Fire effects on the soil seed bank of blue oak woodlands in northern California

Gunner Michaelson[1];
[1]Earth and Environmental Sciences, California State University, Chico

Abstract

Fire is a critical ecological process in shaping oak woodlands through natural ignitions and indigenous practices. However, fire suppression has disrupted this balance, leaving gaps in understanding fire's effects. **This study investigates the 2024 Park Fire's impact on the soil seed bank of seven blue oak (*Quercus douglasii*) woodland (BOW(S)) sites at Big Chico Creek Ecological Reserve (BCCER) in Butte County**. Seed bank samples were collected 6 months prior to the park fire, and again 2 months post-fire. Samples were then prepped in lab and then trayed for grow out in a greenhouse to investigate seed bank response. Preliminary field data indicate moderate to moderate-high burn severity, with mixed in-situ severities influenced by site characteristics such as slope, aspect, elevation (268-353 m), and fuel types ranging from grass to woody shrubs. Ash depth (0-2 cm) and soil color (black/brown to red) varied across sites, reflecting burn severity. **In the greenhouse, low-severity sites, like BOW 1 and BOW 2, show rapid initial germination and growth**, while **high-severity sites, like BOW 5 and BOW 6, exhibit slower germination and homogenization**. **Post-fire samples demonstrate higher germination and growth compared to pre-fire, potentially due to changes in C:N.** Another notable preliminary observation is the emergence of increased germination of grasses in post-fire samples compared with pre-fire samples. In closing, as large wildfires continue to burn these ecosystems, it is more important than ever to understand fire's ecological effects on understory vegetation, seed bank dynamics, and recovery post-fire within blue oak woodlands at BCCER.

Methods

- **Pre-Fire Sampling (January 2024)**
  - Collected soil samples (0-10 cm) in depth at seven randomly selected locations.
- **Post-Fire Sampling (September 2024)**
  - Followed similar protocols as pre-fire sampling near the same locations.
  - Depths collected divided into (1-5 cm) and (5-10 cm)
- **Sample Details**: Total of 21 samples collected.
- **Laboratory Procedures**:
  - Air dried and incremental dried samples for moisture analysis.
  - Lightly ground and sieved soil samples to remove large debris.
  - Prepared samples for carbon-to-nitrogen (C:N) ratio testing.
  - Prepared samples for greenhouse trials.
- **Greenhouse Experiment**:
  - Pre- and post-fire samples grown in controlled conditions.
  - Aim: Assess germination, biomass and species presence differences between the samples.

Figure 1

Figure 2

Figure 3

Figure 1. Collecting soil seedbank samples at BCCER (left), **Figure 2.** ruler demarking 10cm of sample collection depth (middle), and **Figure 3.** soil tins containing soil samples from each site post-drying (right)

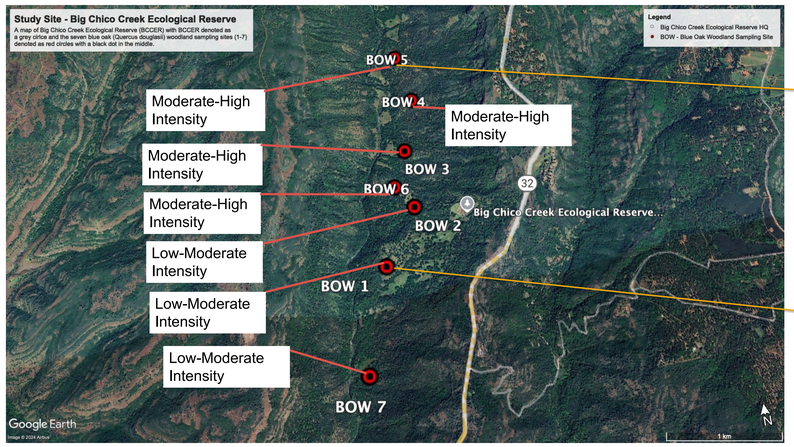

Figure 4. Map of BCCER Denoting BCCER HQ as a grey circle and the 7 blue oak (*Quercus douglasii*) woodland sampling sites (1-7) denoted as red circles. White boxes with connecting lines indicate site-specific fire intensity/burn severity.

Figure 5. Shifts in Soil C:N Ratios Pre-Fire vs. Post-Fire Across Sites (1–7): The visualization highlights changes in nutrient dynamics, with decreases in C:N ratios at most sites indicating increased nitrogen availability post-fire. These shifts are expected to influence vegetation recovery, favoring fast-growing, nitrogen-demanding species in areas with sharp declines, while sites with minimal changes may maintain more stable plant communities.

Site	1	2	3	4	5	6	7
C:N Shift	-	+	-	-	-	-	+

Table 1. A table denoting C:N shifts post-fire across sites (1-7) as either positive (increase in C:N) or negative (decrease in C:N)

Figure 6. Sample point, BOW 5

Figure 7. Sample in greenhouse (Top 5cm – BOW 5)

Figure 8. Sample in greenhouse (Bottom 5cm – BOW 5)

Figure 9. Sample point, BOW 1

Figure 10. Sample in greenhouse (Top 5cm – BOW 1)

Figure 11. Sample in greenhouse (Bottom 5cm – BOW 1)

Notable Observations

Differences in germination between site and pre-fire vs. post-fire samples

- Post-fire sites 1 & 7 show elevated grass germination compared to all other sites both pre-fire and post-fire.
- Pre-fire samples show significantly lower germination rates when compared to post-fire samples.
- Post-fire sites 1, 2, and 7 show the highest amounts of germination and plant growth when compared to all other pre-fire and post-fire site samples.

Shifts in C:N between pre-fire and post-fire soil seedbank samples

- General decreasing shifts in C:N across all sites (1-7)
- Increases in C:N for post-fire samples 2 and 7 does not follow trend[1,4], cause in need of exploration.

Shifts in C:N in post-fire soil seed bank samples yield unexpected germination in the greenhouse

- While site 1 shows expected elevated plant growth likely resulting from a decreasing shift in C:N, sites 2, 3, 5, and 7 show unexpected effects on plant growth in relation to decreasing or increasing shifts in C:N (Figures 5 and Table 1). Elevated plant growth and germination in post-fire sites 2 and 7 samples do concur with other low fire intensity/burn severity vegetation recovery studies[2,3]

Next Steps

1. Explore differences in species presence in greenhouse trials in relation to recorded metrics.
2. Explore differences in C:N shift between soil depths (1-5cm & 5-10cm) and its relation to fire intensity/burn severity, species presence and germination.
3. Compare greenhouse germination and species presence to in-situ.

Contact

Gunner Michaelson
Graduate Student, Earth and Environmental Sciences
Email: gemichaelson@csuchico.edu
Phone: (916) 300-9730

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