Giant Sequoia in the Sierra Nevada

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The ecology of giant sequoias has been a subject of intense interest for the last three decades. Fire, mycorrhizal fungi, squirrels, and insects have essential roles in the survival of the sequoia forest. Managers must implement strategies to create natural conditions in areas overprotected from naturally occurring processes. Pre-Euroamerican forest species and natural processes are the management goals of restoration.

HISTORY

Giant sequoias (*Sequoiadendron giganteum*) have evoked a sense of awe and wonder since the time of their discovery by Euroamericans in 1933 and again in 1952, when their "discovery" was more widely publicized (Harvey et al., 1980). Giant sequoias have been in the Sierra Nevada for thousands of years increasing in abundance since approximately 4500 years ago. After thousands of years of evolving in the microclimates of 75 disjunct groves the big trees faced a century of differing views on their ecology and management. Most of the 75 naturally occurring sequoia groves occur in the southern Sierra Nevada, south of the Kings River (Rundel, 1972). The "big trees" created visions of utilitarian usage in some groves and preservation enclaves to others. Approximately 92% of the sequoia grove area is in some form of public ownership primarily managed by the U.S. Forest Service and the National Park Service.

PUBLIC VALUES

The use and preservation of these forests has always been an arena in which public values are discussed and played out in implementation of specific management plans. The "big trees" are perceived differently by the public than other trees in the forest. *Members of the public tend to perceive sequoias as unchanging, sacred objects, not as* dynamic members of evolving ecosystems. The sequoias had the power to motivate American citizens to reject the political norms of the mid-19th century, which was at the height of the expansionist-pioneer era selling government lands for a minimal price and direct Congress to set aside the Mariposa Grove and give it to the State of California to be managed in perpetuity for preservation and recreation (Tweed, 1994). In the mid-1980s, timber managers on the Sequoia National Forest decided it was time to log within the uncut groves of giant sequoia, but after public outcry the Forest Service concluded a mediated settlement that insured there will be no commercial logging within the groves and the Forest Service will prepare a management plan for each grove aimed at restoration and regeneration.

SEQUOIA MANAGEMENT

Sequoia, Yosemite, and Grant Grove (now Kings Canyon) National Parks were preserved in 1890 as part of the efforts of the American public to protect giant

sequoias. During this era of protection, logging and naturally ignited fires were suppressed. Throughout the early 1960s no significant fires, human or lightning-caused, had burned in any of the groves of the three parks (Parsons, 1990). In a 1963 report to the Secretary of Interior, a Special Advisory Commission on National Parks warned that continued fire suppression would cause an increase in hazardous fuels and change plant and animal communities in the conifer forests of the Sierra Nevada (Leopold et al., 1963). This committee stressed the ecological complexity of the national parks and implied that a more thorough understanding of each area was necessary in order to effectively manage them. Beginning in the early 1960s, the National Park Service began to move away from its founding philosophy of preserving objects to a management strategy based on preserving ecosystems. Yet significant portions of the general public, who have been taught that giant sequoias are sacred objects which transcend the normal limits of life, continue to haunt and to confuse the current world of giant sequoia management (Tweed, 1994).

SEQUOIA ECOLOGY

Viewing the giant sequoias from an ecosystem perspective, mycologists, entomologists, and mammalogists found sequoias to be closely associated with mycorrhizal fungi, various insect species, and a Douglas squirrel (*Tamiasciurus douglasi*). Giant sequoia forms associations with vesicular-arbuscular (VA) mycorrhizae. These mycorrhizae increase the uptake of phosphorus and nitrogen and protect sequoia roots from soil pathogens. Under laboratory and nursery conditions sequoia seedlings inoculated with mycorrhizae were two to three times larger than noninoculated seedlings (Molina, 1994). Burrowing of insect larvae severs vascular connections which results in drying of the cones and seed release from high up in the tree canopy dispersing over wide areas of the forest floor (Harvey et al., 1980). Douglas squirrels cut large numbers of giant sequoias from the canopy and create caches from which they chew the cones and release, but do not eat the seeds, which they leave behind on the surface of the soil. One squirrel was observed to cut 538 cones in 30 minutes (Harvey et al., 1980).

