Fire Hazard Reduction in Chaparral Using Diverse Treatments

Final Report to the Joint Fire Science Program

Project number 00-2-02

Prescribed Fire

Mastication

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EXECUTIVE SUMMARY

Purpose and Need

Fire hazard reduction in chaparral continues to be a formidable challenge for land managers, particularly as people and homes extend further in wildland areas. Chaparral's naturally flammable and fire-dependent ecosystem adds a level of complexity to this challenge because managers must decide how to allow fire to persist as a natural process while protecting against wildfires that threaten human lives and property. This management dilemma is especially pressing in California where fuel reduction is rapidly increasing to keep pace with the expanding wildland-urban intermix.

The goals of this project are to: 1) assess the effectiveness of current California chaparral fuel management practices in reducing fire hazard, and 2) understand the ecological implications of these practices. This project is specifically designed to address the Joint Fire Science Program's Request for Proposals Task 1 (2001-1): *Evaluate impacts of alternative management strategies on fire regimes, costs and operational impacts associated with fire management.* Research is aimed at two pressing management questions: Which fuel treatment maximizes both human safety and ecosystem quality? And, what are the implications if this treatment can not be used (because of logistic, financial or other constraints) and an alternative treatment must be chosen instead?

Goals and Objectives

This project has two primary objectives: first, to compare two common fuel reduction treatments - prescribed burning and mechanical mastication; and second, to contrast the seasonal timing of these treatments – fall, winter and spring. These treatments are specifically examined in relation to: 1) fire hazard reduction, 2) vegetation recovery, 3) fuel resurgence, and 4) treatment costs. An additional study component has been added to investigate bird community recovery.

Project Description

This project specifically contrasts six chaparral fuel reduction treatments: 1) fall fire, 2) winter fire, 3) spring fire, 4) fall mastication and 5) spring mastication and 6) untreated control. Treatments and controls are replicated four times, for a total study area of 120 acres.

Study sites are situated in Northern California's Coast Range, approximately 30 miles from the Pacific coast and 110 miles north of San Francisco. Research plots are located in the Bureau of Land Management (BLM) Cow Mountain Recreation Area and at the University of California Hopland Research and Extension Center (HREC). Research began in 2001 with pre-treatment monitoring, treatments were installed in 2002 and 2003, and post-treatment monitoring was completed by 2006. Project findings synthesize five years of replicated data on fuel recovery, nonnative plant invasion, plant diversity and bird community response.

Primary collaborators include the Bureau of Land Management (BLM), University of California Berkeley (UCB), and California Department of Forestry and Fire Protection (CDF), and University of California Hopland Research and Extension Center (HREC).

Deliverables Overview

Project deliverables (as stated in the original proposal) include:

- Establish collaborative relationships with all partners.
- Establish a research site.
- Collect baseline data.
- Apply experimental treatments.
- Document treatment costs.
- Document short-term responses to treatments.
- Report results in peer-reviewed publications and PhD dissertation
- Designate research site as a demonstration site for technology transfer to professionals and for the education of students and the public.
- Create a world-wide web site by 2003.
- Give short courses in 2003 after treatments are installed.
- Produce a signed public field tour within three months after treatments are installed.
- Submit annual JFSP progress reports.

All deliverables have been completed with the exception of producing peer-review publications, a PhD dissertation and an analysis of treatment costs. These items are currently in

full progress and are expected to be completed by May 2007. All publications will be submitted to the JFSP office in electronic and hard copy form upon completion. The Deliverables Crosswalk Table (Figure 1) provides a comprehensive list of deliverables and completion dates. The Deliverables section of this report also provides additional details on deliverables and outreach.

Additional deliverables (not mentioned in the original proposal) have been completed. These items include:

- Extensive outreach and information transfer, including 10 presentations, 7 field tours, 2 posters, handouts, a university web-story feature and a regional newspaper article (see a complete list in Figure 2 – Outreach Activities).
- Data collection on bird community response to fuel treatments.

SUMMARY OF FINDINGS

Project findings directly support the needs of chaparral fuels planning and management. Specifically, our results address fuel resurgence rates and the ecological impacts of chaparral fuel treatments.

