# Douglas-Fir

## (*Pseudotsuga taxifolia*)

By H. S. Betts, *senior engineer, Division of Forest Products*

The enormous stand of Douglas-fir, the large size and splendid form of the tree, and the suitability of the wood for a wide range of building and general construction purposes make this species one of our most important sources of timber. Douglas-fir grows in the western part of the United States and Canada. Under favorable conditions exceptional trees sometimes attain an age of 1,000 years, and reach a height of 300 feet and a diameter of 10 feet. The stand of Douglas-fir saw timber in the United States is greater than that of any other native species. About three-quarters of this stand is located in western Washington and western Oregon. In amount of lumber produced annually Douglas-fir is exceeded only by the southern pines as a group.

Lumbering operations in the Douglas-fir region are conducted on a large scale. Much waste, both in the woods and at the mill, has resulted from the methods used in felling the trees, skidding the logs, transporting them to the mill, and sawing them into lumber, and also from the market conditions governing the sale of the lumber. In a field study made in 1930 covering the woods operations of 24 representative companies [1] the average amount of material left on the ground after logging operations were completed, because it did not pay to take it out, was approximately 20,000 board feet per acre. This unutilized material was sound and of cordwood size and larger. It represented about 20 percent of the volume of the timber felled in the logging operations studied. At the mill about 7½ board feet of lumber were produced from every cubic foot of logs. Sooner or later ways will undoubtedly be found to reduce the enormous volume of unused material both through improved methods of logging and milling and through new or improved processes of converting it into useful products such as paper, fiberboard, plastics, etc.

**Nomenclature.**—Douglas-fir is the name adopted by various trade and technical associations and by the United States Forest Service. Other names used are: Red fir, Douglas spruce, yellow fir, spruce, Oregon pine, fir, and Puget Sound pine.

**Distribution and growth.**—Douglas-fir grows in most of the forests from the Rocky Mountains to the Pacific coast and from Mexico to central British Columbia. (See fig. 1 for range in the United States.) It reaches its largest size and attains its fastest rate of growth in Washington, Oregon, and British Columbia in the region between the coast and the Cascade Mountains. Here large trees 3 to 6 feet and more in diameter and 200 feet and over in height form very dense forests [2] that commonly yield from 35,000 to 60,000 board feet per acre and sometimes as much as 100,000 feet.

[1] Hodgson, A. H. Logging waste in the douglas-fir region — unutilized trees left after logging in the douglas-fir region. West Coast Lumberman 57 (1) : XXXVII–XL. illus. 1930

[2] These forests may be made up of Douglas-fir alone or may include other species such as western hemlock and several of the cedars.

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FIGURE 1.—Range of Douglas-fir (*Pseudotsuga taxifolia*) in the United States.

In the eastern part of its range in the Rocky Mountains, Douglas-fir generally grows at elevations between 4,000 and 11,000 feet and is considerably smaller in size than the coast type—generally not over 1½ feet in diameter and 90 feet in height.

Douglas-fir is a vigorous, hardy tree which thrives under a wide range of soil and climatic conditions. It grows most rapidly in fairly deep, moist but well drained soils in locations where there is at least 40 inches of rainfall a year and where the growing season is long. Douglas-fir is moderately tolerant of shade when young, but with advancing age it becomes especially dependent on overhead light. Trees which are overshadowed by their neighbors quickly die. Douglas-fir has exceptional ability to form dense stands. In even-aged forests 20 years old there are normally about 900 trees to the acre, some of them over 30 feet in height. As the forest ages and competition for light becomes more intense, the weaker trees die. In a normal forest 100 years old there are about 115 trees to the acre—a large proportion of them close to 2 feet in diameter. The larger trees are approaching 200 feet in height and have nearly attained their full-height growth. Diameter growth continues much longer. Douglas-fir is a good seed producer and bears heavy crops

of cones at intervals of 2 to 4 years. The tree reproduces by seed only and not by sprouting. The seed is light and winged and is scattered widely by the wind. Douglas-fir seed germinates readily anywhere it happens to fall, provided there is sufficient moisture. If the seedlings are to survive, however, they must have light and their roots must reach mineral soil quickly.

