Postfire Succession in Ventura, California: Vegetation Monitoring Over a Thirteen-Month Period

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Abstract

The increasing prevalence and severity of climate-induced wildfires has necessitated further research into the effects wildfires have on plant communities and overall biological ecosystems. Drastic changes in plant species composition and may have monumental effects on local terrestrial and aquatic wildlife, especially if an ecosystem relies on bottom-up control. I monitored and analyzed plant community succession in an area adjacent to the Ventura River that suffered burning in October 2019; monitoring took place between Winter 2020 and Winter 2021 using line-transect and quadrat sampling methods for data collection. This project aims to determine plant species richness and abundance after having been afflicted by fire. Plant species were categorized into groups based on origin, growth form, and general response to fire. Upon analyzing species richness and abundance, the Simpson's Diversity Index was calculated for each transect. Results show that there was a significant difference in biodiversity between the burn site and control site; biodiversity was greater at the burn site than the control site within the first year of burning.

Introduction

Researchers have found that one of the increasingly prevalent effects of climate change is occurrences of wildfires in the western United States (Stavros et al. 2014). Research such as Luo et al. (2013) indicates, using current climate trends, that in the years 2041-2070 it is likely that the average Haines Index (HI), which on a scale from 2 to 6 characterizes dry, unstable lower atmospheric air, will increase to an HI that is greater than or equal to 5 during the month of August, therefore increasing the risk of erratic wildfires. Williams et al. 2019 have found that the state of California alone has experienced a fivefold increase in burned area from the years 1972-2018, which is primarily due to more than an eightfold increase in summer forest-fire extent.

With an increase in prevalence and severity of wildfires comes monumental effects on vegetation and wildlife. Research is limited on the effects that wildfires have on plant diversity in riparian communities, but it is important to investigate these effects as riparian communities act as bridges between terrestrial and aquatic interfaces that can foster great botanical diversity and biodiversity (DeBano & Neary 1996). Keeley et al. 2003 ultimately found in their chaparral site that both diversity and abundance of non-native species increased years after the fire; they also found a positive correlation between fire occurrence and abundance of non-native species, determining that invasive species are given more opportunity to colonize areas that are often interrupted by fire. Importantly, the effects on vegetation bring about effects on the organisms dependent on specific vegetation types, such as avian populations that rely on native vegetation for habitat (Isacch et al. 2004), as well as other organisms such as annelids and chordates (Fletcher et al. 2019).

Land directly east of the Ventura River was chosen as the study site as it had undergone a fire on October 25, 2019, burning 7.5 acres of land. The cause of the fire was undetermined, though investigators suspect it was started accidentally by homeless camps, which was cause for past fires, or intentionally by an individual or individuals. Despite an undetermined cause of the fire, known as the Shoreline Incident, the damage done to the site's vegetation made it an appropriate study site in investigating how future wildfires in riparian communities affect their vegetation types and patterns.

Methods and Materials

The study site (34.277808, -119.307550) was located in Ventura, California, just north of the Ventura River Estuary. The control site chosen was just north of the study site, at the Willoughby Preserve (34.2807, -119.3074), which was unaffected by the Shoreline Incident. Data collection was divided into five time periods, beginning with Winter 2019 and concluding with the Winter 2021. Ten 25-meter long line-transect surveys and ten 25-meter long quadrat surveys were conducted each season. The coordinates for each survey point were determined randomly using an online random-coordinate generator (geomidpoint.com). Any plant touching the transect tape was documented, as well as any plant present within 2.5 feet from the tape on either side. Quadrat surveys were conducted using a 2.5 ft x 2.5 ft quadrat square. Quadrats alternated the transect tape every meter, and the direction of travel was indicated for each survey. The following data were collected at each transect: plant species, abundance, life stage, height, and the side of and distance along the transect at which each species was found.

