# THE INTERIOR DOUGLAS-FIR RESOURCE: CURRENT STATUS AND PROJECTIONS TO THE YEAR 2040

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## ABSTRACT

Stands that contain interior Douglas-fir occupy more than 40 million acres of forest land in the Western United States. In the Rocky Mountain States the species dominates, accounting for 24% of the standing inventory volume. Nearly three-fifths of the volume is in trees less than 17 inches diameter at breast height (d.b.h.), and only 10% is in trees larger than 29 inches d.b.h. Currently, net annual growth is exceeding annual removals by more than 2:1. Projections to the year 2040, however, show harvest increasing and Douglas-fir inventories declining.

**Keywords:** inventory, area, volume, growth, removals, mortality

## INTRODUCTION

Douglas-fir, a species of dichotomies, was discovered on Vancouver Island in British Columbia, but it was initially known as Oregon pine. It was first observed by Archibald Menzies, a Scottish physician and naturalist, in 1793, but named for David Douglas, the Scottish botanist who studied the tree in 1825 (Harlow and Harrar 1950). Menzies finally got his due, however, when the species' scientific name was changed to *Pseudotsuga menziesii* in the mid 1900s. The scientific name literally translates to false hemlock while the common name would place it in the genus *Abies,* but it is neither.

Rather it is a dimorphic species with two distinct forms—one grows along the Pacific Coast and the other favors the interior West. This paper deals primarily with the interior variety, but a comparison of it and its coastal cousin will help set the stage for subsequent discussions of the range of the species, the area it occupies, its volume, how it is behaving—that is, growing, dying, and being harvested—and finally, what the future holds for interior Douglas-fir.

## CHARACTERISTICS

The two North American varieties share several features. They both have flat, linear needles that grow directly from the branch and narrow at the base into short but distinct petioles—one feature that differentiates Douglas-fir from the true firs. The buds are cigar shaped. The bark on young trees is smooth and gray with resin blisters. On older specimens the bark is thick and furrowed, black to reddish-brown outside and marbled cream and brown beneath (Brockman 1986).

The differences between the two forms range from subtle to distinct. For example, the foliage of the interior variety is usually blue-green while the foliage of the coastal version exhibits more yellow-green. Examples of each, however, have been found displaying the "opposite" color. On average, interior Douglas-fir is somewhat smaller than its coastal cousin. The average diameter at breast height (d.b.h.) of the two is about equal at approximately 11 inches. The coastal variety, however, has an average height that is 10-15 feet taller. The maximum height observed for each form is also quite different, being 259 feet for a western Oregon specimen, while the "champ" for the interior is a 200 footer found in Idaho (Table 1).

Aside from foliage color and tree size, an additional characteristic separates the two varieties: the structure of their cones. Trees found on the coast have cones that are 4 inches long with straight, more or less flat bracts. The cones of interior Douglas-fir are smaller, only 3 inches long, and have bracts that are exserted and strongly reflexed.

## RANGE

Interior Douglas-fir can be found as far north and west as northcentral British Columbia and as far south and east as Cordova, Mexico (Little 1971) (Figure 1). In total, the range covers approximately 35° of latitude and 30° of longitude making it one of, if not the most, dispersed ranges of any western species. The interior and coastal varieties intermingle in western British Columbia but become more or less distinct in the United States.

Interior Douglas-fir is concentrated in eastern Washington, eastern Oregon, Idaho, western Montana, and northwestern Wyoming. As the range extends southward the species is found principally in the mountainous regions of Utah, Colorado, Arizona, and New Mexico, with a small amount slipping into eastern Nevada.

