Management of Giant Sequoia at Blodgett Forest Research Station[1]

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Abstract: Researchers at Blodgett Forest Research Station, University of California, are studying giant sequoia (*Sequoiadendron giganteum* [Lindl.] Buchholz) growth under both even-age and selection management in relationship to the presence of several shrub species and five native conifers. The sequoias are also being studied under several types of site preparation, vegetation control techniques, and stand densities. Seven management units are described. In virtually all situations, early (first 18 years) height and diameter growth patterns of sequoia equal or exceed those of native conifers.

FOREST DESCRIPTION

Blodgett Forest Research Station is a 2961-acre (1199 ha) field research station owned by the University of California, Berkeley, and operated by its Department of Forestry and Resource Management. The station provides a location for wildland resource research and demonstrates forest management principles and practices. Most of the property was given to the University by the Michigan-California Lumber Company in 1933 for timber management research. The forest is named in honor of John W Blodgett, who was then president of the lumber company.

The forest is located in the American River watershed on the western slope of the Sierra Nevada in El Dorado County. All of the property is located between 3900 and 4800 feet (1200 and 1500 m) in elevation on the Georgetown divide. The topography is moderate. Most slopes average less than 30 percent and few are greater than 50 percent.

Blodgett provides excellent examples of the Sierra mixed conifer/oak forest type. More than 400 species of plants are found on the forest. Common tree species include ponderosa pine, sugar pine, California black oak, white fir, Douglas-fir, incense-cedar, and tanoak. Some of the most common brush species are manzanita, deerbrush, whitethorn, bear clover and western azalea. Over 150 species of animals have been seen on the forest including mountain lions, coyotes, rattlesnakes, squirrels, porcupines, hawks, chickadees, and deer.

Four major soil types are found on the forest. All are loams or sandy loams, which are generally well drained, fairly deep, and reasonably resistant to erosion---except when they are on steep exposed slopes. The Holland, Pilliken-Variant, and Musick soils are all developed from granodiorite parent materials. The Cohassett soil type is developed from andesitic lahar. These soils support conifers capable of growing 90 to 110 (35 m) feet tall and 18 to 26 inches (46-66 cm) in diameter at age 50 to 60 years. The average acre can produce 200-250 cubic feet (14-17.5 M^3/ha) or 1000-1250 board feet of wood per year.

Blodgett Forest receives an average of 66 inches (168 cm) of precipitation per year with a 22-year range of 23 to 108 inches (58-274 cm). About 85 percent of the precipitation falls between October and March while less than 5 percent falls during the summer months. Snow is common from November to April, averaging about 100 inches (250 cm) per year. Average daily maximum temperatures range from 48 °F (9 °C) in the winter to 80 °F (27 °C) in the summer. Average daily minimums range from 32 °F (0 °C) in the winter to 57 °F (14 °C) in the summer. Frosts are common from October through May.

There are no native giant sequoias (*Sequoiadendron giganteum* [Lindl.] Buchholz) in the area. The nearest native groves are in Placer County about 10 air miles north across the Middle Fork of the American River and in Calaveras County about 50 air miles southeast. Most of the plantings described below are from seed sources at Whitakers Forest, another University of California field station, located on the west edge of Kings Canyon National Park.

FOREST MANAGEMENT

To provide future opportunities for research, portions of the forest are managed utilizing even-and uneven-aged silviculture. Since the mid 1960's, sequoia has been gradually introduced under both systems. Since virtually all the forest was heavily cut-over in the first two decades of this century, all the sequoias planted at Blodgett Forest have been in areas where either young growth mixed-conifer-oak (50- to 70-year-old) forests or brushfields were cleared.

Uneven-Aged Management

Sequoia in uneven-aged management was introduced initially alone and most recently mixed with other native conifers in group selection cuts. These openings have ranged from ¼ to 2 acres (< 1 ha). Most such openings also have natural regeneration of native conifers about the same age as the planted sequoias.

One planting is a 10-year-old ½-acre (¼ ha) group selection cut on Holland soil located on a ridgetop at about 4600 feet (1400 m) elevation and a 10 percent east slope. The surrounding canopy is about 70 years old and 120 feet tall.[3] Sequoias range from less than 3 feet tall near the edge of the cut to about 20 feet tall near the center. Competing natural ponderosa pine (*Pinus ponderosa* Dougl. ex Laws.) and white fir (*Abies concolor* [Gord. & Glend.] Lindl. ex Hildebr.) regeneration at the same age range from 3 to 15 feet tall. Shrub competition is principally deerbrush (*Ceanothus integerrimus*), and is over 6 feet tall despite having been cut to ground level 5 years earlier.

