Projections of Timber Harvest in Western Oregon and Washington by County, Owner, Forest Type, and Age Class

Xiaoping Zhou, Richard W. Haynes, and R. James Barbour

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Authors

Xiaoping Zhou is a forester, **Richard W. Haynes** is a research forester, and **R. James Barbour** is a wood products technologist, Forestry Sciences Laboratory, P.O. Box 3890, Portland, OR 97208.

Abstract

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The Pacific Northwest forest resource is highly dynamic. Expected changes over the next 50 years will greatly challenge some current perceptions of resource managers and various stakeholders. This report describes the current and expected future timberland conditions of western Oregon and Washington and presents the results at the county level. About 50 percent of the timber removals in this region will come from 10 west-side counties, and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) will remain the major species removed. Forest industry will account for 50 percent of the total harvest in the Pacific Northwest West. Some inferences about the attributes of future timber and its utilization will be drawn from the projections at the county level over the next half century.

Keywords: Timber availability, forest resources, wood quality.

Contents

Introduction

Timber availability in Washington and Oregon (the Pacific Northwest region) has changed dramatically since the late 1980s. In 1988 the region produced about 15.7 billion board feet of timber. In 2001 it produced about 7.2 billion board feet (Warren 2003). These changes raise questions about the future sources and attributes of timber available in the region. Most of the current production now comes from private timberlands, and these lands are not distributed evenly throughout Washington and Oregon. The purpose of this report is threefold. First we describe the current and expected future timberland conditions of western Washington and Oregon (the Douglas-fir region). The basic projections used are from the fifth Forest and Rangeland Renewable Resources Planning Act (RPA 1997) assessment *An Analysis of the Timber Situation: 1952–2050* (Haynes 2003), hereafter referred to as the fifth RPA timber assessment. Second, we present the results of disaggregating region-wide timber production projections to the county level. Finally, we will draw some inferences about the attributes of future timber and its utilization as well as those counties that are likely to remain important timber producers over the next half century.

Definition of West-Side Counties

In this report, we refer to the western half of Washington and Oregon (the Douglas-fir region) as the west side. For our purposes, west-side counties are defined as those with all or the majority of their land area west of the Cascade crest. Historically, these have been the major timber-producing counties in Washington and Oregon, although some east-side counties have also produced substantial amounts of timber. Figure 1 shows 38 counties (19 in each state) that compose the west side.

Current Timberland Status on the West Side

This study adopts four ownership groups used in the various RPA documents: National Forest System (NFS), other public, forest industry (FI), and nonindustrial private (NIPF). The use of these ownerships is long standing and attempts to recognize differences among landowner objectives. For example, the NFS lands are managed to maintain broad ecosystem values, whereas FI lands are managed for sustainable wood production. These different objectives manifest themselves in differences in stand structures and timber flows between owners. Current timberland status was extracted from both the RPA database (Smith et al. 2001) and the

Oregon counties: Benton, Clackamas, Clatsop, Columbia, Curry, Douglas, Hood River, Jackson, Josephine, Lane, Lincoln, Linn, Marion, Multnomah, Polk, Tillamook, Washington, Yamhill.

Washington counties: Clallam, Clark, Cowlitz, Grays Harbor, Island, Jefferson, King, Kitsap, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Skamania, Snohomish, Thurston, Wahkiakum, Whatcom.

Figure 1—West-side counties in Oregon and Washington.

fifth RPA timber assessment.[1] This information provides context for the following discussion. There are 23.3 million acres of timberland in these west-side counties, 31 percent of which are administered by NFS, 20 percent by other public agencies, 29 percent by FI, and the remaining 20 percent by NIPF. The major west-side forest types are Douglas-fir and western hemlock. Approximately 52 percent of timberland is Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), and 15 percent is western hemlock (*Tsuga heterophylla* (Raf.) Sarg.). Oregon west-side forests are dominated by Douglas-fir, (60 percent of timberlands), whereas Washington west-side forests are dominated by Douglas-fir (42 percent of timberlands) and western

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[1] The fifth RPA timber assessment presents the U.S. timber scenarios for the next 50 years under various assumptions. Assumptions address future forest policies and behaviors of domestic and global markets of forest products.

hemlock (23 percent of timberlands). Figure 2 shows the timberland distribution by forest type and ownership groups. Forest types are grouped into six major categories: (1) Douglas-fir, including a very small portion of Douglas-fir mixed with other conifer species; (2) western hemlock; (3) fir and spruce, including a very small portion of true fir from NFS; (4) red alder; (5) other softwoods including pine, softwood mix; and (6) other hardwoods, including nonstocked areas.

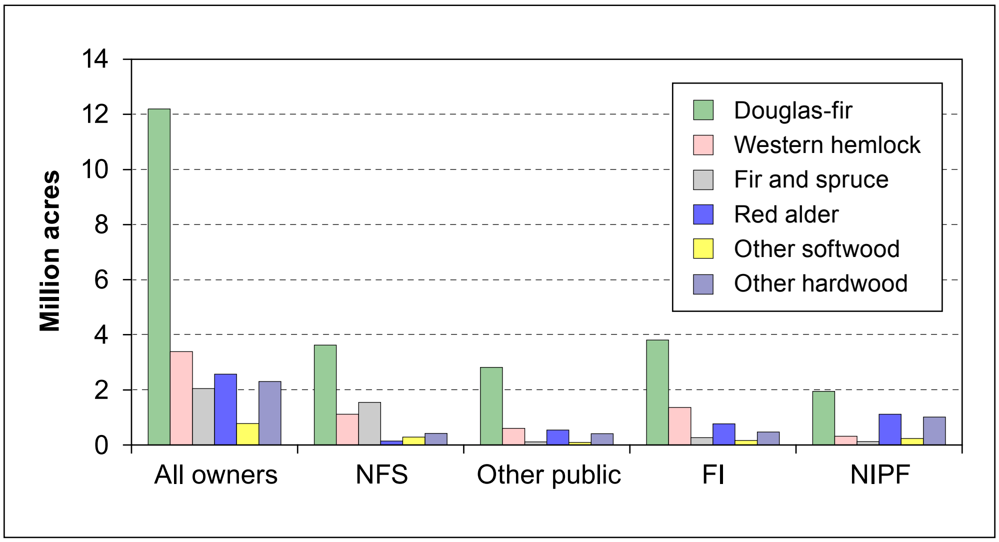

Figure 2—Timberland distribution among owners and forest types (RPA 1997 database). NFS = national forest system, FI = forest industry, NIPF = nonindustrial private forest.

Approximately 53 percent of the acres have stands younger than 50 years old, whereas 13 percent of the acres have stands older than 150 years. The majority of stands less than 150 years old are on other public or private land, whereas the majority of stands greater than or equal to 150 years old are on NFS land (fig. 3). Forest Industry and NIPF timberlands hold a large proportion of younger stands, whereas on NFS timberlands, the age class distribution is more uniform. In fact, about 80 percent of the timberland owned by FI has stands younger than 50 years old (64 percent for NIPF), and 1 percent of stands are older than 150 years on both FI and NIPF timberland. Stands on NFS timberland are much older, with 35 percent older than 150 years and only 21 percent younger than 50 years. The age distribution of stands on other public timberlands is much closer to the average, with 49 percent younger than 50 years and a little over 8 percent older than 150 years.

An important question, in terms of timber production, is whether these differences in age class distribution actually mean there will be differences in the age of harvested trees. Current policy on federally administered land effectively reserves all stands over about 80 years old from harvest and in practice restricts harvest to

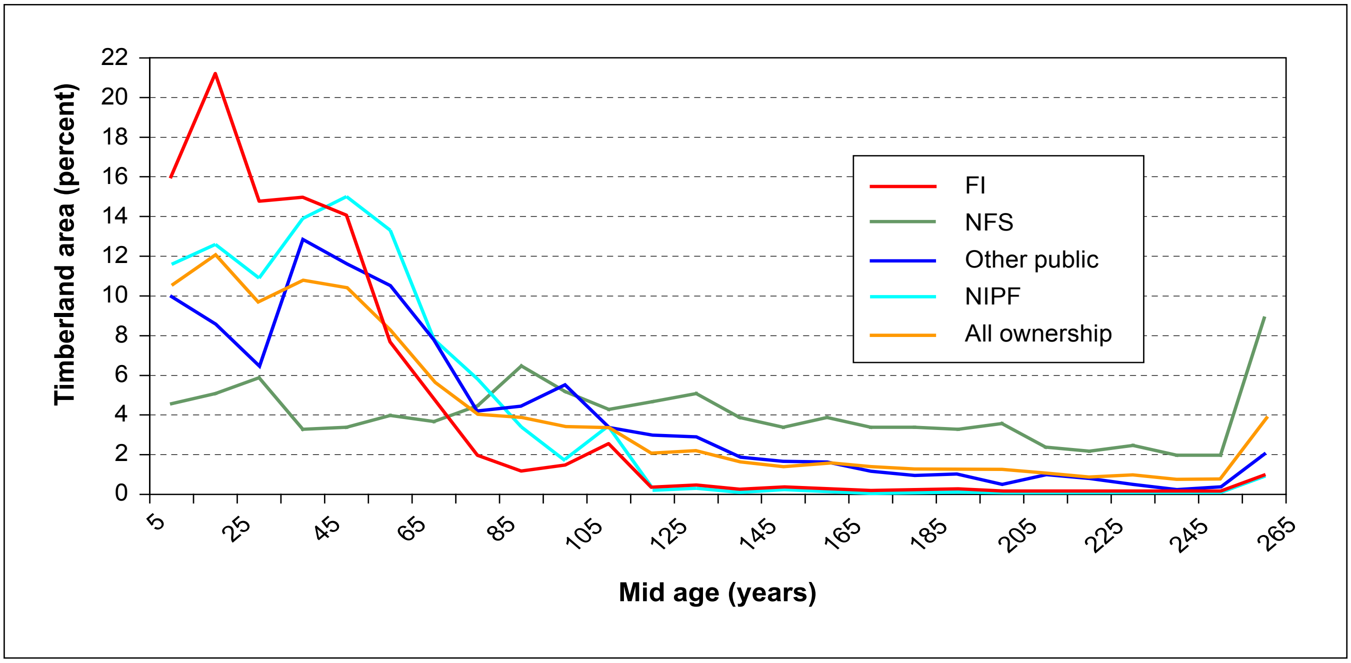

Figure 3—Current age class distribution by ownership. NFS = national forest system, FI = forest industry, NIPF = nonindustrial private forest.

thinning of stands younger than about 50 years old. Managers of state land in both Oregon and Washington are under pressure to harvest only younger stands and then to create structural conditions for developing old forest characteristics that may eventually be managed for habitat protection.

The Projection Model

The inventory projection model used for the fifth RPA timber assessment is known as the Aggregate Timberland Assessment System (ATLAS) (Mills and Kincaid 1992). This inventory projection system includes an inventory module, management module, and harvest module. The inventory module contains descriptions of inventory in terms of forest type, ownership, site class, management intensity, area, and volume by age class. The management module contains the parameters governing growth and yield, including the hardwood-softwood fiber mix, average diameter by age, yield tables by forest type, regeneration, stocking and density change variables, management intensity, harvesting parameters, and area change parameters. The harvest module contains future removals stratified by region, ownership, and fiber type for each projection period.

ATLAS-T is another model variant sharing the same structure of ATLAS but written in SAS (2000). It accommodates the internalized forest type transitions and management intensity shifting. That is, the system will simulate the harvest and stand regeneration based on the management regime designated for the future forest type and management intensity after harvesting. It also projects timber inventory at finer levels (county, state, or subregion). For a county-level inventory projection, ATLAS-T assumes that timberland in each county will be assigned to different management intensities in the same proportion as for the region. In addition, the starting inventory in ATLAS-T is aggregated to the county level and described by ownership, forest type, site class, management intensity, and age class. Those variables will be carried over to the next projection period after management simulation of harvest and growth. ATLAS-T operates with regional estimates of removals (usually the RPA regional level consisting of several states) that are distributed to county level based on the available harvest volumes within each type and management intensity unit.

ATLAS-T consists of a main program and subprograms that deal with different management practices such as type transition, management intensity shifting, and different types of disturbances (fire/insect). Basically, the main program reads the starting inventory data; adds net growth following the yield functions for each forest ownership, type, and management intensity; harvests the volume necessary to meet requests; and writes the inventory output for the next simulation period. The subprograms will be called when type transition, management intensity shifting, or special policy analysis is involved.

Projected Timberland Status

Projected trends in various aspects of timberland conditions are summarized in the fifth RPA timber assessment (Haynes 2003). The assessment results suggest that we can expect consumption of forest products to increase by 40 percent over the next 50 years while output from the forest products sector will increase by 24 percent. The slower rate of growth in production reflects an increasing share of products from imports to meet rising wood products consumption. We will see a change in the mix of types of forest products manufactured, rising prices, shifts in regional concentration of production, and significant changes in the modes and intensities of forest management for private timberland owners.

In this section, we discuss two projections of timberland conditions in the west-side forests of Oregon and Washington. The first projection reflects the various management assumptions for the major west-side forest types used in the base case from the fifth RPA timber assessment: Douglas-fir and western hemlock. The second projection is called the Northwest Forest Plan (NWPF) case.[2] The various

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[2] Jamie Barbour proposed lower partial cutting or final harvest age mainly for national forests. This is related to the NWFP, and we call it the NWFP case.

