Libocedrus decurrens Torr.

Incense-Cedar

Cu pressaceae Cypress family

Robert F. Powers and William W. Oliver

Incense-cedar *(Libocedrus decurrens)* is the only species from the small genus *Libocedrus* that is native to the United States. Increasingly, it is placed in a segregate genus *Calocedrus.* Incense-cedar grows with several conifer species on a variety of soils, generally on western slopes where summer conditions are dry It is long-lived and grows slowly. Most of the top-grade lumber is used for the manufacture of pencils and exterior siding.

Habitat

Native Range

Incense-cedar (fig. 1) is a distinctive component of the Sierra Nevada mixed-conifer forest, where it grows as scattered individuals or in small groups (5). Its range spans about 15" of latitude and a variety of climates from the southern slope of Mount Hood in Oregon, southward through the Siskiyou, Klamath, and Warner Mountains, Cascade and Coast Ranges, and Sierra Nevada to the dry Hanson Laguna and Sierra de San Pedro Martir Ranges in Baja California (7). Incense-cedar grows from the coastal fog belt eastward to the desert fringes. It can be found in the Washoe Mountains of west-central Nevada *(12).*

Climate

Incense-cedar's natural range is characterized by dry summers, usually with less than 25 mm (1 in) precipitation per month; annual temperature extremes are -34" to 48" C (-30" to 118" F). Annual precipitation, part of which is snow, varies from 510 to 2030 mm (20 to 80 in). Precipitation may be as low as 380 mm (15 in) a year for incense-cedar found on the east side of the Cascades and in the Warner Mountains in Oregon and California (22).

Soils and Topography

Incense-cedar grows on many kinds of soils developed from a wide variety of parent rocks-rhyolite, pumice, andesite, diorite, sandstone, shale, basalt, peridotite, serpentinite, limestone, and

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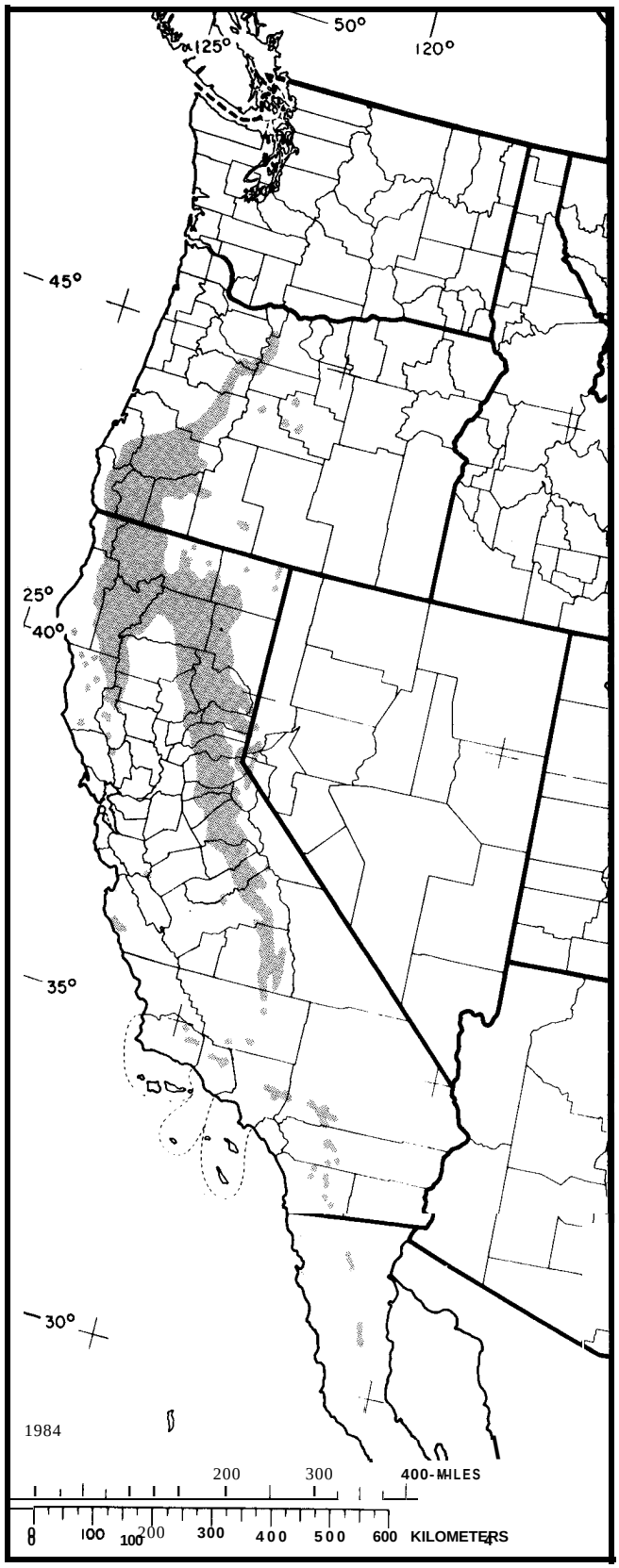