We identified several questions to guide our research:

- Does fuel recovery differ between fuel treatment type and season?
- Does plant diversity differ between fuel treatment type and season?
- Does bird diversity differ with treatment type and season?
- Does deer herbivory alter plant diversity in different treatment types and seasons?

We selected appropriate variables and methods to answer these questions:

Data Objective	Measured Variables	Method	Monitoring Period
Fuel Recovery	Shrub Cover, Height	Permanent line transects	1 yr pre-treatment 3 yrs post-treatment
Plant Diversity	Species Abundance, Cover	Permanent circular 10 m^2 plots	1 yr pre-treatment 3 yrs post-treatment
Bird Diversity	Species Abundance, Density	Variable circle point counts	3 yrs post-treatment (6 times each year)
Deer Herbivory	Plant Cover, Abundance	Fenced 10m^2 exclosures	3 yrs post-treatment

Key findings include:

- **Higher live fuel recovery in post-fire areas compared to post-mastication areas.**

Chamise, the dominant shrub in the study area, has significantly higher regrowth in prescribed fire areas, regardless of the season of treatment. Within three years after fire, chamise covers approximately 60% of the plot area, with average heights of .40 meters. In masticated plots, chamise covers only 45% of the total area, with average heights of .25 meters. This information is critical for evaluating the efficacy of fuel reduction treatments in reducing fire hazard and for calculating future fire behavior.

- **Non-native plants have substantially higher abundance and cover after mastication.**

Non-native plant abundance, particularly of non-native grasses, is significantly higher in masticated sites than in prescribed fire sites. After three years, non-native species comprise ~35% of all species found in masticated plots compared to ~25% of all species in fire plots. There is an additional season-of-treatment effect among fire treatments, with the lowest percentage of non-native species (~18%) in winter and spring fire plots. This data has important implications for fire hazard and ecological impact assessments of fuel treatments. Non-native grasses have the potential to increase ecosystem flammability due to their flashy fuel characteristics and can facilitate fire spread with their extensive cover. From an ecological standpoint, this increase in stand flammability can have significant impacts on native shrub species which require longer fire-free intervals to produce new individuals. In addition, non-native grasses can quickly dominate resources and outcompete slower-growing native species.

- **Birds are eight times more likely to be found in prescribed fire areas.**

In the three year study period, there was a striking difference in the number of bird species and bird individuals found in prescribed fire plots compared to masticated plots. The higher number of bird individuals in post-fire plots may be driven by the vital habitat attributes provided by plant skeletons which remain after fire but are destroyed after mastication. Plant skeletons provide perching and nesting sites, protection from predators, foraging substrate and food sources (wood-dwelling insects) and greater variations in post-treatment microclimate. Post-fire species also tend to be those which favor taller stand structure (ex. Western scrub jays, Spotted towhees and Bewick's wrens) compared to post-mastication species which typically forage and nest on or near the ground (ex. California quail).

Additional data analyses are currently in progress. These topics include:

- Plant functional groups and reproductive strategies
- Effects of deer herbivory on plant recovery
- Bird foraging guilds and habitat preferences.
- Migratory bird abundance and habitat use
- Detailed responses of 170+ plant species and 80+ bird species over three post-treatment years.

DELIVERABLES AND OUTREACH

The goal of this project has been to provide managers with new information regarding the efficacy and ecological impacts of fuel reduction treatments. Without providing our promised deliverables or conducting extensive outreach, we would not have achieved this goal. To date, we have completed the majority of our deliverables and are working to finish the remaining items. Figure 1 provides a complete list of promised project deliverables and completion dates.

We have also provided additional deliverables in the form of outreach and information transfer. Research results have been shared with over 450 people via field tours, national conference presentations, handouts, and websites (see Figure 2 for a complete list of Outreach Activities).

Collaborative Partnerships

This project has provided the opportunity for multiple agencies to join together as primary partners, including the Bureau of Land Management (BLM), University of California Berkeley (UCB), California Department of Forestry and Fire Protection (CDF) and the UC Hopland Research and Extension Center (HREC). These collaborative partnerships were instrumental in establishing the research site and demonstration area, ensuring that treatments were conducted in a timely and accurate manner, and disseminating project results to a broad audience. In 2004, these collaborating agencies received the CDF Director's Superior Accomplishment Award for this achievement.

