Fire Ecology on California's Public Lands and Preserves

Altered fire regimes and an ever increasing wildland-urban interface have created new ecological questions. Research and monitoring inform land management efforts to protect life, property, and biological diversity. Several highlights from this work are presented here.

Seasonality and Burn Objectives

Wetlands and Vernal Pools in the Central Valley

The Sacramento National Wildlife Refuge Complex protects 35,000 acres in the Central Valley. The Nature Conservancy has protected 60,000 acres of vernal pool habitat, interspersed throughout the grasslands in the Central Valley, and plans to protect an additional 120,000 acres in the future. The wetlands, alkali meadows, and vernal pools on these lands provide habitat for millions of waterfowl, shorebirds and other migratory birds. Vernal pools and alkali meadows are also home to a multitude of rare and endemic plants as well as threatened and endangered invertebrates.

The timing and tactics of prescribed burns in these sensitive habitats varies based on the project objectives. Much of the successful burning for cattail and bulrush management takes place in the summer, while burning to reduce non-native grasses is generally done in the spring. Cattails and bulrush are beneficial to wetland species, but can be detrimental when they invade vernal pools and alkali meadows. They require a late-summer burn when they are dry enough to induce mortality.

One of the greatest threats to vernal pools are invasive non-native annual grasses, including Medusahead and ryegrass. Burning non-native annual grasses in the early spring before they release seed, benefits native species which release seed later in the season. Properly timed, short periods of “prescribed grazing” can also reduce non-native annual grasses. Cattle will not graze on Medusahead, however, due to its high silica, so fire is the preferred tool for reducing this invasive species.

Supporting Research

The Use of Presecribed Fire to Control Invasisve Exotic Weeds at Jepson Prairie

Oren Pollack and Tamara Kan - 1998

The Nature Conservancy, 201 Mission Street, 4th Floor , San Francisco, CA 94105

“The results provide strong evidence that late-spring burning reduces the cover of non-native annual grasses, such as Medusahead, while increasing the dominance of native species and the cover of native grasses and forbs. Prescriptions for management of vernal pool and grassland habitats in California should include late-spring burning in areas that have heavy infestations of Medusahead or an accumulated thatch layer.”

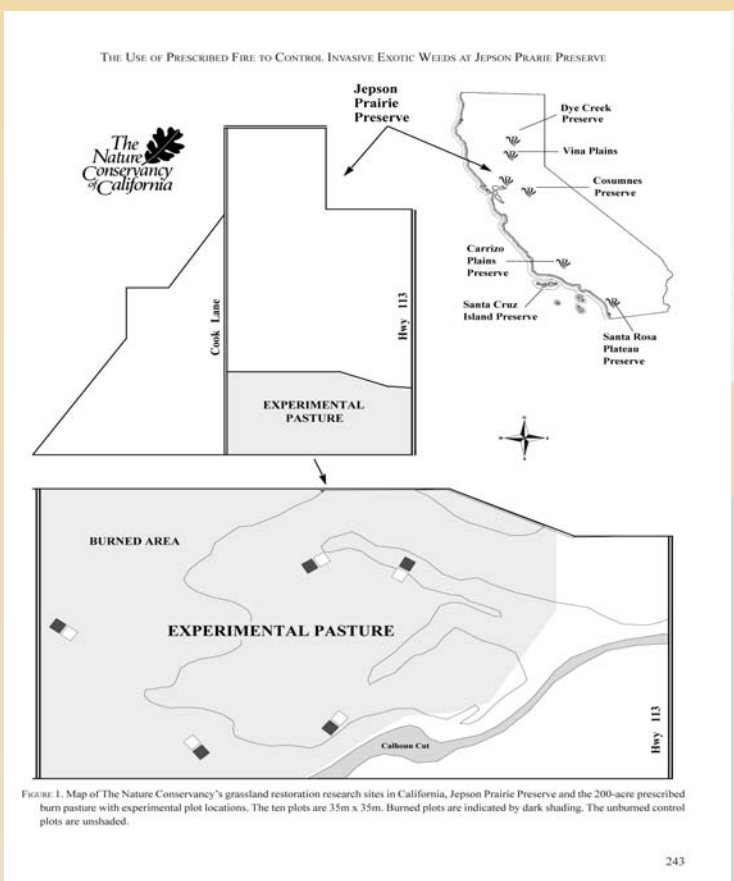


Figure 1. Map of The Nature Conservancy's grassland restoration research sites in California, Jepson Prairie Preserve and the 200-acre prescribed burn pasture with experimental plot locations. The ten plots are 35m x 35m. Burned plots are indicated by dark shading. The unburned control plots are unshaded.

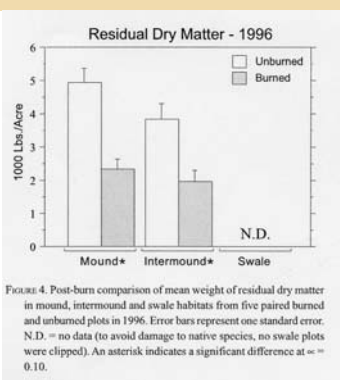


Figure 4. Post-burn comparison of mean weight of residual dry matter in mound, intermound and swale habitats from five paired burned and unburned plots in 1996. Error bars represent one standard error. N.D. = no data (to avoid damage to native species, no swale plots were clipped). An asterisk indicates a significant difference at ∝ = 0.10.