Figure *l-The native range of incense-cedar.*

granitic or metamorphic equivalents. It is particularly adept at extracting soil phosphorus *(21)* and calcium *(35)*, and excluding surplus magnesium.

Soils supporting incense-cedar vary greatly. Reaction ranges from nearly neutral to strongly acid. Textures vary from coarse sands to very fine clays. The best stands generally are found on deep, well-drained, sandy loam soils developed on granitic rocks and sandstone; deep clay loams developed on basalt and rhyolite; and occasionally on deep, coarse-textured, well-drained soils developed from pumice.

In California, incense-cedar grows best on deep, slightly to moderately acid Ultic Haploxeralfs, such as the Holland series weathered from granitic rock (fig. 2), and the Cohasset series derived from andesite and basalt. Incense-cedar also grows on infertile soils derived from peridotite or serpentinite throughout the Sierra Nevada and tends to be restricted to these soils in western portions of the north Coast Ranges and Klamath Mountains *(7)*. Although it is a good competitor on these soils because of its apparent ability to extract calcium and exclude magnesium, its growth is considerably less than on more fertile sites. Apparently the high calcium-extracting ability of incense-cedar may interfere with magnesium and micronutrient uptake on limestone. Incense-cedars are rare on limestone soils, and the trees that do grow there contain high concentrations of calcium and low concentrations of manganese and zinc (35).

Incense-cedar grows at elevations between 50 and 2010 m (165 and 6,600 ft) in its northern extreme *(30)*, and between 910 and 2960 m (3,000 to 9,700 ft) in its southern limits. In the Sierra Nevada, the tree grows best at elevations between 610 and 2100 m (2,000 to 6,900 ft). Once established, incense-cedar is a good competitor on hot, dry sites and commonly shares an upper canopy position on southwestern slopes. On cooler, moister aspects, it is usually subdominant to other species.

Associated Forest Cover

Rarely found in pure stands, incense-cedar grows in several forest cover types where it occupies a subdominant crown position. Except in Sierra Nevada Mixed Conifer (Society of American Foresters Type 243) *(5)* where its stocking may account for half of the stems in a stand *(20,26)*, incense-cedar is a minor component of the cover types in which it is found. These cover types include Pacific Douglas-Fir (Type 229), Pacific Ponderosa Pine-Douglas-Fir (Type 244), California Black Oak (Type 246), Jeffrey Pine (Type 247), and Pacific Ponderosa Pine (Type 245). Southern and drier portions of the types Oregon White Oak (Type 233) and Douglas-Fir–Tanoak–Pacific Madrone (Type 234) as well as inland extensions of Port-Orford-Cedar (Type 231) also contain incense-cedar.

