

Giant Sequoia (*Sequoia gigantea* (Lindl.) Decne.)

Taken from Silvics of Forest Trees of the United States, Agriculture Handbook No. 271, U.S. Department of Agriculture, Forest Service, 1965, Library of Congress: Agr 65-273.

Other common names: Big tree, Sierra redwood.

Giant sequoia is the world's largest tree in terms of volume (13). It grows in more or less isolated groves on the western slopes of the Sierra Nevada in central California, in a narrow belt approximately 260 miles long. The northernmost grove, consisting of six trees, is along the Middle Fork of the American River in Placer County. The southernmost grove with 100 trees is near Deer Creek in Tulare County.

Habitat Conditions

Climate

The best stands grow in protected locations where the average annual precipitation is from 45 to 60 inches. Summer storms are infrequent and light; most of the precipitation occurs in the form of snow during September through May. Snow falls throughout the range of giant sequoia. During the winter of 1905-1966, snow in the Giant Forest (Sequoia National Park) was 29 feet deep; in protected spots, snow as still 12 feet deep by mid-summer (7).

The temperature occasionally drops to -12° F. and seldom exceeds 100°. In the Giant Forest, one of the largest and best developed groves, the minimum recorded temperature was -5° and the maximum 94°. The average growing season in this grove is 124 days - June 2 to October 4.

Soils and Topography

The soils in the sequoia groves are generally developed from granitic, dioritic, or andesitic rocks. The most common soil series are the Hohand, Olympic, and Sierra.

Seedlings grow best in soils of pH 6, with poorer growth at pH 5 and 7 C). Seedlings grown in wet soil do not survive and are not able to grow because of low aeration (2). Giant sequoia is one of the more mesophytic tree species of the Sierra Nevada.

Most of the groves are at elevations between 4,000 and 7,500 feet (5, 11), although some occur as low as 3,000 feet and a few as high as 8,900 feet. At the northern part of its range the trees grow at 4,500 to 5,500 feet; in the central part, at 5,400 to 7,000 feet; and at the southern end, at 6,000 to 8,000 feet. The groves are usually found in canyons where soil moisture is always adequate, but also occur on or near the tops of high exposed ridges where underground water is available (5, 13).

Associated Trees and Shrubs

Giant sequoias grow in small groves within the Ponderosa Pine - Sugar Pine - Fir Type (Type 243). They never make up pure stands except over small areas.

The most common trees associated with giant sequoia are white fir, sugar pine, ponderosa pine, incense-cedar, and California black oak. Other less common trees growing with giant sequoia are Douglas-fir, Pacific yew, California red fir, Jeffrey pine, Pacific dogwood, bigleaf maple, canyon live oak, white alder, and bitter cherry (*Prunus emarginata*).

Common brush species growing with giant sequoia are greenleaf manzanita (*Arctostaphylos patula*), mountain whitethorn (*Ceanothus cordulatus*), deerbrush (*C. integerrimus*), snowbrush (*C. velutinus*), littleleaf ceanothus *C. parvifolius*), bear mat (*C. hamaebatia foliolosa*), bush chinkapin (*Castanopsis sempervirens*), Scouler willow (*Salix scouleriana*), and western azalea (*Rhododendron occidentale*).

Life History

Reproduction and Early Growth

Flowering and Fruiting

Pollination usually occurs between the middle of April and the first of May when the conelets are only two to three times as large in diameter as the twigs on which they are borne (3). By the end of the first growing season the conelets are about one-third mature size. They reach mature size, 2 to 3.5 inches in length, at the end of the second growing season (4).

In one study the number of seeds per cone varied from 97 to 306, and averaged about 230. The greatest number of seeds reported from a single cone was 329 (7).

Seed production and dissemination

Giant sequoias usually produce large numbers of cones only after they are 150 to 200 years old. Cones have been observed on 18- to 24-year-old trees, but they usually contain only infertile seeds (11, 13). Heavy cone crops with viable seeds have been reported on some trees 50 to 75 years old, however cones are produced each year and the largest trees bear enormous quantities (13). Because of the size of the trees, estimates of cone crops are difficult. One cone production study showed that on the average a mature tree produced about 2,000 cones per year (2).

No important seed or cone insects or diseases have been reported for giant sequoia.

Loss from freezing has been observed, as in the early summer of 1906 (7). When an 1-year-old cones were frozen, none of the 2-year-old cones on the same trees were affected.

Squirrels, particularly the Douglas squirrel, cut down and store numbers of mature cones (7). However, rodents prefer other seeds, such as pine seed and acorns, when they are available (2). In a rodent preference study, giant sequoia seed ranked tenth out of fourteen different seeds and fruits.

Giant sequoia seeds are not usually released the first year after the cones mature (3, 7). Viable seeds may be retained in the cones for years. One cone, on a branch broken off a large tree during a wind storm, was 19 years old and still contained 137 seeds—more than half the average number of seeds normally found in cones at maturity (3).

The tissue in the peduncle of mature cones that remain closed on the tree produces annual rings (3). Cones with only 2 growth rings in the peduncle are immature, whereas those having 3 or more rings are mature. Annual rings continue to form in cones that have not shed all their seeds and therefore can be used to determine the age and maturity of the cones.

Giant sequoia seeds are very light - about 91,000 per pound on the average (13) - and may be carried for great distances by air currents. The greatest distance that wind will carry the seeds is not known; however, in one instance they were carried 580 feet (7). In still air seeds fall at the rate of 4 feet per second (2).

Seedling development

Giant sequoia seedlings usually become established only on disturbed soil or on ashes (11, 13). Very few seedlings are found in groves where the litter is deep and dry, although records have never been made, probably only one seed in a million germinates under natural conditions and only a small percentage of these thrive (7).