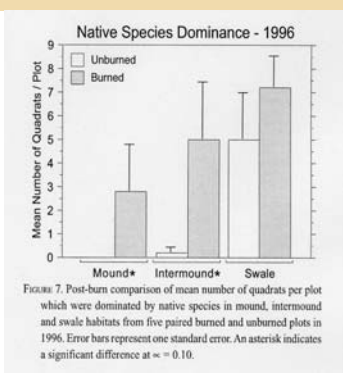


Figure 7. Post-burn comparison of mean number of quadrats per plot which were dominated by native species in mound, intermound and swale habitats from five paired burned and unburned plots in 1996. Error bars represent one standard error. An asterisk indicates a significant difference at ∝ = 0.10.

Residual dry matter (thatch) was significantly lower 1 year after burning in mound and intermound habitats.

Non-native species were significantly lower 1 year after burning in mound and intermound habitats.

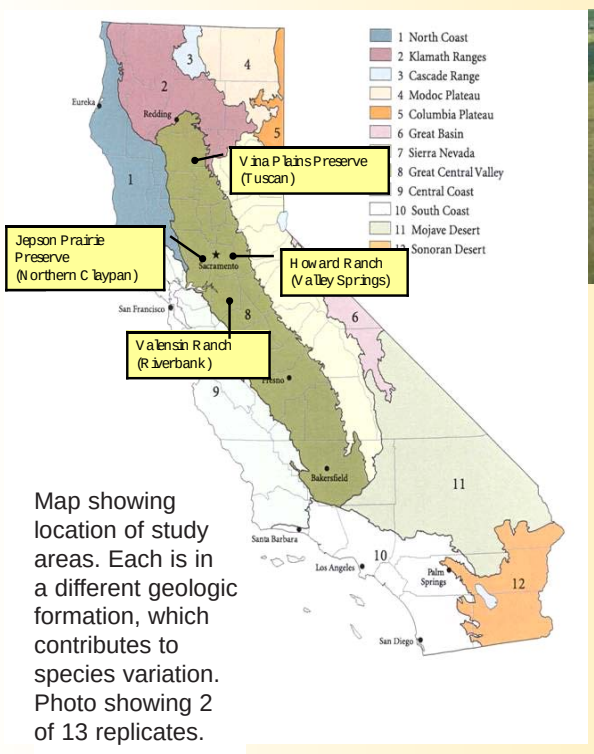
“This study confirms previous observations that prescribed burns, timed to coincide with seed production of Medusahead (after seed set, yet before the seed heads have shattered), are effective at eliminating the current year’s seed production. When seed heads are located above ground level they are subjected to the hottest part of the burn. The effectiveness of this approach for controlling Medusdahead is due to its low seed dormancy characteristics.”

Medusahead illustration by Julie Kiersted Nelson

Fire Effects on Rare Wetland Plant Communities in the Central Valley Region

Jaymee Marty - Ongoing research

The Nature Conservancy, Cosumnes River Preserve, 13501 Franklin Blvd., Franklin, CA 95632



Map showing location of study areas. Each is in a different geologic formation, which contributes to species variation. Photo showing 2 of 13 replicates.

California's Central Valley grasslands represent one of the most invaded ecosystems in the United States with the cover of non-native plant species often exceeding 85 percent. Vernal pools are seasonal wetlands that occur within these grassland systems and serve as a refuge for native species that have adapted to the pools' seasonally flooded and desiccated environment. At four sites in the Sacramento Valley, I studied whether landscape-scale processes such as fire and grazing can promote native species cover and richness in the pools while reducing exotic species cover. Initial results indicate that fire added to a grazed system maintains native species cover while reducing exotic species cover in the vernal pools at some sites. At all sites one year after spring prescribed burn treatments, exotic grass cover was lower in burned versus unburned pools. In contrast, exotic forb cover was higher in burned pools than the unburned pools across all sites. At the two highest productivity sites, native species richness was 20 - 40% higher in burned versus unburned treatments. Native diversity did not differ among burn treatments at the lower productivity sites. These results highlight the tradeoffs associated with using prescribed fire as a management tool in this invaded system, but provide compelling evidence for using prescribed fire to maintain native vernal pool plant communities at sites with higher productivity.

Fuels Management Alternatives

Fire Severity and Intensity in Natural and Manipulated Fuels During Spring Burning in Mixed Shrub Woodlands

TIM BRADLEY, JENNIFER GIBSON, AND WENDY BUNN - 2003

Whiskeytown National Recreation Area, 14412 Kennedy Memorial Drive, Whiskeytown, CA 96095

Introduction
Within recent years, Whiskeytown has implemented a progressive fuels management program that protects high value areas through a variety of alternative fire risk reduction methods, including understory thinning, vegetation chipping, and mastication. While these techniques expand the list of options for fire managers, the ecological impacts and long-term effects of these treatments are uncertain.