Each species was then categorized by life form, origin, response to fire, and at which site(s) the species occurred. Species richness (how many species occurred) and abundance (how many individuals were present) were calculated for each transect. The Simpson's Diversity Index was calculated for each transect using:

$$D = 1 - \frac{\Sigma\, n(n-1)}{N(N-1)},$$

where D represents Simpson's Diversity Index, n represents the total number of organisms for a particular species, and N represents the total number of organisms of all species.

Results

During the one-year study, a total of 92 species was found and recorded at the burn and control sites. Most species recorded were found at both sites (40 species), 33 species were found exclusively at the burn site, and 19 species were found exclusively at the control site. The burn site was dominated by perennial herbs (27 species), followed by annual herbs (24 species) and shrubs (9 species). The control site was equally dominated by perennial herbs and annual herbs (16 species each), followed by shrubs (10 species). Both sites each had 30 native species; however, while the burn site was dominated by non-native and invasive species (43 species), the control site was dominated by native species, having merely 29 non-native and invasive species. More invasive species were present at the burn site (23 species) than at the control site (16 species). Of the species that have known responses to fire, most were both resprouters and seeders (23 species), followed by only seeders (14 species), and only resprouters (6 species).

The resulting Simpson's Diversity Indices calculated for each transect showed a significant difference ($p<0.05$) in biodiversity between the burn site and the control site; the burn site had significantly greater biodiversity than the control site within the first year of the fire, illustrated by *Figure 1*. However, there was no significant difference in biodiversity with respect to time or season, also illustrated by *Figure 1*. While there was no significant difference ($p>0.05$) between each site in terms of species abundance, there was a significant difference between each site in terms of species richness; species richness was greater in the burn site than in the control site, illustrated by *Figure 2*.

