felling, bucking, yarding, road construction, and chemical applications to minimize disturbance of water, vegetation, and soils.

Wildlife reserve tree regulation—In Oregon, 1991 legislation requires two snags or green trees be left per acre on every clearcut larger than 10 acres; this is in addition to the requirements for leave trees in wetlands and riparian areas. At least one-half of these trees must be softwoods and meet specific size criteria. This requirement would seem to have minimal impact on the hardwood supply.

In Washington, the regulations require that specified quantities of wildlife reserve trees as well as "green recruitment" trees be retained on harvest areas. Although there are criteria for the condition and size of reserve trees, there are no criteria for species to be retained. To the extent that hardwood trees might include some of the lower valued trees in a stand, landowners might tend to retain a higher proportion of the hardwoods in a stand. The overall reduction in hardwood harvest volumes due to these requirements should be relatively small: wildlife trees generally have low timber quality, and only two green trees are required per acre harvested. Also, trees retained in riparian zones can be used to meet the wildlife tree provisions.

Overall impact of regulations affecting harvests—In both Oregon and Washington, regulations for riparian areas do not directly favor retention of hardwoods over softwoods. However, to the extent that a greater proportion of the hardwood inventory occurs in riparian areas, a greater proportion of the resource will be precluded from harvest by the rules.

Current inventory data do not allow a definitive accounting of the potential impact of riparian zone and wetland area regulations on hardwood resources and harvest volumes, but a rough approximation of such impacts can be derived from current information. Washington data show about 932,000 acres or 12.6 percent of the total timberland within 100 feet of a class 1 or class 2 stream (table 17). Proportionately more of the land owned by industry is in the defined riparian zone than that of either of the other two ownership classes. Brown (1988) estimates that 11 percent of Oregon's hardwood sawtimber volume occurred in riparian zones near class 1 streams; he estimated 5 to 7 percent of the hardwood volume would need to be left to meet regulations. The proposed new rules may increase this figure.

In Washington, forest survey design does not permit an accurate measurement of riparian forest resources, and it is not possible to determine the volume within the riparian area alone. Some idea of the volume in and adjacent to these riparian zones can be developed by examining the volume for those plots that include one or more of their sample points in the riparian zone (table 18). For every owner class, a greater proportion of hardwood volume than softwood volume is found in or adjacent to the riparian areas (fig. 12). This suggests that regulations restricting harvest in riparian areas will have a greater impact on the quantity of hardwoods available for harvest than on the quantity of softwoods available. Because only a portion of the entire plot might fall in the riparian zone, the volumes shown are higher than the volume that might actually be in the riparian area.

Several additional operational factors may contribute to fewer hardwoods than softwoods being harvested in riparian management areas. Hardwoods generally have lower values than softwoods, and loggers and landowners prefer to remove the most highly valued trees and leave the lower valued trees when leave trees are required by regulation. Operators may be more likely to leave hardwoods, given the greater care and expense required to harvest individual trees in riparian zones. A case study in Oregon indicates that forest practice regulations for riparian areas reduce the hardwood harvest more than the softwood harvest (Morman 1993). An analysis of pre-harvest and postharvest conditions determined that an average of 76 percent of the live hardwood trees is retained in riparian areas and only 39 percent of the live softwoods is retained in the same riparian areas.

Table 17—Western Washington riparian areas by owner, January 1, 1991^a

Zone	Owner			All owners
	Other public	Forest industry	Other private	
Acres ^b				
Within 50 feet	120,156	300,385	87,924	508,465
Within 100 feet	210,388	546,198	175,836	932,422
Total timberland	1,663,000	3,732,000	1,978,000	7,373,000
Percent ^c				
Within 50 feet	7.2	8.0	4.4	6.9
Within 100 feet	12.7	14.6	8.9	12.6

^a USDA Forest Service inventory data.

^b The 100-foot riparian zone includes all of the 50-foot zone plus the additional acreage for the 50- to 100-foot distance. Each zone includes the acres within the specified distance of a class 1 or class 2 stream.

^c Percentage of total timberland acres.

Table 18—Western Washington volume in or adjacent to riparian areas, January 1, 1991

Timber type	Owner			All owners
	Other public	Forest industry	Other private	
Thousand board feet, Scribner rule				
Softwood	6,389,399	11,112,822	2,445,557	19,947,778
Hardwood	1,157,686	2,590,715	1,764,530	5,512,931
Percent ^a				
Softwood	20.6	27.8	13.8	22.5
Hardwood	26.3	36.2	20.8	27.5

^a Percentage of total timber volume.

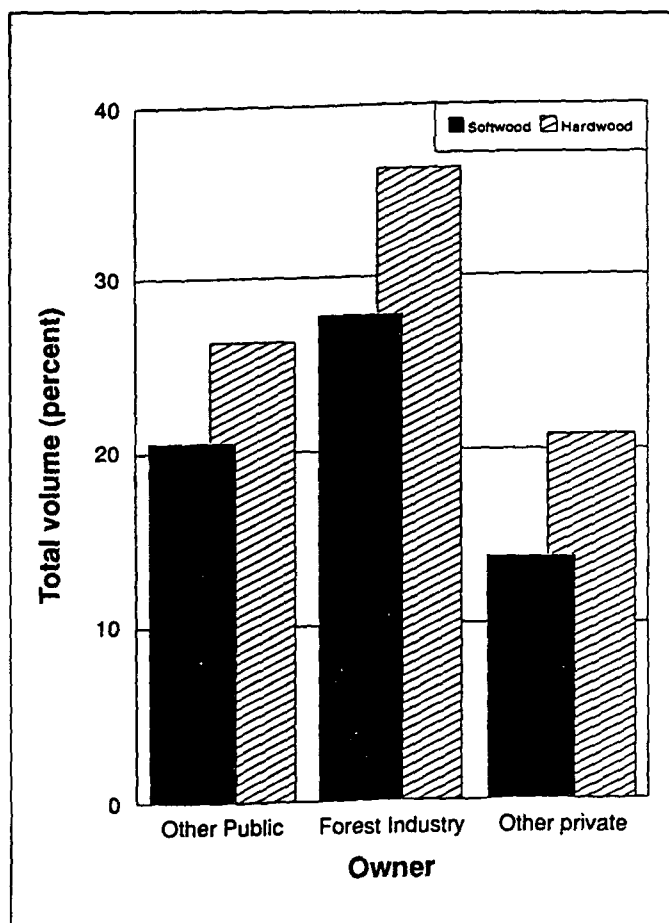


Figure 12—Western Washington sawtimber volume in or adjacent to riparian areas, January 1, 1991.

The immediate availability of hardwoods in riparian areas may be increased by proposed new policies and rules favoring management and retention of softwoods in riparian areas. Results of research increasingly emphasize the importance of softwoods for riparian and aquatic habitat. Management alternatives proposed for Oregon encourage the conversion of hardwood-dominated riparian forests to softwoods; they relax requirements for leave trees to facilitate removal of hardwoods and the establishment of softwoods in their place.

Forest practices rules favoring softwood regeneration—Forest practices rules governing regeneration of forests have been in effect since the 1940s. The earliest rules required retention of seed trees for reforestation compliance. The rules have become increasingly strict and explicit to ensure the replenishment of the native coniferous forests and reduce the encroachment of hardwoods that was observed under earlier rules. For about 20 years, regulations have set minimum levels for regeneration or residual stocking of softwoods on most harvested acres.

Compliance with and enforcement of regulations seem to be quite good; 88 percent of regenerated stands surveyed in Oregon meet or exceed minimum requirements for

stocking of trees free of competing vegetation.⁶ In this regulatory environment, it is probable that the dominance of hardwoods is greatly reduced compared to the stands regenerated under earlier practices. On most industrial lands, pressure to maximize economic returns probably ensures the dominance of softwoods even more effectively than regulations. On other private forest lands, reforestation rules may play a more important role in determining the amount of hardwood ultimately available for harvest.

Regulation of management for hardwoods—Forest practices rules in both Oregon and Washington allow landowners to manage intentionally for hardwoods. As yet, relatively little is known about intentional management of hardwoods. Few owners in the region are making serious attempts to manage hardwoods (see following section on hardwood management). Thus, tried and true methods of regenerating softwood species likely will remain the most common measures taken by private landowners to ensure compliance with forest practices rules for the foreseeable future. The way is clear, however, for management of hardwoods if greater incentives arise.

The current revision of rules in Oregon should make it easier to manage for hardwoods and remain in compliance with regulations. Previously, hardwoods were not on the standard list of acceptable species for reforestation in Oregon; landowners had to gain approval of an alternative plan before regenerating cutover sites with hardwoods. The new legislation for Oregon states that suitable hardwood seedlings are acceptable for forest regeneration without application for alternative practices (Oregon Forest Practices Act, n.d.). Suitable hardwood seedlings are defined as "...any hardwood seedling that will eventually yield logs or fiber, or both, sufficient in size and quality for the production of lumber, plywood, pulp, or other forest products" (fig. 13).

The new rules proposed for Oregon would allow the State to request more information from landowners on how they will accomplish reforestation. This gives foresters a way to address concerns about "the potential for unscrupulous landowners to practice non-management of forest land under the guise of hardwood reforestation...." This and other conditions of the proposed rules are intended to limit acceptance of hardwoods to those situations where the landowner is making a serious attempt at hardwood management.

In Washington, acceptable species are "commercial species," which can include hardwood species as long as the species has a commercial value. Significant changes in species composition from the previous stand may be subject to regulation. For example, planting alder after harvesting a pure softwood stand is allowed only if the reforestation plan shows "...the proposed species to be preferable from any of the following standpoints:

- (A) Site data indicate better potential production for the proposed species than the existing species.
- (B) Control of forest insects or diseases.
- (C) Greater economic return."

⁶ Oregon Department of Forestry. 1987. Free to grow, a survey of private forest lands in western Oregon harvested and reforested between 1972 and 1979. Unpublished report. On file with: Oregon Department of Forestry, 2600 State Street, Salem OR 97310.



Figure 13—A healthy red alder seedling during the first season after planting.

If hardwood species are approved for regeneration on a site, they can meet revegetation requirements for harvesting adjacent stands.

Harvest regulations limiting availability of timber in riparian areas, including the revised regulations that emphasize establishment and maintenance of softwood species in such areas, also may discourage active management favoring hardwoods in these areas. Hardwoods naturally establish and may become the dominate vegetative type in riparian areas, but it is unlikely that practices to ensure stocking, good growth, and stem quality could or would be applied where regulations restrict availability. Indeed, existing hardwood management programs target upland sites outside the regulated riparian zone.

Harvesting Trends and Behavior

In both Oregon and Washington, the growing of tree crops in very short rotations in a manner normally associated with agriculture is not subject to forest practice rules. An example would be the hybrid cottonwood plantations established in the Columbia basin that are harvested on rotations of 6 to 8 years.

Timber harvesting reflects the combined influence of supply-related factors on landowners and demand-related factors on purchasers. The supply of timber is determined by the willingness and ability of landowners to make timber available for harvest given market conditions. Factors determining availability are the condition of the forest (attributes such as standing volume, stage of stand development, accessibility, and species mix), objectives and preferences of the landowner, legal or other institutional restrictions, and markets. Demand for timber is determined by the willingness of purchasers to pay for and harvest timber given logging costs, the price of timber from alternative sources, end-use prices, and conversion technologies. In the short run, much depends on the specific status and needs of the prospective log buyer, their position and connections in the industry, and their demand for alder as a major species versus other hardwood species.

Landowner objectives potentially have great influence over timber supply. Industrial and corporate landowners manage their forests and harvest timber as a commercial venture. Other private or nonindustrial landowners are more numerous and are influenced by a variety of objectives, of which the management and harvesting of timber for profit may be only one. Public agencies manage public land and resources for multiple purposes. Hardwoods on Federal ownerships are decidedly less available than privately owned hardwoods due to factors unrelated to the condition of forests or markets (for example, nontimber concerns, legal restrictions, and changing management strategies). On State-owned forests, timber production and financial returns are primary objectives; thus, the availability of hardwood timber is less constrained than on Federal lands though there are institutional, legal, and political factors that must be accommodated along with the financial objectives.

Time trends in overall timber harvest—The harvest of both hardwoods and softwoods on all ownerships in western Oregon and western Washington decreased by over 4 billion board feet (34 percent) between 1988 and 1991 (table 19). The decline in timber harvest in Oregon was a result of decreasing harvests on public lands; the decline in Washington occurred on both public and private ownerships. Further reductions in timber harvests from Federal lands can be expected, because the amount of timber sold by Federal agencies in 1991 and 1992 was substantially below either the harvest levels from Federal lands or the quantities sold from Federal lands during the late 1980s (Warren 1993).

The decrease in harvest on private lands in Washington has occurred only on industrial lands, while harvests on other private ownerships have increased slightly over time. In Oregon, there is no discernable change in the relative proportion of the private harvest contributed by industry and other private owners. Washington's regulations to protect the northern spotted owl (*Strix occidentalis caurina*) on private lands may be one factor contributing to the decline in private timber harvests in that State. A relatively higher dependence on public timber supplies in Oregon, and therefore greater impact of reductions in those supplies, may be one important factor putting pressure on mills to obtain timber from private lands in that State.