Study Design
The 70 acre study area is located between 1,250 and 1,500 feet in elevation and is characterized by a black oak (*Quercus kelloggii*) and knobcone pine (*Pinus attenuata*) overstory. The dense shrub understory is dominated by whiteleaf manzanita (*Arctostaphylos viscida*), which accounts for 65-90% of total shrub cover. The study area was stratified by vegetation characteristics, slope, and aspect, resulting in the selection of 10 different treatment blocks. Each treatment block was divided into 14 approximately equal-sized units ranging from 0.05 to 0.15 ha, with two units from each block representing one of the following seven different experimental treatments:

1) Masticated brush burned in the fall; 2) Masticated brush burned in the spring; 3) Unmanipulated brush burned in the fall; 4) Unmanipulated brush burned in the spring; 5) Masticated brush left on the ground as mulch; 6) Brush cut by hand and removed to mimic biomass removal; 7) Control (no mastication, burning, or thinning)

Results
The mastication treatment significantly altered the fuel profile, converting live and dead standing materials into downed woody debris and resulting in an approximate 200% average cover increase in woody fuel loading for 1 and 1000 hr TLFM size classes, and greater than 300% average cover increase in 10 and 100 hr TLFM size classes.

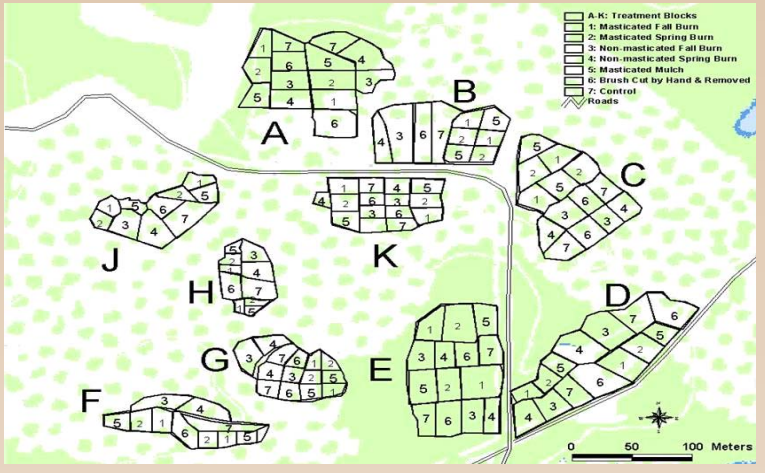
In addition to a fuel quantity increase, the removal of overstory shading directly contributed to an increase in air circulation (drying of fuels) and an increase in direct solar radiation (increased surface fuel temperatures). With the combined effects of these factors, fuel consumption patterns differed significantly among treatments (Chart 2). As a consequence, fire behavior indices also differed significantly, leading to strikingly different severity effects to live vegetation (Table 2).

Recommendations
Results from this study showed significant differences between masticated and unmanipulated treatments. In particular, these results highlight the complexity of burning in masticated fuels when the objective is to retain overstory trees and some vegetation. Where spring burning of masticated fuels is a consideration, the following treatment recommendations have been developed for retention of residual vegetation:

1. Decrease in the level of mastication thinning
A decrease in the level of mastication would have contributed to lower fire behavior indices and severity results by reducing surface fuel loading, decreasing wind circulation, and increasing shading of fuels.

2. Apply fire under a more mild prescription
Without the experience of applying fire in masticated fuels, park staff developed a prescription based on unmanipulated fuels. Future prescribed fire treatments in masticated fuels should consider the differences in expected behavior and subsequent severity.

3. Avoid burning within the early growing season
The post green-up application of fire in our study coincided with a vulnerable phenological period in plant development, when leaf, bud, and cambium tissues are particularly susceptible to thermal effects. Prescription windows that are scheduled during the dormant season would likely minimize severity to retained vegetation.



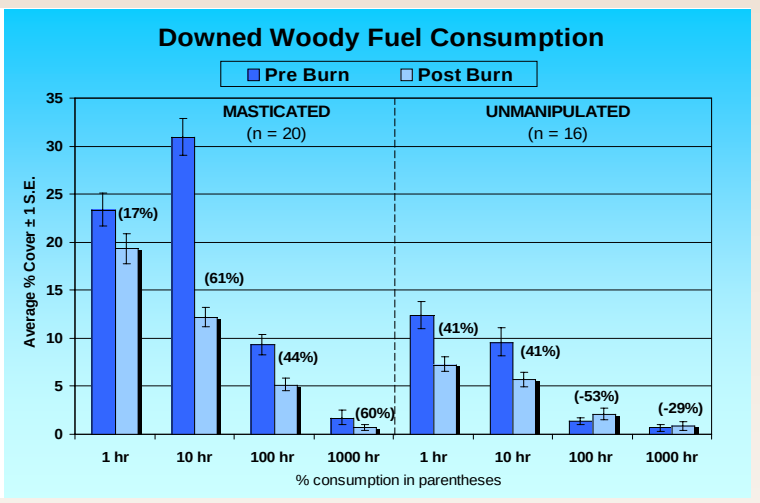


Table 2. Average Mortality of Trees and Shrubs

	Overstory (> 8 in. dbh)		Pole (< 8 in. dbh)	
Species	**Brush**	**Masticated**	**Brush**	**Masticated**
Knobcone Pine	0%	16%	15%	66%
Black Oak	0%	23%	17%	47%
Canyon Live Oak	0%	49%	21%	98%
Shrubs	**Unmanipulated**		**Masticated**	
	30%		96%	