Table 1—Major harvest assumptions under Resources Planning Act (RPA) base case and Northwest Forest Plan (NWFP) case

	Fifth RPA base case		NWFP case	
Owner	**Douglas-fir**	**Western hemlock**	**Douglas-fir**	**Western hemlock**
Nonindustrial private forest	Thin at age 35 Proportional final harvest from age 45 to 175 Final harvest start at age 45, 55, or 65	No thin Proportional final harvest from age 55 to 175 Final harvest start at age 45, 55, or 65	Thin at age 35 Proportional final harvest from age 45 to 175 Final harvest start at age 45, 55, or 65	No thin Proportional final harvest from age 45 to 175 Final harvest start at age 45, 55, or 65
Forest industry	Thin at age 35 Final harvest start at age 45, 55, or 65	No thin Proportional final harvest from age 65 to 175 Final harvest start at age 45, 55, or 65	Thin at age 35 Final harvest start at age 45, 55, or 65	No thin Proportional final harvest from age 65 to 175 Final harvest start at age 45, 55, or 65
National forest system	Thin at midage 35 Partial cutting to certain nonzero age from age 105 to 255 and above Proportional final harvest from age 85 to 255 and above		Thin at midage 35 Partial cutting to certain age from age 105 to 255 and above Proportional final harvest from age 45 to 85	

assumptions for these two cases are summarized in table 1. We also disaggregate these projections to the counties by using a modified version of ATLAS, ATLAS_T. The discussions of the county projections include all ownerships except for other public timberland where projections in this detail are not available. As in any assessment, there are a series of assumptions about economic conditions, the behavior of the forest products, and stumpage markets (see Haynes 2003 for details).

The projections provide information on inventory conditions by age classes. In the Forest Inventory and Analysis (FIA) data, an average age in years was assigned to the stand based on the measured ages for the trees and stand stocking level. For each stand at a certain age class, the diameters at breast height (d.b.h.) varied from tree to tree. The empirical d.b.h. distributions for each age class and forest type were obtained by using the newly created integrated database by Pacific Northwest Research Station (PNW) FIA Program.[3] Stands 200 years and older were grouped into a single age group. Trees less than 5 in d.b.h. are assumed to have zero merchantable volume.

[3] The integrated database (PNW-IDB) integrates forest inventory data from Forest Inventory and Analysis (FIA) program (for private ownership), NFS, and BLM for Oregon, Washington, and California by the FIA in the PNW Research Station. The database contains plot, condition, and tree information.

Projections of harvest (removals) by decade and ownership under the assumptions of the RPA base case scenario suggest a fairly static picture (fig. 4). During the entire simulation period (1997–2056), most of the removals are projected to come from FI timberlands, whereas NFS timberland is only projected to contribute 4 percent of the total removals on average.

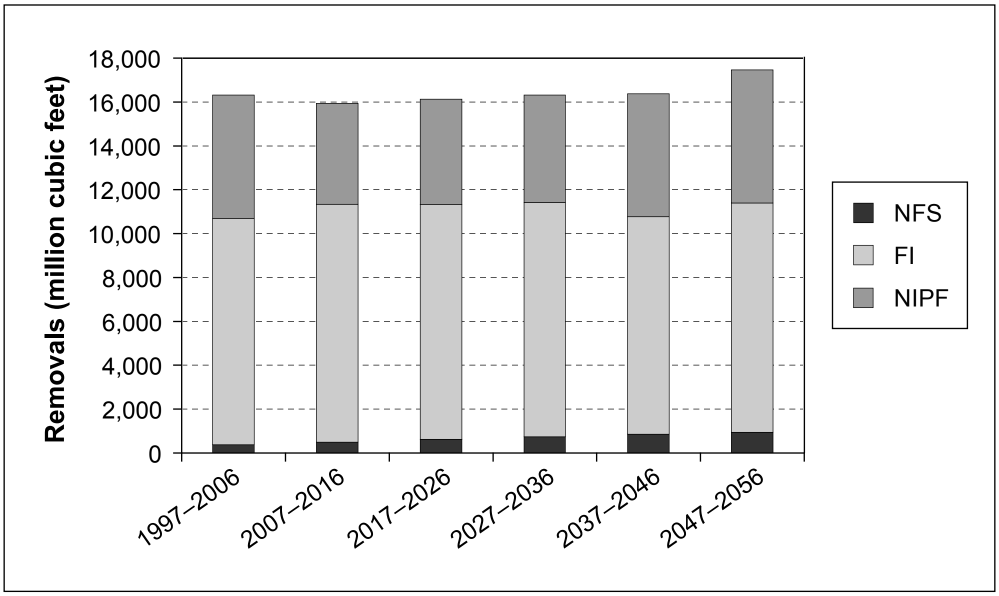

Figure 4—Projected removals by decade and ownership in west-side counties.
NFS = national forest system, FI = forest industry, NIPF = nonindustrial private forest.

Under the base case assumptions, about 63 percent of removals will be Douglas-fir and 20.4 percent will be western hemlock during the simulation period (fig. 5). Approximately 67 percent of Douglas-fir removals and about 80 percent of western hemlock removals will come from FI timberlands. The harvest will be concentrated in age classes 45 to 65. Some removals of older age classes will be from NFS timberlands.

Under the NWFP case, because the proportion of NFS harvest is small relative to both available inventory and the harvest from other owners, the change of harvest age assumptions for the national forest will not affect the total harvest substantially. The Douglas-fir harvest will be 62.7 percent and hemlock harvest will be 20.5 percent of all harvest from all ownership groups. However, for the NFS harvest, the NWFP harvest age assumptions for Douglas-fir and western hemlock differs from the RPA base case assumptions, and they will alter the projections. Under this scenario, the harvest will decrease by 4 percent for Douglas-fir and 2 percent for western hemlock, and will shift to fir and spruce timber types.

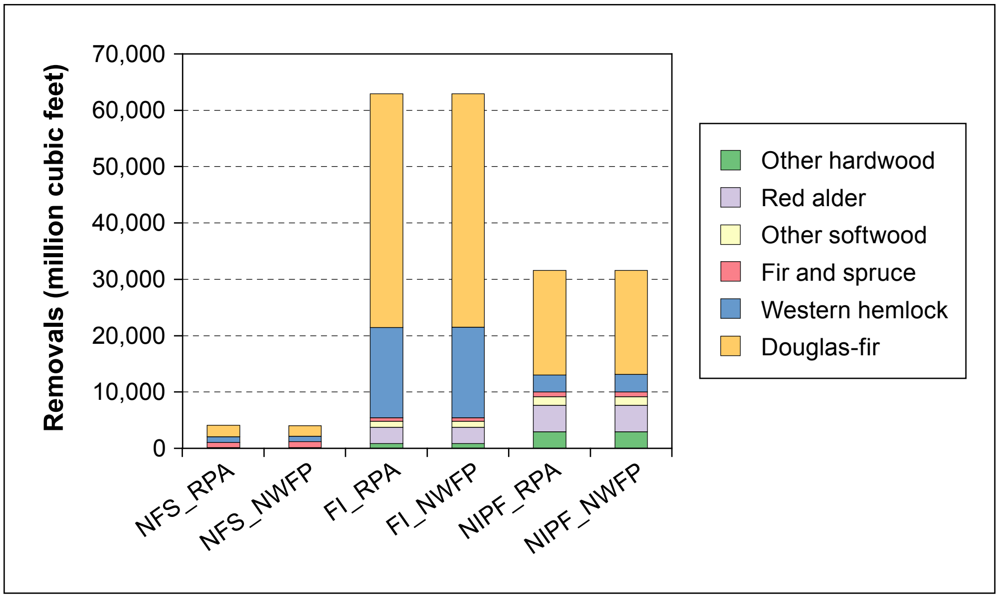

Figure 5—Total removals during projection period by owner and forest types, 1997–2056. NFS = National Forest System, NWFP = Northwest Forest Plan, FI = forest industry, and NIPF = nonindustrial private forest.

The Age Distribution of the Removals

Several harvest regimes were applied to meet the timber stumpage demand. These regimes included commercial thinning, proportional final harvesting (clearcutting) across certain age groups, and partial cutting. The model simulated removals based on the management assumptions for each forest type. The age class distribution of the Douglas-fir (fig. 6.1 to 6.4) and western hemlock (figs. 7.1 to 7.3) removals under the RPA base case are illustrated for NFS, FI, and NIPF ownerships. Under the NWFP case, the proportional final harvest for NFS is assumed to occur in a younger age class, from age 45 to 85 (table 1). The comparison of the harvest age distributions for NFS under these two cases are seen in figures 6.2 and 6.5 for Douglas-fir, and figures 7.2 and 7.3 for western hemlock.

Projected Douglas-fir removals will gradually shift toward younger age classes for all ownership groups (fig. 6.1). Fifty-four percent of the Douglas-fir removals will be younger than age 70 from 1997 to 2006. This proportion is projected at 87 percent from 2037 to 2046. The biggest change will occur for the 45-year age class (ages 40 to 50). The percentage of removals for this age class will change from approximately 7 percent in the period 1997–2006, to 32 percent in the period 2016–26, to 49 percent in the period 2037–46. The removals of Douglas-fir from FI (fig. 6.3) and NIPF (fig. 6.4) lands dominate this shift in age class distribution, with FI lands contributing the most to the change. Although the total harvest increases under both base case (fig. 6.2) and NWFP case (fig. 6.5), NFS lands do not show an age shift

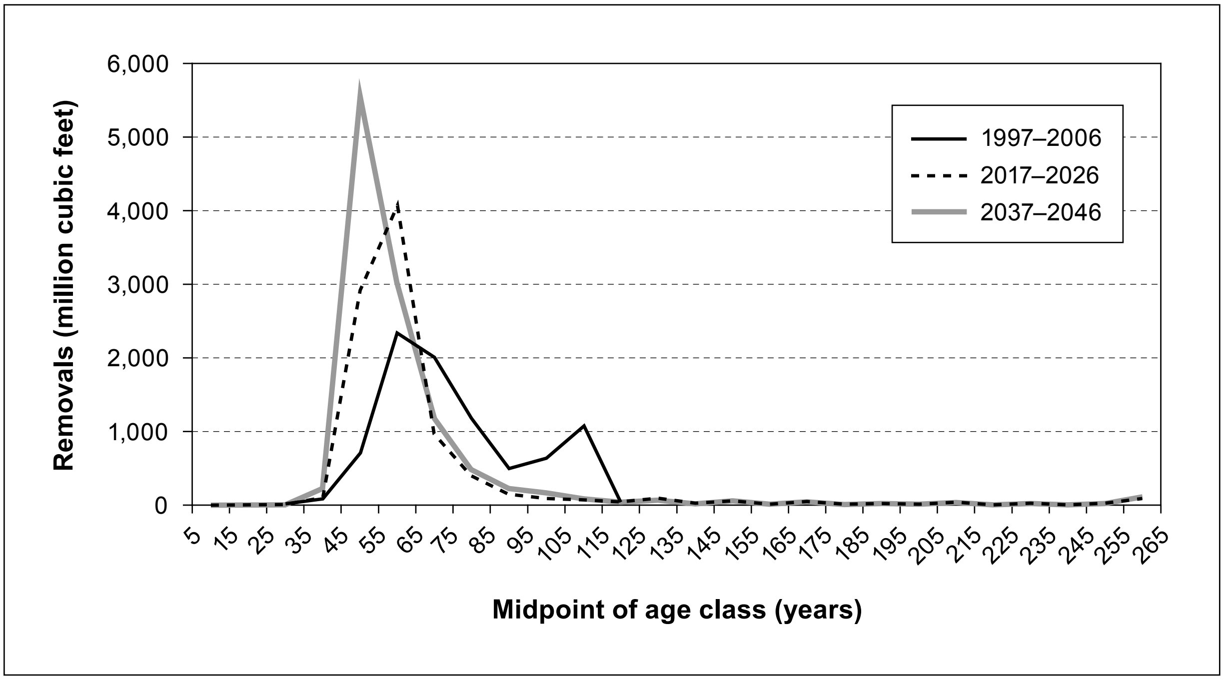

Figure 6.1—Projected age class distribution of Douglas-fir removals for all ownerships, RPA base case.

