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Brush, burn, return: maintaining rangeland health following catastrophic fires

Larson, S[1]; Becchetti, T[2]

[1]University of California Cooperative Extension, Santa Rosa, CA, USA (slarson@ucanr.edu)

[2]University of California Cooperative Extension, Modesto, CA, USA

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Abstract

Rangeland vegetation in California has evolved with a long history of fire. Reports from early Spanish explorers provide insight into Native American use of fire to maintain grasslands for hunting, oak tree germination and acorn production. Lightning also ignited natural fires, and the combination of the two created a mosaic of different age classes of brush with grasslands intermixed, creating natural fire breaks to minimize the spread of wildfire. Brush control by fire ceased in the 1980's due to a range of factors including administrative barriers (permitting), environmental impact, and costs.

While California's Mediterranean shrublands are ecologically adapted to periodic fire, identifying and adopting strategies to reduce the impacts of severe wildfires in shrublands is now key to reducing their destructive impact. One strategy is livestock grazing, an extensive land use (occurring on roughly 33% of land area statewide) that is also frequently adopted by State and local agencies as a fuel management practice. Shrubland ecosystems accounted for approximately 38% of California's burned areas from 2000-2020 but there is relatively little research into long-term management strategies to mitigate the impacts of shrubland fires. Livestock have been documented to browse on resprouts and slow the spread of shrubs; a management strategy that could reduce shrub encroachment.

To understand shrublands' influence on fire intensity, we analyzed changes in land cover type resulting from major fires (based on hectares and structures lost). Results indicated that with no management, and depending on time and climate, shrublands quickly recovered, becoming the dominant vegetation type. However, while shrublands and grasslands fluctuate in extent, results indicated that forests are not recovering. Every fire footprint had similar changes, indicating that these vegetation patterns are not a feature of the most devastating fires only, but occur following any fire in land cover types that contain shrublands and forests.

Introduction

California has a long history of fire with most of our vegetation evolving with it. Stories from early Spanish explores provide insight to Native American use of fire to maintain grasslands for hunting, oak tree germination and acorn production. Lightning strikes have been a natural ignition of fire and the combination of the two created

a mosaic of different age classes of brush with grasslands intermixed, forming natural fire breaks to minimize wildfire spread. With settlers and ranching, control of brush to maintain grasslands for livestock became a common practice (Murphy and Leonard, 1974). Roughly in the 1980's most of the brush control came to a stop. The knowledge of ecosystem functions was lost and the understanding of how grazing keeps a system functioning. With the increase in catastrophic fires experienced in California over the past 20 years, there's a growing interest to manage range and forest lands to lessening wildfire severity. We explore if shrublands (brush) management could be a key to having a resilient community and healthy rangelands.

Methods

While California's Mediterranean shrublands are ecologically adapted to periodic fire, identifying, and adopting strategies to reduce the severity of severe wildfires in shrublands is key to reducing their destructive impact. Even if fine fuels are controlled, the management of shrublands is forgotten. Shrubland ecosystems account for approximately 38% of California's burned areas from 2000-2020 (Calhoun et al. 2022) but there is relatively little research into management strategies to mitigate fire impacts in shrublands.

To better understand the influence of shrublands' regrowth, we examined vegetation types before and after fires occurred. We assessed impacts from the largest California fires, we selected the largest in size (hectares) and most damaging structurally (houses, buildings), according to California Department of Forestry and Fire Protection (Cal Fire) data from 2001 to 2021, a twenty-year span, (Table 1).

We identified twenty-five fires as our sample data point to analyze. Year and season of each fire was entered, and the land cover characterized utilizing National Land Cover Dataset (NLCD) to identify six classes across the footprint of each fire: deciduous forest, evergreen forest, mixed forest, scrub/shrub, herbaceous, and other (developed land). From these six, three basic functional groups were created: forest, shrubland, herbaceous. We used Python 3 and PANDA Python Package to calculate within each fire footprint the percent of the three land cover classifications over time.