Chaparral Fire and Fuels: Ecological Effecs of Fuel Management Practices

SCOTT STEPHENS AND JENNIFER POTTS - RESEARCH IN PROGRESS

University of California Berekely, Department of Environmental Science, Policy and Management, 360 Mulford Hall, Berkeley, CA 94720

Significance and Objectives
Fuel reduction may have detrimental ecological impacts to chaparral if conducted during inappropriate times of the year or using inappropriate techniques. This study investigates the effects of two common chaparral fuel reduction practices (prescribed fire and mastication), and contrasts the effects after fall, winter and spring treatments. The study focuses on the recovery of shrubs, herbaceous plants, and bird communities.

Methods
Ecological recovery of Northern California Coast Range chaparral was examined following 6 treatments: 1) fall fire, 2) winter fire, 3) spring fire, 4) fall mastication, 5) spring mastication, plus an untreated control. Each treatment is conducted on a five acre plot and is replicated four times, for a total of 100 treated acres. Data was collected over five years between 2001 and 2005.

Preliminary Findings
Preliminary analysis shows that non-native plants (particularly non-native grasses) have substantially higher abundance and cover in the masticated plots, regardless of the season of mastication. Winter and spring fire treatments have the lowest number of non-native plant species and abundances. Bird species (both residents and migrants) are at least eight times more likely to be found in post-fire plots compared to post-mastication plots, in part because the plant skeletons that remain after fire provide perching sites and protection from predators. Lastly, shrub regrowth is significantly higher following fire treatments, regardless of the season of treatment.

Management Implications
This research aims to provide region-specific information to chaparral managers who are faced with a formidable fuel reduction challenge as the wildland-urban interface expands. Few, if any, chaparral studies have directly compared the seasonal timing of prescribed fire and mastication in a replicated design.

This project is funded in part by the Joint Fire Science Program in partnership with the Bureau of Land Management.

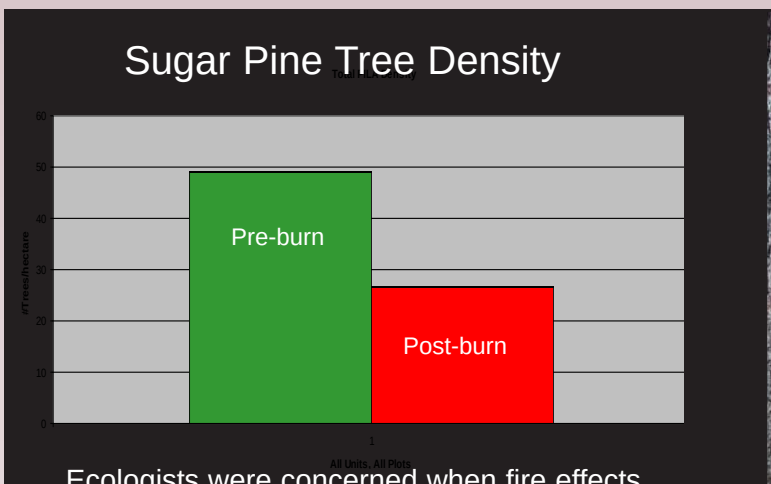
Consequences of Fire Exclusion

Assessing Fire Induced Sugar Pine Mortality

A Study at Yosemite National Park

JEN HOOKE AND MONICA BUHLER - RESEARCH IN PROGRESS

Fire Management Program, Yosemite National Park, California 95389



Ecologists were concerned when fire effects monitoring data from 22 plots showed that sugar pine tree numbers were going down after prescribed burning. The fuel build up at the base of trees where natural fires have been suppressed has increased the risk of prolonged smoldering. Excess exposure to intense heat can kill trees.

Problem

It is widely recognized that the application of management fire is an essential component of mixed conifer ecosystem restoration in the Sierra Nevada. The composition, structure, and function of mixed conifer forests have been heavily impacted by fire suppression and returning management fire to these systems is a challenging process. Sugar pine (*Pinus lambertiana*) is disappearing from these forests due to white pine blister rust (*Cronartium ribicola)* infection and competition with white fir *(Abies concolor)* and incense cedar (*Calocedrus decurrens*) (Yeaton 1983; Stephenson 1996). Fire-induced mortality of sugar pine is a serious concern among resource managers, the scientific community, and the general public. Efforts to mitigate against mortality have been used with some success; however there is a lack of consensus among which methods to use and the efficacy of the methods employed.

Study objectives

The purpose of this study is to assess the effectiveness of mitigation actions on preventing prescribed fire-induced mortality of sugar pines. This study will address the following questions:

1. How effective are two mitigation treatments (clearing and lining) in preventing prescribed fire-induced sugar pine mortality?
2. If mitigation treatments are deemed effective, which treatment is preferred?
3. Do mitigation treatments have an impact on tree mortality and vigor?
4. What variables (alone or in combination) best serve as predictors of sugar pine mortality?
5. How does prescribed fire affect sugar pine regeneration?