Because resource information from the Forest Survey Research Work Units of the Intermountain and Pacific Northwest Research Stations was used to derive the acreage and other resource estimates presented here, a distribution map based on the presence of interior Douglas-fir on Forest Survey field locations was generated. As expected, the distribution closely approximates that derived by Little (1971) and verifies that the data generated from these locations are representative of the species, with the exception of those areas where it is found almost exclusively on National Forest System (NFS) lands, such as in Arizona and Nevada (Figure 2). In fact, there would be an almost perfect correspondence between the areas where Douglas-fir occurs and the land administered by the NFS in the southern Rockies if maps for each were overlaid.

Within its range, where the species will actually be found is dependent upon several factors including climate, soils, and elevation.

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Table 1.—Description of individual tree characteristics for Douglas-fir in the West by state.

| State | Tree Characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | d.b.h (in) | | Height (ft) | | Volume | | | |
| | | | | | Cubic feet | | Board feet[1] | |
| | Mean | Max | Mean | Max | Mean | Max | Mean | Max |
| INTERIOR DOUGLAS-FIR REGION | | | | | | | | |
| Northern Rocky Mountains | | | | | | | | |
| Idaho | 13.6 | 80.6 | 64 | 200 | 38 | 866 | 226 | 4,981 |
| Montana | 11.3 | 49.9 | 52 | 178 | 22 | 509 | 134 | 2,682 |
| Wyoming | 11.3 | 42.2 | 43.1 | 106 | 23 | 226 | 148 | 1,203 |
| Southern Rocky Mountains | | | | | | | | |
| Arizona | 7.3 | 15.2 | 34 | 71 | 5 | 25 | 95 | 105 |
| Colorado | 10.8 | 41.9 | 41 | 127 | 21 | 221 | 119 | 1,178 |
| Nevada | – | – | – | – | – | – | – | – |
| New Mexico | 9.3 | 33.4 | 39 | 105 | 18 | 166 | 105 | 827 |
| Utah | 12.4 | 44.7 | 49 | 125 | 29 | 301 | 150 | 1,537 |
| The Pine Subregion | | | | | | | | |
| E. Oregon | 10.0 | 50.8 | 55 | 169 | 15 | 414 | | |
| E. Washington | 10.0 | 75.9 | 60 | 232 | 17 | 1,305 | | |
| COASTAL DOUGLAS-FIR REGION | | | | | | | | |
| W. Oregon | 10.7 | 77.0 | 66 | 259 | 25 | 1,542 | | |
| W. Washington | 10.9 | 75.8 | 74 | 257 | 28 | 1,596 | | |
| California | 11.4 | 73.2 | 62 | 234 | 34 | 1,696 | | |

[1]International 1/4-inch rule.

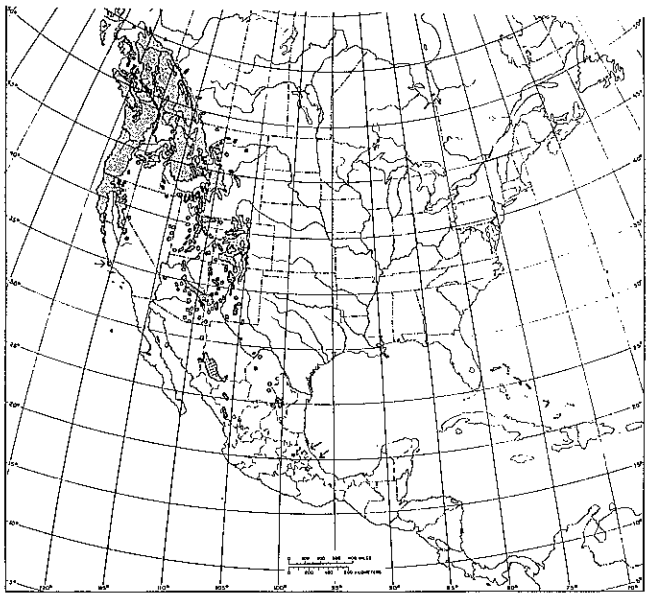

Figure 1.—The range of interior and coastal Douglas-fir (the broken line separates eastward the interior variety *P. menziesii* var. *glauca* and westward the Coastal variety *P. menziesii* var. *menziesii*, Little 1971).