Secondary partnerships have also been established with regional Air Quality Management Districts, California Department of Corrections, California Department of Fish and Game and masticator contractors during the treatment implementation process.

The success of this project has also resulted in $ 37,000 of additional funding from the Bureau of Land Management. The University of California Hopland Research and Extension Center also granted several hundred hours of labor for research needs.

Field Tours

Field tours have been one of the most successful strategies for connecting with information users. Between 2001 and 2006, we have led site tours for over 120 people from twenty organizations, including international, federal, state and local agencies and universities (see Figure 2 for a complete list).

Our most successful field tours have included:

- May 2003. 60+ representatives from federal, state and local collaborating agencies.
- Oct, Dec 2004. Regional Interagency Resource Advisory Councils.
- May 2005. University of California faculty, staff, extension specialists and county advisors.
- July 2006. European Union Fire Paradox project representative, Domingo Molina.

The UC Hopland Research &Extension Center is the official site of the project demonstration area. The Demonstration Area was established in 2003 and provides an entire suite of experimental treatments where visitors can drive/walk through treatment plots to assess the pros and cons of fuel treatments. A large color sign describes the research project and includes a map of the treatment plots, photos, and collaborating agency logos. Smaller signs are located in each treatment plot and provide information on the date, season and type of treatment. In late 2006, fact sheets will be placed at the research site to provide the up-to-date project results. As promised in the Deliverables section of our original proposal, we will maintain this JFSP demonstration area for at least seven years (until 2008).

Future field tours are planned in 2006 and 2007. In the late spring of 2007, we plan to hold our largest field workshop to date, highlighting the culmination of this JFSP project. We expect 150 attendees from federal, state and local agencies and advisory councils. We will also invite private landowners, FIRESAFE councils, and university representatives.

Website

The project website (http://cnr.berkeley.edu/stephens-lab/chaparral/index.htm) was developed in 2003 and includes a project overview, photo gallery, and regularly-updated research results with discussion. Through this world-wide-web publicity, we have been contacted by managers and researchers from the University of California Davis, USFS and

private lands who are interested in learning more about research findings. This website has been a valuable resource for connecting to information users and developing partnerships.

Project information can also be found on the UC Department of Agriculture and Natural Resources website (http://ucanr.org/delivers) as a UC Delivers Success Story.

National Conference Presentations

To date, we have given slideshows and poster presentations to over 250 people at three national conferences (see Figure 2 for details). Two upcoming slideshow presentations are scheduled at the 3rd International Fire Ecology and Management Congress (November 2006) in sessions on 'Fire and Invasive Species' and 'Fire Effects on Wildlife'.

Group posters and exhibits featuring our research have also been displayed at two state conferences (Figure 2).

Publications

Journal articles are being prepared for submission to a variety of peer-reviewed publications. Target journals, article titles and authors are detailed in Figure 1.

Media

The Ukiah Daily Journal, a regional newspaper, featured this project in a front page article and photo on June 8, 2001. A hard copy of this article will be mailed to the JFSP office.

Changes to Promised Deliverables

Research Site Location

The BLM Cow Mountain Recreation Area was intended to be the official Demonstration Site location. Once research plots were established however, we decided that the UC HREC would provide better year-round access and viewing ability. Consequently, the official JFSP Demonstration Site has been moved to the UC HREC in Hopland, CA and will remain there until at least 2008.

Technology Transfer Responsibility

The original JFSP proposal specified that technology transfer would be managed by the new UC Extension Fire Management Specialist, and technology transfer materials (including pamphlets and a world-wide-web site) would be developed into a chaparral fuel management extension program. This Extension Program is currently in its early development stages and is expected to be completed in the summer of 2007.