Treatment classes

1 = Cleared	Clear all fuels (live and dead) within a 2-m radius around each sugar pine without disturbing the forest floor (e.g., remove dead & down fuels >3" diameter, not litter and duff). This includes limbing trees and removing trees <6" DBH.
2 = Lined	Remove all forest floor material to mineral soil within a 9"-collar around base of sugar pine bole (Haase and Webster 1999) using "combie" tools, shovels, and hand removal.
3 = Control	None

References

Haase, S.M. and K.M. Webster. 1999. Protocol for PILA/PIPO mitigation study ála Riverside Fire Lab. Sequoia and Kings Canyon National Parks, Three Rivers, CA, USA.

Stephenson, N.L. 1996. Ecology and management of giant sequoia groves. Pp. 1431-1467 in Sierra Nevada Ecosystems Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. University of California, Centers for Water and Wildland Resources, Davis, CA, USA.

Yeaton, R.I. 1983. The successional replacement of ponderosa pine by sugar pine in the Sierra Nevada. Bulletin of the Torrey Botanical Club 110: 292-297.

Can Knobcone Pine Regenerate without Crown Fire?

A Study at BLM Cow Mountain National Recreation Area

The Effects of Prescribed Fire Season and Fire Surrogates on Crown-Fire Adapted Knobcone Pine Forests

SCOTT STEPHENS AND DANNY L. FRY - RESEARCH IN PROGRESS

University of California Berkeley, Department of Environmental Science, Management and Policy, 360 Mulford Hall, Berkeley, CA 94720

Abstract

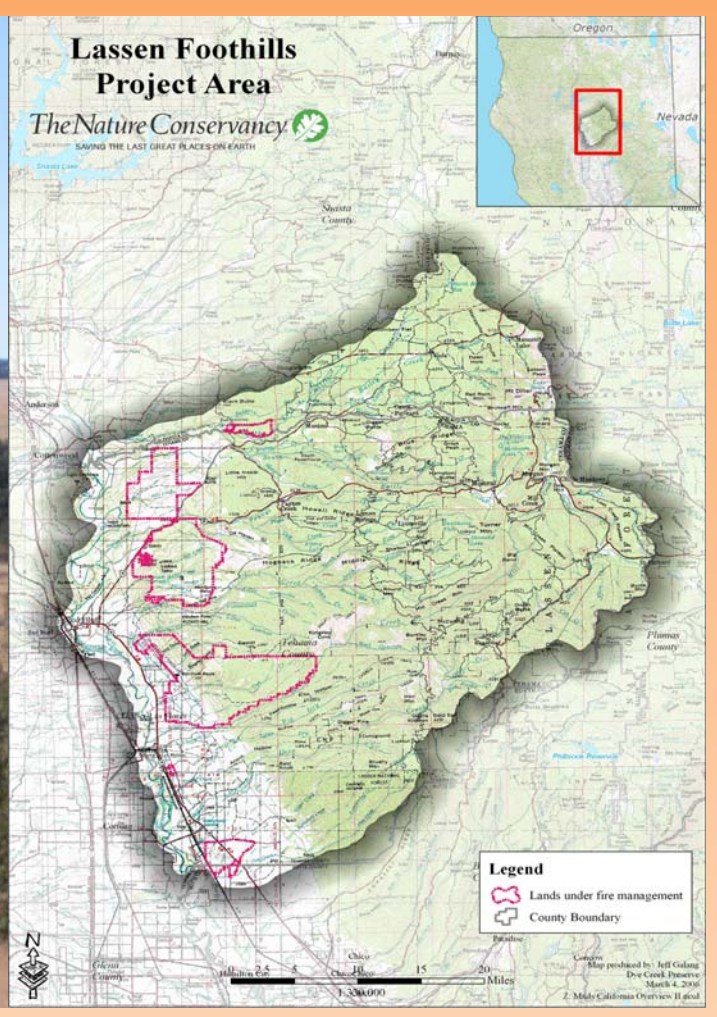
Knobcone pine (*Pinus attenuata*) forests are challenging to manage because high intensity crown fires are thought to be necessary for successful regeneration. The use of prescribed crown fires produces high amounts of emissions and air quality regulators are becoming less supportive of such fires, especially if alternatives treatments are available. The effects of the season of prescribed fire and fire surrogates is not understood in knobcone pine forests. Burning in the spring reduces the chance for fire escapes, but may be inappropriate for regeneration because this coincides with the beginning of the dry season. There is no published information on the effects of fire surrogates treatments (tree falling and lop and scatter of activity fuels with and without prescribed fire) in these ecosystems.

The objective of this study is to contrast the efficacy of prescribed burning in different seasons, mechanical methods and fire, and mechanical methods alone in regenerating knobcone pine forests. This work will assist in the development of land management plans for the BLM Cow Mountain National Recreational Area. In achieving the primary objective several secondary objectives will be addressed including the effect of the season of fire and fire surrogates on (1) fire hazard reduction, (2) recovery of competing vegetation, (3) resurgence of fuels, and (4) costs of the different treatments, and (5) identification of the most effective treatment for regeneration of knobcone pine that is least intrusive to air quality.