## CLIMATE

The occurrence of interior Douglas-fir is correlated with both temperature and moisture (USDA 1965). The species appears to prefer areas that are warm but not hot during the summer and cold but not frigid during the winter. Moisture is important year round with some tolerance for summer deficiencies.

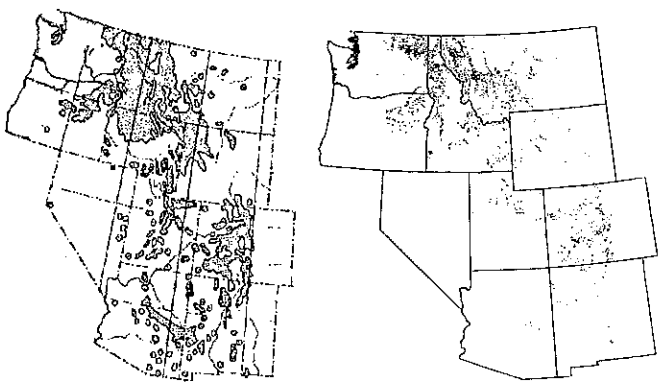

Figure 2.—Comparison of the range of interior Douglas-fir from Little (1971) (left) with that generated from Forest Survey field locations (right).

As the species range moves from south to north, temperature tolerance increases while average summer moisture decreases. Winter moisture, however, increases at the northern limits of the range, apparently offsetting the lack of summer rainfall. Throughout the Rocky Mountains the Douglas-fir zone essentially occurs above the areas most suitable for ponderosa pine and below those preferred by Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). In those areas where Douglas-fir is the pioneering timber species, such as along the Wasatch Front in Utah, it grows on north-facing slopes and in shaded areas. As the range extends elevationally, Douglas-fir grows best on sunny, less shaded exposures.

Throughout the interior West, Douglas-fir is found on sandstone and granitic soils, except in the Southwest where it occurs on soils of limestone or granite origin (USDA 1965).

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## ELEVATION

According to the literature, interior Douglas-fir can be found as low as 1,900 feet in the northern Rockies and as high as 9,500 feet in the southern Rockies. Our data, however, found the species has an elevational distribution from 1,400-11,000 feet. The upper and lower limits change depending upon where within the range the species is observed (Table 2). In the northern Rocky Mountains, for example, the average elevation of our plots was between 3,600 and 4,800 feet. In New Mexico Douglas-fir plots had an average elevation of 8,300 feet. If tree size is an indication of what the species prefers, we find that in the northern Rockies an elevation of 2,400 feet is preferred, while in the southern Rockies interior Douglas-fir grows best at about 9,000 feet.

Table 2.—Elevational range for Douglas-fir in the West by state.

| State | Elevation | |
|---|---|---|
| | Mean | Range |
| | ——Feet above sea level—— | |
| INTERIOR DOUGLAS-FIR REGION | | |
| Northern Rocky Mountains | | |
| Idaho | 3,600 | 1,400- 7,800 |
| Montana | 4,800 | 2,000- 8,500 |
| Wyoming | 7,900 | 6,000- 9,600 |
| Southern Rocky Mountains | | |
| Arizona | 6,200 | 5,300- 7,200 |
| Colorado | 8,600 | 5,800-10,600 |
| Nevada | — | — — |
| New Mexico | 8,300 | 7,000-11,000 |
| Utah | 8,100 | 5,000-10,000 |
| The Pine Subregion | | |
| E. Oregon | 4,049 | 1,900- 7,001 |
| E. Washington | 3,060 | 328- 6,070 |
| COASTAL DOUGLAS-FIR REGION | | |
| W. Oregon | 1,390 | 10- 4,701 |
| W. Washington | 903 | 0- 3,642 |
| California | 2,428 | 10- 6,200 |

## AREA

Within the range of interior Douglas-fir, it predominates on 19.6 million acres and is second only to ponderosa pine (*Pinus ponderosa*) in total area occupied (Figure 3) (Waddell *et al.* 1989). Even though the area on which the interior Douglas-fir type predominates is substantial, the species occurs on several million additional acres. A screen of inventory data recently taken in the Rocky Mountain states indicates that for every acre classified as Douglas-fir forest type there is a companion acre where it is present as a subordinate in association with other, more dominant species.