Harvest data for private lands are developed in Oregon and Washington from forest tax records. In Washington, information is available for both softwoods and hardwoods by county for each ownership class, but a breakdown by species is not available. Oregon provides a species breakdown for hardwood and softwood species by ownership for all of western Oregon combined; county-level harvest data for western Oregon are for all species combined.

Table 19—Total timber harvest in western Washington and Oregon^a

State and owner	Year				
	1987	1988	1989	1990	1991
<i>Thousand board feet, Scribner rule</i>					
Oregon:					
Industry	2,452,428	2,305,905	2,510,508	2,210,796	2,270,236
Other private	343,668	447,670	538,569	458,039	378,925
Total	2,796,096	2,753,575	3,049,077	2,668,835	2,649,161
Public	3,407,678	3,968,550	3,183,124	1,857,500	1,574,158
Total, Oregon	6,203,774	6,722,125	6,232,201	4,526,335	4,223,319
Washington:					
Industry	2,540,168	2,499,672	2,413,897	2,144,205	1,730,442
Other private	1,284,383	1,368,077	1,550,925	1,387,430	1,336,265
Total	3,824,551	3,867,749	3,964,822	3,531,635	3,066,707
Public	1,872,696	1,881,065	1,527,013	1,141,800	946,803
Total, Washington	5,697,247	5,748,814	5,491,835	4,673,435	4,013,510
Total, Pacific Northwest	11,901,021	12,470,939	11,724,036	9,199,770	8,236,829

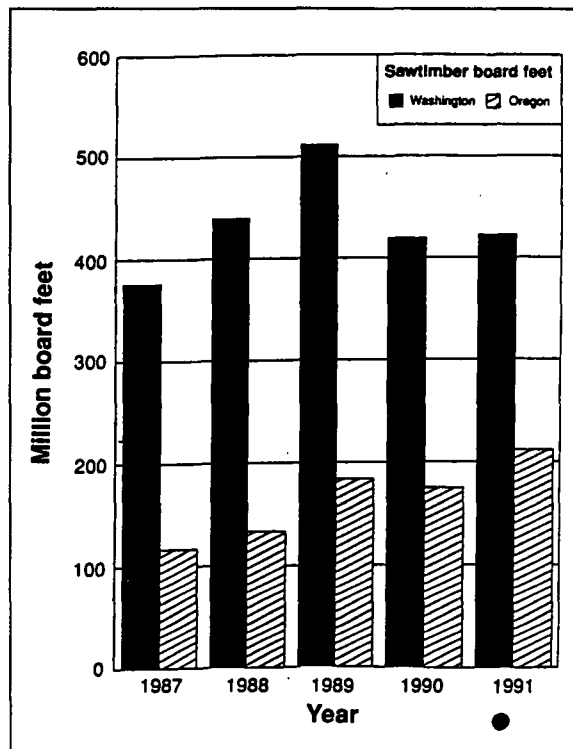


Figure 14—Hardwood sawtimber harvest from all public and private lands in western Washington and western Oregon.

Public agencies maintain records of harvest for lands they manage. The Washington Department of Natural Resources summarizes and publishes this harvest information annually for Washington (Larsen 1994), and the Oregon Department of Forestry includes harvest information as part of their annual report (Oregon Department of Forestry, n.d.). Federal land management agencies maintain detailed records of timber cut and sold.

Time trends in the hardwood harvest—Hardwood harvests have been increasing slightly in Oregon; in Washington, no trend is easily discernable (fig. 14) over the period 1987 to 1991.

Private lands contribute a large proportion of the hardwood timber harvest throughout the region, exceeding harvest from public lands by a 10 to 1 ratio (table 20). Harvest of hardwoods from National Forest lands was an insignificant 1.5 million board feet for the entire Pacific Northwest Region in 1991.⁷ Non-Federal public lands, mostly those managed by the Washington DNR, are an important contributor to hardwood supply in Washington, but still the harvest on public lands is small relative to the hardwood harvest on private lands and the sawtimber inventory on public lands.

⁷ Timber cut and sold reports. On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, P.O. Box 3623, Portland, OR 97208-3623.

Table 20—Hardwood sawtimber harvest in western Washington and Oregon^a

State and owner	Year				
	1987	1988	1989	1990	1991
<i>Thousand board feet, Scribner rule</i>					
Oregon:					
Private	104,999	117,437	172,503	166,500	203,233
Public	11,692	15,291	10,978	8,288	8,353
Total, Oregon	116,691	132,728	183,481	174,788	211,586
Washington:					
Industry	153,188	177,504	219,147	171,393	163,625
Other private	170,661	193,309	238,590	203,679	209,698
Total, Private	323,849	370,813	457,737	375,072	373,323
Public	52,721	69,243	54,410	44,719	49,780
Total, Washington	376,570	440,056	512,147	419,791	423,103
Pacific Northwest:					
Private	428,848	488,250	630,240	541,572	576,556
Public	64,413	84,534	65,388	53,007	58,113
Total	493,261	572,784	695,628	594,579	634,689

^a Oregon data are from Oregon Department of Forestry annual reports (n.d.). Washington data are from Washington timber harvest reports, Washington Department of Natural Resources (1989-94).

Red alder is three-quarters of the hardwood harvest in Oregon, and bigleaf maple currently comprises another 8 percent of the hardwood harvest (Oregon Department of Forestry, n.d.). The balance of the harvest is made up of madrone and other minor species. Although data on species harvested are not available for Washington, industry sources and inventory information suggest that red alder is by far the most important species followed by bigleaf maple and other minor species. County level data for the hardwood harvest are available for Washington (table 31) and indicate the wide variation in hardwood harvest by county.

Hardwood harvest volumes reported in forest tax records may be substantially less than actual harvest and use. MacLean and others (1992) report average annual removals of hardwoods from private ownerships in western Washington of about 549 million board feet per year, but tax records report only 384 million board feet per year harvested from the same lands. Although removals include unused harvest residues, much of this difference in volume may be due to pulpwood and firewood usage that is not reported as hardwood. A survey of hardwood use in 1985 (Beachey and McMahon 1987) estimated that whole-log chippers in both States provide about 733 thousand bone dry units of hardwood chips, equal to about 275 million board feet used for pulpwood compared to 250 million board feet used by sawmills. Representatives of the industry (Washington Hardwoods Commission) report that the volume of hardwoods used for pulpwood has increased greatly since the 1985 survey.

Harvesting behavior on private ownerships—In most timberlands, private supply will continue to make up the preponderance of the harvested hardwood volume. Over the next 20 years (short run), that harvest will come from trees growing in the woods today.

Some understanding of the possibilities for short-run supply is available from projections of hardwood availability for the industrial and nonindustrial landowner groups. For western Washington, Adams and others (1992) develop a scenario in which industrial hardwood growing stock is aggressively depleted and the trend for industrial hardwood harvest is modestly downward, while the trend for nonindustrial growing stock moves slowly downward and is accompanied by little change in nonindustrial hardwood harvesting. For western Oregon, Sessions and others (1990) develop several scenarios of modestly increasing industrial harvest levels, of which about 10 percent of the total is in hardwoods. They also develop two scenarios for the nonindustrial ownership. One is based on the assumption of continued harvesting at historical rates, which are low relative to the ownership's increasing inventory and which have provided a negligible part of the hardwood supply in western Oregon. A second scenario recognizes the possibility of increasing nonindustrial harvest, which would be accompanied by increases in hardwood harvesting. Greber and others (1990) update the nonindustrial harvesting scenarios of Sessions and others (1990) and conclude that nonindustrial harvest levels could rise dramatically above historical rates; their work does not differentiate between hardwoods and softwoods.

Broad differences between industrial and nonindustrial forestry have been noted by other analysts. Gedney (1983) finds significant differences among ownership classes when comparing inventory remeasurements of stand condition, percentage of area harvested, and percentage of volume removed by harvesting method for western Oregon between the early 1960s and the mid-1970s. Others (for example, Binkley 1981, McMahon 1964) suggest that harvesting and management differences across ownership classes are due to landowner objectives, including differences in attitudes about timber as a profit-making opportunity for forest land ownership. Oswald (1986), in an analysis of western Washington, concludes that the nonindustrial supply outlook is further complicated because substantial volumes of timber in that ownership class are found in nonforest development zones where they are subject to urban influences that make timber harvesting unpredictable.

Sessions and others (1990) conclude that the forces determining nonindustrial harvest are largely unknown. In one supply scenario, Adams and others (1992) use landowners' income from nontimber sources as a factor affecting nonindustrial supply. Connaughton and Campbell (1991) provide insight on supply-determining factors by comparing the harvest behavior of the nonindustrial ownership to that of the industrial ownership. Their work, based on observed harvesting in western Oregon between the mid-1970s and mid-1980s, shows that there was no difference in the likelihood that a stand would be harvested in either ownership when stand growth rate and merchantable volume per acre were considered; their work does not differentiate between hardwoods and softwoods, but does reflect the economic conditions prevailing at the time their observations were made.

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We investigated the effect of ownership and species mix on the likelihood that a stand would be harvested in western Washington and western Oregon. Using field plot remeasurement data for the two States, we found no evidence of a difference in the likelihood of harvest for the two ownership categories.⁸ Like Connaughton and Campbell (1991), we considered the impact of stand growth rate and volume per acre, but we also disaggregated those variables into hardwood and softwood components. Further analysis revealed no evidence that the likelihood of harvest had been affected differently by the hardwood and softwood species composition of the stand. Our results, like those of Connaughton and Campbell, reflect the influence of the economic conditions prevailing when the remeasurements were made.

Our results suggest much of the existing hardwood sawtimber volume will be available for use by the hardwood industry over the next 20 years, as the stands containing that volume continue to mature. For example, Gedney (1990) reports that much of western Oregon's hardwood volume is in stands that either have or are expected to have harvestable quantities of either hardwoods or hardwoods mixed with softwoods. Because a substantial number of stands in the other private ownership class are maturing, we expect harvest for the ownership (including hardwoods) to increase. So long as hardwoods and softwoods continue to have equivalent effects on the likelihood of harvest, then we expect that landowners will not choose pure or predominantly softwood stands over the mixed stands of hardwoods and softwoods that contain so much of the region's hardwood inventory. Some caution in interpreting these findings is warranted, however. Past trends may not continue into the future, and the fact that a stand has been harvested does not mean that all felled trees are bucked and transported to mills for primary processing.

Resource Management Issues

Long-run hardwood supply is a more complicated issue than short-run supply because it depends on timber values as an incentive for the management activities of landowners, and on the creativity that foresters use in designing choices for managing both hardwoods and softwoods. Management, therefore, will determine to what extent hardwoods are present in the stands of the future.

The hardwood resources of today are the legacy of past forest practices and forest management. Attitudes toward hardwood management are changing, but that legacy affects current practices, which are likely to favor softwoods. In the following sections, we review the issues pertaining to the role of hardwoods in forest management, concluding with a survey of current practices as they affect hardwoods. In this review, we acknowledge both the difficulties and the advantages of managing hardwoods as a profitable and ecologically important element in Pacific Northwest forestry.

The History of Hardwood Forests

The occurrence of hardwoods across the landscape has increased dramatically since settlement of the Pacific Northwest. Though most forest inventories have not focused on hardwood species and have used different sample designs and utilization standards, the data available illustrate great increases in hardwoods over the past 60 years (fig. 15).

⁸ Connaughton, Kent P.; Raettig, Terry; Ahrens, Glenn. Factors affecting private harvesting behavior and short-run timber supply in the Pacific Northwest. Manuscript in preparation.

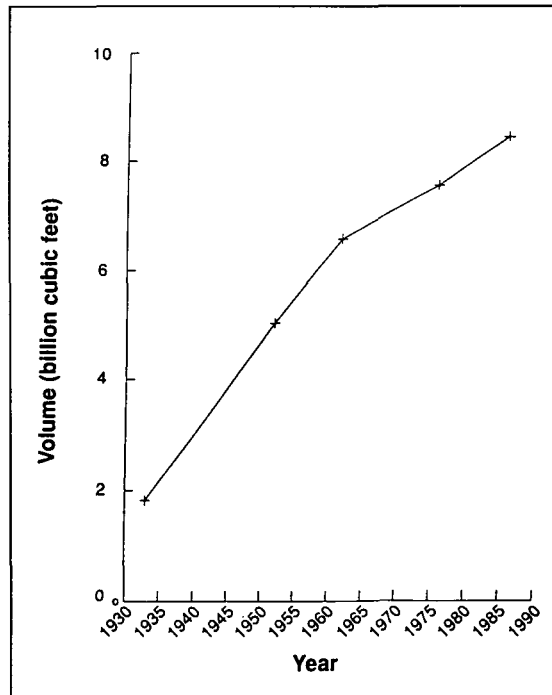


Figure 15—Hardwood inventory on privately owned land in the Pacific Northwest.

The predominant species, red alder, readily invades disturbed soils. Alder proliferates after road building, logging, and other forest disturbances associated with human settlement (fig. 16). The abundance of alder has increased up to 20-fold since the 1920s (Johnson and others 1926, Little 1978). Likewise, the next most common hardwood, bigleaf maple, sprouts vigorously after cutting and regenerates well from seed in partially cut stands (Minore and Zasada 1990). Sprouting hardwoods such as tanoak, Pacific madrone, black oak, chinquapin, and California laurel have increased in abundance up to threefold after extensive burning and harvesting in the southwest part of the region (Andrews and Cowlin 1940, Gratkowski 1961, Overholser 1977).