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[3]1 ft =0.305 m

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Another unit is a 13-year-old group selection cut of about ¾ acre (⅓ ha) on the same type of site. Sequoia heights range from 10 feet on the group cut edge to 26 feet at the group's center. Diameter at breast height ranges up to 10 inches (25 cm) for the largest trees. Live crown ratios (LCR) are all over 90 percent despite the close spacing of about 6 to 8 feet within the group. Branch diameters are all less than 1 inch (2.5 cm) regardless of tree position in the group. Natural ponderosa pine and white fir regeneration of the same age ranges is up to 18 feet in height. The Northern California Forest Yield Cooperative (NCFYC) site for the surrounding 70-year-old natural stand averages (breast height age 50) about 100 (Bigging and Wensel 1984). Dominant ponderosa pine in the group cut also average about site 100 using Oliver's (1972) pine site classification. Dominant sequoia appear to have an equivalent site index (although no real site index for sequoia exists) of about 130, or 30 percent taller at this age than ponderosa pine.

The oldest group selection planting at Blodgett Forest is 18 years old in a less than ¼-acre ($^1/_{10}$ ha) opening. Dominant sequoias are over 30 feet tall with 60 LCR despite the 120-foot tall surrounding conifer stand. Interestingly, the opening was apparently created by harvesting of a pocket *Fomes annosus*-infected white fir. Several white fir stumps among the planted sequoia have numerous *Fomes annosus* fruiting bodies. The sequoia showed no signs of disease at this writing.

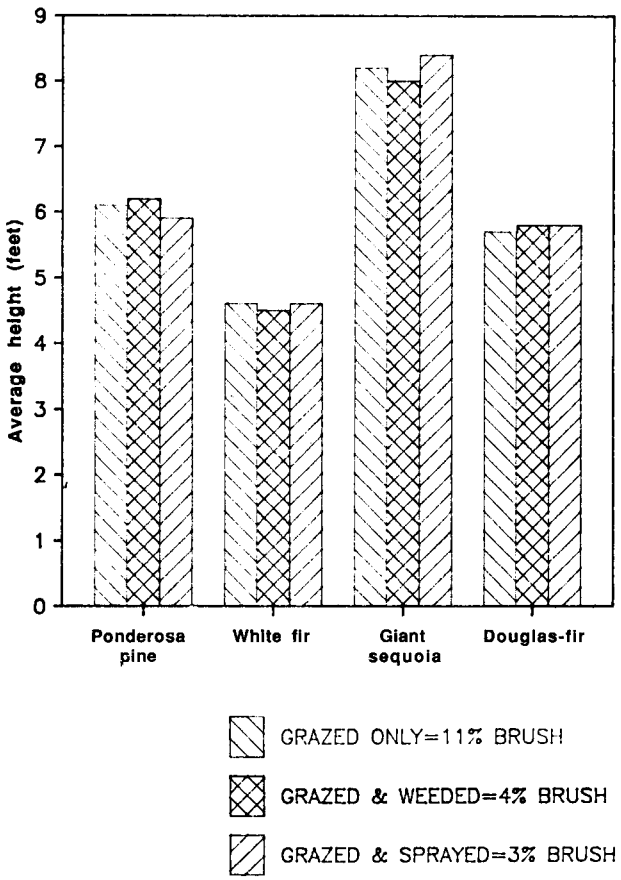

Figure 1-At age 5, planted giant sequoias averaged 8 feet in height on Unit 321-E.

Even-Aged Management

Sequoia has been fully integrated into Blodgett Forest even-aged management regeneration efforts only since 1981. Sequoia is currently included in each clearcut planted at a 10 to 20 percent rate. Unit 321-E is a 15-acre (7 ha) clearcut located on north and east slopes, at 4400 feet (1340 m) elevation. Again it is a Holland soil. Slopes range from 5 to 40 percent. The site was prepared by a crawler tractor equipped with a brushrake. Ponderosa pine, Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), white fir, and giant sequoia were planted on 8-foot (2.5 m) spacings in April 1981. Giant sequoias were container stock grown in 8-inch super cell leach tubes at the Simpson Nursery in Korbel, from Whitaker seed source. Sequoias were less than 8 inches (20 cm) tall at the time of planting. Sequoias averaged 12 inches (30 cm) in height at the end of the second growing season but had more than tripled their volume of foliage. By the start of their fifth growing season (May 1985), sequoias averaged 8 feet in height *(fig. 1)*. Most sequoia trees had full dense foliage throughout their crown despite average fourth year internodes in excess of 3 feet. Ponderosa pine averaged 6 feet with some individuals up to 8 feet. Douglas-fir averaged 5 feet with some individuals up to 7 feet. The tallest sequoias were nearly 10 feet tall at the beginning of their fifth growing season. On this clearcut competing vegetation is quite sparse. Shrub control is almost entirely the result of range cattle grazing. Inside cattle exclosures, deerbrush averaged 5 feet tall with over 80 percent crown cover on this site. Sequoia survival was greater than 80 percent. Despite heavy cattle and deer use, only one damaged sequoia was found. The damaging agent was not identified.