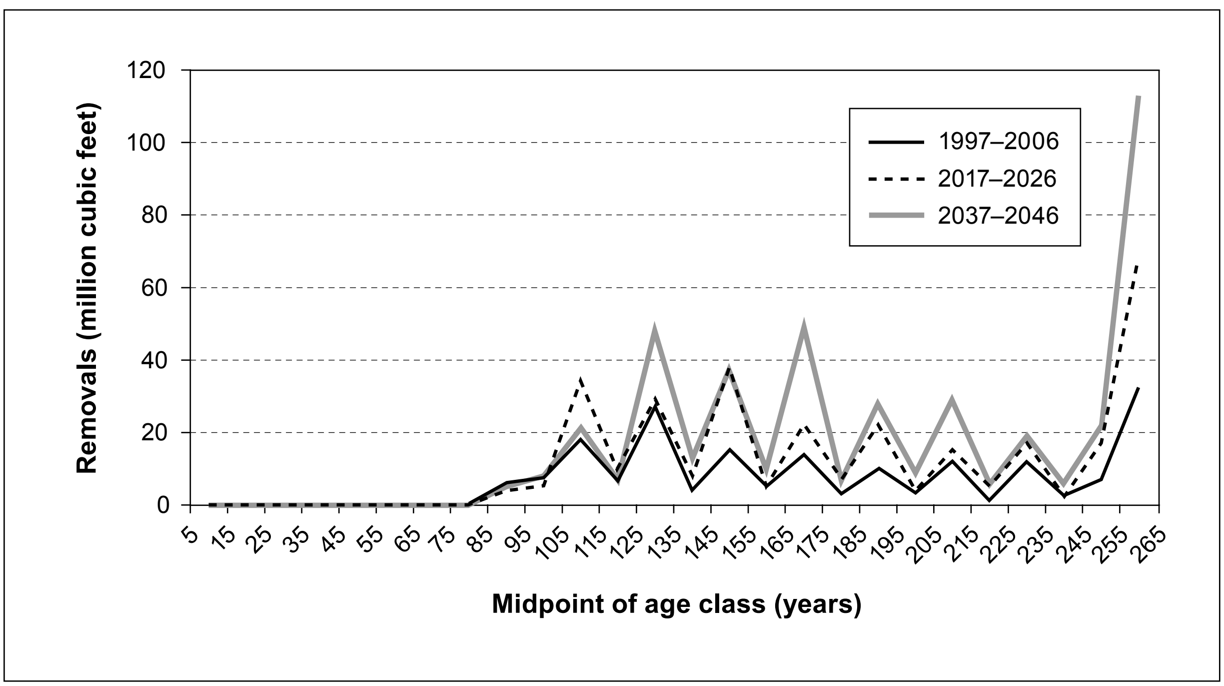

Figure 6.2—Projected age class distribution of Douglas-fir removals for National Forest System, RPA base case.

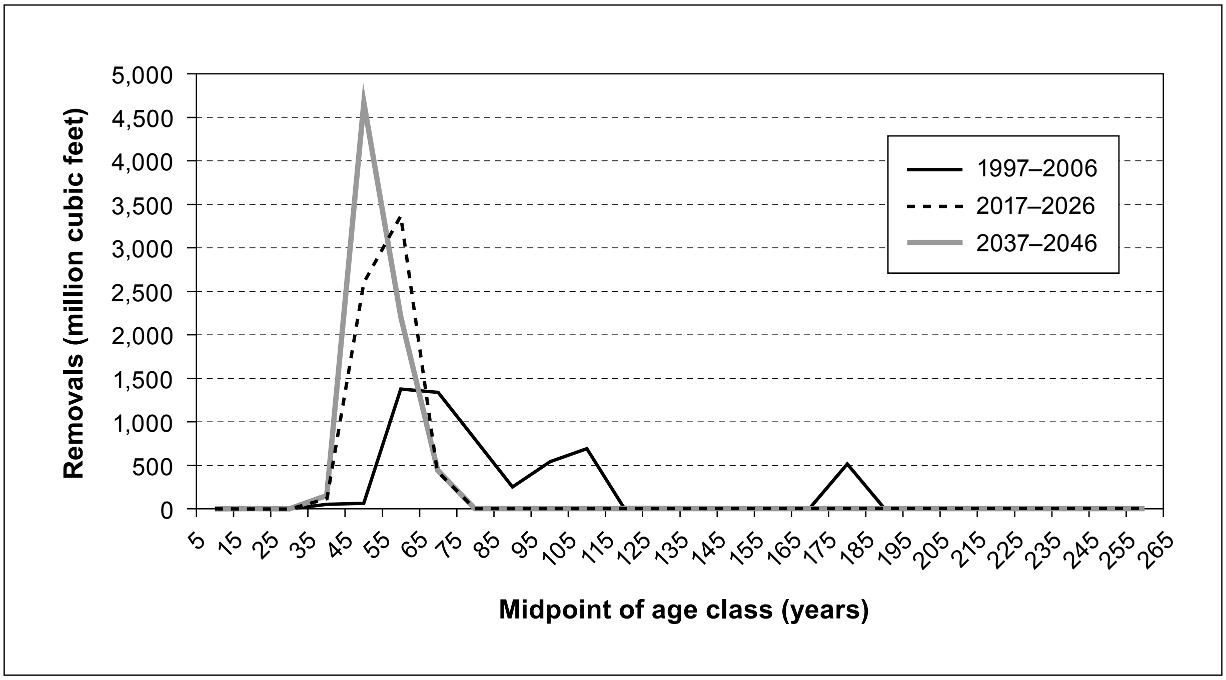

Figure 6.3—Projected age class distribution of Douglas-fir removals for forest industry, RPA base case.

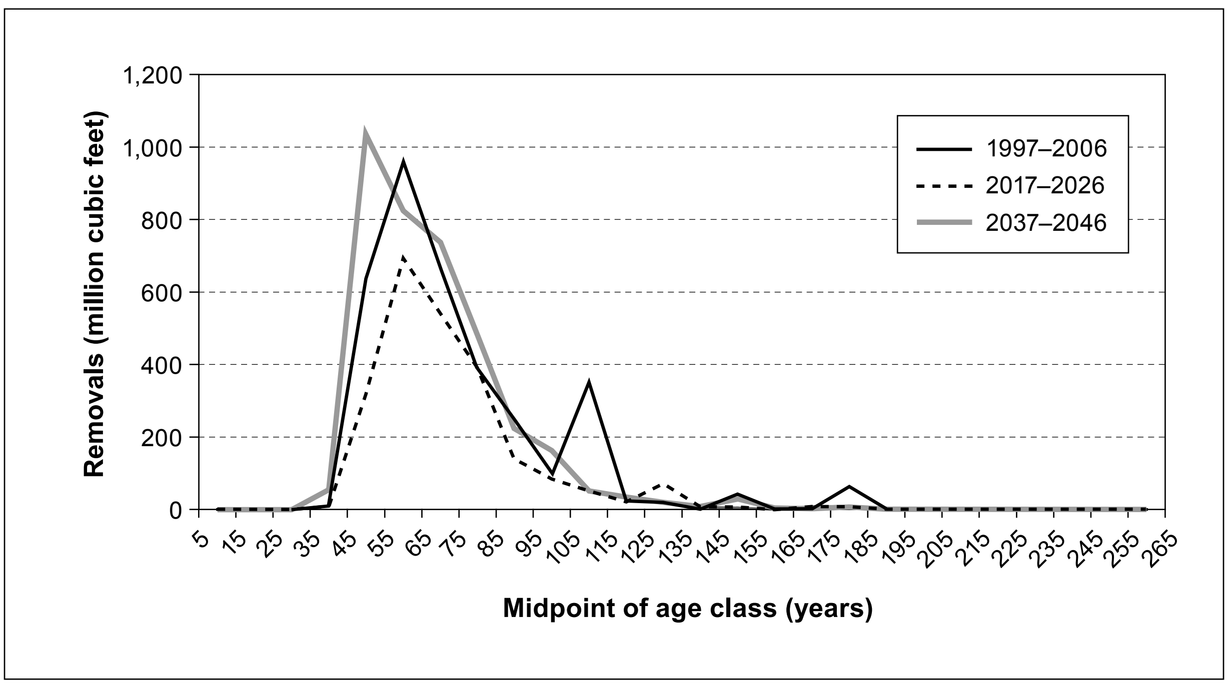

Figure 6.4—Projected age class distribution of Douglas-fir removals for nonindustry private forest, RPA base case.

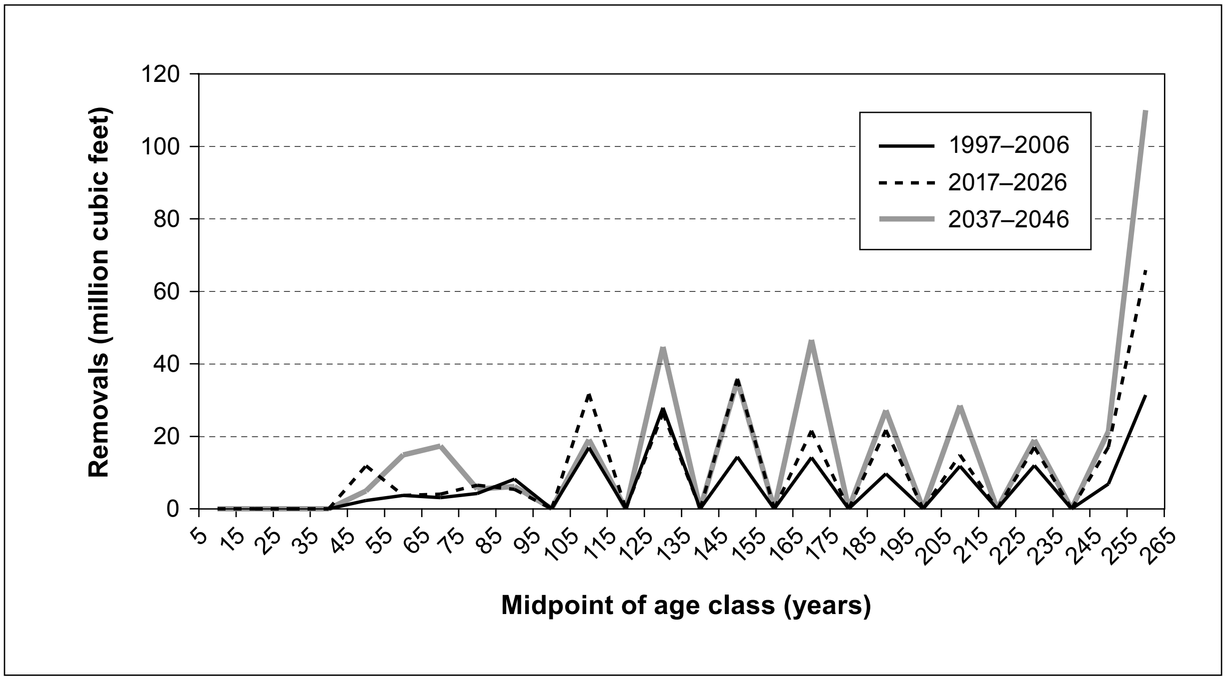

Figure 6.5—Projected age class distribution of Douglas-fir removals for National Forest System, NWFP case.

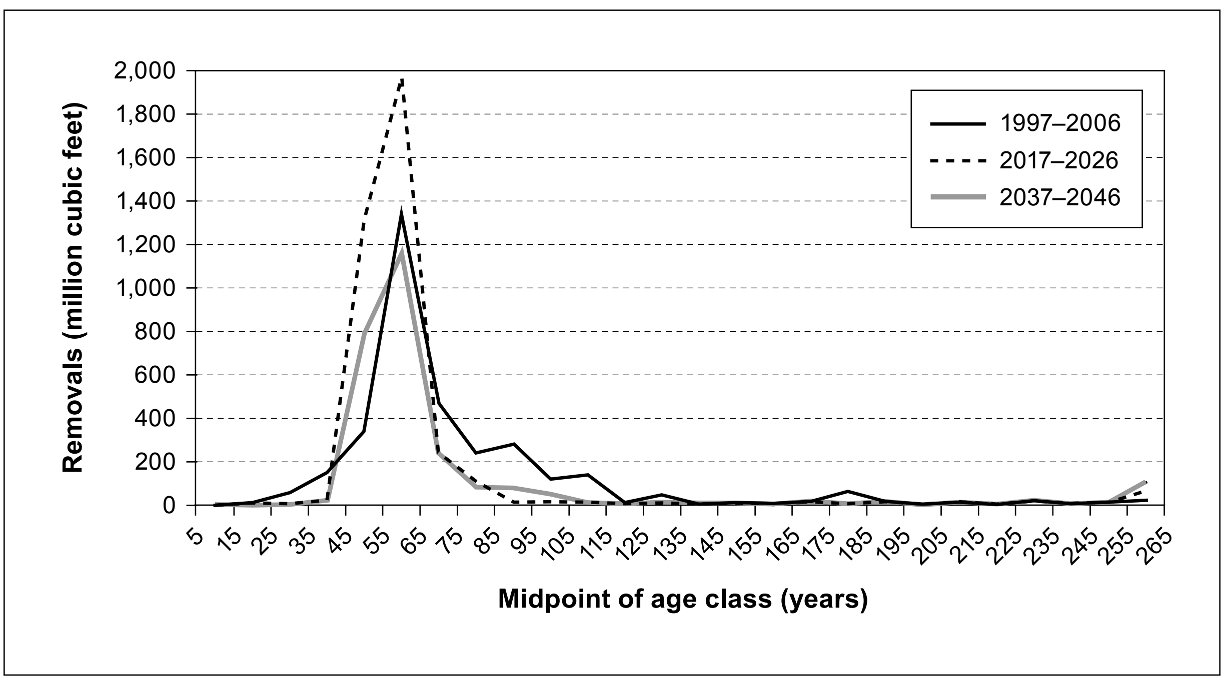

Figure 7.1—Projected age class distribution of western hemlock removals for all ownerships, RPA base case.

Figure 7.2—Projected age class distribution of western hemlock removals for National Forest System, RPA base case.

