アグロエコロジーから見た
持続可能な食料生産と景観保全
― 日本とアメリカの協働 ―

Agroecology, Sustainable Food Production and Landscape Conservation: International Collaborations between Japan and the Americas

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験ではソープルートの生育に対する伝統的手法の効果を観察することができた。今後2024年夏に各区画で球根重を測定し、最終的な成果を2024年にアマ・ムツン部族に報告する（目標2）。これまでに本研究にはUCSCの学部生16名が関わっており、今後さらに多くの学生が関わっていく予定である（目標3）。

Utilizing Traditional Ecological Knowledge to Tend Geophytes on the Central Coast of California

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Introduction

Edible native geophytes were food sources for indigenous people throughout much of California (Anderson, 2005; Lightfoot and Parrish, 2009). However, geophyte populations are declining, possibly due to habitat loss, fragmentation, and lack of traditional ecological management. Using grasslands on the University of California Santa Cruz (UCSC) campus, goals of the 3-year project are to 1) examine the effects of traditional ecological management practices on geophyte populations in grasslands, 2) assist with the Amah Mutsun Relearning Program, a program aiming to assist the Amah Mutsun Tribal Band in the relearning of native plant identification, ethnobotany, and cultivation and stewardship of native plants, and 3) educate UCSC undergraduate students about traditional ecological practices. Here, we report the results of the project's first two years, focusing on Goal 1.

Methods

Chlorogalum pomeridianum var, *pomeridianum* (soaproot. Photo 13.1) was selected as a model geophyte based on its abundant populations at UCSC grasslands and its known multiple uses by multiple tribes in California (Anderson, 2005; Lightfoot and Parrish, 2009). A randomized complete block-designed trial with burning using burn-boxes (B. Kral et al. 2015), harvesting and replanting seeds (H), a combination of both (BH), and untreated control (C) as treatments with 5 replications was established in a mix of grassland and shrubland in the UCSC Arboretum on April 6, 2021 (Photo 13.2). Those treatments were selected based on Anderson (2005: 303). Each plot is a 1 m × 1 m quadrat marked by rebars at 4 corners. Each plot's baseline soaproot population with and without flowers was measured separately on June 10, 2021.

Soaproot seeds (90% germination rate, 6.77 grams/1,000 seeds. Photo 13.3) for H and BH treatments were collected in the UCSC Arboretum on July 6 and 8, 2021. H treatment was applied to H and BH plots on August 26, 2021, in the following manner. 1) Dig out flowered soaproot plants (Photo 13.4), 2) Weigh the root biomass of each soaproot, 3) Cut off the root crown of each soaproot (Photo 13.5), 4) Replant root crowns (a crown/hole) and put seeds into holes (the number of seeds per hole was determined as follows: The number of seeds per hole = the total number of seeds per plot (1,000 seeds/plot)/ number of holes per plot (= number of flowered plants per plot). Photo 13.6), and 5) Bury the holes (Photo 13.7). B treatment was applied to B and BH plots on October 18, 2021. The amount of surface biomass (fuel) was standardized across all B and BH plots to 9 cm thick (= 3.1 kg dry biomass/m^2) by adding dried fallen pine needles collected from the plots' surrounding area to the existing plant litter at each plot (Photo 13.8). The burn box was 4' wide by 4" tall. We cut each 8' corrugated galvanized steel roofing panel in half and overlapped two halves vertically to make each of the four walls of the box (Photo 13.9). Clevis and cotter pins attached the panels to the slotted steel angle iron posts. When fully constructed, we were able to lift and move the box by holding onto the tops of the angle iron posts. We lit each fire by tipping up one side of the box and lighting the pine needle fuel with a small propane torch or long-reach butane lighter, then lowering the box back to the ground. We lit the interior of each of the four corners of the box using this method. Burning time averaged 16.9 minutes per plot (Photos. 13.10, 13.11, 13.12, and 13.13).

To examine the effect of treatments on soaproot populations, the number of soaproot plants with and without flowers was counted separately at each plot on May 17, 2022, and May 17, 2023. The green canopy cover area at each plot was also determined by taking photos of each plot with a cell phone and processing the images using the Canopeo program (Patrignani and Ochsner, 2015) at each counting date.

Data were statistically analyzed by ANOVA (randomized complete block design) and mean separation with One-sided Dunnett's Multiple Comparisons using the Statistix 10 program (Analytical Software, FL).

Results and Discussion

In May 2022, 9 months after H treatment and 7 months after B and BH treatment, we found significant treatment effects in three variables: the green canopy cover, the total plant population, and the flowering plant population.

The green canopy cover, an indicator of total living plant biomass, was much lower at B and BH plots, showing plants other than soaproots were greatly suppressed by burning, but soaproots survived due to their bulb structures in the soil (Figures 13.1 and 13.2).

The increase of total plant population from the baseline was greater at B, H, and BH plots than at C plots (P=0.20. 2022 in Figure 13.3). The increase in the flowering plant population from the baseline was significantly higher at B plots than at C plots (P=0.05, Figure 13.4). All of the three effects, however, were not observed in May 2023 (2023 in Figure 13.3 for the increase in total plant population. Other data not shown).

The total population increase at H and BH plots can be understood easily since we added 1,000 seeds/plot at these plots. However, even non-seeded B and C plots must have received many seeds from the plants in these plots naturally. For example, a soaproot can have 600 flowers and 80 capsules per plant, and each capsule has 1 to 4 seeds (Borchert and Tyler, 2009). Given the average baseline of ~4 flowered plants/plot, all plots, including B and C plots, might have received <1000 seeds naturally from the plants growing in the plot. Burning is known to increase geophytes' overall growth and productivity by adding nutrients and light, two factors often limiting their growth, and by raising soil temperature via overing the soil surface with black burnt biomass (Anderson and Lake, 2016). Thus, burning may have increased the germination of naturally seeded seeds at B plots, although we did not find any additive or synergistic effects of burning and reseeding at BH plots (Figure 13.4).

Borchert and Tyler (2009) found that burning increased the population of soaproots with flowers for two consecutive years in prescribed burned chaparral in Southern California. In our trial, the population-enhancing effect by B, H, and BH treatments was only observed in the first year and disappeared in the second year. This might be simply due to the difference in location and time, but the plot size may have some effect on this. Our small plots are much more sensitive to disturbances by wild animals and humans and can be easily affected by the surrounding environment (e.g., surface biomass transfer from the surrounding area). In that sense, this small trial may have some limitations to monitor long-term effects.

Our trial attempted to use traditional ecological practices developed through thousands of years of observation and experience by indigenous people. The small scale of our experiment, however, placed constraints on some of the more practical and intuitive aspects that may have been part of the ways soap plants were traditionally managed and harvested. By virtue of our study design, we were limited to the particular soaproot plants that fell within our plots, as opposed to having an entire meadow in which to search out the most desirable plants. Our burn treatments, though designed to mimic a larger-scale burn, may have had different effects than a fire that burned across an entire meadow. Additionally, our use of these traditional ecological practices was stripped of any of the cultural and spiritual aspects that may have gone along with the physical practices of harvesting/replanting and burning. Despite these compromises our study may have made, we were still able to see some significant effects of using traditional ecological practices to tend soaproot plants.

We will continue to monitor the above variables for one more year and measure bulb size at each plot in the summer of 2024 to examine the effect of treatments on bulb production. We will present the outcome to the Amah Mutsun Tribal Band in 2024 (Goal 2). Sixteen UCSC undergraduate students have been involved in this study, and more will be involved in the future (Goal 3).

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