Using a complete randomize design with replication (3 replicates for prescribed fire treatments in the spring and fall, 3 replicates of mechanical treatments followed by prescribed fire in the spring and fall, and 3 replicates of mechanical only in the spring and fall), pre-treatment vegetation and fuels data will be collected in all units and post-treatment tree, shrub, and fuel variables will be measured.

This is a 5 year project funded by the Joint Fire Sciences Program.

Integrated Planning



Collaboration in the Lassen Foothills

The foothills of Lassen Peak, located in Tehama County, California, feature diverse blue oak woodlands, foothill chaparral, grasslands and vernal pools. In an outstanding example of public-private collaboration, the Tehama County Resource Conservation District and the Tehama Fire Council are leading the development of a fire management plan for 500,000 acres in the lower elevations of the Lassen Foothills.

The project area covers five ecologically significant watersheds, home to federally protected Chinook salmon and threatened by a build-up of heavy fuels. Small rural communities are also embedded within this expansive landscape, three of which have been designated as “communities at risk” from wildland fire. Fire management has been identified as a key strategy for abating multiple ecological threats in the Lassen foothills, including invasive weed competition in foothill grasslands and oak woodlands, altered age/size structure in montane chapparal and forest, and altered fire regimes across the entire landscape.

Approximately 2,000-6,000 acres per year are burned to control invasive plants and reduce hazardous fuels. Several communities have also begun to develop fuel breaks to protect assets at risk. Ongoing studies are being conducted to better understand the effects of fire and fuel treatments on the ecosystems of the Lassen foothills.

L A S S E N F O O T H I L L S P A R T N E R S

Battle Creek Conservancy
Bureau of Land Management
California Dept. of Fish & Game
Deer Creek Waterhshed Conservancy
Lassen National Forest
Mill Creek Conservancy
Pacific gas and Electric Co.
PRBO Conservation Science
Sierra Pacific Industries
Tehama County RCD
Tehama Fire Council
The Nature Conservancy
University of California - Davis

Consequences of Ecological Disturbance on Ant Communities: Effects of Fire and Grazing in a Blue Oak Savanna, Northern California

EMMA C. UNDERWOOD[1] AND CAROLINE E. CHRISTIAN[2] - RESEARCH IN PROGRESS
[1]Department of Environmental Science and Policy, University of California, Davis, California 95616
[2]The Nature Conservancy, 201 Mission St., San Francisco, California 94105

Abstract
Techniques such as prescribed fire and grazing are widely used by conservation organisations to maintain and restore native biodiversity. However, the effects of such disturbances on ant assemblages are unclear. This study examined responses of ants to fire and grazing in a blue oak savanna (*Quercus douglasii*) habitat in northern California. Twenty-four 30 m x 30 m plots were established across two sites. Each site contained three blocks (replicates) containing four plots which received one of four treatments: grazing only, fire only, grazing and fire, or no treatment. Ants were sampled using 240 pitfall traps left open for 14 days each sample, with one pre-burn collection and three post-burn collections (14 days, 28 days, and one year post-fire). Analysis of total ant abundance showed no effect of grazing, but a significant effect of fire. Responses to fire differed with ant functional groups. No difference was detected in species richness between burn and control plots. Immediate post fire sampling showed a significant increase in cryptic species, particularly of *Brachymyrmex depilis*, as well as increases in *Forelius pruinosus* (omnivore functional group). Over the short-term cryptic species continued to increase significantly, while two species from the omnivore functional group (*Formica moki* and *Camponotus semitestaceus*) declined, which might be explained by the dominance of *Forelius pruinosus*. One year post fire there was no response was detected for either cryptic or omnivore species, but burn plots illustrated a significant increase in seedharvesters. The relatively minor effects of prescribed fire and grazing detected in this study suggests that these are appropriate management techniques, with respect to the ant fauna, for blue oak savannas in northern California.

PHOTOS

a. *Forelius pruinosus* - One of the ants present at the site. Photo provided by California Academy of Sciences.

b. Test tube pitfall traps filled with ethylene glycol to collect ground dwelling ants. White square tile was placed on top of pitfall in burn to avoid melting the plastic tubing.

c. Burning one of the grazed (fenced) treatment plot

d. Plot after burn

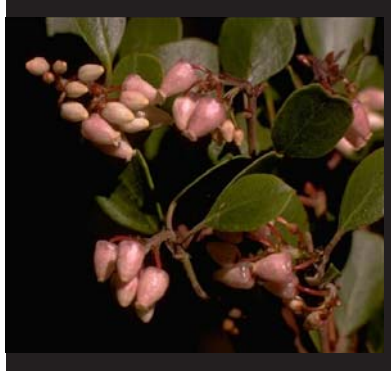
Defining Desired Futures

Fort Ord in Transition

Restoration of natural vegetation patterns in the Parker Flats area is among several conditions being required by the U.S. Fish and Wildlife Service (USFWS) related to approval of a basewide Habitat Conservation Plan and reuse planning effort at Fort Ord. This former military base is currently being redefined into zones of community development and habitat restoration. This will lead to some of California's newest wildland-urban interaface and will protect rare maritime chaparral. The U.S. Army has previously conducted a number of prescribed burns at Fort Ord for the removal of ordnance and explosives. More recent burning at Parker Flats has been done in attempt to regenerate rare plant species which are unique to the Monterey area.