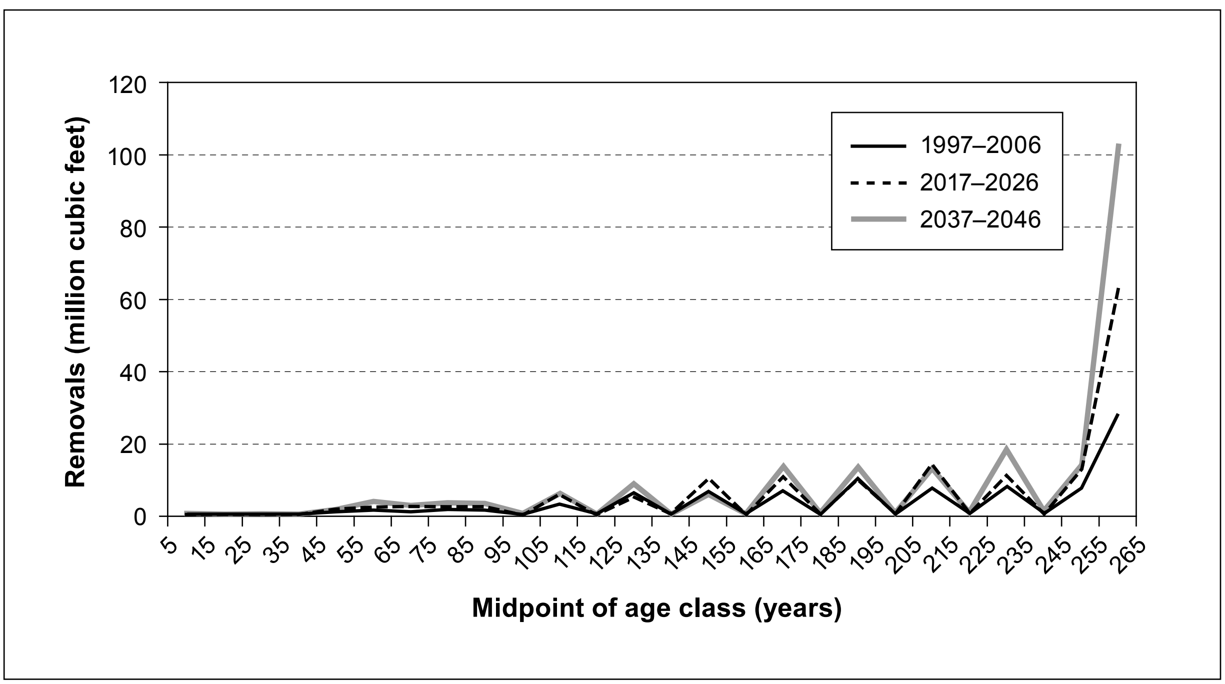

Figure 7.3—Projected age class distribution of western hemlock removals for National Forest System, NWFP case.

because of the small amount of harvest relative to the large pool of inventory available and the total removals for all ownerships.

For western hemlock, the age-class shift in removals for all ownership is seen in the first three decades. Under the base case (fig 7.1), 68 percent of the removals for the first period (1997–2006) and 92 percent for the period 2017–26 will be younger than age 70. This proportion (of removals younger than age 70) will drop to 83 percent during the period 2037–46. The peak age of the harvest will be at age 55 years. Forty percent of the western hemlock removals will be in the 55-year age class during the period 1997–2006, 51 percent during the period 2017–26, and 44 percent during the period 2037–46. Like Douglas-fir, these proportions are dominated by removals on private timberland.

The Diameter Distribution of the Removals

Diameter (d.b.h.) distributions of the removals from the west-side counties are presented in figures 8 to 12. A 3-in d.b.h. interval was used for developing the diameter classes used in these distributions. For example, “Mid-DBH 6.5” stands for all trees having a d.b.h. between 5 and 8 in.

The total removals during the projection period under the two scenarios (RPA base case and NWFP case) result in a similar d.b.h. distribution. However, the removals trend toward smaller d.b.h. classes over time as shown in figure 8 for all ownerships under the base case. Fifty-four percent of the removals are less than 20-in d.b.h. (up to mid-d.b.h. 18.5 in, fig. 9) during the first period, approximately 64 percent of the removals are less than 20-in d.b.h. during the period 2017–26, and 65 percent are less than 20-in d.b.h. for the period 2037–46.

The total removals of Douglas-fir increased during the projection period. There is also a tendency toward removals from smaller diameter trees for all ownership groups (fig. 10), but especially from FI timberlands. Less than 49 percent of FI removals will be from trees smaller than 20-in during the period 1997–2006. This proportion increases to 67 percent in the 2017–26 period and increases again to 70 percent for the 2037–46 period (fig. 11).

Under the base case, removals of western hemlock from all ownership groups are projected to increase for the first three decades and then decline. The d.b.h. distribution of the removals will shift to smaller trees throughout the first three decades for FI and NIPF timberlands. For example, about 66 percent of removals from FI timberlands will be less than 20-in d.b.h. for the first decade; the percentage of small-diameter removals will increase to 77 percent by the third and fifth decades (fig. 12).

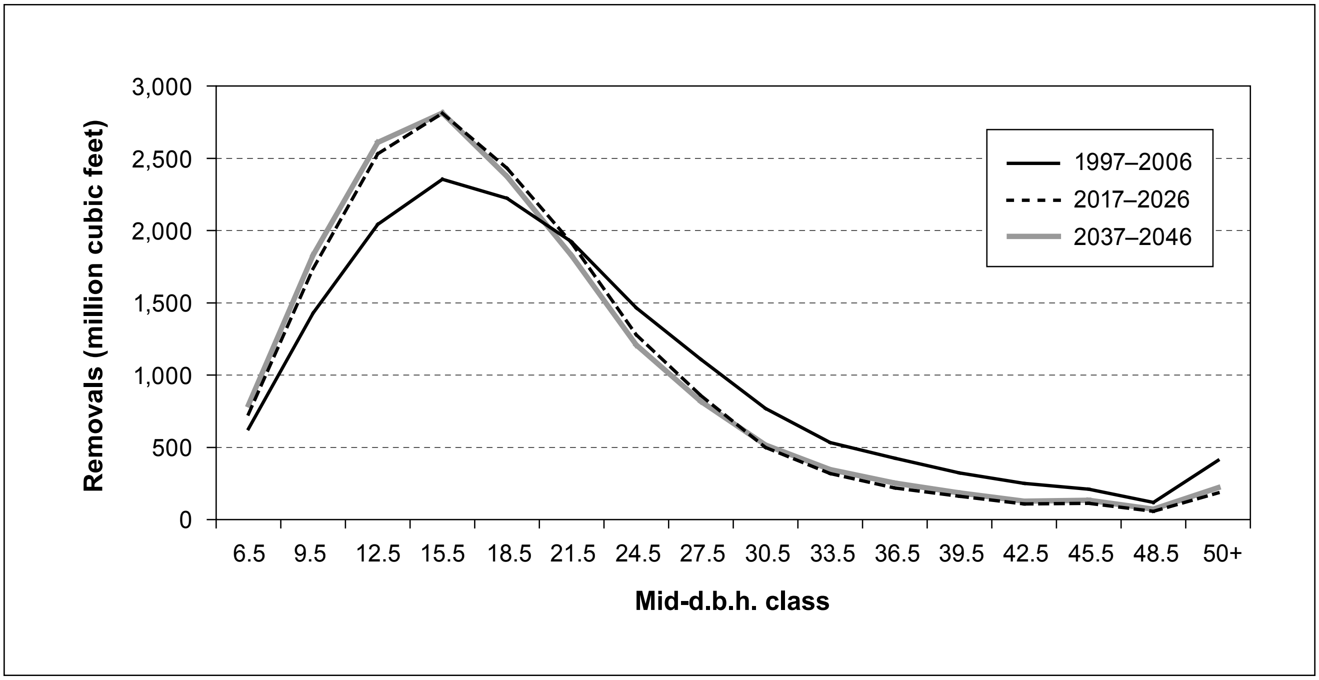

Figure 8—Projected diameter at breast height class distribution of removals for RPA base case, all ownerships.

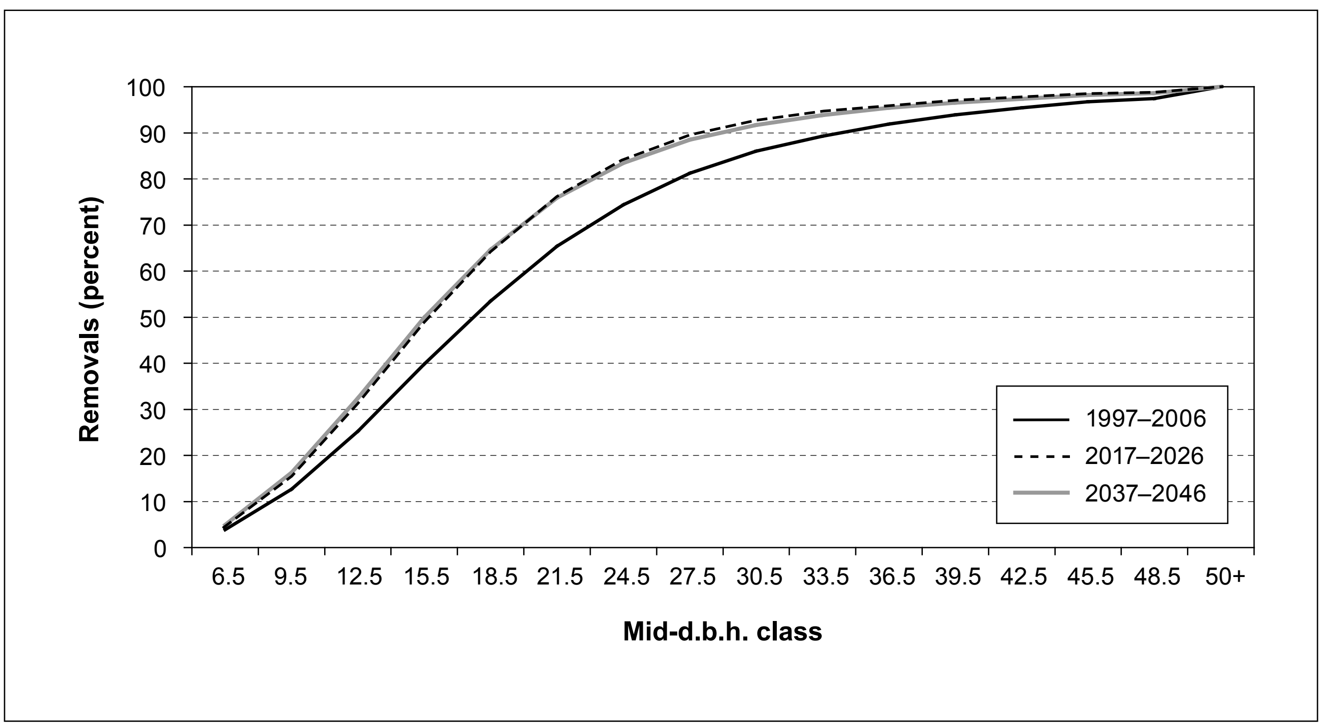

Figure 9—Accumulated percentage distribution of removals by diameter at breast height class for RPA base case.

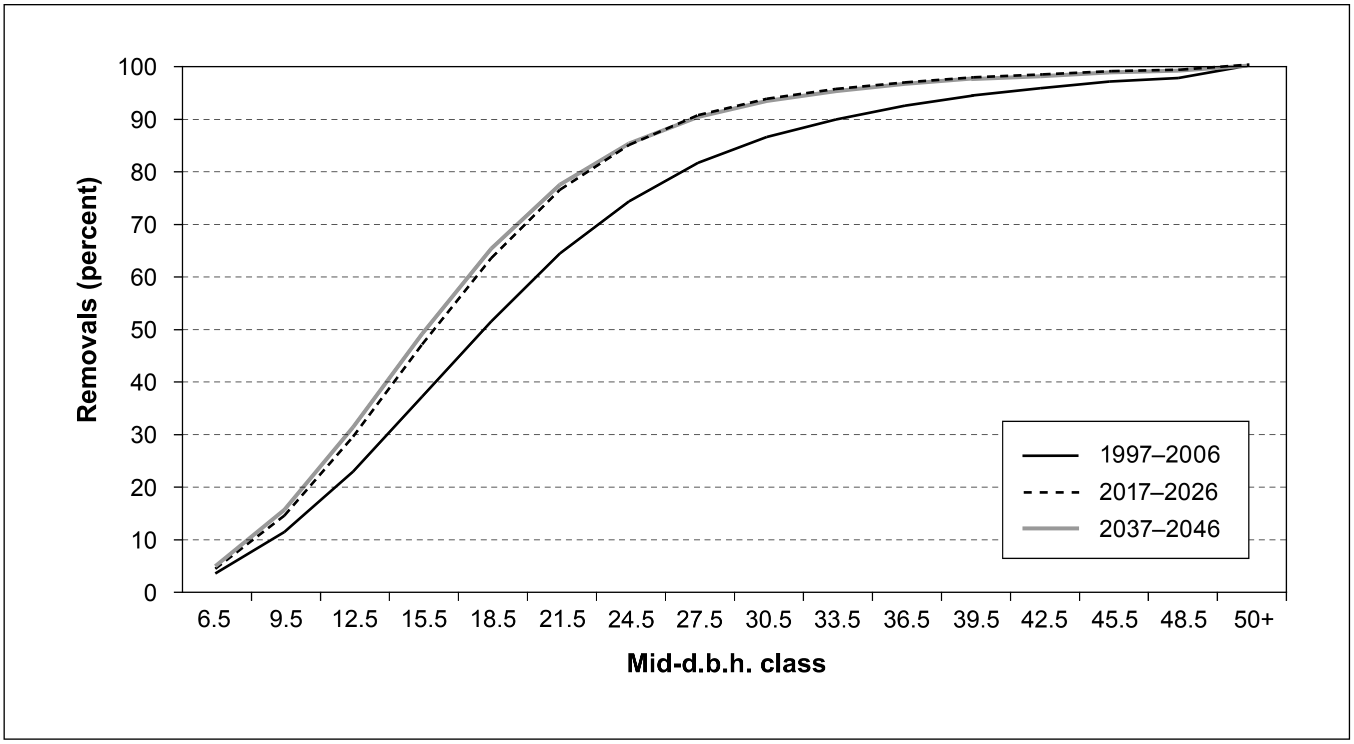

Figure 10—Accumulated percentage distribution of Douglas-fir removals for RPA base case, all ownerships.