Each of the twenty-five wildfires was graphed to show the percent area of each classification (y-axis) and years (x-axis). This allowed changes in each classification before and after the wildfire to be apparent. Wildfires were then grouped into three categories based on the length of time since the fire occurred, or the length of recovery post fire for the vegetation data. In ARCGIS, a web application was created to map all historic fires to 1950. Predictions were made based on the trends observed for vegetation patterns for the fire footprints in the "pre-recovery" fires.

Results

Wildfires distributed across California represent a mix of public and private landowners under a variety of management and idle (no use) land. In all fires examined the same pattern was observed. Forest and shrubland covers decrease immediately post fire and herbaceous layers experience a dramatic increase in cover. After fires, herbaceous cover plummets and shrubland's cover increases, levels well above the pre-fire percentages. The length of time this vegetation shift lasts varies, but within five years, the grassland layer is back to pre-wildfire levels or lower, and the shrubland layer is either at or above pre-wildfire levels. The forest layer drops and even in the longest "recovery" classified wildfires, never seem to recover to pre-fire levels, appearing to be replaced by the shrub layer (Fig. 1).

The Cedar fire started in October 2003, in San Diego County, burning for two weeks, burning 2,232 homes, and killing 15 people. It cost at least $1.331 billion (2003 US).

Table 1. Twenty-five wildfires included in analysis, year occurred, season started, hectares and number of structures destroyed (Cal Fire data).

Wildfire	Year	Season	Hectares	Structures
August Complex	2021	Summer	417,898	935
Camp	2017	Fall	62,053	18,804
Caldor	2021	Summer	89,773	1,003
Carr	2018	Summer	92,936	1,614
Cedar	2003	Fall	110,579	2,820
Creek	2020	Fall	153,738	858
CZU Lightning Complex	2020	Summer	35,009	1,490
Dixie	2021	Summer	389,837	1,311
Glass	2020	Fall	27,310	1,520
Klamath Theater Complex	2008	Summer	77,715	0
LNU Lightning Complex	2020	Summer	146,990	1,491
Mendocino Complex	2018	Summer	185,800	280
Monument	2021	Summer	90,295	28
North Complex	2020	Summer	129,068	2,352
Nuns	2017	Fall	22,008	1,355
Rim	2013	Summer	104,131	112
River Complex	2021	Summer	80,678	122
Rush	2012	Summer	110,038	0
SCU Lightning Complex	2020	Summer	160,508	225
Thomas	2017	Winter	114,078	1,063
Tubbs	2017	Fall	14,895	5,636
Valley	2015	Fall	30,783	1,955
Witch	2007	Fall	80,128	1,650
Woolsey	2018	Fall	39,234	1,643
Zaca	2007	Summer	97,208	1

