

Restoring Indigenous Prescribed Fires to California Oak Woodlands¹

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Abstract

It is recognized that California Indians have stewarded the landscape for millennia. As such, the coupling of fire and culture are interrelated and interdependent in many California ecosystems including oak woodlands. Colonization and subsequent governmental fire policy mandates have disrupted the cultural use of fire, which in turn has disrupted ecological functions where those fires are absent. As society grapples with the devastating impacts of wildfires and the loss of biological diversity, many Indigenous people see traditional fire use as a key to mitigation of devastating losses while retaining traditional livelihoods associated with burning. Indigenous burning in California is a keystone process, which creates heterogeneity of species and habitats while also promoting many culturally significant foods, materials and other resources of value to Indigenous communities and society. This research focuses on the restoration of Indigenous burning to oak woodlands and the ecological and cultural effects thereof. Preliminary findings and community perspectives of this research will be discussed.

Key words: biodiversity, blue oak, Indigenous prescribed fire, valley oak

Introduction

Fire plays an integral role in maintaining many ecosystems globally, and in many of those ecosystems the fire regimes established by Indigenous and local people have become a keystone process. As a keystone process, the decoupling of natural processes may facilitate the existence of such ecosystems, buffer them from environmental change, and contribute to coevolution of process and composition within these systems. Mensing (2005) states that the contemporary biogeography of California's oak woodlands has been established since the last glacial period, and was enhanced and maintained by California Indians (Jepson 1923, Mensing 2006).

Valley oak (*Quercus lobata*) and blue oak (*Quercus douglasii*) represent two species with relatively broad distributions, and are two species of importance to Tribes within their ranges. It is well documented that California Indians burned within oak woodlands for a variety of purposes and spatial and temporal scales (Anderson 1999, 2005; Bean and Lawton 1973, Hankins 2013, Lewis 1973) largely linked to subsistence activities, including production of acorns, grasses, and other cultural resources. Jepson (1923) believed the distribution and structure of valley oak woodlands was tied to regular burning by Indigenous populations.

The spatial-temporal arrangement of fire created heterogeneity within the landscape (Martin and Sapsis 1992) typically at a fine scale. Drawing from Jepson (1923) and Mensing (2006) we can deduce that Indigenous prescribed fires were an integral process in oak woodlands of California. These fires have been applied through past environmental change (in other words, climate change) events (Eriksen

¹ An abbreviated version of this paper was presented at the Seventh California Oak Symposium: Managing Oak Woodlands in a Dynamic World, November 3-6, 2014, Visalia, California.

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and Hankins 2013), and have contributed to ecosystem resiliency and would vary spatially and temporally with respect to environmental parameters.

Due to concomitant effects of colonization, traditional Indigenous burning has been displaced from the landscape. As we look to reinstate Indigenous processes into oak woodlands, we can draw from existing knowledge that both valley oaks and blue oaks are relatively tolerant of fire (Bartolome and others 2002, Holmes and others 2011, Standiford and others 2012, Swieki and Bernhardt 2002), but life stage and fire severity are key factors for survivorship. High severity fire events can cause complete overstory mortality and limited response of sprouting trees (Wills 2006). Van de Water and Safford (2011) summarized pre-contact fire histories and suggest that California oak woodlands had a mean minimum of 5 years and mean maximum of 45 years with a median of 12 years between fires. Standiford and others (2012) found fire return intervals between 5 to 25 years in blue oak woodlands in the southern Sierra Nevada. Given the limited occurrence of lightning ignitions at lower elevations (such as the Sierra Nevada foothills and Central Valley) in California (van Wagonk and Cayan 2008), the fire regime in valley oak and blue oak woodlands is likely one dominated by human ignitions partly due to the greater population densities in these areas. Purcell and Stephens (2005) suggest these fires were likely of lower intensity due to their frequency, but intensity increased as shifts in fire management (in other words, fire suppression) lengthened return intervals and increased fuel loads. Indigenous burning in valley and blue oak woodlands was noted in early explorer accounts (Belcher 1843). In the time since European arrival to California, oak woodlands have undergone changes including invasive species introductions, habitat loss and fragmentation, and altered ecosystem processes (Mensing 2006).

Declines and conservation

Valley oak and blue oak woodlands have undergone many changes following European colonization. Historically, expansive valley oak woodlands extended for miles across the broad floodplains of the Central Valley, and blue oaks occurred as a nearly contiguous belt in the foothills surrounding the Central Valley. Today these woodlands persist in disjunct patches. While still widely distributed, the reduction of valley oak woodlands is cause to consider the remaining woodlands an endangered ecosystem. To a lesser extent blue oaks have also been subjected to land use changes and resulting loss and fragmentation of habitat. Current threats to the valley and blue oak woodlands include invasive species, limited recruitment and altered fire regimes including fire suppression. These woodlands support a tremendous diversity of native species. One conservation concern is for native grasses and forbs, which are largely displaced by non-native species (see Lulow and Young 2011). The relationship between plant associations is complex, but as Roche and others (2012) describe, oak woodlands harbor native grasses, which are less prevalent when oaks are absent.