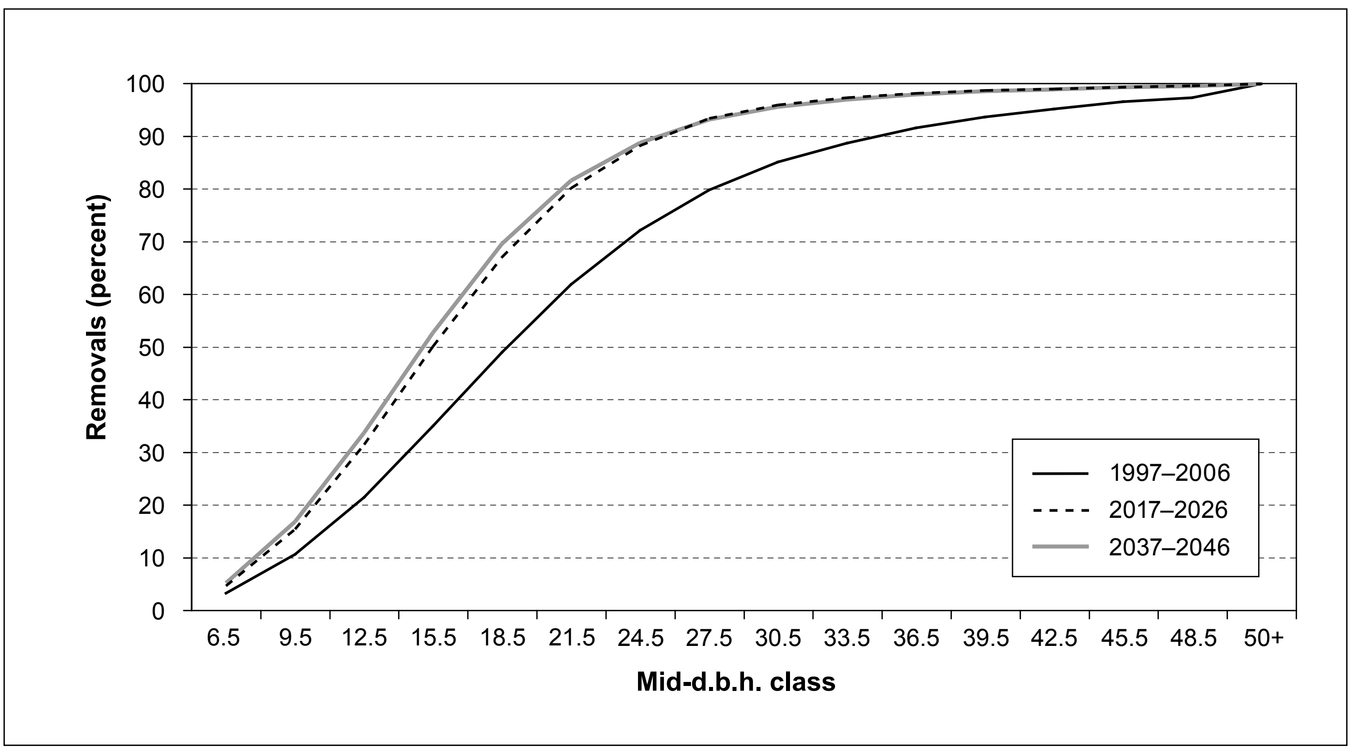

Figure 11—Accumulated percentage distribution of Douglas-fir removals for RPA base case, forest industry.

Figure 12—Accumulated percentage of western hemlock removals for RPA base case, forest industry.

Removals for both Douglas-fir and western hemlock from NFS timberland will, however, tend to be bigger trees. For all the periods, more than 79 percent of Douglas-fir removals and more than 86 percent of the western hemlock removals will be trees larger than 20-in d.b.h.

The Spatial Distribution of the Removals

The accumulated removals under the base case scenario by county over the projection period are shown in figure 13. Douglas, Lane, and Coos Counties in Oregon and Grays Harbor, Lewis, Pacific, and Cowlitz Counties in Washington produce the most timber in western Oregon and Washington as shown in table 2. Douglas and Lane are the major Douglas-fir counties in Oregon, whereas Grays Harbor and Pacific are the major western hemlock counties in Washington (table 3).

At the end of the projection period, the total timberland area will remain stable, both collectively and among ownership groups. The total inventory volume is projected to increase by 61 percent (excluding other public timberlands), with most of the increase (86 percent) concentrated on NFS timberlands where it is unlikely to be available for harvest. Meanwhile, the total inventory volume on FI timberlands will decrease by 30 percent. The decrease in inventory for FI timberlands will lead to a younger age-class distribution. At the end of the projection period, 91 percent

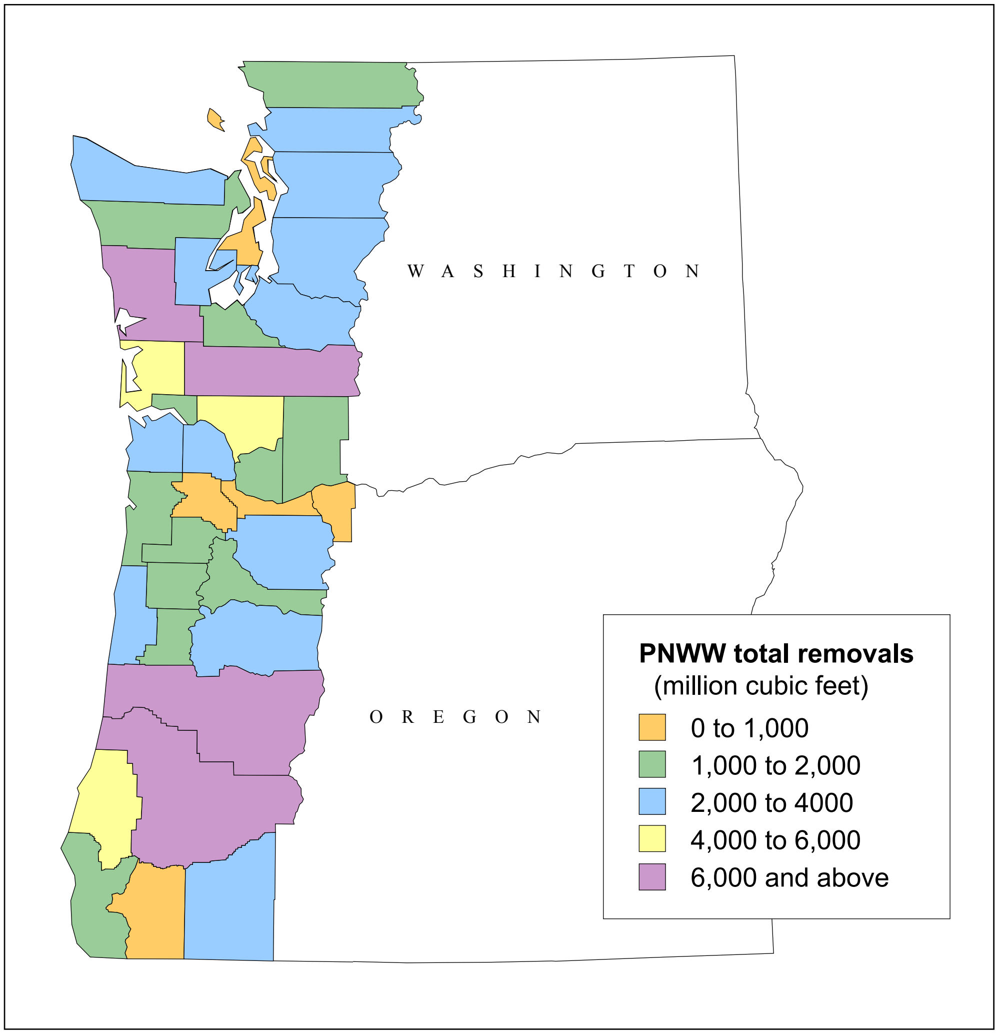

Figure 13—Accumulated removals during projection period by county for all ownerships, RPA base case.

of FI timberland will contain stands that are younger than 60 years old, compared to the current value of 88 percent. There are substantial changes in timber removals by county over the projection period (fig. 14). The projected county removals by selected period for combined and individual ownership groups are listed in tables 4 and 5.

Wood Quality Implication

The projection of future removals tends toward younger and smaller trees for all ownerships, especially for the private owners. An important question for these owners is whether this will influence the wood characteristics and affect the log grades, and therefore the value, of harvested stumpage? By using an existing

Table 2—Accumulated removals over projection period (1997–2056) by county and owners, for Resources Planning Act (RPA) base case and Northwest Forest Plan (NWFP) case

		National forest system		Forest industry		Nonindustrial private		Total	
State	County	Base case	NWFP case	Base case	NWFP case	Base case	NWFP case	Base case	NWFP case
					Million cubic feet				
Oregon	Benton	12	11	360	357	853	861	1,226	1,229
	Clackamas	312	302	1,192	1,231	1,035	1,072	2,539	2,605
	Clatsop	0	0	2,754	2,765	266	292	3,021	3,057
	Columbia	0	0	2,045	2,037	724	720	2,770	2,757
	Coos	44	40	2,274	2,277	1,835	1,787	4,153	4,103
	Curry	120	110	807	810	711	756	1,638	1,677
	Douglas	545	525	6,269	6,267	2,323	2,153	9,138	8,944
	Hood River	59	59	169	170	57	64	285	294
	Jackson	186	189	1,934	1,922	601	677	2,721	2,788
	Josephine	99	93	89	89	527	513	715	695
	Lane	726	689	5,020	5,017	1,587	1,669	7,333	7,375
	Lincoln	56	56	1,606	1,615	837	830	2,499	2,500
	Linn	257	260	1,605	1,615	1,503	1,566	3,365	3,441
	Marion	83	88	402	399	519	534	1,004	1,020
	Multnomah	39	37	34	34	75	75	148	147
	Polk	2	1	1,527	1,525	372	340	1,901	1,866
	Tillamook	25	25	1,196	1,181	309	293	1,530	1,499
	Washington	0	0	221	223	644	618	865	841
	Yamhill	10	9	898	898	362	351	1,271	1,257
Washington	Clallam	99	100	2,062	2,063	567	600	2,728	2,763
	Clark	1	1	528	522	716	661	1,244	1,184
	Cowlitz	4	6	3,346	3,361	798	774	4,148	4,141
	Grays Harbor	79	85	5,686	5,672	1,803	1,853	7,568	7,610
	Island	0	0	0	0	562	531	562	531
	Jefferson	78	79	652	654	1,164	1,152	1,894	1,885
	King	132	141	2,290	2,294	1,164	1,194	3,586	3,628
	Kitsap	0	0	0	0	806	817	806	817
	Lewis	209	200	4,185	4,225	1,790	1,675	6,183	6,099
	Mason	39	41	1,912	1,898	937	946	2,888	2,885
	Pacific	0	0	4,170	4,182	786	732	4,956	4,914
	Pierce	42	46	1,902	1,883	933	962	2,878	2,891
	San Juan	0	0	0	0	562	622	562	622
	Skagit	186	209	1,443	1,431	704	726	2,333	2,366
	Skamania	315	321	627	627	314	342	1,256	1,290
	Snohomish	160	187	1,245	1,236	1,019	1,000	2,425	2,423
	Thurston	0	0	939	935	1,029	1,016	1,968	1,951
	Wahkiakum	0	0	913	905	110	107	1,023	1,011
	Whatcom	120	126	612	598	671	695	1,402	1,419
Total		4,040	4,036	62,915	62,915	31,576	31,576	98,531	98,527

Table 3—Douglas-fir and western hemlock removals by selected period for all ownerships, Resources Planning Act base case