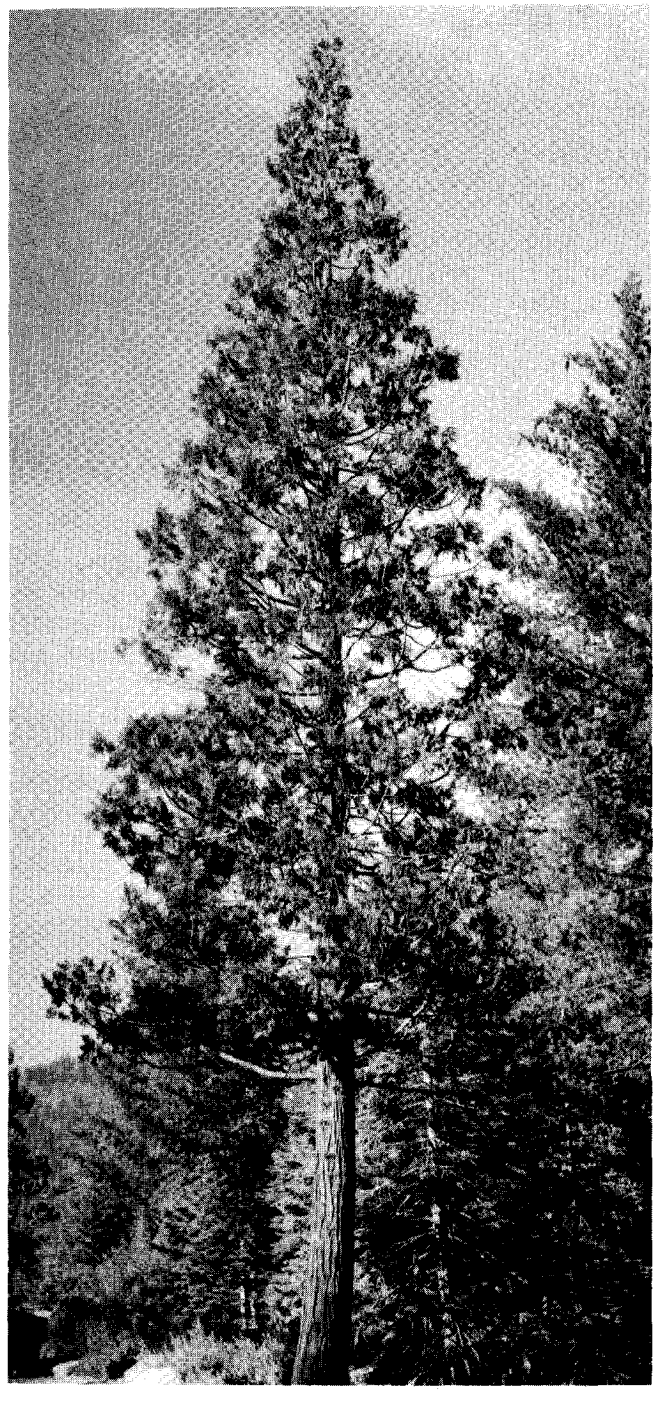

Figure 2—*Young-growth incense-cedar growing in soil derived from granitic rock in the central Sierra Nevada of California.*

In the northern part of its range, incense-cedar often is found with coast Douglas-fir *(Pseudotsugu menziesii* var. *menziesii),* ponderosa pine *(Pinus ponderosa* var. *ponderosa),* sugar pine *(P. lambertiana),* western white pine *(P. monticola),* Jeffrey pine *(P. jeffreyi),* California white fir *(Abies concolor* var. *lowiana),* grand fir *(A. grandis),* western hemlock *(Tsuga heterophylla),* western redcedar *(Thuja plicata),* Port-Orford-cedar *(Chamaecyparis lawsoniana),* Oregon white oak *(Quercus garryanu),* California black oak *(Q. kelloggii),* tanoak *(Lithocarpus densiflorus),* giant chinkapin *(Castanopsis chrysophylla),* and Pacific madrone *(Arbutus menziesii).* In the central part, it grows with coast Douglas-fir, ponderosa pine, sugar pine, Jeffrey pine, Sierra lodgepole pine *(Pinus contorta* var. *murrayana),* California white fir, California red *fir (Abies magnifica),* giant sequoia *(Sequoiadendron giganteum),* California black oak, tanoak, giant chinkapin, and Pacific madrone. In the southern part, common associates are Jeffrey pine, ponderosa pine, sugar pine, Coulter pine *(Pinus coulteri),* bigcone Douglas-fir *(Pseudotsuga macrocarpa),* and California black oak. Tree associates on ultramafic soils include Jeffrey pine, western white pine, sugar pine, knobcone pine *(Pinus attenuata),* and coast Douglas-fir.