Since the 1960s, practices aimed at controlling hardwoods have become increasingly common and effective. Forest practices regulations aimed at ensuring softwood regeneration have been in effect for almost 20 years in both Oregon and Washington (see regulation section, beginning p. 27). Both private and public owners practicing intensive forest management actively pursued conversion of young hardwood stands to softwood plantations throughout the 1970s and 1980s. Control of hardwoods is still considered an integral part of modern forest management if economic returns are the primary objective.

In spite of these efforts, hardwood volumes in general continued to increase in the region during the 1980s (fig. 15). Overall, harvest and removal of growing stock remained substantially less than estimated growth (fig. 17). Much of the current inventory and growth is still the legacy of hardwood stands from earlier practices. Particularly in Washington, the growing hardwood industry depends on this maturing legacy, as indicated by substantial decreases in the acreage of young hardwood stands (poletimber) which must replace harvested or decaying mature stands (table 13).



Figure 16—Red alder has proliferated with human-caused disturbance in the Pacific Northwest. Alder and other hardwoods are particularly abundant on nonindustrial private forests such as this parcel shown here in central coastal Oregon.

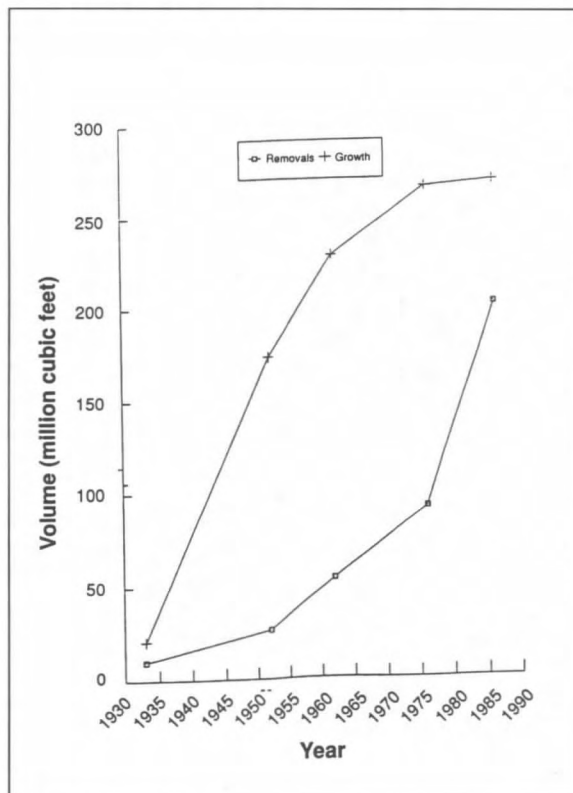


Figure 17—Hardwood removals and growth on privately owned land in the Pacific Northwest.

A closer look at the dynamics of the alder resource in Washington indicates an uncertain future for hardwood resources if current practices continue. The old story of alder as an overabundant, underused resource is dispelled by recent data showing that harvest and removal of alder growing stock exceed net growth by 40 percent (table 16) on private lands in Washington. Also, since the last inventory (1979), growth has declined by 30 percent and mortality has doubled, perhaps due to the preponderance of older stands.

Unlike the softwood species, the alder inventory has a relatively short life span. Volume growth (per acre) of alder may cease as early as age 45 to 60 and stands begin deteriorating at age 60 to 70 years (Williamson 1968, Worthington and others 1962). This, combined with the decreased acreage and lack of management for younger stands, indicates a long-term decrease in the supply of alder in Washington unless forest management practices are changed. Existing sawtimber stands can supply timber only for a relatively limited time, after which stands not used will be lost to mortality.

In Oregon, the development of hardwood industries and increasing use of hardwoods is occurring, though the process appears to lag behind the trends observed in Washington. Thus, as of 1986, growth of hardwoods still exceeded removals and the acreage of younger stands was similar to the acreage of sawtimber. More recently, however, the harvesting of hardwoods, primarily red alder, has nearly doubled in Oregon (table 20). A significant amount of the volume growth is occurring on trees that may not be available for harvest because they are on public lands or are in riparian or wetland areas. Without any increase in management for future hardwood resources, utilization rates for alder in Oregon also could become unsustainable.

Attitudes and Policies

The most recent projections of timber supplies for the region incorporate some characterization of forest harvesting and management activities as they affect hardwoods on major ownerships (Adams and others 1992, Sessions and others 1990). These reports project long-term decreases in hardwood supplies.

The reports mentioned above also assume and recommend increased rates of harvesting or removal of hardwoods to rapidly and completely bring timberland back into softwood production. These policy-level reports suggest that total timber supplies could be increased through increased management intensity, but they do not acknowledge any separate or distinct value for the hardwood component of timber supply. Sessions and others' (1990) projection of potential timber harvests from nonindustrially owned land under "moderately increased management intensity" calls for an increase in hardwood harvest in the short term, leading to complete elimination of the hardwood component of the harvest within 70 years (Sessions and others 1990: p. 58, fig. 19).

Current Management and Planning

In the absence of increased management for young alder stands, the dynamics of the alder resource indicate a long-term decline with increased use. Given the current interest in increasing usage of hardwoods in general, this raises several questions about management of hardwoods. Is the increasing value of hardwoods changing their status in management plans or in philosophies for major forest ownerships? Are there any plans to maintain a hardwood component across the landscape? By intent or by accident, what level of hardwood supplies is likely to be produced by current management practices?

To address these questions, management plans, objectives, and practices affecting hardwoods were assessed for major forest ownerships. Key objectives or practices examined were:

1. Conversion of hardwood types to conifer plantations or other land uses.
2. Control of hardwoods in young forests by weeding or release treatments.
3. Active or passive management practices favoring hardwoods.

USDA Forest Service—The most recent round of planning for National Forests in the Pacific Northwest was completed in 1989. These plans may be significantly altered, depending on the outcome of the current controversy over management of National Forests for protection of the northern spotted owl, marbled murrelet (*Brachyramphus marmoratus*), anadromous fisheries, and old-growth forest conditions. Practices and philosophies affecting hardwoods may, however, carry through the current controversy to some extent. Therefore, practices affecting hardwoods were assessed by examining existing Forest plans⁹ and holding discussions with managers from the Siuslaw and Siskiyou National Forests, which include significant hardwood resources.

Hardwood conversion operations using herbicides or slashing and burning were common in National Forests in the 1970s and 1980s. Vegetation management practices used by National Forests were critically evaluated after the ban on herbicides in 1983. Since then, the Forest Service generally has not invested in conversion of hardwood stands if the existing timber did not pay for the operation. The Siskiyou National Forest plan still allowed for conversion of up to 7,500 acres of predominantly hardwood stands to softwood stands by commercial harvest in the next decade. In general, where existing hardwoods are judged to be growing on softwood sites, hardwoods are slated for removal when feasible, and management of regenerated stands on those sites will favor softwoods.

Control of competing vegetation, including hardwoods, is generally prescribed in National Forests when survival of planted softwoods is threatened. After the ban on herbicides, control was maintained with considerable effectiveness by using manual cutting of invading hardwoods. Even so, hardwoods have not been eradicated in National Forest plantations to the extent often seen on industrial lands. All current Forest plans contain language specifying objectives to maintain viable components of minor species and retain biological diversity and wildlife habitat.

Harvesting, reforestation, and thinning practices used by National Forests for softwoods are now commonly prescribed to maintain some component of hardwoods. With the exception of the Siuslaw National Forest, the hardwood component to be maintained generally is not specified. Harvest volumes and allowable sale quantities also are not designated specifically for hardwoods by most National Forests. National Forest managers often express interest in improving the resolution and accuracy of inventory and harvest estimates for hardwoods, particularly as they perceive an increase in the importance of the hardwood resource.

⁹ Land and resource management plans and related environmental impact statements for all National Forests in the Pacific Northwest Region. 1989. On file with: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, P.O. Box 3623, Portland, OR 97208-3623.

The Siuslaw National Forest, which has the most significant Federal ownership of alder, has specific objectives for maintaining deciduous forest, including a sustained yield projection for hardwoods of 5 million cubic feet per year. At this Forest, pre-commercial thinning prescriptions often call for leaving 20 to 40 alder per acre in softwood plantations.

Two National Forests, the Siuslaw and Gifford Pinchot, have been working with the Hardwood Silviculture Cooperative, headquartered at Oregon State University, to develop successful techniques for regeneration and management of alder. There is great interest in the potential use of hardwoods for reforesting sites in National Forests infected with *Phellinus* root rot. The Siuslaw has the largest acreage of alder plantations infected with *Phellinus* root rot pockets (about 700 acres).

Overall, National Forest management plans reflect a changing attitude toward hardwoods, and most Forests have plans to maintain a hardwood component. Only one National Forest plan specifically identifies maintenance of hardwood timber supplies as an issue. Timber generally is not the primary objective for current plans favoring hardwoods. Until the recent controversy over Federal forest policy, some Forest Service managers were expressing greater interest in providing supplies of hardwood timber. Now, however, management and harvest policies are undergoing revision throughout the region, and it is likely that management plans emerging from this process will reduce the emphasis on timber management. This may slow any progress towards increased supplies of hardwood timber from National Forests.

Bureau of Land Management—Practices affecting hardwoods on Bureau of Land Management (BLM) lands were assessed by examination of recent plans and from informal interviews of some district forest managers. New resource management plans were completed in draft form for all BLM districts in Oregon in 1992. Management of BLM lands generally emphasizes growth of commercial softwoods on all districts. Guidelines for regeneration, vegetation management, and precommercial thinning are designed to enhance growth and survival of softwoods through control of hardwoods when necessary. Existing hardwood stands on softwood sites may be converted to softwood regeneration. Plans refer to a total of 1,000 acres per year of hardwood conversion in all of western Oregon.

All plans call for maintaining some hardwood component for biodiversity or soil productivity. Many Districts plan for maintenance of a hardwood component “resembling that which occurred naturally,” excluding hardwood stands that invaded cutover softwood sites. The Roseburg District prescribes artificial regeneration of hardwoods in nontimber emphasis areas if natural propagation is unlikely. The BLM also is using other hardwoods and less susceptible softwood species for regeneration of areas infected with *Phellinus*. The BLM is working with the Hardwood Silviculture Cooperative to develop techniques for regeneration and management of alder.

Most BLM districts plan to manage hardwoods on “hardwood sites” or “sites not suitable for conifers.” The total acreage of such hardwood sites on BLM land is not available. The Salem, Eugene, and Medford District plans call for management of hardwood sites for sustainable production of hardwood timber. Medford is the only district giving an allowable sale quantity for hardwoods, which is set at 5 million cubic feet per year, or 28 percent of the total timber harvest from the district.

Similar to the Forest Service, BLM is showing a changing attitude towards hardwoods. Overall, BLM managers plan to maintain a hardwood component for a variety of reasons. Several districts have demonstrated that the agency will plan for management of sustainable hardwood timber in areas with significant hardwood resources.

State-owned lands—In Washington, management practices affecting hardwoods on DNR land were assessed through a review of their forest resource plan (1992)¹⁰ and through discussions with DNR foresters involved with management and harvest planning.¹¹

The forest resources plan for the DNR contains little language specific to hardwood resources. The DNR applies strict objectives for producing financial returns from any management activity. This generally precludes efforts to convert young, unmerchantable hardwood stands back to softwood species. Their long-term plan is to harvest hardwood stands when they are merchantable and regenerate with softwoods on most sites. A low but significant proportion of hardwoods is expected to occur in new stands; complete eradication of hardwoods is neither feasible nor desirable.

As with western Washington in general, most hardwood stands on DNR land are mature (40-60 years). A much smaller acreage of 0- to 30-year-old stands indicates the success of more recent efforts to reduce the proportion of hardwoods. In the 1992 plan, the DNR set hardwood harvest levels of 1 billion board feet for the decade of the 1990s and 1.35 billion board feet for the decade beginning in 2000. It was expected that within about 20 years, the current excess of mature hardwood will either be converted to softwood stands with lower proportions of hardwoods, or the hardwoods will have been lost to mortality. Thereafter, a lower level of hardwood harvests could be sustained.

Washington DNR plans are undergoing some revision and there is no official policy for harvest levels of either hardwoods or softwoods at present. Actual levels of hardwood harvest from DNR lands in the 1990s have been only 50 million board feet per year, which has been attributed to a limited ability of markets to absorb larger sale quantities¹² (Adams and others 1992). This apparent limitation is interesting in light of the increasing demand for hardwoods by the industry. Because hardwood stands are composed predominantly of short-lived alder, a decline in supplies is still expected after 30 years, regardless of the level of use of current stands.

¹⁰ Washington forest resources plan. 1992. On file with: Washington Department of Natural Resources, P.O. Box 47010, Olympia, WA 98504-7010.

¹¹ Charles Chambers and Michael Nystrom. Land Management Office. Washington Department of Natural Resources, P.O. Box 47010, Olympia, WA 98504-7010.

¹² Personal communication. 1993. Charles Chambers, Washington Department of Natural Resources, P.O. Box 47010, Olympia, WA 98504-7010.