		Douglas-fir			Western hemlock		
State	County	1997–2006	2017–26	2037–46	1997–2006	2017-26	2037–46
				Million cubic feet			
Oregon	Benton	88.0	83.4	196.6	0.1	0.1	0.2
	Clackamas	132.3	363.7	435.1	16.1	81.2	62.0
	Clatsop	35.9	9.1	145.6	227.6	548.1	315.3
	Columbia	258.7	98.9	373.8	.1	.1	17.7
	Coos	407.5	469.7	686.1	11.5	105.7	57.3
	Curry	136.4	84.0	354.4	9.3	18.6	10.3
	Douglas	1,165.5	1,398.5	1,882.0	132.9	4.7	7.2
	Hood River	21.8	21.8	34.3	1.3	2.0	2.7
	Jackson	438.0	253.5	430.2	1.0	1.7	2.3
	Josephine	71.5	98.9	207.3	0	0	0
	Lane	868.5	1,209.6	1,205.3	141.4	25.6	24.8
	Lincoln	102.6	214.8	295.2	47.6	256.6	55.5
	Linn	264.2	637.8	478.6	11.1	107.2	57.6
	Marion	255.0	57.9	168.8	2.1	3.4	5.2
	Multnomah	1.0	1.7	0	1.8	2.8	3.9
	Polk	169.5	402.8	331.2	0	0	0
	Tillamook	34.1	42.9	197.7	88.3	174.6	122.4
	Washington	15.6	191.7	79.9	0	19.5	50.7
	Yamhill	211.5	91.8	390.8	0	0	0
Washington	Clallam	70.1	119.6	235.6	257.8	191.5	457.4
	Clark	332.0	47.9	218.3	0	0	0
	Cowlitz	528.1	416.5	760.2	35.1	29.2	16.0
	Grays Harbor	553.8	247.3	785.2	907.8	551.5	385.9
	Island	107.9	42.6	126.8	32.2	6.3	4.8
	Jefferson	180.4	112.5	395.8	111.8	94.5	94.7
	King	374.7	270.3	319.5	160.7	185.7	69.9
	Kitsap	161.3	58.9	238.0	0	11.7	5.1
	Lewis	341.4	731.4	950.7	151.5	226.9	170.3
	Mason	582.7	93.0	584.3	32.7	33.3	8.5
	Pacific	80.0	306.0	506.8	330.5	612.5	268.7
	Pierce	257.4	272.6	402.9	161.5	156.2	80.5
	San Juan	140.2	74.6	183.4	0	0	0
	Skagit	131.8	114.5	123.0	126.2	202.9	86.7
	Skamania	156.6	119.3	217.8	7.3	23.5	21.9
	Snohomish	207.0	103.1	237.2	118.5	83.3	136.4
	Thurston	344.2	159.3	364.2	0	0	0
	Wahkiakum	114.5	116.0	83.2	159.4	23.6	16.1
	Whatcom	73.3	22.8	70.7	77.0	74.2	33.5

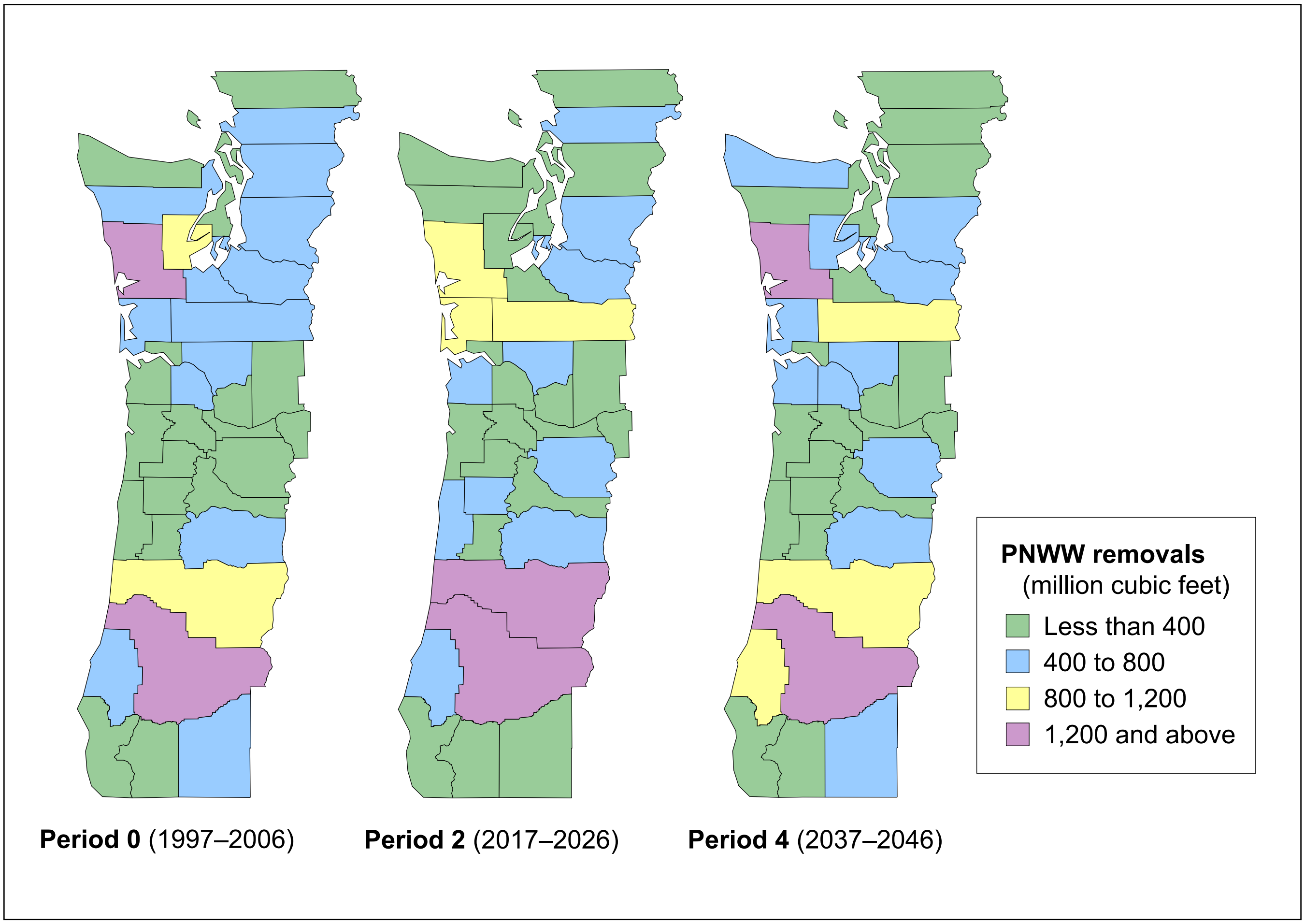

Figure 14—County removals at various projection periods for all ownership, RPA base case.

database of tree information[4] including diameter, age, lumber grade, and yield, product proportions from a tree were estimated with the explanatory variables of age and diameter for Douglas-fir and western hemlock. To simplify this analysis, visual lumber grades were combined into four broad value classes (Barbour et al. 2005). They were appearance (Shop and better), general Construction (No. 1 and No. 2 lumber), Select Structural, and Utility and Economy.[5] The multinomial

[4] This database is maintained by the Ecologically Sustainable Production of Forest Resources team of the Forest Service, Pacific Northwest Research Station, Portland, Oregon.

[5] The appearance category includes Selects and Factory Lumber such as clears and shops that have the highest dollar value and are typically used for finish applications. Select Structural includes only the Select Structural grade and was intended to indicate the amount of lumber that might be available for higher value structural uses. Construction lumber includes No. 1 and No. 2, Standard and Construction, and No. 4 and better Commons plus any heavy timbers or other grades that are typically used for structural purposes. Utility and Economy includes Utility and Economy plus No. 5 Common and other grades that capture the lowest value lumber.

Table 4—County removals by selected period for all ownerships, Resources Planning Act (RPA) base case and Northwest Forest Plan (NWFP) case

State	County	1997–2006 Base case	1997–2006 NWFP case	2017–26 Base case	2017–26 NWFP case	2037–46 Base case	2037–46 NWFP case
				Million cubic feet			
Oregon	Benton	110.7	137.3	233.1	226.4	215.0	218.1
	Clackamas	253.7	257.7	533.8	523.0	496.2	572.7
	Clatsop	381.5	368.8	601.6	628.5	438.1	465.1
	Columbia	408.5	422.9	250.9	266.5	474.0	481.8
	Coos	670.5	679.1	782.6	759.1	839.0	800.2
	Curry	200.4	206.7	146.0	129.9	321.0	344.8
	Douglas	1409.2	1421.6	1477.5	1516.1	1881.0	1672.8
	Hood River	29.2	26.3	53.3	55.3	27.4	27.3
	Jackson	597.5	570.2	339.7	366.4	504.5	495.2
	Josephine	77.6	65.5	161.1	208.9	171.3	101.7
	Lane	1054.5	1056.0	1350.6	1335.7	1146.0	1163.4
	Lincoln	330.0	309.2	510.1	495.2	299.1	292.8
	Linn	405.4	465.2	776.9	736.7	461.1	467.2
	Marion	284.2	253.8	83.6	96.7	63.3	75.3
	Multnomah	45.5	45.8	36.0	35.9	11.3	10.3
	Polk	283.7	274.3	427.9	450.5	319.2	299.3
	Tillamook	132.1	126.3	272.3	292.2	309.2	264.3
	Washington	16.7	14.2	288.7	273.6	152.9	132.9
	Yamhill	216.0	232.0	133.4	132.0	330.3	312.0
Washington	Clallam	382.3	400.5	367.0	352.5	654.6	655.8
	Clark	349.0	328.3	125.7	134.9	94.9	84.6
	Cowlitz	684.2	655.5	524.9	522.2	703.9	736.6
	Grays Harbor	1662.8	1719.2	1002.3	973.7	1245.6	1272.5
	Island	143.8	144.8	53.4	52.5	42.4	48.9
	Jefferson	404.7	365.0	277.3	284.5	350.9	374.7
	King	722.7	761.5	631.5	571.4	401.1	429.6
	Kitsap	190.5	204.7	103.2	95.2	101.2	117.9
	Lewis	617.9	606.5	1149.6	1153.4	1128.6	1181.4
	Mason	806.2	801.2	166.5	173.3	496.6	473.5
	Pacific	623.0	600.8	957.4	963.7	780.2	829.5
	Pierce	562.5	575.0	491.2	470.4	431.3	424.3
	San Juan	186.6	189.0	111.4	88.2	43.2	50.6
	Skagit	424.2	402.3	503.7	542.7	231.8	230.0
	Skamania	173.3	191.2	158.0	146.3	229.8	238.0
	Snohomish	495.4	488.6	324.4	326.3	349.6	369.2
	Thurston	431.2	406.4	295.5	305.6	326.5	335.4
	Wahkiakum	273.9	273.8	156.3	158.7	120.6	112.9
	Whatcom	270.9	264.3	269.2	282.7	183.1	212.4

Table 5—County removals by selected period for each ownership, Resources Planning Act base case

State	County	National Forest System			Forest industry			Nonindustrial private		
		1997–2006	2017–2026	2037–2046	1997–2006	2017-2026	2037–2046	1997–2006	2017–2026	2037–2046
		Million cubic feet								
Oregon	Benton	0.9	1.3	2.3	68.6	2.8	60.2	41.1	229.0	152.5
	Clackamas	28.5	49.3	68.0	8.2	333.6	218.8	217.0	150.9	209.4
	Clatsop	0	0	0	308.6	578.9	402.8	72.8	22.8	35.3
	Columbia	0	0	0	289.5	163.4	373.7	119.0	87.4	100.3
	Coos	4.0	6.7	9.6	395.8	486.1	435.3	270.6	289.9	394.2
	Curry	11.0	16.5	24.5	20.2	51.9	157.3	169.1	77.6	139.2
	Douglas	54.0	86.0	116.8	1,131.9	1,083.6	1,096.1	223.4	307.9	668.1
	Hood River	5.7	9.7	13.3	3.3	38.4	11.5	20.2	5.2	2.6
	Jackson	14.4	27.6	41.1	410.7	225.7	370.5	172.5	86.5	92.8
	Josephine	7.9	14.7	21.4	.9	61.8	3.7	68.7	84.5	146.2
	Lane	73.1	112.6	143.8	717.6	952.0	745.9	263.8	285.9	256.3
	Lincoln	5.4	9.4	12.0	95.9	402.2	174.1	228.7	98.5	113.0
	Linn	21.4	35.6	50.1	128.3	454.2	209.1	255.7	287.1	201.8
	Marion	6.7	11.9	18.1	102.1	19.8	9.0	175.4	51.9	36.3
	Multnomah	3.4	5.9	7.9	.1	13.1	3.4	42.0	16.9	0
	Polk	.1	.1	.1	233.0	375.6	253.6	50.6	52.2	65.5
	Tillamook	2.5	5.0	7.1	94.4	219.1	241.1	35.3	48.2	61.1
	Washington	0	0	0	.6	106.6	0	16.1	182.1	152.9
	Yamhill	.1	1.6	3.3	149.2	79.5	290.6	66.6	52.2	36.3
Washington	Clallam	9.2	14.6	21.8	264.6	270.3	557.0	108.4	82.1	75.7
	Clark	0	.1	.1	204.4	8.7	22.3	144.5	116.9	72.6
	Cowlitz	.8	1.0	1.0	509.5	435.7	589.1	173.9	88.2	113.7
	Grays Harbor	7.4	12.6	15.4	1,462.4	731.5	812.1	193.0	258.2	418.2
	Island	0	0	0	0	0	0	143.8	53.4	42.4
	Jefferson	7.1	11.8	16.8	107.0	117.5	124.1	290.6	148.0	210.0
	King	14.7	24.1	30.8	493.5	354.7	238.9	214.6	252.7	131.4
	Kitsap	0	0	0	0	0	0	190.5	103.2	101.2
	Lewis	20.5	32.7	44.4	331.3	912.6	691.6	266.1	204.3	392.7
	Mason	4.1	6.5	9.5	566.9	87.5	293.0	235.3	72.5	194.1
	Pacific	0	0	0	476.8	898.9	594.3	146.2	58.5	185.8
	Pierce	3.8	6.1	8.3	379.8	311.7	301.6	179.0	173.4	121.4
	San Juan	0	0	0	0	0	0	186.6	111.4	43.2
	Skagit	21.9	31.9	38.7	237.4	360.7	101.7	164.9	111.1	91.3
	Skamania	27.6	46.5	67.4	81.7	60.8	129.3	63.9	50.7	33.1
	Snohomish	13.9	21.9	35.1	282.6	140.3	169.7	199.0	162.1	144.8
	Thurston	0	0	0	277.7	107.1	150.5	153.5	188.4	176.0
	Wahkiakum	0	0	0	273.9	147.1	68.4	0	9.2	52.2
	Whatcom	12.2	22.5	31.4	195.7	109.6	18.0	63.0	137.1	133.7