Fire research at Fort Ord hopes to learn about past fire history to define a desired composition of vegetatation types and age classes. Temperature and vegetation monitoring in conjunction with prescribed fire are being done to learn how different plants and seeds respond to different fire intensities. The results of this work will be used to develop resource management objectives and burn prescriptions.

Seven rare plants at Fort Ord are thought to require fire for seed germination. Five of them are shown here. **Photos courtesy of CalFlora, www.calflora.org**



Hooker's manzanita
Arctostaphylos hookeri

Toro manzanita
Arctostaphylos montereyensis

Sandmat manzanita
Arctostaphylos pumila

Eastwood's goldenfleece
Ericameria fasticulata

Monterey ceanothus
Ceanothus cuneatus ssp. rigidus

A research grant, currently under consideration, would fund additional work to document fire history at Fort Ord. This study would be used to develop a model for prescribed burning over the next 50 years, designed to achieve a desired future of sustainability and preservation for Fort Ord's rare maritime chaparral.

The Parker Flats Prescribed Burn Experiment: Pre-burn and Post-burn Vegetation

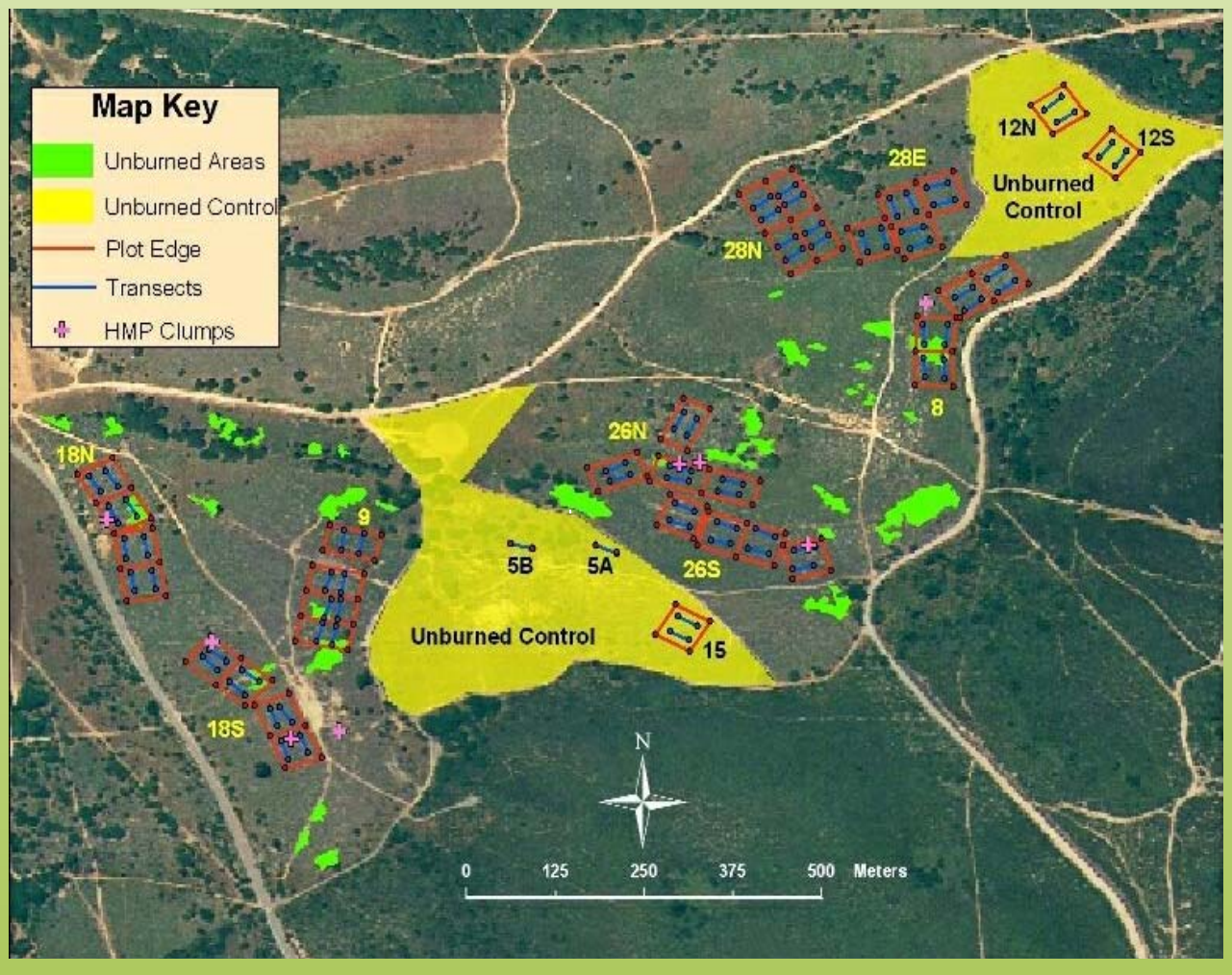
Preliminary Report to the Fort Ord Coordinated Resource Management and Planning Group and the Fort Ord Reuse Authority