Given the decline of valley and blue oak woodlands, it is particularly important to address the role of fire in achieving conservation and management objectives through future environmental change. Hobbs and others (2011) discuss restoring process, inclusive of Indigenous stewardship practices, as a means to manage ecosystems. While it is recognized the past environment cannot be achieved as a restoration goal, it is possible to direct the future potential of these systems by restoring Indigenous prescribed fire as process, thus making them more resilient. This research implements the management goals held in common by land managers and Indigenous populations

working to conserve and perpetuate oak woodlands for ecological and cultural purposes.

Methodology

The goals of this project were to: 1) measure the effects of Indigenous prescribed fire on biodiversity and culturally important species associated with valley oak and blue oak woodlands; and, 2) to implement and share traditional fire knowledge of Indigenous communities. The framework for implementation of this project integrates the use of Indigenous prescribed fire to enhance and conserve native species. Indigenous prescribed fire was achieved through working with local members of the Native American community in the areas surrounding each project site to implement burning according to traditional ecological knowledge. At the Big Chico Creek Ecological Reserve members of the Mechoopda and Konkow Valley Bands of Maidu were involved in burn implementation. At the Cosumnes River Preserve members of the Ione and Wilton Bands of Miwok, unaffiliated Miwok descendants and members of the California Indian Water Commission were involved in burn implementation alongside Tribal, state and local fire crews. The implementation of each burn coincided with the onset of the first fall rains followed by the initial growth of non-native annual grasses and forbs (between 2 to 5 weeks following the first rains). Burns at the Big Chico Creek Ecological Reserve (BCCER) occurred during fall 2011 and 2012, while burns at the Cosumnes River Preserve (CRP) occurred during fall 2013. Ecotones and microtopography along with existing roads and ditches were used as boundaries to confine burning. In areas lacking these features, black lines were established prior to the primary burn day. Ignitions involved strip and spot firing depending upon field conditions and site-specific considerations.

Fire effects monitoring and research outcomes were monitored on 20 x 20 m plots established at each study site. A modified relevé sampling method was utilized to document cover, species composition, structure and fuels in established plots. Additional data was collected on culturally significant species occurring on these plots. Counts or population estimates for select cultural resources were made on each plot, and tribal practitioners determined resource quality. Here I will report on cover, species composition and summarize data on culturally significant species.

At BCCER, nine plots were sampled in spring 2013 according to treatment categories of fire history; specifically 1 or 2 years following burns or on sites that had not been burned. A total of three plots were assigned to each treatment category. At CRP, 15 plots established for ongoing monitoring were sampled in spring 2013 pre-fire and resampled in spring 2014 post-fire on burned and unburned plots. Three of these plots were excluded from burning for comparative purposes.

Statistical analysis of data was completed in JMP 7.0.2[®] (SAS Institute, Inc. Cary, NC) focusing on ground cover and species richness. Data was analyzed with a standard least squares model with an emphasis on effects leveraging for treatment (fire history). Due to the unbalanced sampling between controls and burn plots at CRP the model was adjusted with a restricted least squares (REML) method whereby the random affect of treatment was nested by year.

Results

At BCCER, 91 species of vascular plants were identified across all plots with 59 of those being native. Amongst the native species there are many culturally important

species including at least 31 traditionally utilized for food, 6 for medicine, and 12 for fiber. Some of the representative native species include blue wild rye (*Elymus glaucus*), Ithuriel's spear (*Tritileia laxa*), blue dick (*Dichlostema* sp.) and foothill clover (*Trifolium ciliolatum*). Representative non-native species include red brome (*Bromus madritensis*), common hedge parsley (*Torilis arvensis*), rose clover (*Trifolium hirtum*) and yellow star thistle (*Centaureum solstitialis*).

Cover data from BCCER was averaged by treatment for analysis. Least squares fit for total species richness, native species richness and total cover were not found to differ significantly between treatments. By contrast, the proportion of native cover was found to differ significantly (see table 1). The average total cover on control plots was 53 percent, where plots burned 1 year prior had a reduced cover of 48 percent and plots burned 2 years prior increased cover to percent. In comparison, the average proportion native cover for controls was 13.7 percent, plots burned 1 year prior had increased cover to 20.8 percent, and plots burned 2 years prior had increased cover to 42.9 percent. This suggests that burns promoted native species cover, with a noted increase in cover 2 years following the burns. While native species collectively benefitted from the burns, there are no cultural species that stand out individually as being significantly different in terms of cover.

Table 1—Least squares fit analysis of variance values. Blue oak woodland at the Big Chico Creek Ecological Reserve

Parameter	Analysis of Variance Values
Species richness	F = 0.922, $p = 0.4475$
Native species richness	F = 1.662, $p = 0.2664$
Total cover	F = 2.846, $p = 0.1352$
Proportion native cover	F = 11.449, $p = 0.009^*$

At CRP, 49 species of vascular plants were identified across all plots with 23 being native species. At least 11 of the native species are traditionally utilized for food, 10 for medicine, and 11 for fiber; some species fall into more than one category. Amongst representative native species were creeping wild rye (*Leymus triticoides*), white root sedge (*Carex barbarae*) and goose grass (*Galium aparine*). Representative non-native species include ripgut brome (*Bromus diandrus*), wild radish (*Raphinus sativus*) and Italian thistle (*Carduus pycnocephalus*).