In Oregon, management practices affecting hardwoods on State lands were assessed by reviewing long range timber management plans for 1984, 1987, and 1989¹³ and holding discussions with foresters involved with management and harvest planning.¹⁴ The general goal of State forest management is to “provide a sustained contribution to the people of Oregon by managing the growth and harvest of the forest in a cost-effective and environmentally sound manner.” Timber production has been the primary objective on 90 percent of the acreage. State forest plans currently are being revised, and the emphasis on timber production is likely to be reduced in the new plans.

Softwood saw logs are stated to be the primary timber product, and softwood species are to be managed on a sustained yield basis. (see footnote 13). The management plans call for harvesting of most hardwood stands when they become “merchantable and operationally available.” Inventory or harvest volumes are not given for hardwoods, though the acreage of hardwood stands is estimated at 37,565 or about 5 percent of the total landbase.

Several potential levels of management are described, with the level of implementation dependent on funding. The plans state an objective of harvesting 200 acres of hardwood sales annually under more intensive management levels (level 3 or 4), equal to about 4 percent of the total harvest acreage. No pure hardwood sales were planned for less intensive management levels (level 1 or 2). Although the total volume of hardwoods to be harvested was not scheduled in written plans, a rough estimate of annual hardwood harvests from pure or mixed species stands was 12 million board feet.¹⁵

Reforestation and management of young stands focuses on maintaining survival and growth of softwoods. Competing vegetation, including hardwoods, is controlled where necessary through the use of burning or herbicides, or both. Hardwood conversion is included with rehabilitation of underproductive, nonconifer areas for State forests. An annual total of 408 acres of rehabilitation was planned at high levels of management intensity (level 3 or 4).

In general, State foresters in Oregon must be able to demonstrate competitive economic returns for any proposed timber management scenario. Under the typical set of assumptions, hardwood management is not competitive economically, except where hardwoods are used to sanitize areas infected with *Phellinus*. The Oregon Department of Forestry currently is using red alder as an alternative species for reforestation of *Phellinus* root rot areas. Hardwoods are considered a minor component of State forests, and there are no specific plans to manage a sustainable supply of hardwood timber.

¹³ Long range timber management plans. 1984, 1987, 1989.
On file with: Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.

¹⁴ Personal communication. 1993. Mike DeLaune and Bill Voelker, Forest Land Management Office, Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.

¹⁵ Personal communication. 1993. Mike DeLaune, Forest Land Management Office, Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.

Private, industrially owned lands—Management practices affecting hardwoods on private, industrially owned lands were assessed from surveys of forest practices foresters who review harvesting and reforestation activities on all private lands. Nineteen forest practices foresters from Oregon and six from Washington responded to the survey; the responses came from the range of subregions in Oregon, but most respondents in Washington were from the Puget Sound region (representing a total of about 7,600 applications for forest practices of some kind). Additional information was gained from discussions with industry representatives and from field observations of industrial practices. Detailed management plans on industrial holdings are proprietary information and not available for public review.

Forty-seven percent of the survey respondents said that conversion of young hardwood stands was not commonly practiced. Half of the respondents thought conversion from hardwoods to softwoods was still common, and one-third of these said the incidence was decreasing. A reduction in the amount of conversion has occurred because many acres of nonmerchantable hardwoods that were economically convertible have been converted. Modern reforestation practices generally prevent substantial new acreages of pure hardwoods from developing. In general, increasing prices for hardwoods have allowed accelerated commercial harvesting at younger ages, and investment in conversion of nonmerchantable hardwoods to softwoods is not common.

Effective control of hardwoods in regenerating stands is almost universal on industry lands (95 percent of respondents said effective treatments were the norm). After harvest, most stands will be restocked with softwoods. Recently, there seems to be a reduction in the intensity of vegetation management as compared to the practices of previous decades. Most respondents (79 percent) agreed that there will be a substantial reduction in the proportion of hardwoods in regenerating stands compared to the previous stand. Where the existing component of hardwoods is low there will be little change.

Industrial foresters acknowledge a variety of values for incidental hardwoods on softwood plantations. Thus, complete eradication is not generally desirable. Very few industrial owners see an incentive to manage large acreages of hardwood forest to replace harvested hardwood stands. Most managers probably feel that well-tested methods of softwood management provide the greatest assurance of success; pressure to maximize economic returns from industrial lands still precludes hardwood management except for ownerships tied to the hardwood industry.

Intentional efforts of any kind to favor hardwoods are rare on industrial lands, and 63 percent of respondents said there were no such efforts. In some cases, companies will leave hardwoods during precommercial thinning in areas with no softwood species. A small number of industrial owners are growing red alder to provide sawtimber for their (or their clients') mills. At most, about 3,000 acres per year may be intentionally regenerated with alder on industrial lands in the Pacific Northwest—this figure represents a rough estimate based on the known efforts by the hardwood industry and public agencies. This amounts to about 1 percent of the harvested acreage. Intensive management of hybrid poplar plantations on short rotations by paper companies is another kind of hardwood management that is expanding rapidly in the Pacific Northwest.

Private, nonindustrially owned lands—Management practices affecting hardwoods on private, nonindustrially owned lands were assessed from surveys of forest practice foresters who review harvesting and reforestation activities on all private lands. Additional information was summarized from discussions held at hardwood management workshops with public and private foresters who advise private, nonindustrial landowners. The private, nonindustrial ownership category corresponds closely to the other private ownership category used earlier in the review of forest resource conditions and includes landowners without mills who have small- to medium-sized forest properties.

The intensity of forest management on private, nonindustrially owned lands is often low compared to industrial or public lands. Hardwood conversion treatments are not common on nonindustrially owned lands (74 percent of forest practice foresters responding), and many owners do not effectively control hardwoods in regenerating stands (53 percent of forest practice foresters responding). In many cases softwood species are harvested and the hardwoods species are left. Thus, while few non-industrial owners are likely to intensively manage for hardwoods, a relatively large hardwood component is likely to continue reproducing naturally. Most of the forest practice foresters responding (74 percent) said there is no reduction in the hardwood component in regenerating stands and in some cases there is an increase.

Nonindustrial landowners often have objectives for managing their forest properties other than timber production. In recent years, nonindustrial owners have expressed increasing interest in hardwood management options. Much of this may stem from publicity highlighting the potential for fast growth and shorter rotations with hardwoods. Landowners may not follow up on their initial interest after a realistic appraisal of the specific capabilities of their land and the resources available for active management. Intentional efforts to favor hardwoods do occur on nonindustrial land (53 percent of forest practice foresters responding indicated some level of management favoring hardwoods), though they are not frequent or intensive.

Future harvesting and management of hardwood resources on private, nonindustrially owned lands also is influenced by the proximity of many forested acres to urban areas and the continuing conversion to nonforest uses. Hardwoods are particularly abundant in areas influenced by nonforest uses. In western Washington, 49 percent of the hardwood growing stock on private, nonindustrially owned lands occurs in low-density residential or urban zones compared to only 31 percent for softwoods (Oswald 1984). For western Oregon, Gedney (1981) shows a 15-percent decrease in the acreage of hardwood forest types on other private lands between the 1961-62 and 1973-76 inventories due primarily to conversion to nonforest uses. This trend continues, but more recent estimates of specific effects on hardwoods are not available. Conversion to nonforest uses may increase short-term hardwood supplies as land is cleared for development; long-term supplies are subsequently decreased as the land is removed from timber production.

Benefits From Managing Hardwoods

There is little benefit to managing a resource that is abundant but underused. Although this has been the status of hardwoods in the past, there is increasing acknowledgment of the benefits of growing hardwoods under various conditions. In the following sections, we discuss the economic and ecological benefits that landowners can expect from hardwood management.

Economic benefits—Typical economic analyses for the 1970s and 1980s estimate a negative present net worth for alder management regimes (Brodie and others 1987, Doran and others 1971, McGillivray 1981, Yoho and others 1969). The general conclusion has been that prices for standing alder timber would need to increase by 200 to 400 percent for returns from alder planting and management to be competitive with Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco). The usual goal of economic analyses was to determine the age when young alder become too old for conversion to softwoods to achieve an increase in returns. Tarrant and others (1983) suggest that alternating rotations of alder and Douglas-fir would be more profitable than continuous management of Douglas-fir.

Recent increases in prices for alder logs make management of alder profitable. Estimated returns are still higher for softwood alternatives at present, however. A recent analysis estimated returns from alder that are competitive with Douglas-fir regimes if future log prices for alder are assumed to be equal to Douglas-fir.¹⁶ In this case, the disadvantages of lower volumes per acre and higher harvest costs for alder are negated by a shorter return interval (30 versus 60 years). All such analyses become speculative, however, because they depend on important assumptions about future product prices and costs; the lack of information on yields from managed stands of hardwoods, which is the foundation for estimating returns from hardwood management, increases the uncertainty of the analysis. In general, a factor favoring some hardwood species, notably alder and cottonwood, is the potential for short rotation ages and quicker returns for fast-growing species in managed stands.

As noted earlier, except for the intensive management of hybrid poplar in agriculturallike operations, the only major investments in regeneration and management of hardwoods are being made by landowners with a vested interest in hardwood manufacturing industries. Based on the current success of their mills, these owners are more inclined to speculate on continued increases in the value of hardwoods relative to softwoods in the Northwest.

Regardless of the uncertainties surrounding rotation ages or yields, landowners may perceive little economic incentive to produce hardwood timber as long as monetary returns for standing timber continue to be substantially higher for softwood species. Increasing values for end products may provide good returns for hardwood processors; however, stumpage prices and returns are often too low to encourage private, nonindustrial landowners. This is due to several factors, some of which are changing.

First, the initial success of the Northwest hardwood manufacturing industry was due in part to the overabundance and lack of demand for the raw material, which meant that stumpage and log prices were low. Future hardwood stumpage prices are likely to be higher, perhaps significantly so, than they have been in the past because demand for the industry's products has been increasing and available raw material supplies may already be decreasing.

¹⁶ J. Douglas Brodie. 1993. Unpublished analysis. 2 p. On file with: College of Forestry, Oregon State University, Corvallis, OR. 97331-5704.

Second, costs of harvest and transport have tended to be much higher for hardwoods relative to softwoods, which reduces hardwood stumpage value (Cleaves 1992, Feddern 1978). Hardwoods were often a somewhat inconvenient byproduct of harvesting dominant softwoods. There was no motivation for loggers to harvest hardwoods efficiently. Recently, experienced operators performing industrial-scale harvests of alder have demonstrated increased efficiency. Even so, harvest and transport costs for hardwood are likely to run 15 to 20 percent higher than typical softwood operations.

A third reason for low stumpage prices is the relatively low rate of lumber recovery or overrun for hardwoods versus softwoods (Plank and others 1990). Typical rates for the recovery of hardwood lumber as a percentage of incoming log scale are only 70 to 110 percent (logs 12-20 inches in diameter), while comparable rates for Douglas-fir are 160 to 230 percent (Plank and others 1990, Willits and Fahey 1988). Though the value of high-grade hardwood lumber is high, only 20 to 30 percent of the lumber volume is recovered in select grades.

Finally, hardwood stands do not attain the high volumes per acre typical for fully stocked softwood stands. Typical hardwood stands range from 8 to 20 thousand board feet per acre at rotation age, while softwood stands can yield 20 to 60 thousand board feet per acre at rotation.

Ecological benefits—Forest managers, particularly in the public sector, often have objectives other than direct economic returns. There are several ecological benefits that result from maintaining a hardwood component in the forest.

Some of these ecological benefits are linked to economic incentives and may provide economic benefits in the longer term. Hardwood species are not susceptible to *Phellinus* root rot. Thus there are increasing efforts to establish and manage hardwoods to sanitize areas where *Phellinus* reduces the viability of many softwood species. In some localities, serious *Phellinus* infections occur on as much as 10 percent of the land.¹⁷ Under current assumptions, if alder is successful in sanitizing the site, economic values are maximized by restoring the capability to grow softwoods.

Under certain conditions, hardwoods can help maintain or improve desirable soil characteristics by their input of nutrients and organic matter (Binkley and others 1994, Miller and Murray 1978, Minore and Zasada 1990). Thus, there is interest in culturing hardwoods in mixture with softwoods or in crop rotation to maintain productivity of soils. Most research on this has focused on red alder, which has the capability to fix atmospheric nitrogen in root nodules formed through symbiotic association with the actinomycete, *Frankia*. Other hardwood species, such as bigleaf maple, also may help the productivity of soils by providing litter that is relatively high in basic nutrients, such as calcium and magnesium (Minore and Zasada 1990).

¹⁷ Personal communication. 1993. Alan Kanaski. Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.

Young alder provide for rapid accumulation of organic matter and soil nitrogen after disturbances that produce new mineral substrates or degraded subsoils. The potential for alder to improve forest soils seems to be greatest where there are deficiencies in nitrogen or organic matter, though substantial addition of nitrogen still occurs on soils with adequate supplies of nitrogen (Binkley and others 1994, Binkley and Greene 1983; Heilman 1982). For this reason, various species of alder are often planted for reclamation projects after mining or road construction. Fast-growing hardwoods are also of interest for their ability to store carbon and offset carbon dioxide emissions from burning fossil fuels.

