Progress Report
UC Natural Reserve System Field Science Fellowship

Project:
Post-Fire Impacts of Wood-boring Beetles on Oak Woodlands

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I. Project Summary

A. This project aims to investigate the relationship between wood boring beetles and oak trees following prescribed burns. Our research takes place at UCSB's Sedgwick Reserve, where we have been monitoring coast live oaks (*Quercus agrifolia*) and blue oaks (*Quercus douglasii*) for beetle activity in a plot that underwent a prescribed burn in November 2024 as well as in two control plots.

B. Objectives:

1. Describe the relationship between fire events and beetle activity.
2. Quantify the physiological effects of wood boring beetles on coast live oaks and blue oaks.
3. Assess whether fire events impair oak trees' defenses against wood-boring beetle attacks, thereby contributing to overall declines in tree health.

II. Progress to Date

A. Establish Study Plots

1. We established a 50m x 30m plot within the burn diameter of the 2024 TREX prescribed burn at Sedgwick Reserve and in two adjacent unburned areas for control plots.

B. Visual Surveys

1. Monthly visual surveys began on November 20th, 2024–shortly after the burn.
2. Surveys assess physical qualities such as number of boreholes, tree health, boring dust, galleries, and fungi.

C. Pheromone Trapping

1. Six pheromone traps were deployed in May across the three plots, with three positioned within the burn perimeter and three placed outside it.
2. The traps have been monitored for beetle activity on a biweekly basis.

III. Preliminary Results

A. We used a linear mixed-effects model to evaluate the effects of bark beetle activity (number of boreholes) and survey date on tree condition, including tree identity as a random effect to account for repeated measurements. For the control plots tree condition declined significantly with increasing boreholes ($\beta = -0.0305$, $SE = 0.0030$, $t = -10.21$, $p < 0.001$), and there was a significant positive effect of survey date ($\beta = 0.00194$, $SE = 0.00039$, $t = 5.00$, $p < 0.001$). For the burned plot tree condition declined significantly as the number of boreholes increased ($\beta = -0.0260$, $SE = 0.0041$, $t = -6.28$, $p < 0.001$) and improved slightly over time ($\beta = 0.00142$, $SE = 0.00061$, $t = 2.32$, $p = 0.022$).

Overall, boreholes and tree conditions were strongly related, with tree conditions decreasing as boreholes increased. In the unburned plots, tree condition improved significantly throughout the year, whereas it only improved slightly in the burn plots.

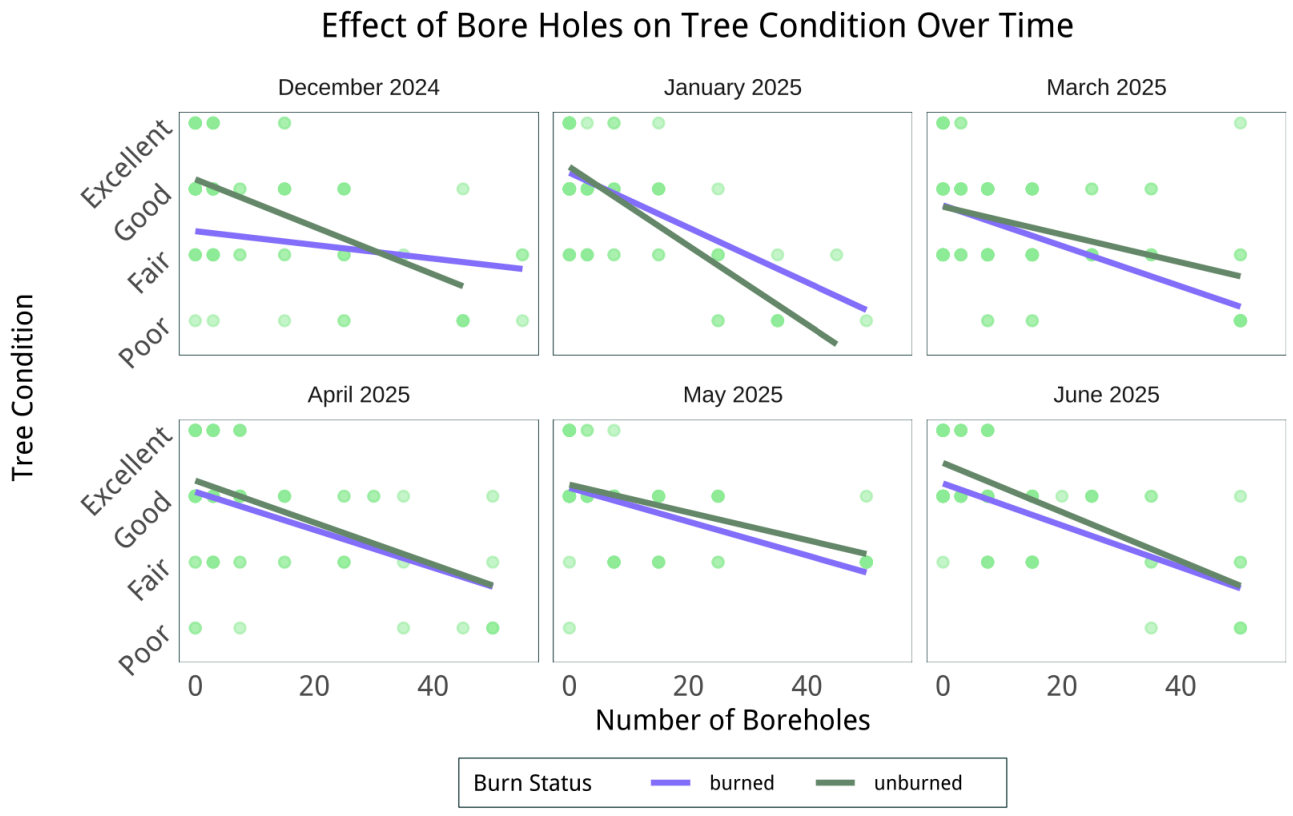

Figure 2. "Effect of Bore Holes on Tree Condition Over Time." This figure displays the relationship between the number of boreholes and tree condition across monthly surveys over seven months.. Tree condition was scored from 1 (poor) to 4 (excellent). Green lines indicate fitted linear trends of the unburned plots while purple lines indicate the linear trends of the burned plot, with jittered points representing individual trees. The relationship between tree condition and boreholes becomes significantly less for unburned trees while staying mostly the same for the burned trees.