Douglas-fir forests suffer comparatively little from attacks by fungi or insects. The only serious attacks by decay-producing fungi occur in the young seedlings and in the overmature trees. The most destructive insects are those that devour the needles or destroy the inner bark. The depredations of these pests in certain areas have resulted in the loss of millions of feet of high-quality timber.

**Supply.**—The total stand of Douglas-fir of saw-timber size in the United States was recently placed at approximately 493,000,000,000 board feet. This stand was made up as follows:

| Region: | *Stand (Board feet—lumber tally)* |
|---|---|
| Western Washington | [1] 114, 313, 200, 000 |
| Western Oregon | [1] 266, 742, 800, 000 |
| Eastern Washington | [2] 12, 814, 018, 100 |
| Eastern Oregon | [2] 20, 370, 100, 000 |
| Northern Idaho | [3] 8, 901, 400, 000 |
| Western Montana | [3] 6, 938, 800, 000 |
| California | [4] 51, 400, 000, 000 |
| South Rocky Mountain Region | [4] 12, 041, 000, 000 |
| Total stand of Douglas-fir saw timber in the United States | 493, 521, 318, 100 |

[1] See ANDREWS, H. J. and COWLIN, R. W. FOREST RESOURCES OF THE DOUGLAS-FIR REGION. U. S. Dept. Agr. Misc. Pub. 389, 169 pp., illus. 1940.

[2] See COWLIN, R. W., BRIEGLEB, P. A., and MORAVETS, F. L. FOREST RESOURCES OF THE PONDEROSA PINE REGION OF WASHINGTON AND OREGON. U. S. Dept. Agr. Misc. Pub. 490, 99 pp., illus. 1942. Also U. S. FOREST SERVICE, NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION. FOREST STATISTICS PEND OREILLE COUNTY, WASHINGTON. Forest Survey Release 2, 24 pp., illus. 1937. [Processed.] FOREST STATISTICS, SPOKANE COUNTY, WASHINGTON. Forest Survey Release 4, 24 pp., illus. 1937. [Processed.] FOREST STATISTICS, STEVENS COUNTY, WASHINGTON. Forest Survey Release 5, 24 pp., illus. 1937. [Processed.]

[3] U. S. FOREST SERVICE, NORTHERN ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION. FOREST STATISTICS FOR NORTHERN IDAHO, Forest Survey Statis. Serv. 10, illus. 1941. [Processed.] HIGHLIGHTS OF THE FOREST SITUATION IN WESTERN MONTANA. Forest Survey Statis. Serv. 14, illus. 1943. [Processed.]

[4] JOINT COMMITTEE ON FORESTRY. FOREST LANDS OF THE UNITED STATES. 77th Cong., 1st sess., Senate Doc. 32, 44 pp. 1941.

Douglas-fir made up about 61 percent of the stand of saw timber of all species in western Washington and western Oregon. In this region, in spite of the heavy cutting that has taken place, over 40 percent of the remaining stand of Douglas-fir timber was still in old-growth trees more than 40 inches in diameter. These trees furnish a large proportion of the narrow-ringed, slow-growing "yellow fir" suitable for the manufacture of high-quality lumber and veneer. Western Washington and western Oregon together contained slightly over 75 percent of the total stand of Douglas-fir of saw-timber size.

**Production of lumber.**—Among the 10 individual species listed in the lumber production statistics for 1869 [3] Douglas-fir ranked eighth with a cut of 196,000,000 board feet. (See fig. 2.) By 1906 it had moved up to second place [4] with a cut of approximately 5,000,000,000

[3] The first year for which lumber-cut statistics (Bureau of the Census) are available for Douglas-fir as a separate species.