Negative effects also may result from nitrogen fixation by alder, although the processes involved are not fully understood and environmental conditions producing risks have not been defined. Under some conditions, soil acidity may increase and availability of nutrients other than nitrogen may decrease after decades of site occupancy by alder (Cole and others 1990, Van Miegroet and Cole 1988). There is also concern that heavy inputs of nitrate in soils can lead to excess concentrations of nitrate in streams or ground water (Binkley and others 1994). Concern over negative effects may be discouraging management of alder, particularly in consecutive rotations where it otherwise be considered.

Finally, in a forested landscape generally dominated by softwoods, hardwoods provide important biodiversity in wildlife habitat, visual aesthetics, and forest products. Shrub and herb vegetation beneath a hardwood canopy is often different from that beneath softwoods.¹⁸ A variety of animals seem to prefer or depend on hardwoods for food or habitat (Enns and others 1993, McComb 1994).

All the noneconomic benefits above are most easily accommodated or realized on public lands managed with multiple objectives, and policies and practices favoring the maintenance of some hardwood component are beginning to be implemented on those lands. With the exception of *Phellinus* sites, however, hardwoods maintained for noneconomic objectives on public lands may not produce sawtimber that is available for industrial use. Noneconomic values, such as biodiversity and wildlife habitat, are probably important factors contributing to the continued passive management that maintains substantial hardwood forests on private, nonindustrial owned lands. There is little incidence of active hardwood management arising from noneconomic benefits on private lands, which currently provide the bulk of the hardwood harvest.

Management Summary

The status of hardwoods in the forests of western Oregon and western Washington is changing. They are no longer considered exclusively as weed trees in management plans. Researchers and foresters have made substantial progress in developing techniques for intentional regeneration and management of red alder. The Western Hardwood Association and the Washington Hardwoods Commission are increasing public awareness of the importance and potential value of hardwood resources. Forest practices rules allow landowners to regenerate hardwoods.

¹⁸ Carlton, G.C.; Hibbs, D.E. Development of red alder understory communities in western Oregon. Manuscript in preparation.

Even though theoretical knowledge and attitudes pertaining to hardwoods may be improving, actual practices may change more slowly due to the risks involved with investing in forest management. After decades of learning and refinement, techniques for managing softwoods are successful and well demonstrated. Many landowners may feel that management of softwood species provides the greatest assurance of success, in both economic returns and compliance with forest practices rules.

Future hardwood resources could be ensured with silvicultural practices aimed at maintaining the hardwood component of the forest. Presently, however, less than 1 percent of the harvested timberland is targeted for active regeneration and management of hardwoods. Aside from the minority of owners with vested interests in the hardwood industry, most forest owners will not intensively manage for production of hardwood timber until stumpage prices become more competitive with softwood species.

The replenishment of hardwood timber resources, therefore, largely depends on continuing regeneration by passive or custodial management on nonindustrial forest ownerships. There will also be incidental hardwoods that survive vegetation management treatments on actively managed softwood plantations. Significant amounts of hardwoods will stem from these sources. The overall effect of modern forest management is to reduce the proportion of hardwood compared to previous practices, which provided for the currently high level of supply and use.

The Hardwood Industry

The hardwood industry is an important contributor to the economies of several rural communities in the Pacific Northwest. Growing domestic and international markets for a range of products manufactured from the region's hardwoods bode well for demand and product prices. Hardwood-related employment and income are respectable and growing, showing few of the signs of historical cyclical variation common in other wood processing sectors. In the following section, we further develop these ideas and conclude with a discussion of opportunities for expanding the industry through new uses and marketing.

The Pacific Northwest Hardwood Industry

The hardwood industry in Oregon and Washington is large and diversified; about 600 million board feet of hardwood sawtimber is harvested annually. The industry processes most of the hardwood timber at mills in the region, but some is exported as unprocessed logs, and a substantial volume is exported as chips. In 1990, the western hardwood industry processed 478 million board feet of hardwood logs and exported an additional 16 million board feet of unprocessed hardwood logs (table 21). Red alder is by far the most common western hardwood species harvested and processed.

Sawmills process the largest share of the 478 million board feet of hardwood timber processed in the Pacific Northwest (81 percent) with the balance split evenly between pulp mills and veneer and plywood plants. Lumber output in 1991 was estimated to be 352 million board feet.¹⁹ This is a dramatic increase from the 146 million and 229 million board feet produced in 1977 and 1985, respectively, and is an indication of past growth of the industry (Beachy and McMahon 1987, Cunningham and McMahon 1978).

¹⁹ Unpublished estimate. 1991. Gilbert P. Dempsey, Senior Economist, Northeastern Forest Experiment Station, Forestry Sciences Laboratory, Route 2, Box 562-B, Princeton, WV 24740.

Table 21—Primary hardwood sawtimber consumption in Washington and Oregon, 1990^a

Industry	Washington	Oregon	Pacific Northwest
<i>Thousand board, feet Scribner rule</i>			
Sawmills	279,345	107,824	387,169
Veneer mills	14,809	28,906	43,715
Pulp mills	10,024	37,140	47,164
Log export	15,342	917	16,259
Total	319,520	174,787	494,307

^a Washington data are from the Washington Department of Natural Resources. Oregon data are calculated from Howard (1991).

There are important differences in the industry in the two Northwest States (fig. 18). The hardwood industry in Washington is almost exclusively a sawmill industry, with an estimated 92 percent of the hardwood timber processed in the State processed by sawmills. Pulp mills and veneer mills are more important in Oregon, where sawmills process 62 percent of the hardwood timber.

National perspective—Researchers at the Northeastern Forest Experiment Station estimate that 11.2 billion board feet of hardwood lumber were produced in the United States in 1991 (see footnote 19). The 352 million board feet produced in Oregon and Washington represented slightly over 3 percent of the national total. Even though this is not a very large share of national hardwood lumber production, Pacific Northwest production is approaching the volume of hardwood produced in New England, which historically has been noted for hardwood lumber production. Pacific Northwest hardwood lumber production is particularly significant in export markets, and red alder is second only to red oak²⁰ in volume exported to Asian destinations.

Economic value of the resource—Traditionally, western hardwoods have been viewed as inferior species in their value to the landowner. In part, this perception has led to the regulatory discrimination against hardwoods and efforts by forest managers to eliminate hardwoods competing with regenerated softwoods. For public forest land managers, the result has been sale programs that treat the hardwood volume available in mixed stands as an inconsequential item of minimal value, sold on a per-acre basis or at nominal rates.

There is little information available on the stumpage value of western hardwoods sold by public agencies. For example, lump-sum sale procedures now being used by the Washington DNR provide estimates of the bid value of hardwood stumpage only for those few sales that are exclusively hardwood. Similarly, stumpage values for hardwoods included in National Forest timber sales seldom are available.

²⁰ A number of different eastern oak species (*Quercus* sp.) are included in red oak lumber statistics.

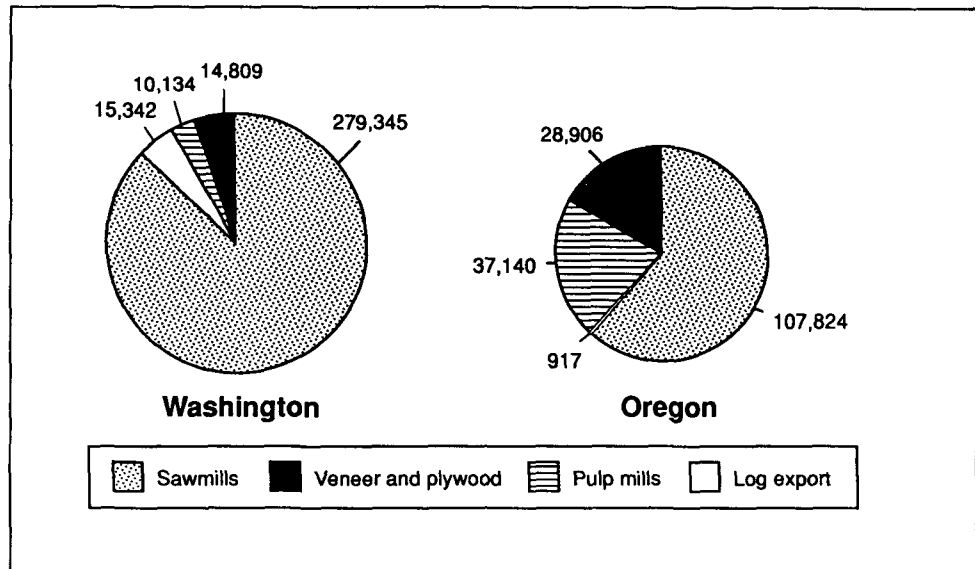


Figure 18—Primary hardwood log consumption by industry in Washington and Oregon, 1990, in thousands of board feet.

Hardwood timber sales recently sold by the Washington DNR suggest that the perception of hardwoods as having minimal value is no longer true. In the early 1990s, the Washington DNR made two sales that were entirely hardwood, one for \$218 per thousand board feet and the other for \$250 per thousand board feet. Although these stumpage values are significantly less than average values for softwoods in western Washington, and do not constitute a large enough base from which to make generalizations about the value of hardwoods, they indicate that western hardwoods can generate important stumpage values.

Log values—Although reliable information about the stumpage value for hardwoods has been scarce, useful information on delivered log prices has been collected in both Oregon and Washington (Sohnngen and Haynes, 1994) (fig. 19). The Washington DNR has collected log values for various species throughout the State. The average price for delivered red alder logs increased from \$162.93 per thousand board feet in the first quarter of 1985 to \$253.50 per thousand board feet in September 1992 in nominal dollars and from \$157.83 to \$215.20 in real dollars (1982 base). Although this hardwood log price information was determined to be both consistent and reliable in Washington, the DNR has ceased collecting log price information for any species, and the latest information available from public sources is prices in September 1992.

Similar information has been collected by the Oregon Department of Forestry. Prices for red alder logs delivered in Oregon have increased from \$200.00 per thousand board feet in the first quarter of 1985 to \$285.00 per thousand board feet in the fourth quarter of 1992 in nominal dollars and from \$193.75 to \$241.87 in real dollars (1982 base). For comparison, nominal fourth-quarter 1992 Douglas-fir log prices in the same Oregon reporting area ranged from \$475 per thousand board feet for no. 4 saw logs to \$640 per thousand board feet for no. 2 saw logs. Historically, prices for red alder logs in Oregon have been higher than prices in Washington. Two private log price reporting services currently publish monthly hardwood log price information for the Pacific Northwest (Arbor-Pacific and Jay Gruenfeld Associates; see "Literature Citations").

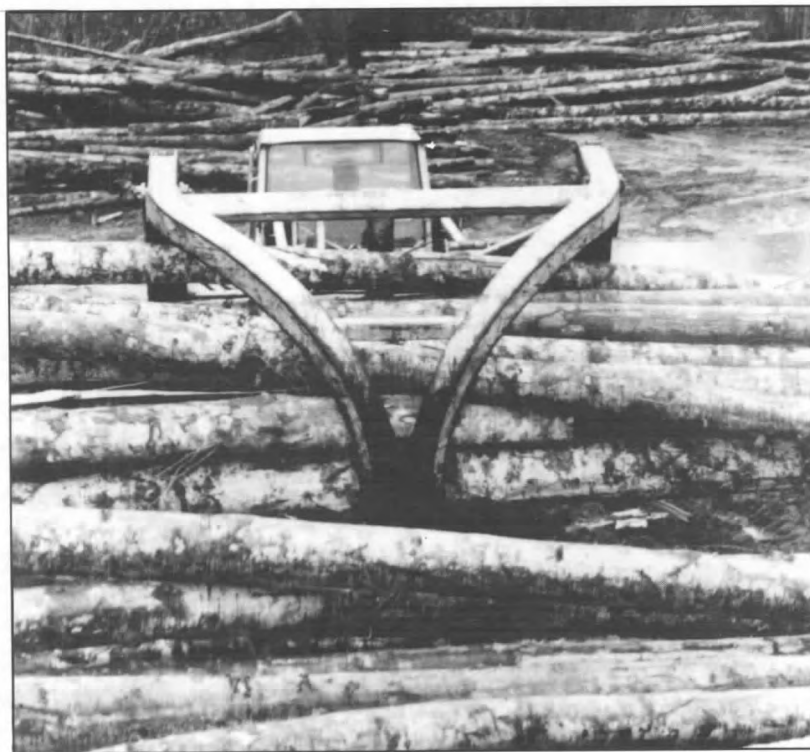


Figure 19—The value of red alder logs increased steadily during the 1980s.

Estimated costs of harvest and transportation of hardwood logs range from \$80 to \$140 per thousand board feet for western Oregon and Washington.²¹ Subtracting these estimates of logging costs from 1992 log prices implies a maximum average stumpage value in 1992 of about \$170 per thousand board feet for red alder in Washington and \$205 per thousand board feet in Oregon.

Lumber values—Plank and others (1990) clearly demonstrate the potential product yield and value of red alder. Log values based on lumber recovery and 1991 prices were as high as \$398.70 per thousand board feet, log scale, for logs 14 inches in diameter at the small end. Lower values are indicated for both smaller and very large logs. When chips produced as a byproduct are considered, value per hundred cubic feet of logs for smaller red alder logs compares favorably with young-growth Douglas-fir. Red alder log values exceed those of young-growth Douglas-fir for log diameters greater than 14 inches at the small end. Recent changes in lumber prices may have increased the price of Douglas-fir relative to red alder somewhat and made small changes in the relative log values.

