Pyrodiversity: prescribed fire intensity and the fuels that are left behind in California's maritime chaparral

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Find out more about the Wilkin Fire Ecology and Management Lab at https://fireecology.wixsite.com/katewilkin or scan the QR code.

To learn more about the California Canyon Fire Experiment drone data collection check out https://arcg.is/zOfvD or scan the QR code.

Background

Maritime chaparral burns at high severity, but also has unique fire intensities within sites due to weather, topography, and fuels. These differences cause unique fire effects, including fuel consumption and biodiversity. Small diameter fuels burn in high intensity fire, so **measuring remaining twig diameters** of burned shrubs may relate to fire intensity (Moreno and Oechel). Past research focused on ***Adenostoma fasciculatum* (chamise)** burned at maximum temperatures of 300-600°C. We refine this research on chamise and expand it to include a wider range of temperatures and ***Salvia mellifera* (black sage)** and assess applicability of this method.

Methods

Collaborators: CALFIRE and San José State University (SJSU) Wildfire Interdisciplinary Research Center, a National Science Foundation Industry-University Interdisciplinary Research Center

Site:

- **Steep canyon** on private ranch, San Gabilan range, Salinas, CA
- 3,617-acre Vegetation Management Plan with prescribed upslope headfire, October, 2022

Equipment:

- **Drone:** variable position; DJI M200V2 with DJI IR camera, calibrated to 1000°C. 60-minute flight time
- **Helicopter:** fixed position; SJSU Wildfire Imaging System (SWIS), Telops M150 camera at an oblique angle to the canyon, capturing 30 frames per second for 12 minutes. Temperature filtered ≥ 250°C.

2023 Shrub measurements:

- **Twig diameters: chamise, black sage** measured across the range of maximum temperature, with at least 10 shrub individuals in each of six temperature bins (Fig. 1)
- **Minimum diameters of the smallest diameter twig** at least 1 cm long, measured at the tip, on each stem of the plant, max. 10 stems per plant
- **Sample size: Plots** N=32, **chamise**: individuals N=80 and twigs N=354, **black sage**: individuals N=81 and twigs=302
- **Zero to ten shrubs of each species sampled at each plot**, based on how many shrubs near the plot.

2024 Shrub measurements:

- Measurements similar to other methods (Table 1). Chamise and black sage twig diameters measured 1 cm from tip and at tip (Fig. 2). Up to 10 outer twigs selected on up to 5 stems per plant, prioritizing terminal branches.

Figure 2: Twig diameter variation at tip (left) vs 1 cm from tip (right).

Results

Table 1: Selection of chaparral research using post-fire twig diameter measurements.

Citation	Species	Stem selection	Location	Tool	Fire intensity
Keeley, Brennan, and Pfaff 2008	Chamise and others	Smallest diameter twig remaining on the 2 chamise closest to each quadrat	Unspecified	Unspecified	Not measured
Moreno and Oechel 1989	Chamise	Outer twigs of stems originating in plot. Twigs extend ≥1 cm long from node (or lead to other significant branches).	Unspecified	Vernier calipers	• Heat release measured using cans of water • Temperature measured using Tempil° temperature pellets
Odion and Davis 2000	Chamise	All remaining branches within 1x1m plot around each thermocouple. All branches directly over each transect plot.	Unspecified	Unspecified	• Thermocouples • Tempilac pyrometers (paint) • Metal cans with water
Rice 1993	Chamise	5 smallest twigs within quadrat	2 cm from tip	Unspecified	Not measured
Rundel et al. 1987	Chamise	Unspecified	Unspecified	Unspecified	Not measured
Safford and Harrison 2004	Chamise and other	4 stem termini on each randomly chosen individual that was rooted in or adjacent to the quadrat or belt transect.	1 cm from tip	Unspecified	Not measured
Our preliminary analysis	Chamise and black sage	Smallest twig ≥1 cm long on each stem	tip	ruler	Helicopter imagery