[4] Southern pine, including the various commercial species of the southern yellow pines, ranked first.

board feet and continued to hold second place from 1906 to 1931. In 1931 the lumber production figures reported by the Bureau of the Census indicated a greater cut for Douglas-fir than for southern pine.[5] In 1932 Douglas-fir dropped back to second place again where it has remained. The maximum production of Douglas-fir lumber—8,806,000,000 board feet—occurred in 1926. Six years later, because of the depression in business, production had dropped to 2,904,000,000 board feet. In 1942, largely because of war conditions, it rose to 8,550,000,000 board feet—nearly as much as the maximum. The average annual production of Douglas-fir lumber for the 10-year period 1933–42 was 6,159,000,000 board feet. About 52 percent of this cut came from Washington and about 43 percent from Oregon. Of the small remainder, some came from each of the other 9 States within the Douglas-fir range.

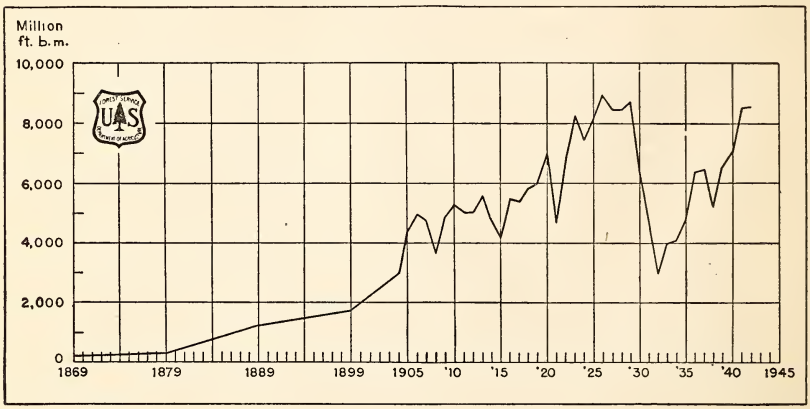


FIGURE 2.—Lumber production of Douglas-fir, 1869–1942.

**Fuel wood.**—The production of fuel wood cut from Douglas-fir of saw-timber size in western Washington and western Oregon amounted to approximately 371,000,000 board feet in 1930.[6] This does not include fuel wood cut from trees below saw-timber size or in other parts of the Douglas-fir range. It is probable that the total amount of Douglas-fir used annually for fuel in recent years would approximate 700,000,000 board feet.

**Veneer.**—The consumption of Douglas-fir logs for veneer, practically all of which is used in the manufacture of plywood, has increased markedly in recent years. In 1906 [7] it was 370,000 board feet log scale. Thirteen years later (1919) it was 10,604,000 board feet, and in 1929 it reached 162,415,000 board feet. Consumption dropped back to about 100,000,000 board feet in 1931—a year of business depression—but recovered rapidly and in 1937 Douglas-fir became the

[5] Past production figures for Douglas-fir, however, have been much more complete than those for southern pine because the production of many small southern pine mills was not reported. Such mills produce an appreciable proportion of the cut of southern pine, and revised figures on past production indicate that the cut of southern pine lumber in 1931 exceeded that of Douglas-fir.

[6] U. S. Dept. Agr. Misc. Pub. 389. (See References, p. 9.)

[7] The earliest year in which Douglas-fir veneer is listed separately in the production statistics of the Bureau of the Census.

leading wood in the production of veneer,[8] requiring the consumption of 304,000,000 board feet of logs. In 1942 the equivalent of approximately 1,800,000,000 square feet of three-eighths inch 3-ply plywood was produced,[9] requiring about 783,000,000 board feet of veneer logs.[10] This figure represents nearly 50 percent of the total quantity of wood used for veneer in the United States. The increase in the production of Douglas-fir veneer for plywood since 1938 is due to the extensive use of plywood for war construction of various kinds. The average annual consumption of Douglas-fir veneer logs for the 10-year period 1933–42 was about 400,000,000 board feet.