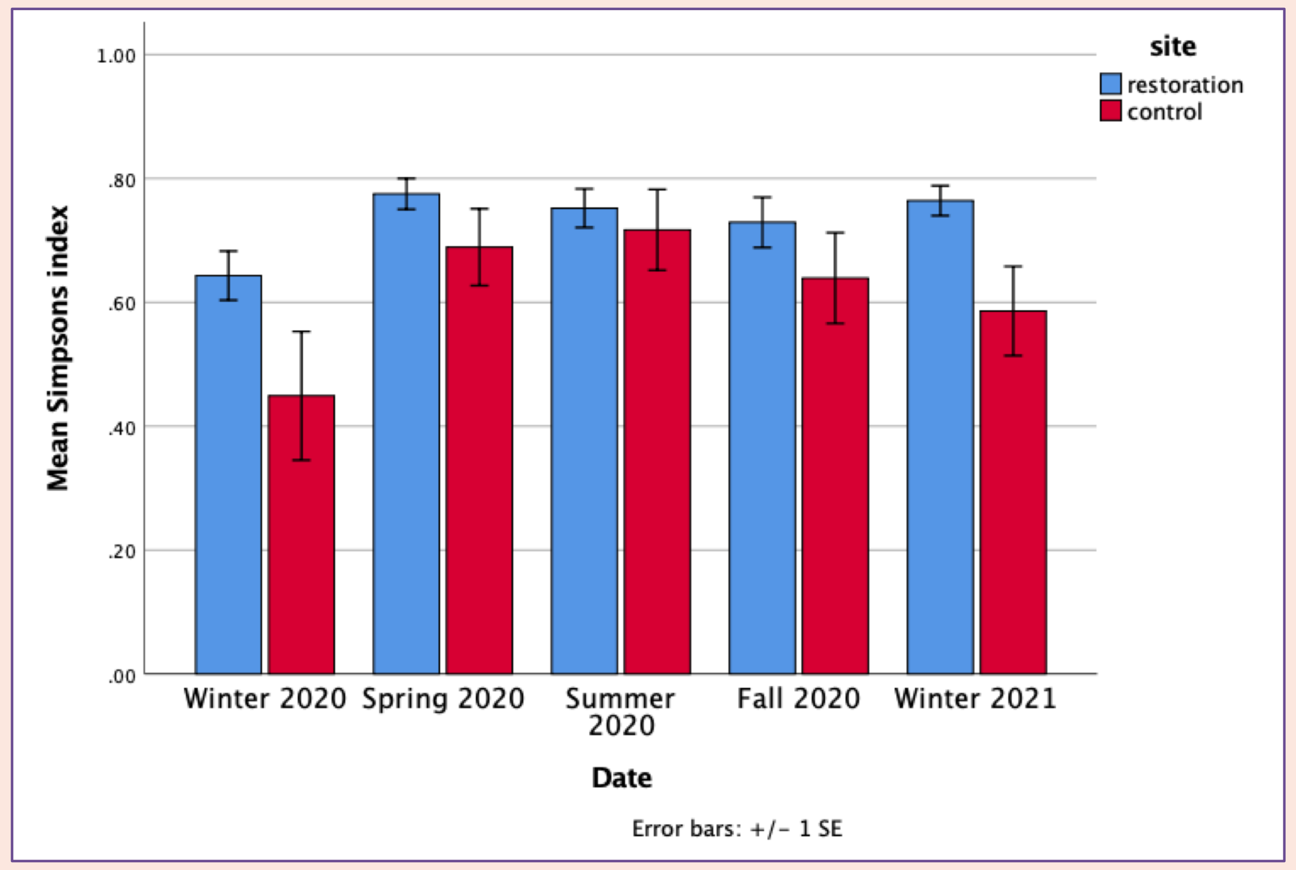

Figure 1. The burn had significantly greater biodiversity than the control site throughout the year ($t=3.002$, $df=67.256$, $p<0.05$). There was no significant difference in biodiversity relative to season. The greatest biodiversity at the burn site occurred in Spring 2020, whereas the greatest biodiversity at the control site occurred in Summer 2020.