Common brush species growing with incense-cedar are greenleaf manzanita *(Arctostaphylos patula),* mountain whitethorn *(Ceanothus cordulatus),* deerbrush *(C. integerrimus),* snowbrush (C. *velutinus),* littleleaf ceanothus *(C. parvifolius),* bearclover *(Chamaebatia foliolosa),* bush chinkapin *(Castanopsis sempervirens),* salal *(Gaultheria shallon),* and coast rhododendron *(Rhododendron californicum)* (22). On ultramafic soils, sclerophyllous shrubs predominate and include barberry *(Rerberis pumila),* silk-tassel *(Garrya buxifolia),* tanoak, huckleberry oak *(Quercus vaccinifolia),* coffeeberry *(Rhamnus californica),* western azalea *(Rhododendron occidentale),* and red huckleberry *(Vaccinium parvifolium) (32).*

Life History

Reproduction and Early Growth

Flowering and Fruiting-Yellow-green, pollen-bearing strobili are borne terminally on twigs as early as September and reach a length of about 6 mm (0.25 in) at pollen shed in late winter to early spring. Incense-cedar is monoecious; both male and female flowers may be borne on the same twig. Cones, inconspicuous in spring, are pendent and 20 to 40 mm (0.8 to 1.5 in) long when they mature in late summer. They are composed of three pairs of opposing leathery scales. Two of the six scales become greatly enlarged and form a cover around the two scales that bear the seeds. Each seed has two wings of unequal length. Embryos have two cotyledons.

Seed Production and Dissemination-Al-though incense-cedars are considered prolific seed producers, medium to heavy seed crops are borne at intervals usually averaging 3 to 6 years. Sometimes, cone crops are absent entirely (22). In a southwestern Oregon study, medium to abundant crops appeared in only 3 years, and light or no crops were found in 12 of the 15-year reporting period (28). As many as 961,500 seeds per hectare (389,100/acre) may fall during heavy production years (22). Geographic variability in cone and seed production is great (23). Seed dispersal begins in late August at the lowest elevations and in October at higher levels. Although seedfall may extend into winter months, seed soundness seems unrelated to time of dispersal (table 1).

Incense-cedar seeds average 33,100/kg (15,000/lb) and vary from 14,100 to 63,900/kg (6,400 to 29,000/lb). Averages for collections from the northern and central part of incense-cedar's range vary from 29,800 to 44,500/kg (13,500 to 20,200/lb) (28). Because they are light in weight and have a large wing (averaging 2.5 cm (1 in) in length and nearly one-third that in width), seeds of incense-cedar fall slowly (1.8 m/s, or 5.9 ft/s, in still air) *(22),* and are carried great distances by wind.

Seedling Development-Germination may be doubled by stratifying seeds at 3" to 5° C (37" to 41" F) for 30- to 60-day periods, although results are not always consistent. Germination under controlled conditions may be as much as 98 percent but usually averages 20 to 40 percent (28). These values are similar to those found under field conditions (22). Germination is epigeal (28). In nature, incense-cedar

Table l-Incense-cedar seedfall as measured from traps on the Stanislaus National Forest, CA (22).

Measurement date	Percent of all seed trapped	Percent sound seed
1937		
October 6	11	3
October 27	36	37
November 11	53	60
1940		
October 11	32	54
October 29	34	38
November 13	34	8

germinates on a wide range of surface conditions. Although survival is best under partial shade *(22)*, incense-cedar seedlings survive over a broader array of site conditions than do most conifers *(22,26)*.