logit model was employed to estimate the yield proportion of each value class by using either age or d.b.h. as explanatory variable. The resulting models show strong relations between the yields of the four lumber value groups and age (fig. 15a and 16a) and diameter (fig. 15b and 16b). When these models are applied to estimate removals by value class based on projections of removals by species and diameter or age, the result suggests that most if not all of any potential shift in visual grade yield has already occurred for coastal Oregon and Washington. Figures 17 and 18 show the percentage of each value class based on the age of removals for Douglas-fir and hemlock during each of three periods (1997–2006, 2017–26, and 2037–46). For both species, the percentage of each value class is essentially constant across all three periods in spite of the fact that the age and size of removals continue to decline for the FI and NIPF ownership groups (these are by far the largest contributors to the region's timber production). This suggests that as far as visual grades are concerned, the transition to a young-growth resource with fairly uniform characteristics has already occurred. This means that as the industry continues the shift to harvesting and processing smaller, younger trees little change in visual lumber grade yield should be expected. Additional evidence of this shift and its completion is provided in Warren (1991, 2003).[6] Table 9 in Warren documents a decline in the production of appearance grades and Utility and Economy along with a corresponding increase in the amount of general Construction lumber from the late 1970s through the late 1980s. In recent years, the industry summaries reported by Warren (2003) have more or less leveled off to a new equilibrium where very little appearance grade lumber is manufactured in the coastal half of the region, and the bulk of the production is in the general construction lumber category. This is typical of young vigorous stands of managed timber where defects are minimal and branch size is controlled by early spacing (Barbour 2004).

The projections made here do not account for the potential change in basic wood properties that could potentially occur as a result of the continuing decline in harvest age on private industrial and nonindustrial land. As tree age for both hemlock and Douglas-fir dips below about age 40, the proportion of juvenile wood is expected to increase to the point where a substantial reduction in mechanical properties begins to occur. Evidence of this erosion of mechanical properties was reported by Barbour et al. (2003) based on the change in yields of machine stress rated lumber for both species from trees in the 40-to-60-year age class and trees in the 40-and-under age class. Although there was some change in visual grade between these two age classes, it was not nearly large enough to account for the

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[6] The complete data set is published in appendix 2 tables 10 and 12 in Haynes and Fight (2004).

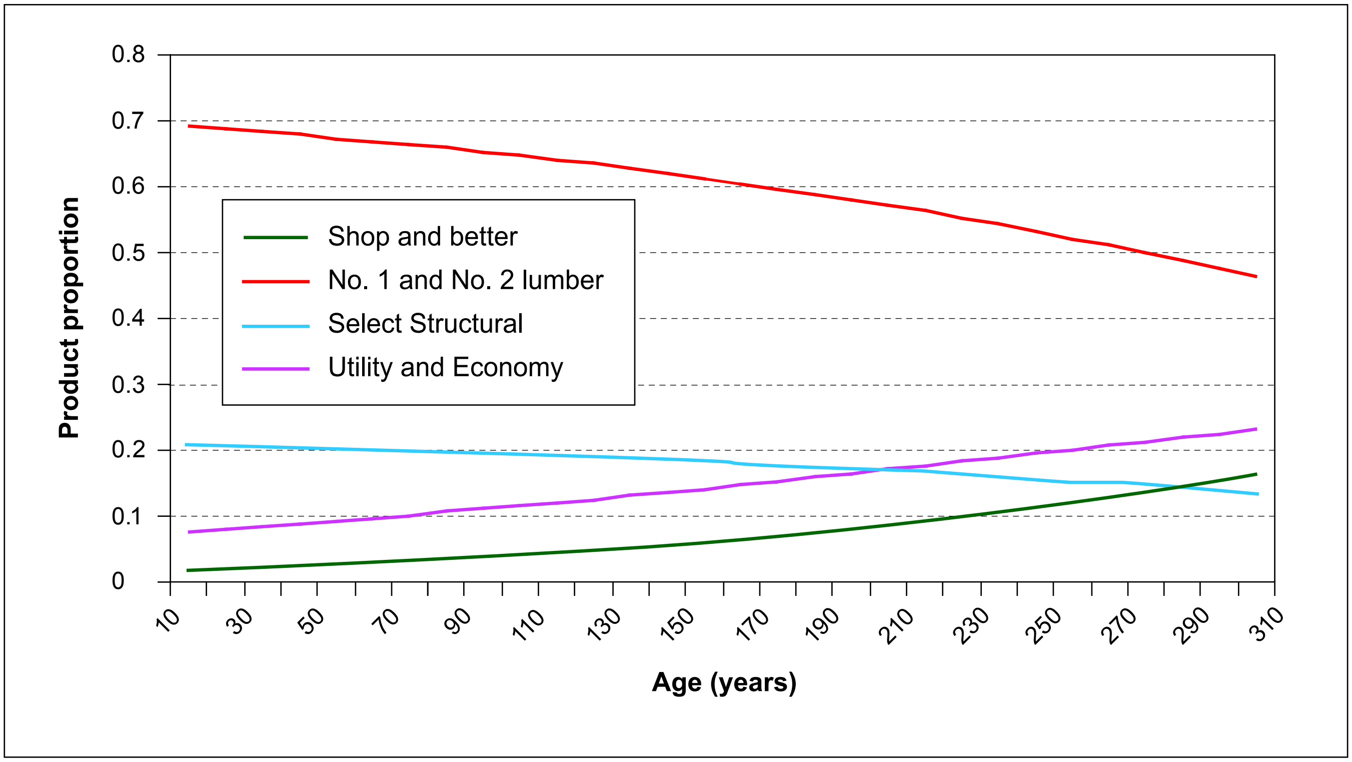

Figure 15a—Pacific Northwest west side Douglas-fir product proportion by age.

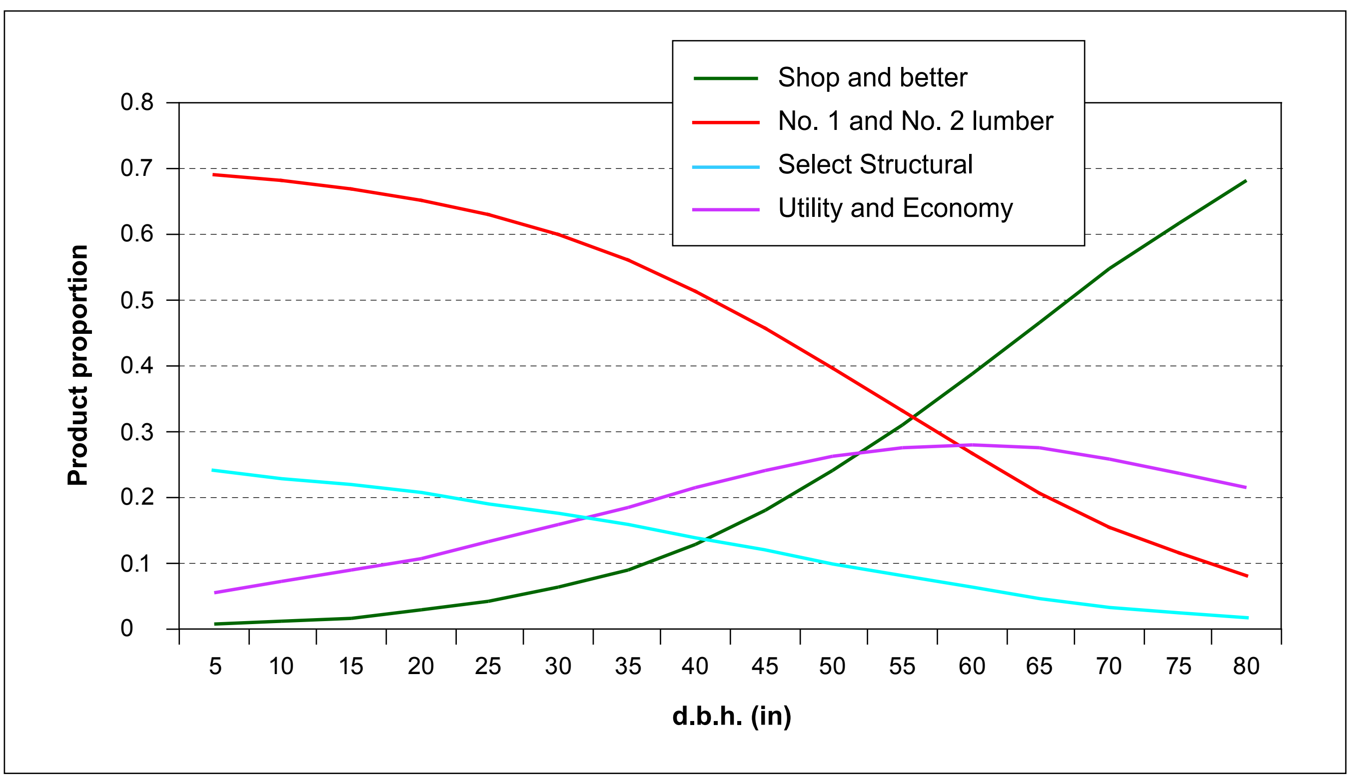

Figure 15b— Pacific Northwest west side Douglas-fir product proportion by diameter at breast height.

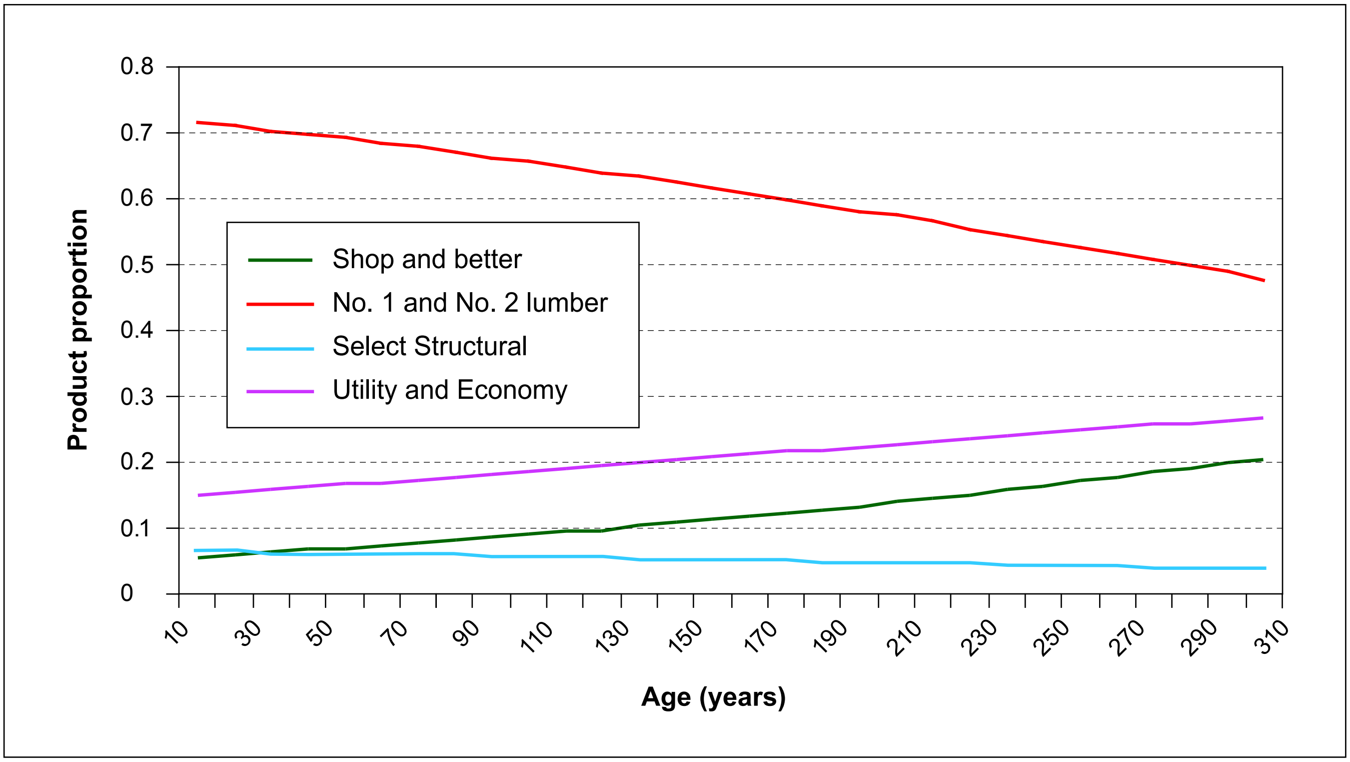

Figure 16a—Pacific Northwest west side Hemlock product proportion by age.