**Cooperage.**—The production of Douglas-fir cooperage stock has fallen off considerably in recent years. The average annual production of slack cooperage for the period 1935–39 was 22,503,000 staves and 1,319,000 sets of heading.[11] The maximum production of staves (over 52,000,000) occurred in 1925 and the maximum production of heading (2,315,000 sets) in 1929. The maximum production of Douglas-fir tight cooperage stock was approximately 80,000,000 staves in 1929 and 5,638,000 sets of heading in 1931. The only year for which production figures are available on tight cooperage since 1931 is 1939. In that year production amounted to 19,573,000 Douglas-fir staves and 1,445,000 sets of heading. The slack staves and heading produced in recent years from Douglas-fir are equivalent to about 10,000,000 board feet and the tight staves and heading to about 25,000,000 board feet—a total for all Douglas-fir cooperage of approximately 35,000,000 board feet.[12]

**Poles, piling, and railroad ties.**—Statistics on the production or consumption of poles, piling, and ties[13] are not available except those that are given a preservative treatment before being placed in service. The average number of these products made from Douglas-fir and treated annually[14] in the 10-year period 1931–40 was approximately as follows: Poles—28,500; piling—2,373,000 linear feet; and ties—3,848,000. An appreciable but indeterminate proportion of Douglas-fir poles, piling, and ties are used without treatment. The proportion of treated material is placed roughly at from two-thirds to three-fourths of the total amount used. It is probable that the combined average annual production of Douglas-fir poles, piling, and ties (hewed) is equivalent to approximately 35,000,000 board feet.

In addition to the Douglas-fir cut for lumber, fuel, veneer, cooperage, poles, piling, and hewed ties, indeterminate amounts are cut for mine timbers, fencing, pulpwood, etc. The average annual cut of Douglas-fir for all purposes in recent years is estimated roughly at 7,500,000,000 board feet.

**Properties.**—The wood of Douglas-fir varies widely in quality both in the Pacific coast type, which makes up all but a small proportion of

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[8] Up to 1937 sweetgum ranked first in quantity as a veneer wood.

[9] See table on Douglas-fir plywood production 1925–42. Timberman, January 1943, p. 12.

[10] Board feet log scale and board feet lumber tally in large Douglas-fir veneer logs are practically equivalent. Such logs are called "peeler" logs or "peelers."

[11] Years averaged 1935, 1937, and 1939. Cooperage statistics are not available later than 1939.

[12] The following factors were used in converting staves and heading to equivalent board feet: one slack stave=one-third board foot, one set slack heading=two board feet, one tight stave=one board foot, one set tight heading=four board feet. The 1939 figures for tight staves and heading were considered representative of recent years.

[13] A large proportion of Douglas-fir ties are produced by sawmills and are reported as lumber in the annual returns furnished by such mills. Probably not more than 10 percent of the ties cut from Douglas-fir are hewed.

[14] Proceedings of the American Wood-Preservers' Association.

the cut, and to a less extent in the Rocky Mountain type. Average material from the Pacific coast is rated as strong, moderately hard, moderately heavy,[15] and very stiff. In strength, Pacific coast Douglas-fir and the southern pines as a whole rank about alike. Douglas-fir from the Rocky Mountains averages considerably below that from the Pacific coast in weight and in strength properties.

Douglas-fir has a narrow whitish sapwood generally not over 3 inches wide in timber of commercial size and often not over 1 inch wide in Rocky Mountain timber. In comparatively young trees of the coast type the rate of growth is generally quite rapid, the wood of such trees frequently showing from three to six rings to the inch. The wood formed when the trees are older is generally of slower growth with rings running from 15 to 30 to the inch. Wide-ringed wood is usually reddish brown and is commonly called "red fir." Narrow-ringed wood is usually yellowish brown, and is commonly called "yellow fir." Both red fir and yellow fir may come from the same tree. Tests on small clear pieces of Douglas-fir show that the strongest and heaviest wood frequently has from 12 to 16 rings per inch. Dry weight, however, where it can be determined, is a better criterion of strength than rate of growth. The wood splits easily and is rather difficult to work with hand tools. It can be readily kiln dried if proper methods are used, but care must be taken in drying lumber containing knots to prevent them from becoming loose or falling out.