Studies carried out in the l960s and early 1970s documented the importance of periodic fire in maintaining the giant sequoia mixed-conifer forests of the Sierra Nevada. In 1968 the National Park Service reversed its official resource management policy of fire exclusion and recognized that the "presence or absence of natural fire within a given habitat is recognized as one of the ecological factors contributing to the perpetuation of plants and animals native to that habitat. Prescribed burning to achieve approved vegetation and/or wildlife management objectives may be employed as a substitute for natural fires" (Biswell, 1989). For thousands of years fire has reduced flammable surface fuels, thinned forest trees, stimulated sprouting of shrubs and other hardwoods, released seeds and prepared seedbeds favorable for germination of giant sequoia, efficiently recycled nutrients, and influenced insect and disease populations (Kilgore, 1972). It was clear the practice of fire suppression was in conflict with what researchers were discovering about the need for fire in the survival of young sequoias. In the late 1960s the National Park Service began a program of prescribed burning in the sequoia groves.

FIRE AND GIANT SEQUOIAS

The challenge of returning to more "natural" conditions with the use of fire is subject

to different interpretations and values. What is natural? Should grove conditions be recreated to what existed prior to Euroamerican expansion? For at least the last 2 or 3 thousand years preceding Euroamerican settlement, predominantly low- to moderate-intensity surface fires burned within individual sequoia groves on the order of every 2 to 10 years. Because of the suppression of natural fires most groves have experienced a 100- to 130-year period without significant fire. Giant sequoia reproduction has effectively ceased in groves protected from fire and dead material has accumulated. Shade tolerant species such as white fir have increased creating "ladder" fuels capable of conducting fire into the crowns of mature trees. Because of this increase in fuel load and ladder fuels, high severity fire conditions are created which threaten even mature monarch giant sequoias. Fire is important in creating conditions for the release and germination of the small and delicate giant sequoia seeds. In addition fire-created forest gaps are the site of abundant sequoia seedling establishment (seed germination, rooting, and survival for the first few summers) and recruitment (growth of the seedling into a mature, seed-producing tree). Not just any fire will result in successful giant sequoia seedling establishment and recruitment. Giant sequoia is what is known as a "pioneer species," requiring canopy-destroying disturbance to complete its life cycle. "Patch dynamics" driven by canopy-destroying disturbance is the rule in the giant sequoia forest community, not the exception (Stephenson, 1994).

For better or worse, people are now a part of the Sierra Nevada ecosystem. Forests surrounding some groves have been logged which results in hydrological changes, air quality from human activities respects no ecosystem boundaries, and groves are managed by different land-use agencies each with different management philosophies and objectives.

The literature on giant sequoia research, different management philosophies from land resource agencies and research universities, and current field studies have been reviewed by Nathan Stephenson of the National Biological Survey for the Sierra Nevada Ecosystem Project (Stephenson, 1996).

While most researchers agree for the need to return fire to the sequoia forest there is disagreement over the methods used to restore sequoia groves. Structural restorationists argue that grove structure and species composition must be restored, by whatever means possible, before natural processes (particularly fire) are allowed to run a more natural course in determining grove dynamics. Process restorationists argue that the goal of restoration is to restore the major processes (particularly fire) that shaped sequoia ecosystems in pre-Euroamerican times. Fire becomes a tool of choice in determining future grove structure and composition (Stephenson, 1996). The practicality of these two approaches is currently debated with economic, political, philosophical, and ecological issues influencing specific management plans.

Giant sequoias have a special place in the hearts and minds of many people. They are an international attraction and play a role in the identity of our local community including my college, College of the Sequoias. For many years giant sequoias were thought to be self-perpetuating and by taking action in the 1890s to preserve these trees in National Parks, it was thought the sequoia forests were safe. One hundred years later we know that the giant sequoia needs to be viewed as part of an ecosystem that requires the natural processes of fire, as well as invertebrate and vertebrate interactions to maintain viable mixed-age forests.

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