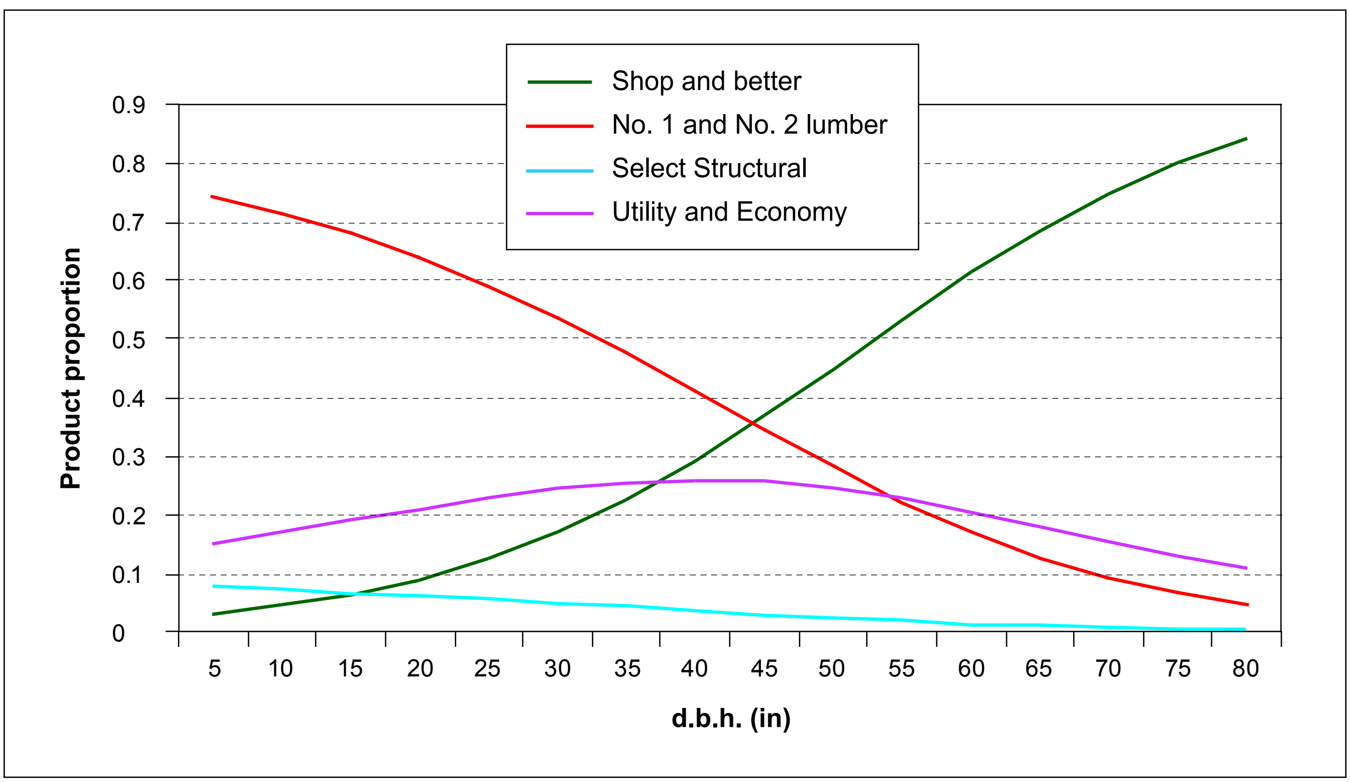

Figure 16b— Pacific Northwest west side Hemlock product proportion by diameter at breast height.

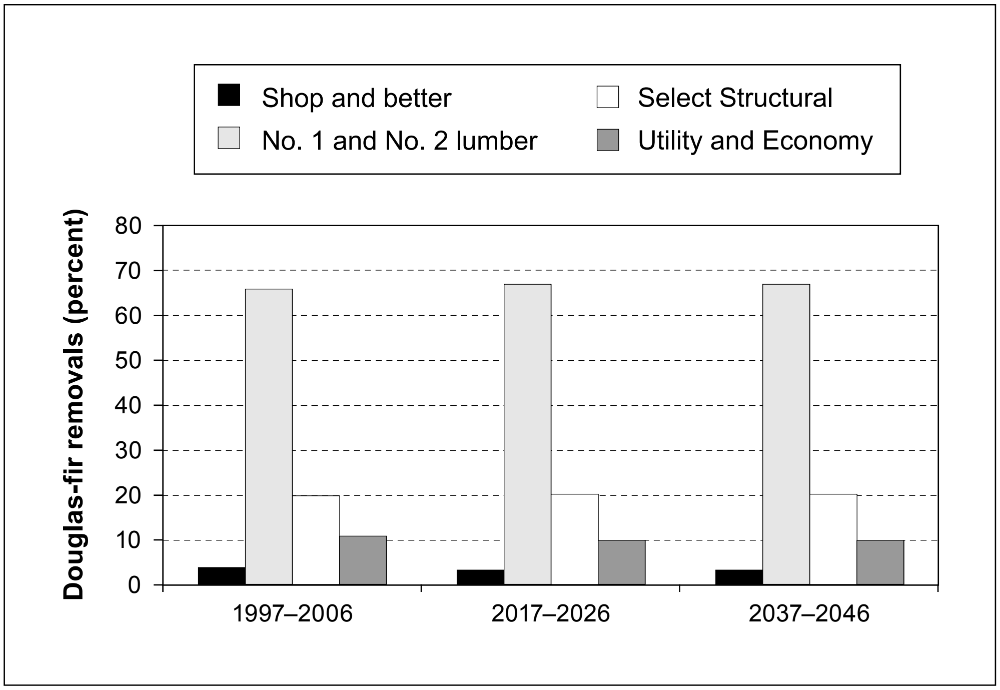

Figure 17—Projected proportion of each value class from Douglas-fir removals by period, all ownerships.

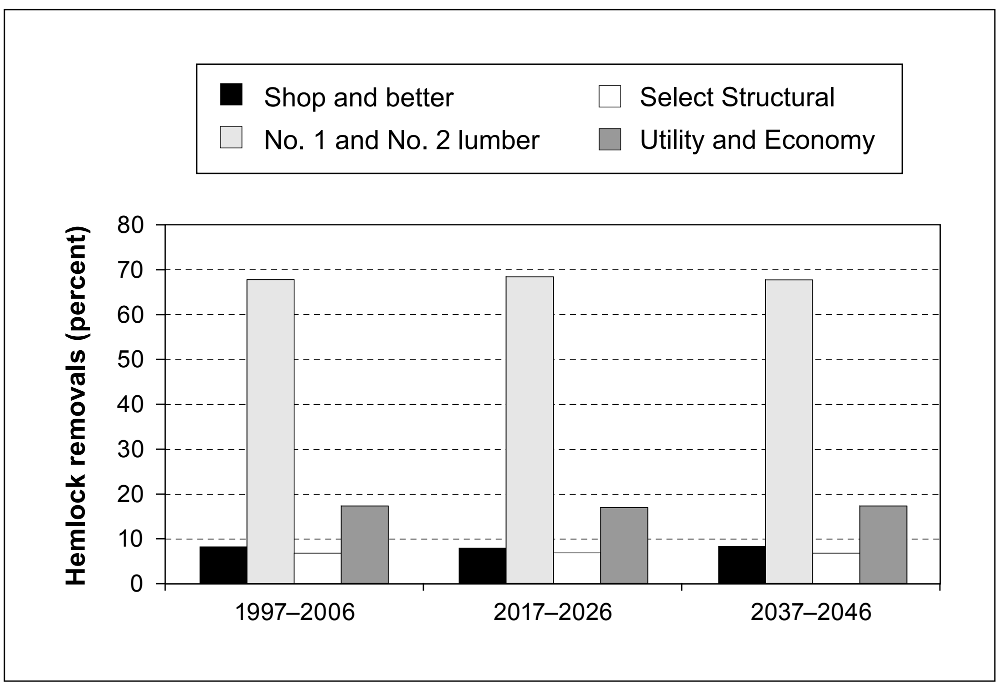

Figure 18—Projected proportion of each value class from Hemlock removals by period, all ownerships.

major drop in the yield of higher stress ratings of mechanically graded lumber. This result suggests that although manufacturers will be able to produce lumber with acceptable visual characteristics from a resource less than 40 years old, the lumber might not have mechanical properties that meet the requirements of the higher grades. This is particularly true for hemlock and is somewhat less of an issue for Douglas-fir. This could have a major influence on the ability to use this material for engineered wood products but might be alleviated through tree breeding programs and other silvicultural practices.

Discussion and Summary

The Pacific Northwest west-side is one of the major timber production regions in the Nation. Although the total removals for this region are projected to increase over 50 percent by 2050 from current levels, inventories will be sustained for the next 50 years. Douglas-fir remains the major species accounting for 63 percent of total removals for 1997–2056 (fig. 5). Relatively quickly all Douglas-fir removals from private lands will represent the 45- to 65-year age classes. The national forest will provide older Douglas-fir but in relatively limited volumes. Almost 50 percent of the total timber removals will come from the 10 west counties (see table 2), including Douglas, Lane, Coos, Linn, and Clatsop in Oregon, and Grays Harbor, Lewis, Pacific, Cowlitz, and King Counties in Washington, where much of the private land base is located. The sizes of future timber will be similar to log mixes today except for fewer logs in the 24-in plus category (both because of the collapse of the export market (which focused on logs larger than 14 in)[7] and relatively low level of NFS removals). As industrial and nonindustrial private landowners continue to reduce the harvest age of removed Douglas-fir and hemlock, only minimal changes in visual lumber grade yield are anticipated. If harvest age falls much below 40 years, substantial changes in mechanical properties of both species, but particularly hemlock, could occur. Although this might not interfere with visual grading it might have a major influence on mechanical grade yields and the ability to use this material for engineered wood products. These changes emphasize the need for further studies on lumber grade yields related to the different species and tree diameter or age classes

Finally, like all projections, these reflect a number of underlying assumptions that would be improved with further information. One critical assumption is that forest management in each county mirrors what is taking place across the region. One implication of the current assumption is that forest management is probably

[7] Japanese log sorts require straight logs with a clean, smooth surface. Logs for the higher grades must average 36 ft and have a small-end diameter of at least 14 in.

overstated for counties where forest management activities are less common (say near urban areas) and understated in other areas.

Improving this assumption is difficult, however, given the periodic nature of forest inventories and surveys of landowner's management intentions. These projections in their current form do provide a powerful starting point for discussion of how forest resources might evolve in this region. As a region with a rich history of forest management (see Haynes et al. 2003 for details), these projections suggest a future where landowners and managers improve forest stewardship by responding to the challenges imposed by changing markets and land uses.

Metric Equivalents

When you know:	Multiply by:	To get:
Inches (in)	2.54	Centimeters
Feet (ft)	0.3048	Meter
Cubic feet (ft^3)	.0283	Cubic meters
Acres	.405	Hectares
Thousand board feet, log scale	4.53	Cubic meters, log scale

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Appendix: Management Assumptions

For National Forest System (NFS) timberland, only one site class was used, and we only conducted the cutting for midage class 85 years and older. Our decision of harvest type used in the model was based on a survey of national forest regional silviculturists coordinated by Burch (1999).[1] We also assumed that NFS timberland area would remain constant through the projection period.

For nonindustrial private forest timberlands, the management intensity was described in the fifth RPA timber assessment (Haynes 2003) as follows:

> Pacific Northwest West—Management intensity classes (MICs) were developed for the Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco) and western hemlock (*Tsuga heterophylla* [Raf.] Sarg.) forest types as stratified by three site productivity classes. Both forest industry and nonindustrial private owners were assumed to employ the same practices, what varied was the amount of area each management invested under the various regimes (as discussed later). Five regimes were developed to represent Douglas-fir management: (MIC-1) custodial management; (MIC-2) plant only; (MIC-3) plant and precommercial thin; (MIC-4) plant with genetically improved stock, precommercial thin, and fertilize; (MIC-5) all of MIC-4 plus commercial thinning. Differences in growth by treatment varied by site class, age class, initial stocking, and density change parameters. Figure 5 shows a summary of the average projected volume by age for Douglas-fir on forest industry lands when we aggregate across site classes. It can be seen that available volume is reduced from commercial thinning at age 45, which is the first age class that allows final harvesting for industrial stands. Just two regimes were developed for western hemlock, these were: (MIC-1) custodial management; and (MIC-3) plant and precommercial thin.

[1] Burch, F. 1999. Two decades of national forest harvest assumptions: regional silviculturists survey results by region and forest type. Unpublished report. [No pagination]. On file with: John Mills, Portland Forestry Sciences Laboratory, Pacific Northwest Research Station, P.O. Box 3890, Portland, OR 97208-3890.

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