Initial rates of root growth are slow to moderate in incense-cedar compared with other species. In the first season, primary roots may extend to a depth of *30* cm (12 in), compared with as much as twice that length for ponderosa pine and sugar pine (22). Incense-cedar, therefore, is particularly susceptible to drought on exposed sites during the first year. Root systems develop rapidly, however, and by the end of the second year, lateral and tap root lengths compare well with ponderosa pine (29). In an artificially controlled study *(33)*, seedling roots showed a peak of growth in the spring, with rates averaging 3 to 5 mm (0.12 to 0.20 in) per day. Growth slowed in midsummer, but increased again in fall, averaging 1 to 3 mm (0.04 to 0.12 in) per day between October and December. Activity cycles varied for individual roots. Not all roots were active at any one time.

Incense-cedar lacks the distinct spring flush typical of many temperate conifers. Successive years' growth is not easily seen along the stem. Instead, elongation of several leaf internodes near the shoot tip in fall is arrested over winter and is not completed until the following spring. Hence, shoot growth is a more or less continuous process characterized by changes in tempo that are influenced primarily by current environment (9).

On the Stanislaus National Forest in the central Sierra Nevada, CA, at an elevation of 1600 m (5,250 ft), seasonal height growth of incense-cedar started an average of 11 days later than ponderosa pine, was similar to sugar pine, but averaged 31 days earlier than white fir (22). At Challenge Experimental Forest, 1° 30' of latitude farther north in the Sierra Nevada and 810 m (2,660 ft) lower in elevation, sugar pine and ponderosa pine began height growth 3 to 5 weeks sooner than incense-cedar, and white fir began a week later (21). On the Stanislaus National Forest, the height growth period for incense-cedar lasts an average of 91 days, a period greater than for any other native species. At Challenge Experimental Forest it lasted 112 days but stopped sooner than the height growth period for ponderosa or sugar pine.

Seasonal radial growth starts before height growth. On the Stanislaus National Forest, growth begins about April 15, some 2 weeks later than at Challenge. At both locations, however, incense-cedar begins radial growth at about the same time as ponderosa and sugar pine, but 2 weeks earlier than white fir. At both locations, the period of diameter growth for incense-cedar is second only to that for ponderosa pine, lasting 136 days at Stanislaus and 146 days at Challenge *(21,22)*.

Table 2—Height growth of conifer seedlings relative to ponderosa pine under several silvicultural systems

Silvicultural system	Ponderosa pine	Incense-cedar	Sugar pine	White fir	Douglas fir
Selection[1]					
Single-tree	1.00	1.80	2.00	2.80	1.40
Group	1.00	0.90	1.50	1.50	1.50
Shelterwood[1]	1.00	0.70	0.96	1.07	0.78
U.A.C.[2]	1.00	0.22	0.70	0.25	—
Clearcut					
Natural[1]	1.00	0.00	0.89	0.65	0.68
Planted[3]	1.00	0.71	0.56	0.41	0.55

[1]Nine-year-old naturally regenerated seedlings, Challenge Experimental Forest, CA. Group selection openings were 9 to 27 m (30 to 90 ft) in diameter (13).
[2]Average of all natural seedlings regenerating in 12 years after Unit Area Control cuttings, Stanislaus National Forest, CA (26).
[3]x-year-old seedlings from local seed, Challenge Experimental Forest, CA (21).

Naturally regenerated incense-cedar grows slowly because of low sunlight or heavy browsing, often taking 3 to 5 years to reach a height of 8 to 15 cm (3 to 6 in). Although increased sunlight favors height growth, poor initial root development of naturally regenerated incense-cedar and preferential browsing by deer may mask its ability to respond to increased light, compared with other species (table 2).

Incense-cedar raised from local seed and planted as 1-O stock in a fresh clearcut at Challenge Experimental Forest, however, grew faster than three other species, and at 6 years from planting was second only to ponderosa pine in both height and standing biomass (21). Apparently, the well-developed root systems of planted seedlings provide enough water uptake to sustain vigor, which helps seedlings resist browsing pressure.