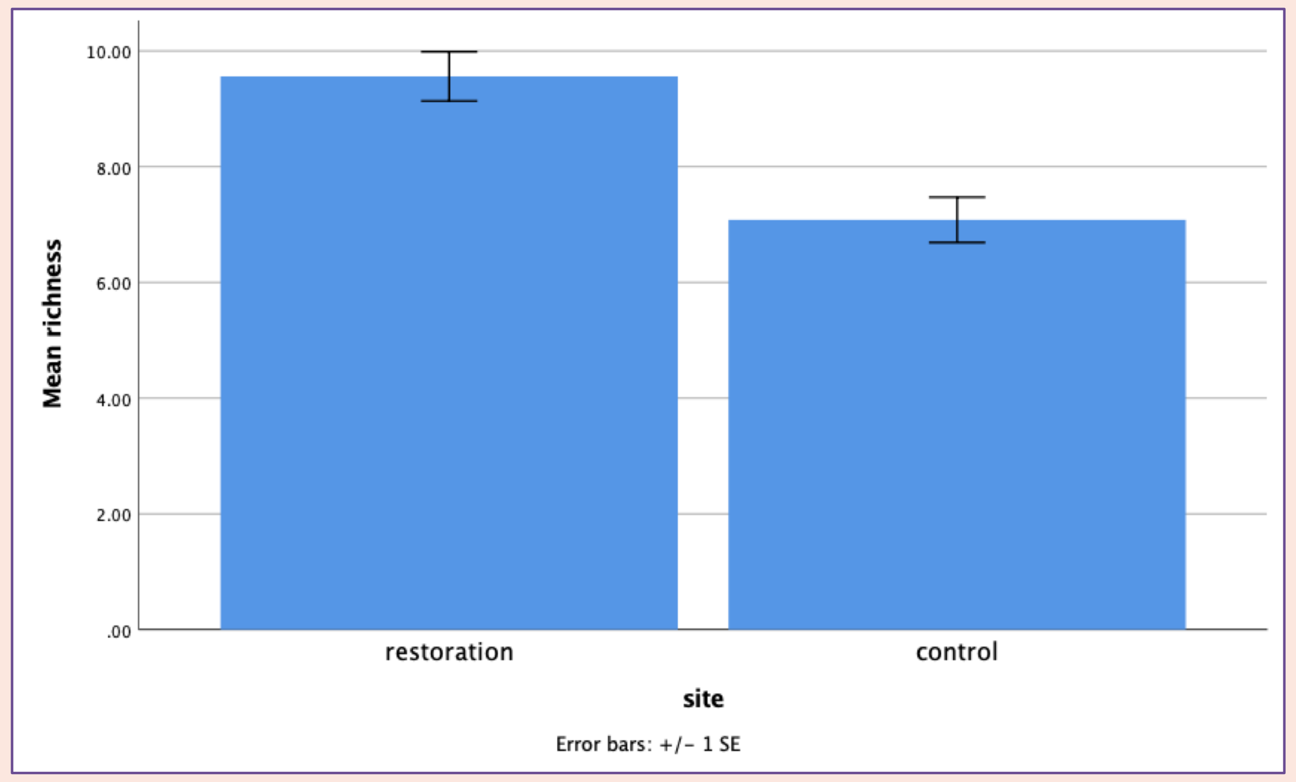

Figure 2. Species richness was significantly greater at the burn site than at the control site ($t=4.287$, $df=99$, $p<0.05$). Despite a greater species richness, the burn site was dominated by non-native and invasive species, whereas the control site was dominated by native species.

Discussion

This study addresses two aspects of post-fire succession: biodiversity and species composition. The results indicate that within the first year of fire, biodiversity may increase, but species composition of burned areas may become heavily afflicted by invasive and non-native species. The results align with studies such as Keeley et al. 2003, who found that burn areas give invasive species more opportunity for colonization. The results concerning species composition align with studies such as Guo 2001, who found that annual herbaceous, perennial herbaceous, and shrub species dominated burn areas post-fire. Because both the burn site and the control site are so heavily disturbed by human activity, it is difficult to quantify to what degree humans have contributed to increased invasive-species colonization. Biodiversity and species composition may well change in the burn site over many years; continued research is needed to determine these changes. Additionally, future studies should take into account human disturbance and determine how greatly humans contribute to the spread of invasive species, especially within the context of burned areas.

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References

1. DeBano, L. F. & Neary, D. G. (1996). Effects of Fire on Riparian Systems. *U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station*, 69-76.
2. Fletcher, RA, Brooks, RK, Lakoba, VT, et al. (2019). Invasive plants negatively impact native, but not exotic, animals. Glob Change Biol. 2019; 25: 3694– 3705.
3. Guo, Q. (2001). Early post-fire succession in California chaparral: Changes in diversity, density, cover and biomass. *Ecological Research*, *16*(3), 471-485.
4. Isaach, J. P., Holz, S., Ricci, L., & Martínez, M. M. (2004). Post-Fire Vegetation Change and Bird Use of a Salt Marsh in Coastal Argentina. *Wetlands*, *24*(2), 235-243.
5. Keeley, J. E., Lubin, D., & Fotheringham, C. J. (2003). Fire and Grazing Impacts on Plant Diversity and Alien Plant Invasions in the Southern Sierra Nevada. *Ecological Applications*, *13*(5), 1355-1374.
6. Luo, L., Tang, Y., Zhong, S., Bian, X., & Heilman W. E. (2013). Will Future Climate Favor More Erratic Wildfires in the Western United States? *Journal of Applied Meteorology and Climatology*, *52*, 2410-2417.
7. Stavros, E. N., Abatzoglou, J. T., McKenzie, D., & Larkin, N. K. (2014). Regional projections of the likelihood of very large wildland fires under a changing climate in the contiguous Western United States. *Climatic Change*, *126*, 455-468.
8. Williams, A. P., Abatzoglou, J. T., Gershunov, A., Guzman-Morales, J., Bishop, D. A., Balch, J. K., & Lettenmaier, D. P. (2019). Observed Impacts of Anthropogenic Climate Change on Wildfire in California. *Earth's Future*, *7*(8), 892-910.