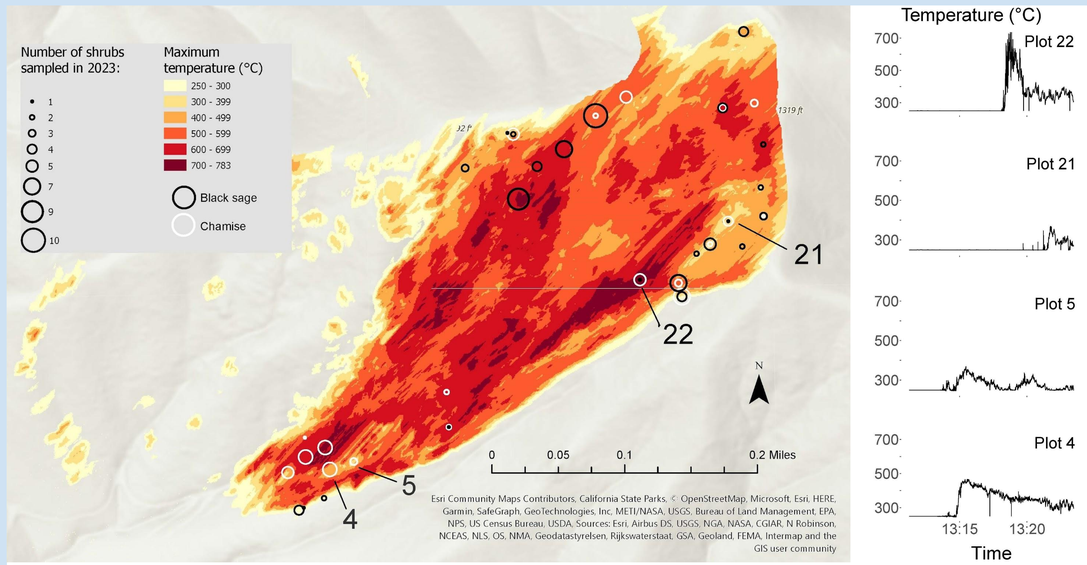

Figure 1: Helicopter maximum temperature: (Left) Map (Right) Time series temperature at three frames per second for selected plots.

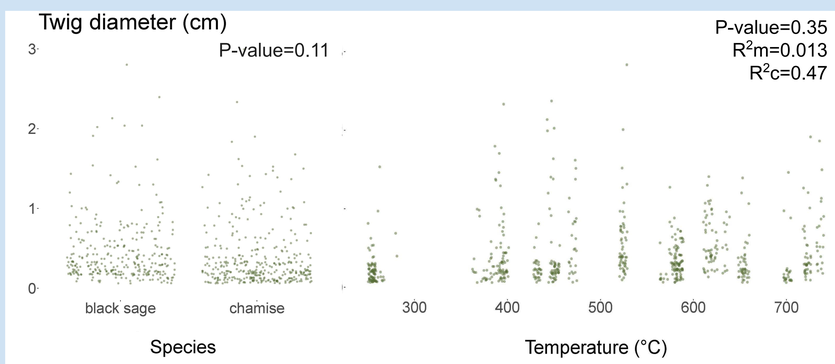

Figure 3: Remaining twig diameter (cm) at tip related to (left) black sage and chamise, and (right) temperature.

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Discussion

- There is no significant relationship between remaining twig diameter at tip and maximum temperature.
- When our temperature data is binned like Moreno and Oechel, no statistical relation exists for species or temperature with remaining twig diameter at tip.
- **Other methods of measuring twig diameter may be more efficient and have better correlation with maximum temperature or other fire intensity measurements than our 2023 method. Other methods may also better relate fire intensity and pyrodiversity to biodiversity.**

Conclusions

- Nuances in how twig diameter is measured may be important for correlating remaining twig diameter with fire intensity, or duration at specific temperatures.
- Measuring the twig diameter at the tip may not be the best indicator of maximum fire temperature. We don't recommend it to managers.

Future Work

This highly instrumented prescribed fire provided an opportunity to investigate the relationship between thermal and visible image measurements from drone, helicopter, and ground stations to fire effects. We will further investigate:

- Different methods of measuring post burn remaining twig diameter
- How fire intensities metrics, such as maximum temperature reached and duration above multiple temperature thresholds, relate to remaining twig diameters.

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