This research demonstrates the dramatic increase in yields of high-valued, select grade and no. 1 shop grade red alder lumber as log sizes increase. Because the production of the higher valued grades provides the comparative economic advantage for red alder relative to Douglas-fir, management and harvest decisions for red alder

²¹ Personal communication. 1993. Wayne Sedgwick, Forestry Technician, USDA Forest Service, Pacific Northwest Region, Division of Timber Management, P.O. Box 3623, Portland OR 97208-3623.

Markets for Western Hardwood Products

should account for the premiums associated with larger sized logs. The management implications are straightforward: harvesting red alder stands at too young an age imposes a significant economic penalty relative to the returns that could be obtained if the same stands were harvested at older ages.

Prices for higher grades of red alder (select and better) are increasing steadily in real terms (fig. 20). Real prices for pallet stock, for which there are many substitute species, have been relatively constant for the past few years. This is further evidence of the importance of wood quality considerations in the management of hardwoods.

Western hardwoods in general and red alder specifically are widely used by various domestic and overseas industries. The harvest and use of western hardwoods is becoming relatively more important as the softwood timber sales and volume under contract decrease. Prices and production increases suggest that the demand for western hardwoods continues to increase and product acceptance, particularly for high-quality red alder, is not a problem.

Domestic markets—Sixty percent of the red alder lumber and pallet stock produced in Washington in 1990 was used in cabinets and furniture (Ekström 1992). Both of these secondary wood products industries have high value added by manufacture (fig. 21). Pallets account for 33 percent of the domestic consumption of sawn red alder lumber from Washington. The same study determined that 12 percent of the domestic shipments of alder lumber are to Washington destinations, and an additional 20 percent are to Oregon destinations. California is by far the major domestic destination for hardwood lumber originating in Washington, receiving 50 percent of total domestic shipments. Earlier information on hardwood lumber use from Oregon suggests a greater percentage of the hardwood sawn in Oregon is used in furniture and cabinets and a smaller percentage in pallets.

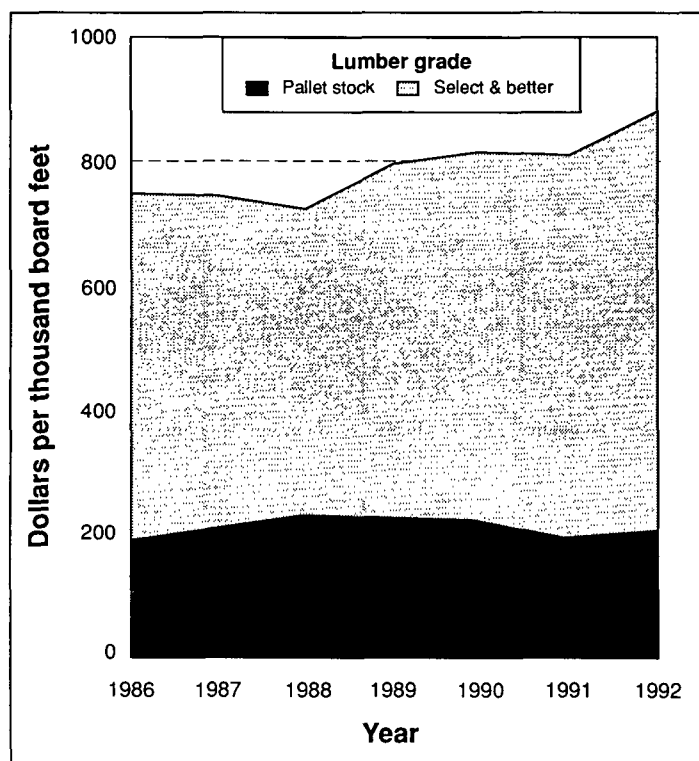


Figure 20—Trends in real red alder lumber prices, 1986 through 1992 (1982 dollars).

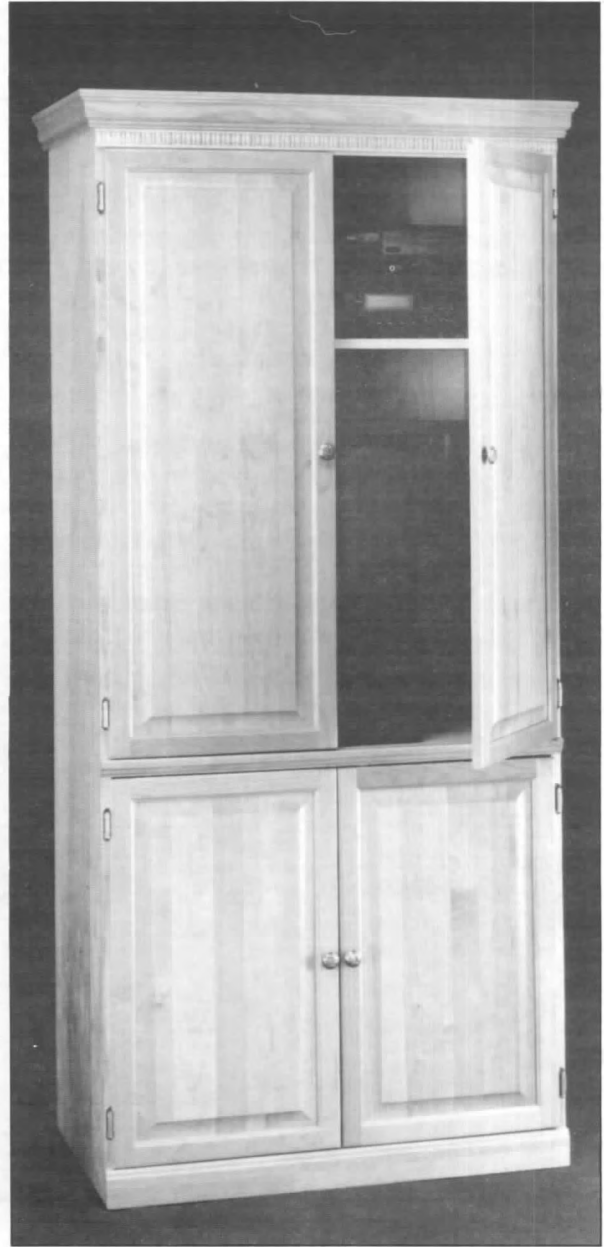


Figure 21—The primary use of red alder is in high value-added products such as furniture and cabinets (photos courtesy of Whittier Wood Products Inc., Eugene OR).

Pulp and paper are also important end products of Pacific Northwest hardwoods. The pulp industry in Washington in 1988 consumed 8.6 million board feet of hardwood roundwood and 196 thousand tons of hardwood chips from residue (Larsen 1992). The American Pulpwood Association estimates that, in 1990, 5 percent of the wood consumed by Washington pulp mills was hardwood as was 13.3 percent of the wood consumed by Oregon pulp mills.²² The proportion and quantity of hardwood consumed by pulp mills in the Pacific Northwest has been relatively stable in recent years.

Other domestic markets include the veneer and plywood industry (which uses red alder in various applications), moulding manufacturing, a wide variety of secondary wood products, and furniture and cabinets. As is true for hardwoods in general, the use of western hardwoods in furniture and specialty products means that western hardwood consumption depends less on new home construction than is the case for softwood lumber.

Exports of western hardwoods—Exports of western hardwood products, particularly red alder, are an important part of the market for western hardwoods. Data on log and lumber exports by species have been collected by the U.S. Department of Commerce, but there is evidence that the information on the volume of exports has been unreliable (Luppold and Thomas 1991a, 1991b). The Northeastern Forest Experiment Station at Princeton, West Virginia, has developed new estimates on the volume of hardwood logs, chips, and lumber exported to Asian and European destinations from the United States (tables 22 and 23). Red alder is the only western hardwood for which separate information for log and lumber exports is available.

The export of unprocessed red alder logs is relatively insignificant. In 1990, the 17 million board feet of logs exported from the West Coast represented only 3 percent of the total harvest of hardwoods in the Pacific Northwest, and the volume of logs exported has decreased since 1990 (table 22). Japan and Korea have been the most important customers for unprocessed red alder logs. Exports of red alder logs to Europe have been negligible. Although the volume of red alder log exports has not been very significant in regional terms, the 1990 volume represented 25 percent of total U.S. hardwood log exports to the Pacific Rim.

Hardwood chips also are a significant product exported from the Pacific Northwest (table 22). Until 1989, most of the hardwood chips exported from the United States were western hardwood chips leaving from the West Coast for Japan; an expansion of chip exports from the South has occurred since 1989. The quantity of western hardwood chips exported has increased in recent years, and current chip quantities are about twice those exported in 1988. Not included in these estimates are pulp and paper products manufactured by domestic mills from western hardwoods and then exported.

²² Unpublished estimate. 1993 American Pulpwood Association, 2300 Oakmont Way, Eugene, OR 97401.

Table 22—Western hardwood log and chip exports

Product and destination	Year					
	1985	1988	1989	1990	1991	1992
<i>Thousand board feet^a</i>						
Red alder logs: ^b						
Asia—						
Japan	117	14,307	9,860	7,578	7,765	2,310
Taiwan	156	1,489	2,814	1,935	363	1,171
Korea	8	7,012	3,893	7,565	5,833	2,702
Other Asia	278					586
Total, Asia	559	22,868	16,566	17,078	13,901	6,769
Europe			18		5	39
Total logs	559	22,868	16,584	17,078	13,906	6,808
<i>Thousand green metric tons</i>						
Chips ^c	—	722	974	1,185	1,413	1,333

^a Converted to board feet from cubic meters.

^b Data for 1985-89 are from Luppold and Thomas (1991b). 1990-92 data are from the Northeastern Forest Experiment Station, unpublished tables on file at Princeton, West Virginia.

Table 23—Western hardwood lumber exports^a

Destination	Year					
	1985	1988	1989	1990	1991	1992
<i>Thousand board feet</i>						
Asia:						
Japan	6,994	14,674	44,509	30,302	27,299	26,240
Taiwan	95	6,560	4,492	5,747	7,164	7,846
Korea	—	954	1,792	2,586	1,386	1,083
Other Asia	16	114	355	488	606	95
Total, Asia	7,104	22,302	51,149	39,123	36,455	35,264
Europe:						
Germany	—	1,683	1,985	1,152	4,107	13,431
Italy	8	4,141	5,570	7,379	8,773	9,550
Other Europe	997	1,292	2,409	3,133	2,752	6,397
Total, Europe	1,005	7,116	9,964	11,664	15,631	29,377
Total all hardwood lumber	8,109	29,418	61,113	50,787	52,086	64,641

^a Data for 1985-89 are from Luppold and Thomas (1991a). 1990-92 data are from the Northeastern Forest Experiment Station, unpublished tables on file at Princeton, West Virginia. Totals may be off because of rounding.

The volume of western hardwood lumber exported is higher than the volume of western hardwood logs. In 1992, 65 million board feet of red alder lumber was exported to Asian and European destinations, with roughly equal volumes going to the two markets (table 22). The relative proportion of red alder lumber exports going to European destinations has increased in recent years, with Germany and Italy being the most important destinations. In 1990, red alder lumber exports accounted for 10 percent by volume of U.S. hardwood lumber exports to Europe and Asia and 15 percent of the total volume of hardwood lumber produced in the Pacific Northwest. In addition to red alder lumber exports, remanufactured products such as panels also are exported in quantity.

Exports of hardwood logs, lumber, and chips were worth an estimated \$105 million in 1990 (Ekström 1992, Warren 1993). Chip exports accounted for 48 percent of the total value of hardwood exports from the Pacific Northwest, and lumber exports made up an additional 45 percent of the total export value. Western hardwoods, particularly red alder, were widely accepted and their acceptance is growing in world markets.

Evaluation of the European alder market—A comprehensive review of the European market for red alder was completed in 1991.²³ This study evaluated the market for red alder in Germany and Italy, the two major European consumers of red alder, and an examination of the potential in Poland, a nation that has not imported red alder in the past. The authors concluded that potential for the development of trade in red alder between Washington and Poland may exist. The study also concluded that Germany is interested in buying higher value-added products, such as furniture blanks and edge-glued panels manufactured from red alder. Both findings indicate that the expansion of international markets for red alder, particularly value-added alder products, may continue into the future.

Market development—The current popularity of red alder in foreign and domestic markets does not indicate that market-development efforts are unnecessary. The foreign market for red alder lumber and remanufactured products is concentrated in Germany, Italy, and Japan, with furniture as the significant end use. Although this means demand for red alder is partially insulated from domestic housing cycles, tastes in furniture change, and demand for specific species is not static. The comparative advantage of red alder is further reinforced because it easily takes a stain and can be used in both lighter and darker lines of furniture.

Efforts in foreign and domestic market development may pay off in several ways. Better markets for products made from lower grade lumber would help lumber manufacturers who, from the same log, produce both low- and high-grade lumber. New markets for species currently underused or not used at all offer an avenue for industry expansion. Finally, the current popularity of red alder offers an opportunity to devote resources to market development activities without the urgency, motivated by a concern over industry survival, to obtain immediate results.