Changes in cover were not significant across treatments. The average pre-burn cover for control plots was 58 percent, whereas burn plots had 68.4 percent. Following the burn cover on control plots was 56.2 percent, but burn plot cover was reduced to 52 percent. Total cover following burn treatment was significantly lower on burned plots (see table 2). However, the change in proportional cover for native species was not significant. Changes in species richness and native species richness were also not significant. Although, some of the culturally important species were observed to increase. For instance, across all plots the pre-treatment culm count of creeping wild rye yielded a mean of 26.5 culms, whereas the post-treatment count yielded a mean of 76.7 culms; most substantial gains were on burned plots, but the difference between burned and control plots was not significant.

Table 2—Least squares fit random effects predictions. Valley oak woodland at the Cosumnes River Preserve

Parameter	Burn	Control
Species richness	$t = 1.29, p = 0.3116$	$t = 0.09, p = 0.9409$
Native species richness	$t = -0.43, p = 0.7429$	$t = 0.15, p = 0.9049$
Total cover	$t = -2.46, p = 0.0250^*$	$t = 0.11, p = 0.9190$
Proportion native cover	$t = -2.07, p = 0.0606$	$t = 0.36, p = 0.7435$
Creeping wild rye abundance	$t = 1.05, p = 0.4791$	$t = -0.01, p = 0.9935$

Discussion

The data suggests that fire may play an important role in maintaining and enhancing native vegetation in blue oak and valley oak woodlands, but more monitoring time may yield stronger conclusions. Based on the results, it appears that the reduced cover 1 year following burns may provide an opportunity for native species establishment by the second year following burns. This data suggests that fires may temporally facilitate the prevalence of native species, which has been previously observed in other vegetation communities (see Hankins 2013). Although analysis did not demonstrate a significant relationship between treatment and the proportion native cover or richness within the valley oak woodland, presumably, the observed temporal lag in cover response amongst blue oak woodlands is an indicator for what could occur in valley oak woodland. In consideration of the observed response differences, it is possible that this difference between cover responses may be attributed to variability in precipitation during the years under analysis. Specifically, the valley oak woodland was burned during a period with no subsequent precipitation for months following the burn, and thus little moisture was available to facilitate response by native perennial grasses and forbs. By contrast, more typical precipitation patterns followed the burns in blue oak woodland. Under normal conditions, the periodic precipitation would provide moisture to enable native vegetation to recover. As stated previously, the timing of the burns coincided with the onset of the rainy season. Plant phenology, mostly germination of non-native grasses and forbs, was a key indicator for implementation of burns at both sites, but the outcomes of these burns yielded somewhat differing results. One critical consideration that has yet to be analyzed is the role of climate parameters on the outcomes of these burns. Specifically, a persistent dry period followed the valley oak burn, and lasted several months. Based on observations of many of the same native species in other burned environments, there is usually a rapid regeneration of vegetation, particularly amongst perennials. Following the valley oak burn there was little regeneration until precipitation resumed months later. This late precipitation was observed to enable another germination period for non-native grasses and forbs, which may have been outcompeted by natives under normal rainfall.

Another factor to consider in the management of these oak woodlands is the relationship of patch size to species richness and the composition thereof. From a conservation biogeography perspective, it is likely that blue oak woodlands would be more resilient to non-native species due to the spatial extent and configuration of these woodlands within the landscape (in other words, they often occur in extensive and contiguous belts), whereas valley oak woodlands largely exist in relatively small remnant patches which are more susceptible to invasion. This particular valley oak woodland was bordered on two sides by annual grasslands with a dominance of invasive species, a highway, and an agricultural field. Thus the invasion potential is high. Furthermore, the numbers of species observed within blue oak versus valley

oak woodlands represent the additive phenomenon of increased richness relative to increased habitat area.

This data represents preliminary work in the restoration of Indigenous prescribed fire to oak woodlands. Given changes to the landscape and the ubiquity of non-native species, achievement of management objectives may require mixed approaches. For instance, it was observed that areas subject to higher burn intensity (such as where coarse debris had burned) recovered mostly to native species. Based on previous research by Lewis (1994) and Fulé and others (2004) and field observations (personal notes), this begs the question of whether alternative prescriptions such as high intensity or higher severity may be a potential management approach in the short term. Future research should investigate this further.

Acknowledgments

This project was funded in part by the National Science Foundation – Coupled Natural Human Systems grant NSF-1232319. Instrumental to the support and implementation of this project was the staff at the Cosumnes River Preserve (Bureau of Land Management, California Department of Fish and Wildlife, and Nature Conservancy), California Indian Water Commission, Cosumnes Fire Department (and others), Big Chico Creek Ecological Reserve, and numerous students and volunteers who spent time learning at these sites.

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