Established incense-cedar seedlings are remarkably drought tolerant. The species has been ranked more tolerant than sugar pine or ponderosa pine, Douglas-fir, or grand fir when grown in pumice, and second only to ponderosa pine when grown in sand *(19)*. The tolerance was attributed to a complete occupancy of the soil mass by incense-cedar roots. In a controlled experiment, artificial dew more than doubled the survival period of incense-cedar seedlings grown in soils dried to permanent wilting point *(31)*. Dew helped incense-cedar tolerate drought better than ponderosa pine and Jeffrey pine, although pines were more tolerant when dew was withheld. At Challenge Experimental Forest, predawn measurements of xylem moisture tension in September showed that incense-cedar, ponderosa pine, and sugar pine were similar to each other and sig-

nificantly lower in water stress than Douglas-fir or white-fir *(21).*

Although drought may kill many first-year seedlings, particularly on compacted landings and skid trails, insects usually account for greater losses. Cutworms destroy many seedlings. Rodents are generally of only minor importance. During a 5-year period, 53 percent of the 1- to a-month-old incense-cedar seedlings on Stanislaus National Forest plots were destroyed by cutworms *(Noctuidae* larvae) (22). The seed-to-seedling ratio on four cutover plots varied from 20:1 to 355:1 (22). Seedling tap roots may be damaged by root rot, but recovery can be rapid and tops may show no sign of attack (27).

Vegetative Reproduction-Incense-cedar does not reproduce vegetatively in nature, but can be stimulated to do so in the greenhouse *(18).*

Sapling and Pole Stages to Maturity

Growth and Yield-Incense-cedar varies greatly in size in different parts of its range. In the Coast Ranges and in southern California, the largest trees generally are from 18 to 24 m (60 to 80 ft) tall and 90 to 120 cm (36 to 48 in) in d.b.h. In the Sierra Nevada, incense-cedars frequently grow to heights near 46 m (150 ft) with d.b.h.'s near 210 cm (84 in). The largest tree measured was 375 cm (148 in) in d.b.h. *(1).* A tree 69 m (225 ft) tall was reported from southern Oregon. At high elevations, especially on dry, exposed sites, trees tend to be small and scrubby.

Incense-cedar is long-lived. Large trees often are more than 500 years old (22). The oldest recorded age is 542 years for a tree only 130 cm (51 in) in d.b.h.

Growth rates of young mixed conifer stands in the central Sierra Nevada were investigated recently (3). In stands with basal areas of 23 to 69 m^2/ha (100 to 300 $ft^2/acre$), periodic annual increment of incense-cedar was 0.81 cm (0.32 in) in d.b.h. and 0.3 m (1.0 ft) in height at age 40. By age 90, periodic annual increment had declined to 0.36 cm (0.14 in) for d.b.h. and 0.2 m (0.6 ft) for height.

Incense-cedar often grows more slowly than associated conifers and is therefore a major component of the intermediate and suppressed crown classes. Seldom does it contribute more than 5 to 10 percent of the stand volume (22). At Blodgett Forest in the northern Sierra Nevada, for example, volume growth of incense-cedar was consistently slower than its associates, regardless of stand density or tree size (4). In stands of moderate density, incense-cedar grew in volume at an annual rate of 1.6 percent, compounded. The average rate for all species was 2.3 percent. On poor sites, however, open-grown incense-cedars as large as 60 cm (24 in) in d.b.h. can exceed all other species, except white fir, in basal area growth (22). On better sites, incense-cedars generally fall behind and are forced to endure more and more shade. Increasing shade further slows their growth to the point of bare existence. On such trees, 16 annual rings per centimeter (40/in) of diameter are not uncommon *(12).*

Rooting Habit-From seedling stage through maturity, incense-cedar has a more spreading and extensive rooting habit than many of its associates. This extensive, well-developed root system allows it to survive droughty sites and resist windthrow. Root branching of seedlings in an artificially controlled environment was inversely proportional to growth rate (33). Rapidly growing roots produced few laterals, but when growth of these roots temporarily ceased, laterals were produced in profusion. When growth resumed, laterals again were widely spaced, resulting in a node-internode pattern.