This pattern of sequoia growth is essentially duplicated on a 10-acre (4.5 ha) clearcut (Unit 200-E) planted at Blodgett in 1981. This second site is a steeper (30 to 50 percent) west-facing slope at 4100 feet (1250 m) elevation on Musick Series soil. The tallest sequoias were over 10 feet at the end of their fourth growing season *(fig. 2)*. This location does not have cattle grazing. Shrubs---deerbrush and tanoak *(Lithocarpus densiflorus)*---were controlled in a third of the site by hand grubbing, and in another third by herbicide; one third of the site had no shrub control at all. Deerbrush cover in the control area exceeds 60 percent with average height over 4 feet. Although all trees including sequoia exhibited less dense foliage in areas with heavy shrub competition, only a slight difference in total height of sequoia was evident at the end of the fourth growing season. Ponderosa pine, Douglas-fir, and white fir showed significant reductions in height at age 4, when grown in the untreated brushy area.

On an 11-acre (5 ha) clearcut planted with white fir in 1970, approximately a 1-acre (½ ha) area was planted with giant sequoia in spring 1971. A dense shrubfield of deerbrush and greenleaf manzanita *(Arctostaphylos patula)* over 6 feet in average height has developed since planting. White fir averages less than 3 feet in height with occasional natural ponderosa pine overtopping the brush. Sequoias, on the other hand, average nearly 30 feet in height, with several trees over 35 feet. Diameter at breast height ranges from 6 to 13 inches (15 - 33 cm), despite about 6-foot average spacing in this 14-year-old plantation. This is a

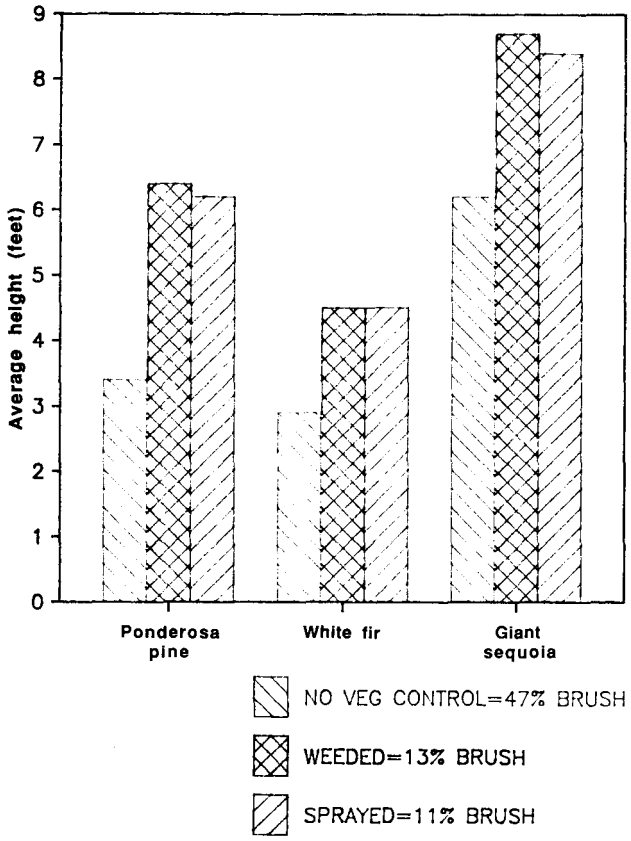

Figure 2-After four growing seasons, the tallest giant sequoias were over 10-feet high on Unit 200-E.

wet site on the edge of a spring. Nevertheless, the sequoias were able to suppress both grass, sedges, and deerbrush (as evidenced by skeletons inside the sequoia stand) that had a 2-year headstart on growth. Indeed, the sequoias on this wet site were actually about 20 percent shorter at age 5 than on the aforementioned 5-year-old plantation, which is on a well-drained hillside. Perhaps the extra moisture on this site partially compensated for early shrub competition. Some individual trees are truly impressive. One tree had a height of 38 feet and d.b.h. of 14.9 inches (38 cm) at age 14. Several trees have been pruned over the last 3 years. They exhibit virtually no epicormic branching. Some apparently minor sapsucker damage is visible.

Another plantation, which is about 16 years old, was originnally started as a density study. This site is a dry, eastfacing midslope area at 4200 feet (1280 m) in elevation on Pilliken-Variant soil. The area was a brushfield before clearing and planting with giant sequoia. A dense 6-foot tall greenleaf manzanita, bush chinquapin *(Castanopsis sempervirens),* and bear clover *(Chameabatea foliolosa)* shrubfield again occupied the site by the early 1980's. Natural pine regeneration is scattered throughout the area with heights ranging up to 16 feet. Pine trees and sequoias are taller where tree survival was higher, and tree spacing closer together. Many sequoias survive at or below the general brush canopy height. In 1983, the brush was cut with a chainsaw-powered cutter. Sprouting shrubs were sprayed in 1984. Released sequoias had already increased height growth and greatly increased in crown volume only 2 years after brush control. Typical giant sequoias were 7 to 10 feet tall with about 20 to 40 percent crown height above the brush in 1983.

At this early stage of research, adding sequoia to both even- and uneven-age managed young-growth stands seems quite compatible with existing wood production goals. Increased species diversity may be an additional benefit to wildlife habitat and visual quality. Early sequoia height and diameter growth appears less susceptible to growth reductions due to competition with ceanothus shrub species than are other native Sierra conifers.

REFERENCES

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