Of the 19.6 million acres in the interior Douglas-fir type, some 73% is found in three states—eastern Washington, Idaho, and western Montana. In these areas the type is the predominant forest condition, accounting for nearly three-fourths of the total forest land. Montana has the largest concentration with over 6 million acres, which represents more than 35% of the state's forested areas.

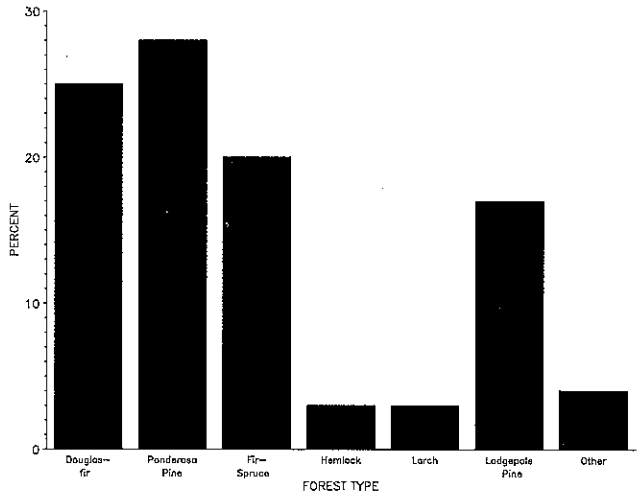


Figure 3.—Distribution of timberland in the Western United States by forest type (USDA, in press).

As the range extends southward into the central Rocky Mountains, interior Douglas-fir more or less shares equal billing with ponderosa pine, although both are upstaged by the fir-spruce type. In the southern Rockies ponderosa becomes the dominant type outnumbering interior Douglas-fir acreage by more than 3:1 in New Mexico and 14:1 in Arizona.

Where interior Douglas-fir occurs the ownership distribution of the area the species occupies remains relatively stable. With the exception of eastern Oregon, the majority stockholder is the National Forest System. On average, the NFS share of the Douglas-fir acreage is nearly 55%. In states in the Southwest, the National Forests administer nearly all of the Douglas-fir type. In eastern Oregon, however, less than 25% of it is in the National Forests.

Nearly 5 million acres is privately held, with the Farmer and Other Private category accounting for 3.5 million acres and Forest Industry ownerships containing about 1.5 million acres.

The areas that interior Douglas-fir occupy are generally better than average in productivity. More than one-fifth of the sites are capable of producing 85 cubic feet of wood per acre per year, and the overall average for all sites is in excess of 64 cubic feet annually, compared to 58 cubic feet for the other western types. About half of the more productive sites are contained in northern Idaho. The rest are about equally distributed between eastern Washington and western Montana.

As with most of the forest lands in the Western United States, the composition of the interior Douglas-fir type tends to be predominated by sawtimber-size stands. Fully three-fourths of the area is in this category.

## VOLUME

Within the Western United States, interior Douglas-fir accounts for some 31 billion cubic feet of growing stock and is the fifth most plentiful species. The most dominant species, of course, is the coastal variety, which accounts for one-fifth of the volume and in total contributes nearly 60 billion cubic feet to the Western states inventory. The other species that exceed

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the volume of interior Douglas-fir are the true firs (*Abies sp.*) with more than 41 billion cubic feet, western hemlock (*Tsuga heterophylla*) with 37 billion cubic feet, and ponderosa pine with 33 billion cubic feet.