Dense Douglas-fir is of intermediate durability, ranking with dense southern pine and white oak in decay resistance but below the cedars, cypress, and redwood. The wood is difficult to impregnate with a preservative. Material to be treated is often incised; i. e., run between cylinders having sharp projections which cut slots about one-half inch deep and thus make possible better penetration of the preservative. In ability to hold paint satisfactorily Douglas-fir holds a low rank. In this respect it is classed with southern pine and red pine in the fourth or least satisfactory of four groups of wood arranged in the order of paint holding ability. The first group contains woods such as the cedars and redwood which rate highest in paint holding. As a source of pulp and paper, Douglas-fir has not proved as satisfactory as many other woods, including its associate western hemlock. Modified methods of pulping recently developed give promise of bringing about greater usefulness of Douglas-fir as a pulp wood. While not among the easiest woods to glue, Douglas-fir can be glued satisfactorily if moderate care is exercised.

**Principal uses.**—Douglas-fir is used principally for building and construction purposes in the form of lumber, timbers, piling, and plywood. Considerable quantities also go into fuel; railroad ties (largely sawed); cooperage stock (principally tight staves for casks, half barrels, and kegs used as containers for pork, oil, etc.); mine timbers; and fencing. The lumber used in the manufacture of various products goes principally into sash, doors, and general millwork; car construction and repair; and boxes and crates. Smaller amounts are used for flooring, furniture, ships and boats, fixtures, motor vehicle

[15] The average weight of Douglas-fir in a thoroughly air-dry condition (12 percent moisture) is 34 pounds per cubic foot for material from the Pacific coast and 30 pounds per cubic foot for material from the Rocky Mountains.

parts, wood pipe, tanks, and other miscellaneous items. Minor uses include distillation products and paper pulp.

The strength and stiffness of Douglas-fir, combined with its moderate weight and availability in large sizes, give it a leading place as a structural timber. Pieces can be supplied as large as 2 feet square in cross section and 60 feet long. Douglas-fir plywood [16] has recently come into wide use for sheathing, concrete forms, wallboard, prefabricated house panels, and other structural forms. Construction timbers exposed to conditions favorable to decay or insect attack, including bridge timbers, piling, ties, mine timbers, and timbers for marine construction, are generally pressure treated with a preservative such as creosote.

Attempts to distill Douglas-fir to obtain turpentine, pyroligneous acid, tar oil, and charcoal have been limited to a few plants using pitchy wood selected from sawmill waste. Douglas-fir, largely in the form of sawmill waste, is used to a limited extent in the manufacture of fiberboard, bleached book paper, and wrapping paper.

A large proportion of the total cut of Douglas-fir lumber, possibly two-thirds of it, is used as it comes from the sawmill. The remainder is further manufactured before use. The following tabulation shows the amounts of Douglas-fir used in the manufacture of different classes of products in 1912, 1928, 1933, and 1940. The material is largely in the form of lumber with much smaller amounts of veneer, and short logs and bolts.

TABLE 1.—*Douglas-fir used in the manufacture of wooden products*

[Thousands of board feet]

