

Diseases and Insects of Giant Sequoia¹

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Abstract: Giant sequoias (*Sequoiadendron giganteum* [Lindl.] Buchholz) are susceptible to a number of diseases and insects at each state of development from seeds to overmature trees. We presently have little more than a catalog of occurrences. The impacts and the management implications of disease and insect losses have scarcely been investigated or evaluated, and much study is needed to provide data for sound management and protection of giant sequoia stands.

Management implications of disease and insect impacts in stands of giant sequoias (*Sequoiadendron giganteum* [Lindl.] Buchholz) are largely speculative, and available information is mainly descriptive or anecdotal. Review of standard lists of pathogens (Anon. 1960, Bega 1978, Hepting 1971, Peace 1962) or insects (Furniss and Carolin 1977, Keen 1952) of forest trees indicates that few pests of giant sequoia have been described. Giant sequoia is not even mentioned in Boyce's (1948) classic text on forest pathology. Pathogens (Bega 1964), fungi (Piirto and others 1984a), and insects (Stecker 1980a) on sequoia have been listed, and a few nematodes have been described (Cid del Prado and Lownsbury 1984, Maggenti and Viglierchio 1975). Knowledge of sequoia pests is gradually increasing, but--in general--their management implications are assessed mainly by extrapolation from what is known about similar pests of other species.

I have not attempted an exhaustive listing of references to diseases and insects of giant sequoia. I have, rather, selected references that provide good literature lists or that provide information bearing directly on evaluation of pest potentials in managed stands.

Pests become problems when they adversely affect the realization of management goals to an unacceptable degree. Pests do this by interfering with stand regeneration, development, and productivity. In stands managed for recreation or preservation, tree longevity and visitor safety may also be important.

REGENERATION

Factors affecting regeneration of giant sequoia were reviewed by Harvey and others (1980). They indicated that sequoias annually produce large numbers of seeds, the release of which is

due in part to the activity of the cone beetle (*Phymatodes nitidus*). Seedling survival is rare in undisturbed duff and litter. Where mineral soil is exposed by fire or scarification, seedlings can become established, but not without considerable loss.

Seedling losses on suitable beds were attributed mainly to insect grazing and to desiccation, of which desiccation was by far the most important (Harvey 1980, Stecker 1980b). Insects variously injured large numbers of seedlings. Final mortality attributed to insects varied on study plots, with averages of about 6-25 percent in different years (Harvey 1980) but almost 30 percent on one plot (Stecker 1980b). Most insect damage occurred on first-year seedlings and was heavier on recent burns than on areas burned 2 or more years before seeding, presumably because in the first year or two after burning, sequoia seedlings were about the only plants available. The camel cricket (*Pristocaulophilus pacificus*) and two geometrids (*Sabuloides caberata* and *Pero behresarius*) were prominent among seedling grazers (Stecker 1980b). Cutworms (*Noctuidae* spp.) have also been reported to destroy giant sequoia seedlings (Metcalf 1948). Any general grazers apparently can kill seedlings.

In closely related coast redwood (*Sequoia sempervirens* [D. Don] Endl.), cone and seed molds are associated with reduced seed viability. Damping-off and rootrot fungi are major factors in preventing seedling establishment in undisturbed duff and litter (Davidson 1971, Muelder and Hansen 1961). Research will likely show a similar situation in giant sequoia, especially since the effects of desiccation and disease can be difficult to separate.

Regeneration by planting requires nursery seedlings, and several pathogens can cause heavy losses of giant sequoia seedlings in nurseries, especially charcoal root disease caused by *Macrophomina phaseoli* and grey mold caused by *Botrytis cinerea* (Peterson and Smith 1975). Cultural and chemical methods are available to control nursery diseases, and care should be taken to see that healthy seedlings are planted.

STAND DEVELOPMENT

Little is known about how diseases and insects might affect developing, young-growth stands, especially those within the native range. Trees planted outside the native range in California (Bega 1964) or abroad (Libby 1981) can be severely damaged by a canker fungus (*Botryosphaeria* sp.) or by *Armillaria mellea*. Stumps of coast redwood are susceptible to colonization by *F. annosus*; therefore, giant sequoia stumps probably would also be colonized (Cobb and Barber 1968). Because *F. annosus* attacks sequoia roots (Piirto and others 1974), managers should recognize the possibility that this pathogen could cause problems in thinned stands or stands established after cutting.

Because a number of insects have been recorded on giant sequoia, some probably could become problems in managed stands. The wood borer (*Trachykele opulenta*) reportedly kills trees stressed by road or stream cuts (Hartesveldt and others

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1975), but killing by other insects is virtually unknown. In fact, Fowells (1965) stated: "None of the insects or diseases reported on giant sequoia has caused the death of a single tree." Giant sequoia is also one of the trees most resistant to "smog" damage (Miller 1978).

MATURITY

Maturity and decline of giant sequoia stands have been studied in some detail because of the recreational and specimen values of large, old trees. Historical, popular, and scientific accounts generally agree that mature giant sequoias seldom---if ever---are killed by insects or diseases. Excluding lethal fire, lightning, or other environmental damage, death of large trees generally results from uprooting or from stem breaking. Of 33 failures of big trees, 7 (21 percent) apparently fell mainly because of poor footing (wet soil, stream undercutting, etc.), 22 (67 percent) because of the failure of decayed roots, and 4 (12 percent) because of stem breaks (Piirto and others 1984b). All but 2 trees (both fell because of poor footing) had decay in either the stem or roots. Carpenter ants were found in 16 trees but appeared to contribute to failure of only 6. Fire scars were present in 27 trees and 26 fell to the fire-scarred side. Hartesveldt and others (1975) reported that 90 percent of the scarred trees fell to the scarred side.

Early beliefs held by Muir and others (see Piirto 1977 for discussion) that giant sequoias have no insect or disease problems are not tenable. While trees in native stands obviously resist much disease and insect attack, they eventually succumb to the sorts of decays and insects that limit the ages of other species of trees. Most records suggest that these effects of diseases and insects occur mainly in very old trees and would be a factor only in the management of "specimen" trees in park and recreational settings. However, because we lack knowledge of the losses that might have occurred in younger trees during grove development, we cannot be comfortable with the assumption that only very old trees will be injured or killed by insects and diseases.

Full assessment of pest impacts in mature sequoias will require additional study, but existing data (Piirto 1977, Piirto and others 1984b) suggest two important management implications:

1. Decay and carpenter ant activity were usually associated with fire scars. This may mean that protection of trees from fire scarring could increase longevity and decrease hazard to visitors. Such protection would involve mainly the removal of fuels from around the bases of specimen trees.

2. White firs serve as "pasture" for the aphids tended by carpenter ants (Tilles and Wood 1982, David and Wood 1980) and are highly susceptible to decay fungi that also attack giant sequoia roots. This may mean that white fir encroachment in giant sequoia stands might lead to increased insect and disease activity. Therefore, prescribed burning to reduce fir encroachment may also reduce the disease inoculum and the support for carpenter ant populations. Contrary to earlier reports (Hartesveldt and others 1975), food left by visitors does not appear to increase carpenter ant populations.

Intensive forest management often leads to increased pest problems, and it would be surprising if this were not the case

with giant sequoia. It would certainly be prudent to learn as much as we can as fast as we can if we are to undertake large-scale planting of giant sequoia.

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