Within the range of interior Douglas-fir, however, the relative contribution of each species shifts markedly, and Douglas-fir becomes predominant, accounting for nearly one-fourth of the total volume in the Rocky Mountain States, eastern Oregon, and eastern Washington (Figure 4). Volume in lodgepole pine (*Pinus contorta*), ponderosa pine, and the true firs account for 19, 18, and 16% of the inventory, respectively.

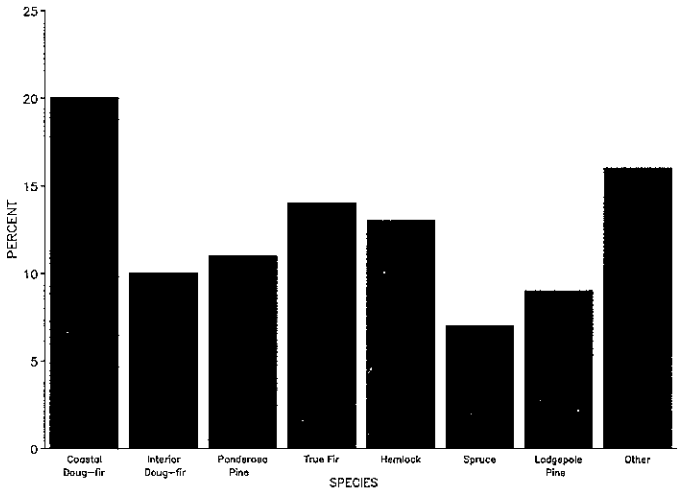


Figure 4.—Distribution of growing-stock volume on timberland in the interior West by species (USDA, in press).

In the states where interior Douglas-fir is the most predominant, the species nearly overwhelms its competition. In eastern Washington it accounts for 35% of the total volume. In Montana and Idaho the species represents 30 and 27%, respectively, of each state's standing growing-stock inventory. Altogether, these three states account for nearly three-fourths of the total volume contained in the species. As with the relative area it occupies, the proportion of a state's growing-stock volume that the species contributes diminishes as the range moves south.

The distribution of the growing-stock volume by tree-size class indicates that the future will see continued well-balanced stand development. A majority of the volume is contained in small sawtimber trees, that is, those between 9.0 and 16.9 inches d.b.h. The volume in poletimber trees is about equal to that contained in trees over 29 inches d.b.h., and large sawtimber trees account for 32% of the growing-stock volume. Furthermore, if our recent inventories are any indication, these stands also contain a substantial understory of saplings. In Idaho and Montana, for example, this component of the inventory accounted for 43 and 60% of the total stand table, respectively (Benson *et al.* 1987; Green *et al.* 1985).

Throughout the range of the species more than half of the total growing-stock volume is contained in trees under 17 inches in diameter. One exception is Arizona where more than 80% of the standing inventory is in trees larger than 17 inches d.b.h. In the northern Rockies more than half of the standing volume is again in small sawtimber and poletimber size trees with a relatively small component of volume in trees over 29 inches d.b.h.

## COMPONENTS OF CHANGE

Altogether, interior Douglas-fir is present on more than 40 million acres within the Western United States, and the standing inventory amounts to more than 31 billion cubic feet. Throughout its range, but especially in the northern Rocky Mountains, the species is an important resource for the forest products industry. Thus, the questions become how long can the inventory sustain annual withdrawals at the level it is experiencing today, and what does the future of the species hold. To answer the first question, current stand dynamics must be considered.

### Mortality

Various causal agents are killing interior Douglas-fir trees at an annual rate of about three-tenths of 1% of the standing inventory. Compared with other species and the total inventory in general, this represents about average mortality. The major causes of death, when one could be determined, are weather and disease, with insects killing their fair share.