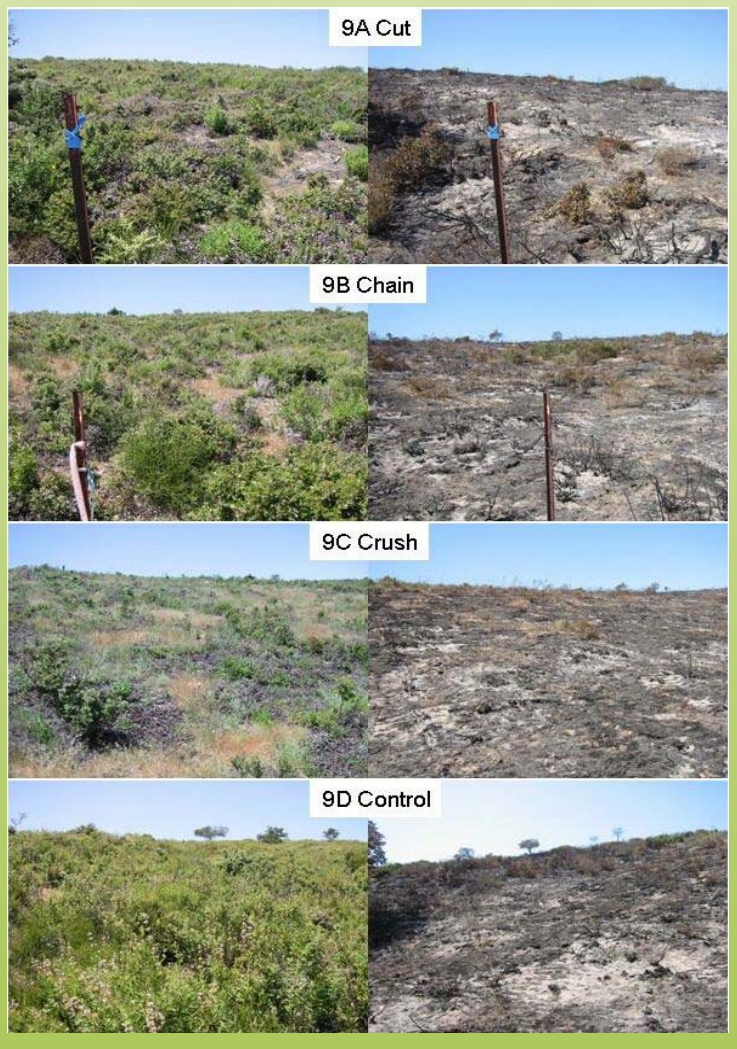
LARS PIERCE[1], JAMI DAVIS[1], REGINA WILLIAMS[1] AND BRUCE DELGADO[2] - RESEARCH IN PROGRESS

[1]Division of Science & Environmental Policy, California State University Monterey Bay, Seaside, CA 93955
[2] Bureau of Land Management, Fort Ord Project Office, Hollister Resource Area, 20 Hamilton Ct., Hollister, CA 95023

Summary
The Parker Flats Parcel is 150 acres of maritime chaparral, oak woodland, and grassland located on Fort Ord, Monterey, CA. This parcel was mowed in 1999 for ordnance removal and development. The parcel was later rezoned as habitat preserve; however, mowing significantly reduced the cover of several obligate seeding, special-status plant species in maritime chaparral. In order to enhance the cover of these species, the parcel was burned in Fall 2005. Prior to the burn, in Fall 2004, we applied a series of pre-burn vegetation treatments (cutting, crushing, and chaining) designed to enhance the flammability of vegetation and to increase the spatial variations in fire intensity, with the goal of improving the regeneration of special-status plant species. It is hypothesized that fire will release the historic seedbank at Parker Flats, and that the composition of the regenerating species will come to represent the more natural mix of species that occupied the parcel prior to mowing in 1999, thereby restoring the Parcel's utility as habitat preserve.

We found that the cover of non-native annuals substantially increased in the plots that received the crush and chain treatments. There were no statistically significant differences between treatment and control plots in fire intensity, or post-fire cover of plant and litter material, cover of white ash, or ash depth. Fire carried surprisingly well across the six year-old maritime chaparral at Parker Flats, regardless of the pre-burn treatment. There is no clear evidence that any of the treatments improved the flammability of six year-old maritime chaparral at Parker Flats. The wider range in temperatures found in the crush and chain treatments may be favorable for regeneration of special-status plant species, although we do not yet understand the burn conditions necessary for release of seed dormancy in these HMP species. The introduction of non-native annuals may also negatively impact regeneration of these special-status species through competition. Future measurements will document post-burn changes in the cover and abundance of native, non-native, and special-status plant species in these plots over time.





ABOVE
Locations of the treatment and control (CT) blocks, plots (A-D), and transects within the Parker Flats Parcel.

The effects of pre-burn desiccation treatments on vegetation at Parker Flats. A. Effects of hand-cutting along border of plot in block 28N. B. Bulldozer and chain. Before (C) and after (D) chaining the

LEFT
Hand ignition during the Parker Flats Prescribed Burn.

Steel temperature tag showing the temperature-sensitive lacquers. In this case, the 200 oF and 300 oF lacquers melted (top), while the 400 oF lacquer (middle left) did not melt.