B. We also used Welch's t-tests to evaluate whether the mean number of boreholes differed between burned and unburned trees for each species. For coast live oak (Quercus agrifolia), the mean number of boreholes was significantly higher in burned trees (mean = 16.3) compared to unburned trees (mean = 7.3). This difference was statistically significant ($t(176.38) = 4.78$, $p < 0.001$), with a 95% confidence interval for the difference in means of 5.30 to 12.76. In contrast, for

blue oak (Quercus douglasii), there was no significant difference in the mean number of boreholes between burned (mean = 9.3) and unburned trees (mean = 8.5) ($t(62.67) = 0.39$, $p = 0.70$), and the 95% confidence interval for the difference in means (-3.36 to 4.97) included zero.

These results suggest that fire may increase bark beetle activity in coast live oak but not in blue oak.

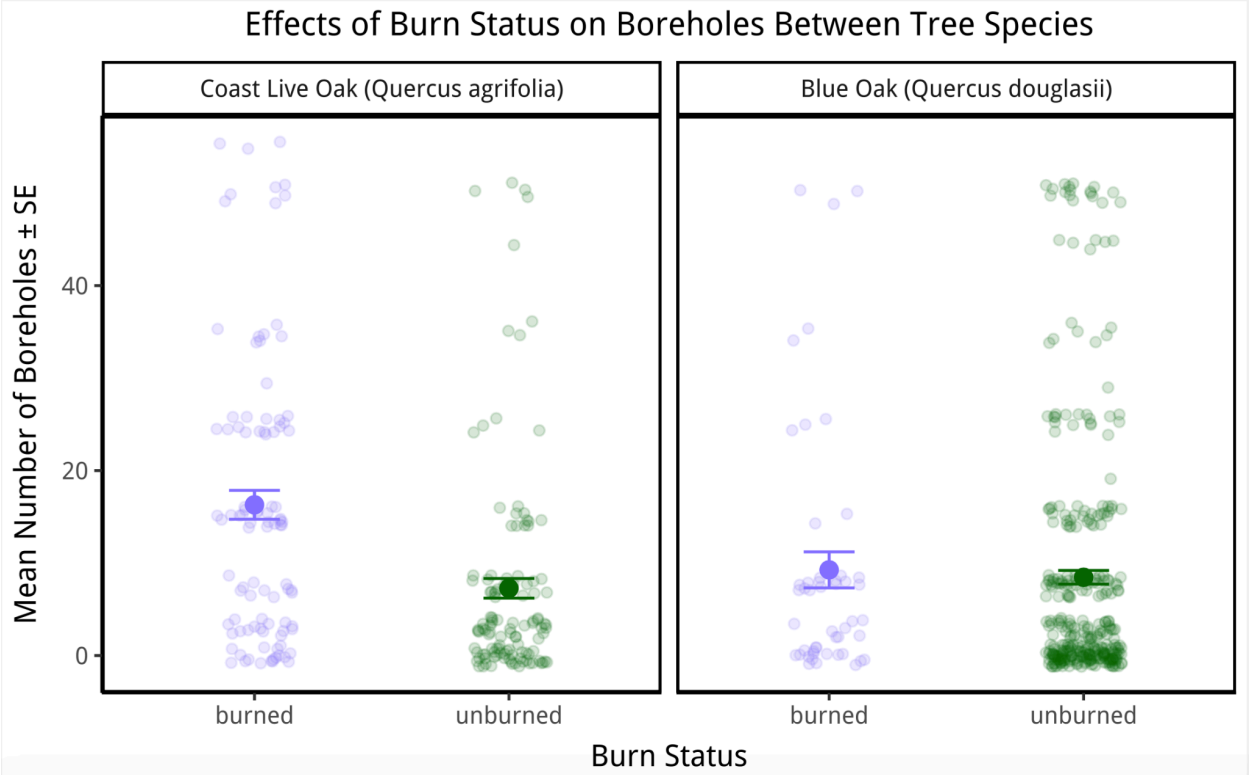

Fig. 2: "Effects of Burn Status on Boreholes between Tree Species" This figure displays the mean number of boreholes with standard error bars for burned and unburned trees between tree species. Horizontal jittering is applied to the underlying data, with purple representing the burned trees and green representing the unburned trees.

IV. Next Steps

A. Beetle Identification

1. Beetle identification will be carried out through a combination of microscopy and dichotomous keys.
2. Beetle IDs will be confirmed with the help of bark beetle specialists with the University of Florida Forest Entomology Lab.

B. Xylem Staining

1. Xylem staining will be performed actively in the field and passively in the lab using basic fuchsin and alcian blue dye. This will demonstrate if there is a clear relationship between beetle boreholes/activity and tree vascular impairment by introduced fungi.

V. Acknowledgments

A. This work was performed at the University of California Natural Reserve System and supported by a Field Science Fellowship from the University of California Natural Reserve System.