| Classes of products | 1912 | 1928 | 1933 | 1940 |
|---|---|---|---|---|
| Airplanes | | 12 | 19 | 945 |
| Agricultural implements | 2, 537 | 9, 565 | 1, 108 | 2, 877 |
| Boot and shoe findings | | 25 | | |
| Boxes, baskets and crating | 7, 350 | 75, 301 | [1] 38, 878 | [1] 130, 033 |
| Boxes, cigar and tobacco | | 57 | | |
| Butchers blocks | | | 90 | |
| Car construction and repair | 86, 544 | 371, 503 | 88, 748 | 203, 099 |
| Caskets and burial boxes | 6 | 500 | 80 | 207 |
| Conduits, pumps and wood pipe | [2] 24, 851 | [2] 6, 751 | 1, 542 | 14, 400 |
| Dairy, poultry, and apiary supplies | [3] | 1, 543 | 103 | 180 |
| Dowels and skewers | | 17 | 75 | 26 |
| Electrical equipment | 138 | 614 | 1, 947 | 2, 145 |
| Fixtures | 5, 512 | 4, 968 | 4, 418 | 23, 263 |
| Flooring | [4] | [4] | 128, 658 | 80, 197 |
| Furniture | 11, 453 | 11, 677 | 24, 049 | 44, 689 |
| Handles | 247 | 9, 485 | 11, 311 | 12, 299 |
| Instruments, musical | 480 | 685 | 61 | 53 |
| Instruments, professional and scientific | 30 | 227 | 45 | 58 |
| Ladders | [3] | | 2, 020 | 8, 212 |
| Laundry appliances | 184 | 1, 836 | 261 | 417 |
| Machinery | 1, 631 | 310 | 207 | 329 |
| Patterns and flasks | 54 | 180 | 200 | 3, 267 |
| Playground equipment | 1 | 753 | 51 | 7, 468 |
| Printing material | | 150 | | 22 |
| Radio and phonograph cabinets | [5] | [5] | 1, 384 | 3, 104 |
| Refrigerators | [6] 544 | [6] 10, 887 | 2, 393 | 9, 437 |
| Rollers, shade and map | 3, 000 | 93 | 12 | 2 |

See footnotes at end of table.

[16] Douglas-fir plywood generally consists of an odd number of sheets of veneer (3, 5, or 7) glued together so that the grain of each sheet or ply is at right angles to the grain of the adjacent ply or plies. The veneer is made by the rotary-cut method in which short logs are revolved in a lathe against a constantly advancing heavy knife. It is commonly cut 1/16 inch or 1/8 inch thick. The plywood is made in thicknesses from about 3/16 inch (3 plies, each 1/16 inch) to over 1 inch. For interior construction the plies are frequently glued with casein glue or soybean glue. For permanent exterior construction "resin-bonded" plywood glued with phenolic-resin glues provides a highly water-resistant bond.

TABLE 1.—*Douglas-fir used in the manufacture of wooden products*—Continued

[Thousands of board feet]

| Classes of products | 1912 | 1928 | 1933 | 1940 |
|---|---|---|---|---|
| Sash, doors, general millwork | [7] 1,991,992 | [7] 1,896,648 | [8] 148,293 | [8] 391,222 |
| Sewing machines | | | | 148 |
| Ship and boat building | 44,342 | 33,705 | 10,040 | 25,333 |
| Shuttles, spools, bobbins, looms | (9) | (9) | (9) | 80 |
| Signs, scenery, displays | 36 | 13,410 | 1,104 | 5,254 |
| Sporting and athletic goods | 85 | 1,101 | 42 | 267 |
| Surgical supplies | | | | 1 |
| Tanks | 89,705 | 42,513 | 4,142 | 12,590 |
| Toys | | 760 | 64 | 431 |
| Trunks and valises | | 2,407 | 1,033 | 1,091 |
| Vehicles, motor | (10) | 36,345 | 12,467 | 15,490 |
| Vehicles, nonmotor | 931 | 631 | 64 | 2,067 |
| Venetian blinds | | | | 119 |
| Woodenware and novelties | [11] 2,135 | 12,770 | 560 | 2,669 |
| Total | 2,273,788 | 2,547,429 | 485,469 | 1,003,491 |

[1] These figures for 1933 and 1940 include Douglas-fir used for boxes and crates by plants not classified as manufacturers of wooden products which were not included in 1912 and 1928. The amounts included for nonmanufacturers of wooden products were as follows: For 1933, 22,016,000 board feet and for 1940, 76,691,000 board feet.

[2] Includes paving material.

[3] Included with "Woodenware and novelties."

[4] Included with "Sash, doors, and general millwork."

[5] Included with "Furniture."

[6] Includes kitchen cabinets.

[7] Includes planing mill products, such as siding, ceiling, and flooring.

[8] Planing mill products not included in 1933 and 1940 canvasses, except flooring, which is listed separately.

[9] Does not include looms.

[10] Included in "Vehicles, nonmotor."

[11] Includes "Dairy, poultry, and apiary supplies."

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