²³ Jensen International. 1991. European alder market study, Jensen International. Unpublished report. On file with: Washington Department of Trade and Economic Development, Forest Products Program, 919 Lakeridge Way SW, Olympia, WA 98504-2516.

Employment and Income

Growing, harvesting, and processing hardwoods in western Oregon and western Washington provide significant employment and income both locally and regionally. Although the portion of the forest products industry that depends on hardwoods has been relatively small compared to the very large Pacific Northwest softwood industry, the softwood industry is declining in relative importance because of the reductions in public timber harvest. In addition, the hardwood industry has been free from the cyclical variations that have characterized the softwood industry.

Separate employment and income statistics for the hardwood industry in the Pacific Northwest are available for two of the largest direct processing sectors—hardwood sawmills and hardwood veneer and plywood mills. The hardwood veneer and plywood industry uses significant amounts of imported and Eastern United States hardwoods, so a portion of the sector's employment and income does not depend on the hardwood resources of the Pacific Northwest.

Employment and income information for all other sectors involved in growing, harvesting, and processing wood products are combined with information for the softwood industry. Reasonable estimates of the employment and income in these other sectors are possible, however, by using the published employment and income data for the various sectors of the forest products industry and information on the relative volume contribution of hardwoods to the total volume of timber harvested for industrial use. For example, the income and employment in pulp and paper mills dependent on hardwoods is calculated by multiplying the total employment in the mills depending on raw wood by the percentage of the wood that is hardwood.

Direct employment in the hardwood industry—Table 24 shows the estimated and reported employment associated with hardwoods in western Oregon and western Washington for 1990 and 1991. The data represent direct employment in growing, manufacturing, and remanufacturing hardwoods and do not include indirect or induced (multiplier) effects. Reported data were provided by the Washington Department of Employment Security and the Employment Division of the Oregon Department of Human Resources for wage and salary employment; these data exclude those involved in proprietorships. Employment information used to develop estimates for those sectors not reported separately for the hardwood industry is from the same sources.

Employment and income information for the secondary industries that depend on hardwoods in the two States is based on an informal survey.²⁴ Included were wood furniture, upholstered furniture, cabinet, and pallet manufacturers and cut stock plants. Estimates also were made of employment nationwide in these industries that depends on western hardwood lumber.

Employment in the Pacific Northwest hardwood industry was 7,294 in 1990 and 7,510 in 1991. This year-to-year stability in the hardwood industry is a marked contrast to the variation in employment in the region's wood products industry as a whole, which in 1991 fell by just over 11,000 jobs from the 1990 total of 103,530 for all of standard industrial classification (SIC) sector 24 (lumber and wood products) in Oregon and Washington.

²⁴ Unpublished survey. 1993. Richard Behm, President, R.D Behm Company, P.O. Box 1175, Vancouver, WA 98660.

Table 24—Estimated average annual employment from the Pacific Northwest hardwood resource

Industrial sector	1990		1991	
	Oregon	Washington	Oregon	Washington
	<i>Workers</i>			
Forestry	197	184	234	196
Lumber and wood products:				
Logging	320	674	350	692
Sawmills ^a	790	845	741	847
Veneer and plywood	199	177	241	179
Total, lumber	1,309	1,696	1,327	1,718
Secondary ^b	1,677	725	1,677	725
Pulp and paper	863	643	875	758
Total, all sectors	4,046	3,248	4,113	3,397

^a Employment reported by the Oregon Department of Human Resources (Lux and others 1992a, 1992b) and the Washington Department of Employment Security (1992a, 1992b). Other employment in this table is calculated from data reported by these agencies except as otherwise noted.

^b Based on survey by Richard Behm, P.O. Box 1175, Vancouver, WA 98660. Includes furniture, pallet manufacturing, and cut stock.

Hardwood manufacturing generates more jobs in Oregon than in Washington in spite of the volume of hardwoods harvested in Washington being twice as great as that harvested in Oregon. This is because of the greater dependence of Oregon pulp mills on hardwoods as a raw material (using chips that otherwise would be exported), the greater importance of the hardwood veneer and plywood industry in Oregon, and a larger secondary manufacturing sector in Oregon.

Direct income payments—In 1991 the growing, processing, and secondary manufacturing of the hardwood resource generated \$209 million in wages and salaries (table 25), an 8-percent increase from 1990. These estimates included only the income generated in those industries that grow and process western hardwoods and did not include other indirect impacts and induced impacts from the responding of direct income by households in trade and service sectors (the multiplier effect).

The multiplier effect—Employment and income generated by those directly employed in the hardwood industry tells only part of the story of how the industry contributes to the Pacific Northwest economy. Indirect employment and income effects also occur through the purchases by the hardwood industry of nontimber goods and services; induced employment and income effects occur when workers who either directly or indirectly receive their wages and salaries from the hardwood industry spend those incomes. Although there are various estimates of the magnitude of these or broader measures of impact (the multiplier effect), a 1992 analysis in Washington estimated

Table 25—Estimated income impact from the Pacific Northwest hardwood resource

Industrial sector	1990		1991	
	Oregon	Washington	Oregon	Washington
	<i>Million dollars</i>			
Forestry	3.414	2.835	4.609	3.282
Lumber and wood products:				
Logging	7.971	17.516	8.819	18.745
Sawmills ^a	17.131	22.717	17.193	23.751
Veneer and plywood	4.608	3.341	6.092	3.326
Total, lumber	29.710	43.574	32.104	45.822
Secondary ^b	34.362	13.707	35.900	14.471
Pulp and paper	38.224	27.665	39.619	33.649
Total, all sectors	105.710	87.781	112.232	97.224

^a Income reported by the Oregon Department of Human Resources (Lux and others 1992a, 1992b) and the Washington Department of Employment Security (1992a, 1992b). All other income in this table is calculated from data reported by these agencies, except as otherwise noted.

^b Calculated from employment estimate by Richard Behm, P.O. Box 1175, Vancouver, WA 98660, and reported income per job in the furniture sector.

that for every direct job in the timber industry an additional 1.54 jobs were created throughout the State in other sectors such as trade and services.²⁵ This means that the total current impact of the hardwood resource on the economy of the Pacific Northwest is 19,075 jobs (7,510 multiplied by 2.54 [the original job plus the 1.54 additional jobs]).

The income multiplier is less than the employment multiplier, because many of the trade and service jobs dependent on the jobs in the forest products industry have lower wages than the forest industry jobs. In 1992 the income multiplier was estimated to be \$0.92 of income in other sectors for every dollar of income in the forest products industry. This means that the hardwood resource generated \$402 million of wages and salaries in the Pacific Northwest economy in 1991 (\$209.46 million multiplied by 1.92).

The contribution of industries that remanufacture and use western hardwoods, the secondary industries, is also significant. The 1993 directory of the Forest Products Industry (Malpas 1992) identified 214 plants throughout the Nation that use alder. Included in this total are 54 plants in the Eastern and Southern United States where

²⁵ Governor's Timber Team. 1992. Understanding log export restrictions. 7 p. Unpublished report. On file with: Governor's Timber Team, P.O. Box 43113, Olympia, WA 98504-3113.

Opportunities for Species Other Than Red Alder

alder must compete with local hardwoods. Many of the remaining plants are in California, and only 59 (20 of which are sawmills) are in Oregon and Washington. Secondary wood processing generally locates near its final markets; this is particularly true of the kitchen cabinet manufacturing industry, which is concentrated close to its final markets rather than its sources of raw material.

Nationwide, between 23,000 and 24,000 people are directly employed in using red alder to manufacture pallets, kitchen cabinets, wood furniture, and upholstered furniture (table 26). These estimates were derived from recent estimates of the volume of red alder shipped to various pallet, furniture, and kitchen cabinet industries throughout the United States (including the Pacific Northwest). The estimates are for production workers only and do not include sales, shipping, and overhead employees. Clearly, a large number of jobs in secondary manufacturing industries throughout the United States are supported by red alder from the Pacific Northwest. This estimate of nationwide employment is not a measure of regional economic contributions, but it does indicate the magnitude and wide range of value-added jobs associated with a given quantity of input lumber in the different industries.

While the Pacific Northwest is approaching full use or overuse of the alder resource, there may be potential for economic development based on increased use of other hardwood species.

The key issue to understanding the potential for industries developing around hardwood species other than red alder is to anticipate the dynamics of the resource and then plan for sustainable rates of use of available raw material. There is currently little economic incentive to manage for minor hardwood species, and silvicultural methods are not well understood. With any substantial increase in use, local supplies may be depleted unless steps are taken to ensure renewal of the resource.

Table 26—Red alder shipments to all U.S. destinations and nationwide employment, 1992^a

Industry	Red alder shipments	Employment
	<i>Million board feet</i>	<i>Number of jobs</i>
Pallets	132	242
Kitchen cabinets	40	5,313
Wood furniture	95	12,082
Upholstered furniture	60	5,905
Total	327	23,542

^a From unpublished tables, R.D. Behm Company, P.O. Box 1175, Vancouver, WA 98660.

Substantial volumes of bigleaf maple, the most abundant hardwood after alder, are present throughout western Oregon and Washington. The estimated harvest of maple in Oregon is only about 25 percent of growth, and in Washington is about 40 percent of growth. Compared to red alder, a relatively high percentage of the existing volume of maple is in large diameter classes, which produce the most valuable wood (45 percent of the growing stock volume is in trees greater than 17 inches in diameter).

The current demand for alder lumber was stimulated by intensive marketing campaigns. A similar effort to market products from Western U.S. maple and increase secondary manufacturing capacity could have substantial local impact. Because maples are common in other regions, there probably is less potential for the dramatic increases in demand developed for unique alder lumber. Straight-grained bigleaf maple is between Eastern U.S. hard and soft maples in wood quality. However, established uses for maple from the west, particularly highly figured wood, have high value-added potential (musical instruments, furniture). Most hardwood mills already run some proportion of their capacity to produce maple lumber of good quality. This proportion might easily be increased with greater demand for maple products.

Because the resource is widespread and trees reproduce vigorously in even- or uneven-aged stands, there is certainly potential to maintain maple timber resources. Bigleaf maple trees have a reputation for producing poor quality stems, resulting in inefficient production and low value per acre. This is particularly true for ubiquitous stump sprouts, which can occupy large areas with numerous stems of small size and poor form. Trees grown from seedlings can mature as rapidly as red alder and develop long, straight trunks. No efforts have been made to manage dense sprout clumps to improve quality; experience with Northeastern U.S. hardwood species suggests that good growth and quality of individual stems can be achieved by managing maple stump sprouts (Stroempl 1983).

Other minor hardwood species in the region occur in concentrated local abundance. Oregon white oak is common in the Willamette Valley. Madrone and tanoak are equally abundant in southwestern Oregon and northern California. Southwestern Oregon is at the northern edge of a large area of mixed hardwood forest types common in California. Past efforts to use various hardwood species in California have not been successful, and an examination of the reasons why so many attempts have failed may be useful in preventing similar problems in the Pacific Northwest (Huber and McDonald 1992). Thus, there is a substantial resource base with potential to support new or expanded wood products industries if markets are developed for these unique species, and there are signs that these markets are developing.

Oregon white oak has a unique potential as the basis for manufacture of tight cooperage. Recent tests indicate that barrels manufactured from Oregon white oak are suitable for aging wine and may provide a substitute for expensive barrels from France.²⁶ Manufacturing of aging barrels is labor intensive and requires very high-quality wood. There is a large potential market in the Pacific Northwest and an even larger potential in the wine-producing regions of California.

²⁶ Personal communication. 1993. V.L. Kreimeyer and A.P. DiBenedetto. Oregon Oak Barrels, 3312 SW Water, Portland, OR 97201.

Conclusions and Recommendations

A recent report provides a comprehensive summary on the status of the Oregon white oak in the Willamette Valley.²⁷ The report indicates that the Oregon white oak resource in the Willamette Valley is found mainly on farmer and other private ownerships. It also provides a review of some of the wildlife implications of oak woodlands as well as the current status of management.

Madrone has unique and attractive qualities for flooring, paneling, and some specialty products. There seem to be some active efforts to increase markets and manufacturing capacity for select lumber and sliced veneer from this species. There is, however, relatively little processing of madrone within the southwestern Oregon area. Demand and prices for larger madrone logs have increased substantially, though many of these logs are exported from the southwestern Oregon timbershed.

Tanoak has excellent qualities for flooring and thresholds. There have been periodic efforts to develop markets and manufacturing capacity for tanoak flooring. The most recent efforts in northern California may result in new industries, which could be strengthened by similar efforts in southwest Oregon.²⁸

California-laurel (Oregon-myrtle) already provides for a successful and well-known specialty forest products industry. Manufacturers on the southern Oregon coast already may have sufficient capacity to fully use this species. Indeed, representatives of the myrtlewood industry believe that the available supply of Oregon-myrtle is near exhaustion.

Adequate availability and supply of raw material are as important as product marketing for the industries based on hardwood species other than red alder. Entrepreneurs involved in previous efforts to establish these industries have identified lack of consistent supplies as a major factor limiting their success with minor hardwood species. Several factors come into play, as discussed in the section on availability. A key factor affecting the availability of tanoak and madrone is that the preponderance of the volume for the two species occurs on public ownerships.

