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Sustaining native giant sequoia groves requires active, adaptive management

A Position Statement of the California Society of American Foresters

Adopted in 2022, to be revised annually in order to incorporate new research and management as it develops

Position

I. The social, economic, and ecological values provided by native giant sequoia groves to current and future generations have been impacted by wildfires that are interacting in novel ways with a rapidly changing climate and a legacy of past forest management decisions.

II. Without urgent yet deliberate management action that reduces the probability of high severity fires occurring within and around groves, millennia-old trees will continue to die at an unacceptable rate when future wildfires inevitably occur.

III. Wildfire is an ecological process that belongs in giant sequoia ecosystems, but its behavior is influenced fundamentally by human decisions. We have an ethical obligation to respond to unprecedented catastrophic losses of giant sequoias to high severity wildfires by applying our scientific understanding of ecology toward improving the capacity for giant sequoia groves to persist through future generations.

IV. Giant sequoia groves should be managed so that future wildfires behave in beneficial, not negative ways. Several treatment options, including mechanical restorations, that can increase the probability of using prescribed fire in the future, are known to be effective and should be used. The standards for effectiveness have changed, however. Treatments need to reduce both surface fuels and forest density dramatically, and then be maintained with either frequent fires or mechanical surrogates where fires are not feasible.

Background and Purpose

While all species of the California mixed conifer forest are adapted to low and moderate severity (LMS) fires, giant sequoia's adaptations are notable in how distinct and numerous they are. They are extremely long-lived trees (3000+ years, Stephenson 2000) that persist within a forest ecosystem that burned frequently for millennia prior to Euro-American colonization that forcefully removed human populations that actively managed with fire. The longevity of giant sequoia has provided an extremely well-developed record of fire history, providing physical evidence that LMS fires occurred at least every 3 years on average at grove scales (Swetnam et al. 2009). Millions of seeds are stored in the cones of large tree canopies, opening up during fires with heat intensity that is sufficient to release large amounts of seed. Frequent fires maintained low surface fuels, reduced the number and density of fire-intolerant conifer species, and maintained a patchy mosaic of canopy densities, including distinct canopy openings where dense cohorts of giant sequoia could regenerate (York et al. 2011).

The life history of giant sequoia is intertwined with fire during all phases, from regeneration to young tree development to the eventual recruitment of large, old trees. Seedlings establish and grow faster within ash substrates (York et al. 2009), young trees have a relatively high capacity to survive LMS fires (York et al. 2021), and large tree development is accelerated by the reduction of competition via fires (York et al. 2010).

This interaction between giant sequoia and LMS fires, which in the past sustained the presence of populations, has been fundamentally interrupted by fire suppression and exclusion. Prescribed fire and wildland fire use programs have resulted in the improvement of conditions in some isolated areas of groves, but they have been insufficient in their pace and have not been conducted at a scale that is significant for the entire population. Leading up to the wildfires that impacted groves beginning in 2015, most of the giant sequoia groves were managed over the past century with fire exclusion and without active efforts to replace the role of fire. This resulted in fire regimes that were far less frequent than the regime to which they are adapted (York et al. 2014). The effect of this lack of fire has been surface fuel loads, fuel ladders, and tree densities that are beyond ecological thresholds of sustainability for the species. Changes in the climate have accelerated the crossing of this threshold, resulting in rapid and profound mortality of large, old giant sequoia. The statistics are alarming: 10 to 14% of the earth's existing population of trees greater than 4 feet in diameter were estimated to have been killed by high severity fire effects in 2020, and an additional 3-5% were killed in 2021 (Shive et al. 2021).

The current and future climate raises the standards for treatment effectiveness

Ecological restoration work that prepares giant sequoia groves for the future can be nuanced in a myriad of ways that are specific to the needs of giant sequoia and the objectives of the particular landowner. Generally, there are two fundamental tools that are available:

1. Surface fuels should be reduced to levels that allow for low to moderate severity fire effects during extreme weather conditions; and
2. Density must be reduced to levels that result in sustained high vigor of large trees during drought stress.

Ideally, prescribed fire and wildland fire use (allowing wildfires to burn when conditions are appropriate) would be the tools that accomplish both of these outcomes. However, intractable constraints continue to limit managers' capacity to rely on fire alone (Schulz and Moseley 2019). Further, prescribed fires have often not been hot enough to result in the establishment of new cohorts of giant sequoia (Webster and Halpern 2010). It is not just the absence of fire, but also the absence of appropriate fire severity that is at the root of what is currently an unsustainable situation. The harvesting of medium-sized trees, which may result in sawlogs that can be used for lumber, may be necessary in and around groves that have not burned in several decades or where prescribed fires have not reduced tree density significantly. This thinning of medium-sized trees can accomplish structural goals to protect and sustain groves in ways that low-intensity prescribed fires cannot. There are opportunities for new approaches that merge prescribed fires with timber harvests so that they can be synergistic toward restoration, carbon sequestration, and fire hazard reduction goals (York et al. 2022).

Densities of small and medium sized trees found in current forests where fire has been removed without replacing it with a proper surrogate are far greater than what was present in the past (North et al. 2022). Future climate scenarios suggest that forest densities will need to be much lower than what we see

broadly across the landscape (Bernal et al. 2022). Forest densities will likely need to be even lower than what has been the standard in conventional forest management. Large, old giant sequoia trees are not decadent. They are physiologically plastic trees, capable of increasing their growth rates in response to density reductions (York et al. 2010). They are also relatively capable of persisting through drought stress events (Stephenson et al. 2018). The loss of large, old trees from high severity fires, however, means the loss of the capacity for these adaptations to function.

Active adaptive management is needed

Active management is needed to prepare groves so that large trees will survive fires, and so new cohorts of giant sequoia can regenerate. Those groves that have not experienced beneficial effects from prescribed or wild fires or mechanical treatments for the longest time should be prioritized for treatment. Active management should focus on implementing treatments that are known to work. Of highest priority is to reduce fuels within and around groves. Recently, the boundaries of groves have been mapped precisely with high-resolution remote sensing tools. These maps, along with fire behavior prediction tools, should be used to identify treatment locations that are designed to protect entire groves. Where prescribed fire programs are not able to burn groves with a high frequency (at least every 10 years) and also maintain low levels of surface fuels that are predicted to result in LMS fires during extreme conditions, mechanical treatments that result in surface fuel reductions (e.g. pile and burn) should be used. Density management should be used to reduce competition, increase tree vigor, and lower the rate of surface fuel production. Again, mechanical treatments should be used if prescribed fire programs are not able to achieve significant reductions in density.

An active adaptive management approach is appropriate given what are expected to be profound yet uncertain climate change effects in groves. This means actively using various alternatives that are known to be effective. Monitoring for treatment effectiveness is then used to alter the design of future treatments.

The cost of a hands-off approach is clear. It is the continued decline of giant sequoia and its associated plant and animal species. It is critical to conduct hands-on work now and invest at a level that is commensurate with giant sequoia's ecological, social, and economic values.

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