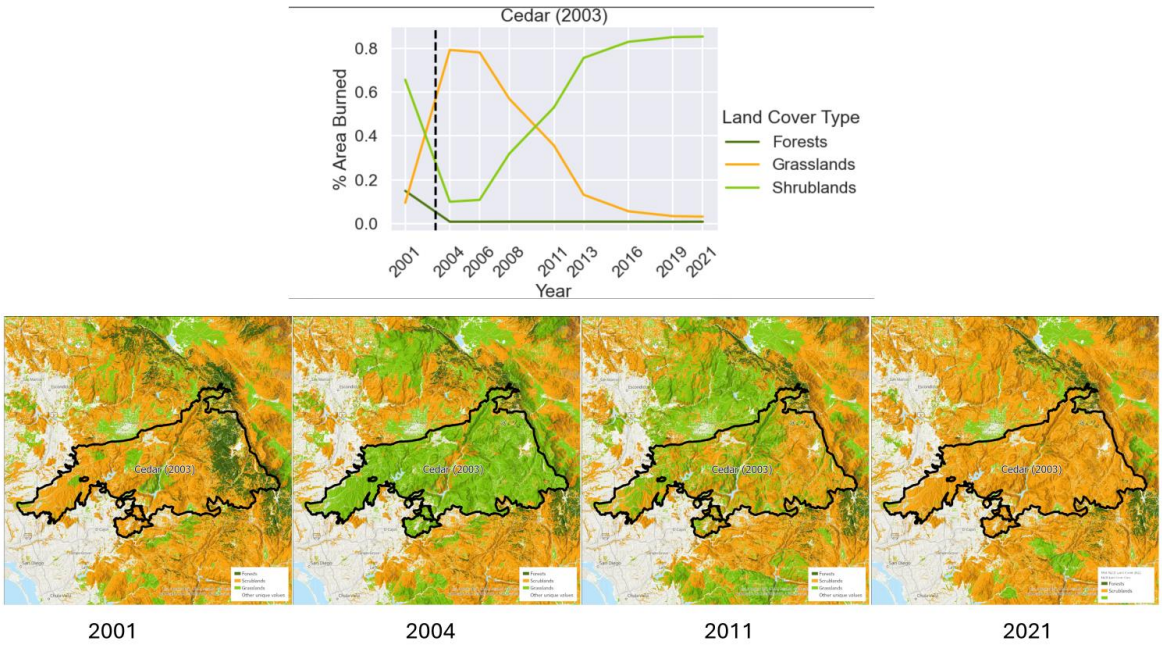

Figure 1. Cedar Fire, October 2003, 110,579 hectares.

Discussion, Conclusions & Implications

Research showed that wildfires are making large vegetation changes to ecosystems with the most drastic changes predominantly in shrublands, both in the short term and long term. Without interventions to maintain shrublands at the pre-fire levels, and steps to reforest fire footprints, there will be continuing shifts in species. Species that rely on forested land cover will either need to adapt to shrubland habitat, relocate, or will disappear completely. Vegetation pattern changes also raise questions about post-wildfire management. Livestock as well as wildlife have been documented to browse on resprouts and slow the spread of shrubs (Rouet-Leduc et. al., 2021). Our data shows that choosing no post fire fuel treatments will result in a decrease in forested landscapes and an increase in shrublands. Fires can destroy permanent fencing on rangelands but with temporary electric fences or even virtual fencing areas could be targeted for vegetation management using ruminants.

Our findings document that some form of fuel treatment is needed following a catastrophic wildfire to assist rangeland health. Fuel treatments can alter fuel conditions so that wildfire is easier to control and less destructive (Reinhardt et. al., 2008). The costs of fuel treatments vary widely, yet the relative cost and success must be considered as opposed to doing nothing and having the fuel loads return (Strand et. al., 2014). Potential benefits of fuel treatments such as reduced wildfire risk, reduced fire suppression costs, and reduced structural losses will be site-specific. Thus, a site-specific analysis must account for the cumulative cost of fuel treatments, the likelihood of wildfire return, with or without treatments, and the overall health of the rangeland. Grazing with cattle, sheep, and goats can support post-wildfire recovery to extend the return interval of the shrubland, and therefore lengthening the fire return interval, mimicking what was naturally occurring before European settlers. Grazing for fuel reduction has the potential to offer a low cost, landscape-level fuel treatment (Germano et. al., 2012). With fire hazard increasing as fuels go untreated, management after catastrophic fires will become more critical to maintain rangeland health.

Research indicated that with no management, after a period, depending on climate, shrublands become the dominant vegetation. While shrublands and grasslands fluctuate, the data indicated forests are not recovering. Other fires assessed had similar vegetation (land cover changes), indicating this pattern is not a factor of the most

devastating fires only, but any fires that occur in land cover types containing shrublands and forests. More active prescribed grazing post-wildfire is needed to manage the abundance of herbaceous and re-sprouting shrubs. Prescribed grazing can manage the height and structure of herbaceous growth, result in changes in fire behavior and the decrease of catastrophic fires on the landscape.

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