Assessing giant sequoia mortality and regeneration following high-severity wildfire

Background

Giant sequoia (*Sequoiadendron giganteum*) regeneration is reliant on local surface fires, where episodic pulses of heat desiccate and open their cones, releasing seed onto bare mineral soil. Historically, these fires were characterized as 'mixed severity', composed of a large matrix that burned at low or moderate severity interspersed with small forest gaps created by local high-severity fire. While sequoia regeneration can flourish within these small, high severity gaps, recent 'megafires' have produced unprecedentedly large patches of high severity, where the majority of sequoias as killed. Sequoia crowns, which contain seed-bearing cones, are also increasingly igniting – an unusual occurrence – incinerating the seed source.

Regeneration of giant sequoia in large, high severity burn patches is not well understood. Given the high levels of mortality of mature sequoias within recent years (13-19%), the authors set out to determine whether large areas of high-severity fire-impacted groves will naturally regenerate to a state resembling their prefire structure. This research aims to help resource managers determine whether and where

Management Implications

- Areas of very high fire severity are at high risk for loss of grove area due to increased tree mortality and decreased regeneration

- Seedling densities within large, high severity burn areas were well below average densities measured after prescribed fires

- Non-contiguous patches of high severity wildfire may provide a buffer against regeneration failure due to proximity of surviving seed trees

to replant giant sequoia after high severity wildfire.

Study Goals

Data were collected on regeneration, giant sequoia mortality, and crown damage in four groves recently affected by the 2020 SQF- and 2021 KNP-Complex fires within Sequoia and Kings Canyon national parks. Study goals were to 1) assess postfire giant sequoia regeneration, 2) develop predictive models of regeneration as a function of canopy conditions and a metric of remotely sensed burn severity (RdNBR) and use this information to estimate seedling densities within large high severity burn areas and 3) apply those predictions to other high-severity burn areas of recently fire-affected groves.

Key Findings

The results suggest that giant sequoia groves impacted by large patches of high-severity fire are at significant risk of losing grove area due to mature tree mortality and insufficient regeneration. Mortality rates were exceptionally high in these high-severity burn patches, which account for 28-92% of the grove area in the sampled sites. Additionally, seedling densities were markedly lower than those typically observed in the second year following prescribed fires, where postfire conditions more closely resembled historical patterns. Regeneration failure was at least partly a function of reduced seed availability due to direct consumption of cones during fire. Where tree mortality is less contiguous (i.e., 'mixed severity' burn areas), regeneration failure should be less likely to result in permanent loss of grove area.
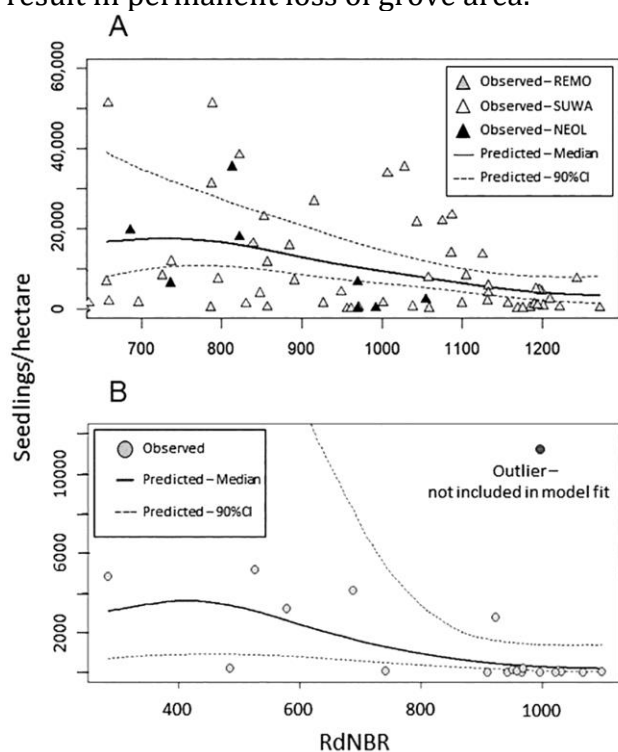

Figure 1. Predicted mean regeneration (seedlings per hectare) for groves affected by (A) the 2021 KNP-Complex (i.e., REMO, Redwood Mountain; SUWA, Suwanee; and NEOL, New Oriole Lake) and (B) the 2020 SQF-Complex fires (i.e., Board Camp) as a function of relativized differenced normalized burn ratio (RdNBR) values. Adapted from Soderberg et al. 2024.

Detailed Results

Within high severity areas, specifically, there was a strong relationship between seedling density and fire severity, with seedling densities decreasing with increasing RdNBR (Figure 1).

Giant sequoia mortality rates in high severity burn areas ranged from 63-97% in the four groves. The majority of sampled plots within areas of ~800 or greater RdNBR had zero surviving sequoias and/or the volume of live foliage within a 50m radius was nearly zero.

The probability of regeneration levels meeting those observed in the second year after prescribed fire was 0.1%, 4.9%, 9.2%, and 27.2% within the four groves, respectively.

Suggested Further Reading

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