Reaction to Competition-Incense-cedar has been rated as more shade tolerant (22) than the associated pines and Douglas-fir *(16),* and perhaps less tolerant than white fir and grand fir. In the seedling stage, incense-cedar can endure dense shade, especially in cool, moist environments (17). But for full development from sapling stage through maturity, it requires more light (22).

Incense-cedar shows good response to release. Much of the extremely slow growth of young reproduction results from suppression or browsing. When released, seedlings grow rapidly in height. But because height growth usually is slower than that of associated species of comparable age, incense-cedar usually is a secondary species in the final stand (22). Although shaded out, lower branches are slow to shed, even in dense stands, Many dead branches must be removed, therefore, if clear lumber is to be produced in rotations of 80 to 120 years.

Damaging Agents-Overmature incense-cedars are more defective than their associates. The amount of cull increases with age of the trees and varies among stands (22). Average cull percents based upon gross volume are 4 to 6 percent for immature dominants, 21 percent for mature dominants, and 68 to 77 percent for overmature dominants.

The single most destructive agent affecting incense-cedar is the pocket dry rot *(Tyromyces amarus).* Pocket dry rot is most common in trees growing on good sites. In parts of the Sierra Nevada, 75 to 100 percent of the mature trees are infected. Trees on

marginal sites near incense-cedar's eastern limit usually are infected less (2).

The spores of pocket dry rot must be deposited on an open wound to infect trees because the mycelium cannot penetrate through the bark into the heartwood ***(14). The*** most prevalent port of entry is through fire scars (84 percent). Knots (10 percent) are next in frequency and injuries resulting from lightning and frost (6 percent) are least (22). Pocket dry rot seems relatively resistant to heartwood extractives that are toxic to other heart-rotting fungi and may actually detoxify them (34). This unusual ability may explain the apparent anomaly of highly defective heartwood in live, overmature trees and high durability of heartwood in sawn products.

In management of young-growth incense-cedar, the age at which dry rot begins to cause losses is of primary significance. Suppressed trees are subject to severe dry rot infection after they reach 165 years, but dominant trees generally are safe until 210 years old (22). Because the rotation age of young-growth stands is considerably less than these critical ages, pocket dry rot should not cause severe cull in managed stands. Two other fungi that occasionally rot the heartwood of living incense-cedar are *Phellinus pini* and ***Phaeolus schweinitzii (10).***

Root disease kills more incense-cedar trees than any other pathogen (24). Of the three facultative, parasitic fungi found attacking incense-cedar roots, ***Armillaria*** sp., ***Heterobasidion annosum,*** and *Phellinus weiri*, probably the most destructive is ***Heterobasidion annosum.*** More than 100 ***H. annosum*** infection centers have been confirmed on developed sites in Yosemite Valley, CA (25). Property damage caused by falling root-diseased trees has been substantial and has led to the development of a risk-rating system. On the basis of crown characteristics, the system predicts the potential for early failure of root-diseased incense-cedar (25).

The only foliage disease of any consequence is the rust caused by ***Gymnosporangium libocedri*** *(10)*, which infects incense-cedar of all ages, causing witches' brooms, but only infrequently kills smaller branches, Although extensive infections of leaf rust retard growth, no deaths have been attributed directly to the disease. Infections in the main stem may result in burls that cause defect in lumber *(2)*.

Ozone, the major plant-damaging constituent of photochemical oxidant air pollution, injures the foliage of many coniferous species. Incense-cedar is insensitive to injury from ozone. It appears to have sufficient numbers of tolerant individuals so that it may be planted with reasonable success in the ozone-affected forests common in the southern portion of this species' natural range (15).

Incense-cedar mistletoe ***(Phoradendron*** *juniperinum* subsp. ***libocedri)*** grows on incense-cedar throughout the range of the tree. This true mistletoe causes elongated swellings on the branches and occasionally on the trunk. Severe infections suppress growth but rarely kill large trees (2).