### Growth

After deducting annual mortality, interior Douglas-fir stands are increasing at an annual rate of 2%. In real terms this equates to 685 million cubic feet per year. As would be expected, the northern portion of the range is producing the most woodsome 595 million cubic feet. This is equivalent to 40 cubic feet per acre per year and represents just over 60% of the potential annual growth attainable on those sites where interior Douglas-fir is predominant. The potential of 64 cubic feet per acre per year could be attained in fully stocked stands. This condition, however, seldom if ever exists in nature, and certainly the condition would not exist on every acre of forest land.

Within the interior Douglas-fir type in Idaho and Montana, for example, just over half of the area is actually fully stocked with growing-stock trees or those trees that would be featured in management. An additional 15% is either nonstocked or contains conditions that would preclude stocking of any kind. The remaining areas are poorly stocked or are deemed to be in mature forests. Thus, achieving 60% of the growth potential for the Douglas-fir type is commendable. Removals The third component of change that must be addressed is removals. Harvesting of interior Douglas-fir is reducing the standing inventory by just under 1% per year. Removals are less than growth throughout the area. Moreover, the growth:drain ratio indicates that inventories should be increasing. In eastern Washington and eastern Oregon, for example, harvest is equal to 60% of net growth, and in the southern Rockies only 17% of the net growth is being cut. In the northern Rockies, for every 40 cubic feet removed from the woods, 60 cubic feet are being added to the standing inventory.

The events that have shaped today's resource have generally been positive. Recent analysis (USDA, in press) indicates that the area of Douglas-fir type has increased overall, with the slight decline in acreage in eastern Washington and eastern Oregon more than offset by acreage gains in the northern and southern

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Rocky Mountains. As a result of favorable growth:drain relationships and near expected mortality, the volume the species contains is also increasing. Taken together these factors bode well for the future of interior Douglas-fir and indicate that unless catastrophic change occurs or harvesting increases drastically, the ecosystem should be able to sustain itself for some time to come. But what does the future hold and what can we expect future outcomes to be under different sets of assumptions? Well, let's see...

## THE FUTURE OF INTERIOR DOUGLAS-FIR

### Background

The projections of interior Douglas-fir presented here were derived from the Renewable Resources Planning Act (RPA) 1989 timber assessment (USDA, in press). This assessment of the national timber supply included 50-year projections of timber resources. In the process of making these projections, private timberlands were modeled explicitly, while projections for National Forests were derived from the planning process, and projections for the other public owners—state, county, BLM, etc.—were developed with simpler growth:drain techniques.

The projections of private acres resulted from the implementation of the aggregate timberland assessment system (ATLAS) (Mills and Kincaid, in press) with Forest Survey plot summary data. Yield tables and growth parameters were developed from plot data. Projections were made for the interior Douglas-fir type in conjunction with the total softwood inventory. The western softwood harvest was derived from the demand created by wood products markets modeled in the timber assessment market model (TAMM) (Adams and Haynes 1980). Softwood harvest was allocated to the interior Douglas-fir forest type based on the available volume within the type.

The projections reported for public timberlands did not directly account for the interior Douglas-fir forest type. The RPA National data base (Waddell *et al.* 1989) was used to determine the interior Douglas-fir proportion of total softwood volume and softwood growth reported on public acres for 1986. This proportion was then applied to the public softwood projections to "break out" the volume represented by interior Douglas-fir. Harvest was determined much the same way. The average proportion of interior Douglas-fir in the total softwood harvest was derived from the 1979-1988 National Forest "cut and sold" report data. The cut and sold value represented the interior Douglas-fir species. Forest Survey tree level data from private lands in eastern Washington and eastern Oregon and the Rocky Mountains were used to calculate the percentage of interior Douglas-fir volume in the interior Douglas-fir forest type. Lacking detailed National Forest data, an assumption was made that the average composition of the interior Douglas-fir type did not vary significantly among ownerships. The major assumption for the public projections is that, over time, interior Douglas-fir maintains the same relative proportion of volume, growth, and harvest. Even for such a large region, natural and human intervention could change this proportion, but for lack of better data the proportion was assumed to be constant.