Today's hardwood inventory of 11.9 billion cubic feet is a historical legacy of economic and biological importance for the Pacific Northwest. This hardwood inventory is higher than at any time in the 20th century, but rates of increase are slowing, and subregional supply shortages have developed, especially for red alder. In western Washington, current removal rates for red alder growing stock exceed additions to available inventory. A decline in the acreage and volume of hardwoods in young, poletimber-sized stands implies reduced hardwood timber availability in the long term. A similar situation appears to be developing in western Oregon, though data are lacking. Most hardwood inventory in existing sawtimber stands is available only in the short term, because the principle species (red alder) is short lived.

²⁷ Guntow-Farrior, Daniel L.; Guntow-Farrior, Catherine M. 1992. Managing Oregon white oak communities for wildlife in Oregon's Willamette Valley: a problem analysis. 75 p. Unpublished report. On file with: Oregon Department of Fish and Wildlife, Northwest Regional Office, 7118 NE Vandenberg Ave., Corvallis, OR 97330-9446.

²⁸ Sullivan, W.J.; Nunenkamp, D.C., eds. 1987. Economic potential of tanoak timber in the north coast region of California. Unpublished report. On file with: Humboldt State College, Arcata, CA 95521.

Estimates of inventory for local areas lack precision, and reported harvest volumes for hardwoods may underestimate actual use. In general, hardwood volumes have not been consistently inventoried across all forest land ownerships, probably a result of the historically low status of hardwoods relative to softwoods. Consumption of hardwoods for pulpwood and firewood may be underestimated because logs are not categorized by species or are not reported at all.

Some 70 percent of the hardwood inventory in the Pacific Northwest is located on private land. The short-term contribution of that inventory to the regional economy will be limited only by the regulation of forest practices and the willingness of landowners to view hardwood supply as a profitable forest harvesting opportunity. The remaining 32 percent of the hardwood sawtimber inventory is on public land, but only 10 percent of the hardwood harvest has come from public forests; the short-term outlook for public hardwood supply mirrors the difficulties surrounding softwood supply and the fact that hardwoods have not been recognized as a valuable timber resource by most public land management agencies. The longer term hardwood supply picture is considerably more complicated than that for the short term because forest management will determine where and how much hardwood timber will be permitted to grow in the region's forests.

The short-term supply of hardwoods should be adequate in many localities. Most hardwoods occur in mixed softwood-hardwood stands, and occurrence of hardwoods in conjunction with softwoods appears to have no differential effect on the likelihood that a stand will be harvested. Additionally, substantial hardwood volumes occur in stands on nonindustrial lands, and the supply prospects from this ownership appear promising—the likelihood that the mature and maturing stands on this ownership will be harvested seems to be comparable to the likelihood that such stands would be harvested if they were in industrial ownership.

Regulation of forest harvesting is an important institutional determinant of available supplies of hardwood. Increased protection of riparian areas and wetlands reduces short-term hardwood supply simply because hardwoods are commonly found in such areas. The restrictions on use of equipment and on species, size, and number of trees that must remain after harvesting reduces the available volume of hardwoods in riparian and wetland areas. The extent of this reduction is not known because inventories have not been designed specifically to evaluate the riparian and wetland timber resources.

Long-term hardwood supply is uncertain, and concerns are well founded as indicated by the nonsustainable rate of removal for alder in Washington. Returns to landowners are still not high enough, in general, to stimulate management of alder in new or existing stands in most cases, and incentives for regenerating and maintaining other hardwood species are unfavorable compared to softwoods. Modern forest practices and regulations generally aim to ensure regeneration of conifers on sites previously supporting conifers. The success of these practices is becoming apparent, and the high hardwood volumes that are a legacy of past practices are unlikely to be sustained by current practices, particularly on industrial forest lands.

Other private forest lands will be increasingly important in determining the available supply of hardwoods. The large component of hardwoods in existing stands, along with relatively high rates of hardwood regeneration, ensures the continued abundance of hardwoods on other private lands. But as short-term supplies from other private lands have increased, the preponderance of hardwoods in zones influenced by non-forest use, particularly areas surrounding the major metropolitan centers in the Pacific Northwest, produces uncertainty about continued availability of supplies from many other private acres.

Prospects for long-run hardwood supply clearly could be improved with a better understanding of hardwood management and silviculture. Hardwood stumpage and log prices have shown dramatic increases in the recent past and are providing returns that will allow serious consideration for managing hardwoods on appropriate sites in the Pacific Northwest. Substantial research and development in hardwood silviculture is beginning to demonstrate successful techniques, which make the option to grow hardwoods more available and attractive to foresters and forest landowners. Management of many hardwood species is also favored by beneficial attributes of hardwood trees or forests including rapid growth, improved soil nutrition and organic matter, immunity to softwood root rot, wildlife habitat, and biological diversity. There is a growing awareness that hardwoods play a distinct and beneficial role in Northwestern forests.

The demand for products made from hardwoods and the contributions of the hardwood industry to the rural Northwestern economies are successes. Red alder has widespread domestic and foreign market acceptance, and potential exists to increase international markets as indicated by the growing market for alder products in Germany. The large quantities of pallets, furniture, and cabinets manufactured from red alder in other States indicates the potential for increased value-added manufacturing in western Oregon and Washington. Other Northwestern hardwoods, with the exception of myrtlewood, are not nearly so completely utilized as red alder, so the potential exists to expand their applications and markets. In the face of favorable markets, the hardwood industry, currently employing some 7,000 workers in Oregon and Washington is limited only by its supply of raw material. Supply is the key problem determining the short- and long-term health of the hardwood industry and its continued contribution to the Pacific Northwest economy.

These policy recommendations can help ensure that the western hardwood resource plays an appropriate role in the forests and economic development of the Pacific Northwest:

- State and Federal programs that promote forest management on private lands need to emphasize hardwood management, where appropriate. Research and development programs targeting hardwood biology and management need to be maintained and enhanced.
- Strategies for increasing use of hardwood species to encourage rural economic development must be accompanied by workable plans for hardwood forest management.
- Improved methods of measurement and accounting for both the private and public hardwood resource are needed for forest inventory and harvest reporting. Better information is needed to account for the dynamics of the resource and to estimate sustainable levels of hardwood supply. There is an urgent need for more useful information about Federal lands.

- Public hardwood resources should be specifically recognized in planning and harvest activities. Public timber sale procedures need to be designed to ensure that hardwood values are reflected in those programs.
- Research is needed to determine what level of utilization and management of hardwoods is possible while achieving the intent of forest practice regulations. Inventories and environmental monitoring should be designed to measure hardwood resources in the region's riparian zones and allow for evaluation of the impact of changing regulations. Future changes in forest practice regulations might well benefit from a better recognition of their impact on the hardwood resource.
- Policy makers and resource managers need to learn more about the benefits and the problems associated with hardwoods to develop a realistic vision of the place of hardwoods in Northwestern forestry.
- The expansion of secondary and value-added manufacturing capacity should be a primary part of the rural economic development strategy. Value-added manufacturing of western hardwoods that is now completed at foreign or domestic locations outside the Pacific Northwest should be targeted for rural Northwest communities.

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Appendix

Table 27—Washington hardwood sawtimber inventory on other public and private timberlands by county, January 1, 1991

County	Ownership		Total ^a	Volume per acre of timberland
	Other public	Private		
	----- Million board feet -----			Thousand board feet
Clallam	216±66	531±183	746±194	1.526
Clark	214±126	272±83	485±151	2.437
Cowlitz	175±79	1,083±158	1,257±176	2.152
Grays Harbor	411±115	1,758±249	2,169±259	2.293
Island and San Juan	50±38	299±91	349±98	2.458
Jefferson	219±99	446±111	665±148	1.755
King	357±160	1,554±224	1,911±275	3.382
Kitsap	80±34	453±152	534±156	3.380
Lewis	395±120	1,703±201	2,098±233	2.489
Mason	4±4	701±152	705±152	1.900
Pacific	310±109	812±152	1,122±186	2.179
Pierce	136±70	1,076±207	1,212±218	2.536
Skagit	552±175	1,080±190	1,632±257	3.961
Skamania	40±13	75±31	115±34	.572
Snohomish	642±211	1,570±215	2,212±299	5.171
Thurston	216±107	775±138	990±174	3.498
Wahkiakum	190±70	113±38	303±79	2.349
Whatcom	307±70	1,299±199	1,606±209	5.993

^a Totals may be off due to rounding.

Table 28—Washington hardwood growing stock inventory on other public and private timberlands by county, January 1, 1991

County	Ownership		Total ^a
	Other public	Private	
	<i>Million cubic feet</i>		
Clallam	102±30	182±47	284±55
Clark	53±24	81±19	134±31
Cowlitz	49±20	345±47	394±51
Grays Harbor	123±34	550±67	673±70
Island and San Juan	11±8	86±21	97±22
Jefferson	57±21	122±27	179±34
King	101±36	419±55	519±65
Kitsap	22±9	127±34	150±35
Lewis	120±33	563±54	683±63
Mason	2±2	205±37	208±37
Pacific	64±23	209±37	273±43
Pierce	42±18	291±48	333±51
Skagit	138±39	313±45	451±59
Skamania	26±6	36±15	62±16
Snohomish	148±48	433±49	581±68
Thurston	65±28	261±42	326±51
Wahkiakum	41±14	35±10	76±17
Whatcomb	90±18	373±46	463±49

^a Totals may be off due to rounding.

Table 29—Oregon hardwood sawtimber inventory on non-Federal timberlands by county^a

County	Ownership		Total ^a	Volume per acre of timberland
	Other public	Private		
	----- Million board feet -----			Thousand board feet
Benton	70±11	400±112	470±115	2.513
Clackamas	48±48	455±84	503±97	1.644
Clatsop and Columbia	376±176	1,560±251	1,936±306	2.630
Coos and Curry	299±284	1977±276	2,276±396	
Douglas	241±167	498±81	739±185	.676
Hood River	—	11±11	11±11	.153
Jackson	1±1	200±37	200±37	.430
Josephine	29±22	165±51	194±56	1.078
Lane	28±17	587±123	615±124	.749
Lincoln	119±60	940±287	1,059±293	3.087
Linn	165±165	343±96	508±190	1.065
Marion	76±54	319±187	395±194	2.669
Multnomah and Washington	77±58	498±147	575±157	2.076
Polk and Yamhill	—	924±303	927±303	2.452
Tillamook	460±136	168±61	628±149	1.396

^a Estimates for Benton, Lane, Lincoln, and Linn Counties are as of January 1, 1987. Estimates for all other counties are as of January 1, 1986.

^b Totals may be off due to rounding.

Table 30—Oregon hardwood growing stock inventory on non-Federal timberlands by county^a

County	Ownership		Total ^a
	Other public	Private	
<i>Million cubic feet</i>			
Benton	17±4	222±60	239±60
Clackamas	27±27	177±35	204±44
Clatsop and Columbia	123±61	505±64	628±88
Coos and Curry	67±63	815±92	882±110
Douglas	58±32	32±141	379±52
Hood River	—	18±12	18±12
Jackson	1±1	132±22	133±22
Josephine	15±9	124±38	139±39
Lane	9±2	257±48	266±48
Lincoln	29±14	335±75	364±77
Linn	46±46	124±28	170±54
Marion	22±16	126±36	148±39
Multnomah and Washington	32±14	183±44	215±46
Polk and Yamhill	—	406±99	406±99
Tillamook	195±42	69±20	264±47

^a Estimates for Benton, Lane, Lincoln, and Linn Counties are as of January 1, 1987. Estimates for all other counties are as of January 1, 1986.

^b Totals may be off due to rounding.

Table 31—Washington hardwood harvest by county for 1990 and 1991^a

County	1991 hardwood harvest	1990 hardwood harvest
<i>Thousand board feet, Scribner rule</i>		
Clallam	29,369	35,287
Clark	8,402	9,149
Cowlitz	58,418	45,958
Grays Harbor	39,804	49,585
Island	1,591	673
Jefferson	12,981	6,413
King	17,714	15,821
Kitsap	2,151	3,080
Lewis	62,329	70,761
Mason	14,672	15,814
Pacific	26,267	27,824
Pierce	14,168	15,768
San Juan	371	148
Skagit	46,866	39,847
Skamania	1,074	544
Snohomish	33,353	34,610
Thurston	22,579	19,914
Wahkiakum	10,885	9,665
Whatcom	20,109	18,930
Total	423,103	419,791

^a Data are from Washington timber harvest reports, Washington Department of Natural Resources.

Raettig, Terry L.; Connaughton, Kent P.; Ahrens, Glenn R. 1995. Hardwood supply in the Pacific Northwest: a policy perspective. Res. Pap. PNW-RP-478 Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 80 p.

The policy framework for the hardwood resource and hardwood industry in western Oregon and Washington is examined. Harvesting trends, harvesting behavior of public and private landowners, and harvesting regulation are presented to complete the analysis of factors affecting short-run hardwood supply. In the short term, the supply of hardwoods is generally favorable, but in the long term, the supply is uncertain and cause for concern. Hardwoods need to be recognized in forest management in the Pacific Northwest.

Keywords: Supply, demand, hardwoods, red alder, *Alnus rubra*, Pacific Northwest.

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