Many species of insects are found on incense-cedar, but relatively few cause serious losses. A cone sawfly ***(Augomonoctenus libocedrii)*** sometimes infests cones, resulting in damage resembling that of cone-feeding caterpillars (6). The juniper scale *(Carulaspis* ***juniperi)*** is a European species now distributed throughout the range of incense-cedar (6). It attacks twigs, leaves, branches, and cones, causing the foliage to turn yellow. Sometimes branches and entire trees are killed. Six species of cedar bark beetles *(Phloeosinus* spp.) can be found working under bark of trunks, tops, and limbs of weakened, dying, or felled trees or of broken branches (6). Although damage usually is inconsequential, beetles occasionally become sufficiently numerous and aggressive to attack and kill apparently healthy trees. Several wood borers have been found in incense-cedar, but none poses a threat to the life of the tree (6). The flatheaded cedar borer ***(Chrysobothris*** *nixa)* mines the bark and outer wood of limbs, trunks, and roots of weakened, dying, and dead trees, principally in the coast region. The amethyst cedar borer *(Semanotus* ***amethystinus)*** is similar to ***Chrysobothris*** *nixa* but confines its work to the inner bark and a scoring of the outer sapwood of boles and large limbs throughout the range of incense-cedar. The western cedar borer *(Trachykele* ***blondeli),*** like ***Chrysobothris*** *nixa*, can cause serious degrade and cull in trees cut for products requiring sound wood. Its larvae mine the sapwood and heartwood of living trees. *Trachykele opulenta* is similar to *T. blondeli* but less destructive. The incense-cedar wasp *(Syntexis* ***libocedrii)*** bores in the sapwood of fire-scorched trees in California.

Fire has played a significant role in the health and relative abundance of incense-cedar in mixed-conifer stands. Sapling incense-cedars are more readily killed by fire than most of their associates; the thick bark of mature incense-cedar offers considerable protection from fire. Intense fires indirectly result in more damage to mature trees, however, by exposing trunks to infection by pocket dry rot. As a result of fire control by land management agencies beginning about 1900, and partial cutting practices, the proportion of incense-cedar in the understory has increased. Incense-cedar is favored because it is a prolific seeder and because the shade-tolerant seedlings and saplings can persist for long periods in the understory.

Special Uses

The outstanding durability and resistance to decay of lumber from incense-cedar heartwood make it ideal for exterior use where moisture is present. This wood gives long service with little maintenance in such uses as mud sills, window sashes, sheathing under stucco or brick veneer construction, greenhouse benches, fencing, poles, and trellises *(12).* Incense-cedar also is used extensively for exterior siding because it is dimensionally stable and holds paint well, in addition to being durable.

Rich color, sound knots, and aromatic fragrance make the wood popular for interior paneling and woodwork. At present, pecky cedar (boards sawn from trees infected with pocket dry rot) is in demand for paneling and backyard fencing, thereby making a market for poor quality grades that formerly were not utilized.

Incense-cedar is ideally suited to the manufacture of pencils because it is soft, easily whittled, and has straight grain (12). Much of the top-grade lumber produced goes to this use.

Incense-cedar is cultivated widely as an ornamental tree both within its natural range and as an introduced species. The tree grows well in western and central Europe *(11)* and in the Eastern United States as far north as Massachusetts.

Genetics

A few horticultural varieties are recognized. In southern California, especially in southwestern San Bernardino County, trees with conspicuously narrower crowns and more spire-like silhouettes than those of the Sierra Nevada are common. European experience with incense-cedar as an ornamental suggests that the columnar trees from southern California may be more sensitive to cold than are the trees from northerly sources (11).

The genetic structure of incense-cedar was studied in stands that occupy different elevations and aspects within each of three locations in the southern Cascades and Sierra Nevada (8). Genetic variation was assessed using two approaches: measuring characteristics of seedling growth and estimating allele and genotypic frequencies. Conclusions were similar for both approaches. Genetic diversity was as great among local stands as among regions, and no consistent pattern could be related to elevational or aspect differences. Growth in height and branch length was less for southern sources. Striking differences among provenances, however, like those found for Douglas-fir, lodgepole pine, and white fir, were not apparent.

No hybrids of incense-cedar are known.

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