Because most of interior Douglas-fir in the interior West is in National Forests, these projections are heavily weighted by the results of the National Forest Plans. For the Rocky Mountain region these projections show a 35% decline in inventory volume, a 58% decline in growth, and a 61% increase in harvest between 1986 and 2000. One might assume the sharp decline in inventory is the result of acres removed from the available timberland class for wilderness or other nontimber designation related to the implementation of the forest plans. Because total harvest increases, it might be assumed that acres remaining in the available timber class are being managed more intensively. Softwood growth as a percentage of inventory volume, however, drops by 36% between the 1986 estimate and the projected value for the year 2000. This indicates the inventory acreage or volume to be "removed" would include a larger proportion of the faster growing stands. But the question remains—are they actually being harvested or just reclassified? It is also possible that the average age of softwood stands increases, reaching an age of slower growth; that is, past the culmination of mean annual increment. As the projections will show, the impact of the National Forest growth decline is large, but the reasons for it are not clear. Though the magnitude is much smaller, a similar scenario takes place in the National Forest projections for eastern Washington and eastern Oregon.

### Projections

The projections for the interior Douglas-fir resource are dominated by the National Forest component. In 1987, NFS administered 55% of the timberland acres, 60% of the growing-stock volume, and accounted for 51% of the annual growth on growing stock.

The projections indicate that by the year 2000, total growth will have dropped 14%, harvest will have risen 15%, and total volume will have declined by 14% (Figure 5). Among ownerships, however, this trend is not consistent. Private inventories increase 19% by 2000 and then decline as harvest exceeds growth. By 2040 they are almost back at the 1987 level. Growth on private acres declines slightly over the projection. Harvest increases rapidly, however, surpassing growth around 2005 before leveling off after 2015 at 60% above the 1985 level.

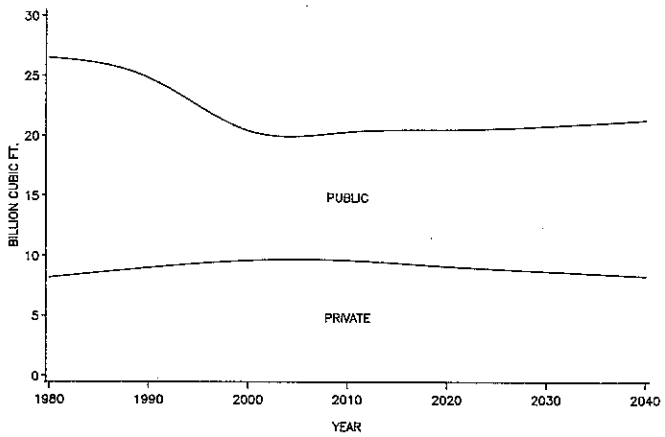


Figure 5.—Projections of interior Douglas-fir growing-stock volume by owner class 1980-2040 (USDA, in press).

The public inventories of interior Douglas-fir show the greatest decline. Between the current values and the projections for the year 2000, public inventories of interior Douglas-fir

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decrease by 6.2 billion cubic feet or 23%. Growth is down 22%, and harvest is up 15%. In 1987, interior Douglas-fir on public acres accounted for two-thirds of the growth reported. The projections for the year 2000 show the public share of growth declining to 50%. The share projected for the other public ownership was fairly constant. Thus, the change was due to the magnitude of the shift in contribution from the National Forests going from 51% to 33%.

The long-term outlook indicates that after the year 2000, the resource will remain relatively stable. At the start of the projection, growth exceeds harvest. Near-term increases in harvest, coupled with declines in growth, however, bring the inventory down. After 2000, growth and harvest are nearly equal, leading to the "flattening off" of the inventory projection.

Intensive forest management practices were not specifically modeled for interior Douglas-fir in the private sector. If one assumes management strategies will be implemented that increase growth, then growth and harvest would come into better long-term balance and future inventories will again be increasing.

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