Few seedlings ever develop from the cones buried by rodents, even from cones buried with the upper surface no more than 0.2 inch deep (2). Seeds buried more than 0.9 inches will not germinate and produce seedlings.

Seedlings rarely become established in dense grass cover, probably because of the depletion of moisture in the surface soil early in the season (2). During the initial stages of seedling establishment under natural conditions, some shade will reduce the damage from stem insolation (2). In one study, none of the seedlings survived full exposure to sunlight, 16 percent survived under partial shade, and 68 percent

survived in full shade (12). However, in a more recent study (2) seedlings grown in full sunlight on litter-covered soil were 86 percent larger than those grown in 75 percent of full sunlight. Those under 50 percent and 25 percent sunlight grew poorly.

Sparrows, the California purple finch, ground squirrels, chipmunks, and cutworms (Noctuidae spp.) destroy many seedlings during the first months after germination (9). Root rot fungi, such as *Sclerotium bataticola*, and stem insolation also damage or kill seedlings.

Evidence for the difficulty with which Giant sequoia is established in groves despite the great quantity of seed disseminated, is provided by the relative composition of reproduction (2):

Relative Composition of Reproduction

Species	Percent Composition
Giant sequoia	1.0%
White fir	60.2%
Incense-cedar	24.1%
Sugar pine	9.3%
Ponderosa pine	3.5%
Other	1.9%

Height growth of giant sequoia seedlings is slow during the first year but increases rapidly after the second or third year (11). One-year-old seedlings are 1 to 3 inches tall. By the end of the second year they are 3 to 6 inches, and after 3 growing seasons, 6 to 12 inches. With an even start, giant sequoias are capable of outgrowing many of the associated species (9).

Although giant sequoia seedlings have been reported to have strong taproots, in the nursery, they have a less-developed taproot than do pines and Douglas-fir.

Vegetative reproduction

Giant sequoia does not produce sprouts from roots or stumps as is common in redwood, but tall broken stubs and crowns will sprout vigorously and form new tops provided sufficient live foliage remains below the breakage point.

Sapling Stage to Maturity

Growth and yield

Although giant sequoia is not the tallest species and although occasional individuals of other species may surpass it in basal circumference, it is the most massive tree in the world (11). The highest volume from a single tree was estimated to be 600,120 board feet; many individuals have a gross volume of more than 500,000 board feet.

The General Sherman tree in the Giant Forest has the greatest circumference of the measured trees. Its basal circumference is 101.6 feet at 4.5 feet and its height is 272 feet (1). The tallest giant sequoia (California tree in the General Grant Grove, Kings Canyon National Park) had been reported to be 310 feet high (11), but recent measurements indicate that the 291-foot McKinley tree is the tallest. Trees with an average basal diameter of 20 feet and a height of 275 feet are common in the southern groves where the best stands are found (13).

Giant sequoias are long lived. Trees in many groves are from 2,000 to 3 000 years old; a few are over 3,000 years (11, 13). The maximum age is reported to be over 4,000 years (13), but no authentic records substantiate this claim. The actual age of the oldest living tree is a subject of much speculation and only crude estimates can be made. Ring counts on felled trees show ages of 3,200 years (11). Huge old trees, which were big to cut in early years and which are protected, may be older.

Giant sequoias grow rapidly during their youth; old age growth is rather slow. Trees under 75 years old increase in diameter at an average age of 1 inch every 3 to 5 years, but ancient, over-mature trees may require more

than 20 years to gain 1 inch in diameter (6). Periodic annual growth rates of giant sequoia have not been determined.

Giant sequoias less than 100 years old retain most of their branches. In contrast, trunks of mature trees are generally free of branches to a height of 100 to 150 feet.

Reaction to Competition

Giant sequoia's tolerance compared to its associates is not well established. Much depends on the period in the life span during which the trees were rated. Young trees are more shade tolerant than older trees. For best development, giant sequoias seem to require full overhead light (2, 13). In comparison with white fir, young sequoias can withstand drought better than white fir but cannot endure shade as well. Incense-cedar, however, withstands drought as well as sequoia and also endures moderate shade (2).

In dense thickets, growth is very poor and when released the spindly trees recover slowly. However, after the crown has filled out, growth is rapid (13).

Principal Enemies

Giant sequoia has few enemies other than fire (13). Crown fires are especially destructive during the seedling and sapling stage (11, 13). Mature trees, protected by bark up to 2 feet thick, are able to survive repeated fires without serious loss (11). However, after the bark has been burned off, repeated hot fires may hollow out large trees. Few of the veteran trees have been destroyed by fire alone, but some have been wind-thrown where roots were destroyed by fire road construction, or exposure by erosion following fires. Most trees larger than 10 feet in diameter have fire scars (6).

Soil compaction by the thousands of tourists that visit the groves each year has seriously reduced the vigor of many large trees (8).

Once established, giant sequoia is noted for its resistance to insect and disease attacks (6, 11, 13). None of the insects or diseases reported on giant sequoia has caused the death of a single

tree. Old trees which fell centuries ago show very little evidence of decay in the heartwood (11), but the 2 to 3-inch layer of sapwood rots away in a few years.

Races and Hybrids

There are no known races or hybrids of giant sequoia but five horticultural varieties are known as ornamentals.

Revised from "Silvicultural characteristics of Giant Sequoia," by G. H. Schubert and N. M. Beetham. U.S. Forest Service California [Pacific Southwest] Forest and Range Experimental Station Technical Paper 20. 1957 (Revised 1962).

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