FIGURE 1. Deliverables Crosswalk Table

PROPOSED DELIVERABLES	OUTCOME	STATUS
1. Establish collaborative relationships with all partners.	1) Primary partners (BLM, CDF, UC) met regularly during the planning and implementation phases of the project. Additional partnerships were formed with local air quality management boards and masticator operators during treatment implementation. Primary partners continue to work together in the info transfer phase.	Completed, 2001
2. Perform experiment to examine effects of prescribed fire and mastication treatments conducted in different seasons of the year. a. Establish research site. b. Collect baseline data. c. Apply experimental treatments. d. Document short-term responses. e. Document treatment costs.	2a) Installed 24 treatment and control plots.	Completed, 2001
	2b) Collected pre-treatment vegetation data along permanent transects.	Completed, 2002
	2c) Completed 12 prescribed fires and 8 mastication treatments on schedule.	Completed, 2003
	2d.1) Vegetation recovery - Collected 3 yrs of post-treatment data along permanent transects in each plot.	Completed, 2006
	2d.2) Efficacy of fire hazard reduction - Collected 3 yrs of fuel resurgence data along permanent transects in each plot.	Completed, 2006
	2e) Comparative treatment cost analysis	In progress, for 2007 completion
3. Designate the research site as a demonstration area for information transfer to professionals, students and public. a. Interpretive displays that facilitate self-guided tours and workshops. b. Signed public field tour three months after all treatments installed)	3a) Installed large color sign with project description, map and photos at the demonstration area. Also installed smaller descriptive signs in each treatment plot.	Completed, 2002
	3b) Invited 60+ federal, state and local representatives from agencies, universities, FIRESAFE organizations, etc. for a full-day presentation and field tour.	Completed, 2002

4. Share project results via printed materials, presentations, workshops and a website.	4a) Journal articles in preparation: - Potts, J., S. Stephens. Ecological effects of prescribed fire and mechanical cutting in California chaparral. Target journal: *Ecol Applications* - Potts, J., S. Stephens. Non-native plant invasion following fuel reduction in California chaparral. Target journal: *Cons Biology* - Potts, J., C.E. Vaughn. Bird community response to fuel reduction treatments in Northern California chaparral. Target journal: *Condor* - Potts, J., S. Stephens. Success of shrub reproductive strategies following prescribed fire and mastication. Target journal: *J. Veg Science* - Stephens, S., J. Potts, D. Weise. Fire hazard reduction in chaparral using diverse treatments. Target journal: *Intl J. Wildland Fire*	In progress, to be submitted by Spring 2007.
	4b) Presentations	Ongoing, see Figure 2 for complete list
	4c) Workshops/Short Courses	Ongoing, see Figure 2 for complete list
	4d) Website	Completed, 2003, continual updates
	4e) PhD dissertation	In progress, for May 2007 completion.
5. JFSP Annual Progress Reports	5) Submitted progress reports to JFSP Board	Completed, 2002-2006

FIGURE 2. Outreach Activities

YEAR	MONTH	AUDIENCE	PRESENTATION TYPE
2006	Aug	**European Union Fire Paradox Project Researcher** / University of Lleida-Spain, Professor. (Domingo Molina).	Field Tour
	Jul	**UC Davis Reserve Manager.** (Kenny Walker)	Field Tour
	Jun	**14th Annual Wildland Shrub Symposium.** Cedar City, UT. 100 attendees.	Short Presentation (20 min slideshow): "Ecological Diversity in California Chaparral Following Prescribed Fire and Mastication Treatment"
	Apr	**UC Berkeley, Fire Science class**. 15 students.	Field Tour
	Mar	**UC Berkeley, Fire Science class.** 15 students.	Long Presentation (50 min slideshow) "Ecological Diversity in California Chaparral Following Prescribed Fire and Mastication Treatment"
		California Interagency Fire Prevention & Mitigation Conference. Sacramento CA.	Interagency Exhibit "Fire Ecology on California's Public Lands and Preserves: Chaparral Fire and Fuels"
2005	Dec	**Santa Rosa Community College** Natl Resource class 10 students.	Field Tour
	Oct	**Tall Timbers 23rd Fire Ecology Conference.** Bartlesville, OK. 120 attendees.	Short Presentation (20 min slideshow)
	May	**Univ. of California Research & Advisory Council.** 12 members.	Short Presentation (20 min slideshow)

		Univ. of California (UC) Office of the President. 25 attendees.	Field Tour
	Mar	**UC Berkeley, Fire Science class.** 15 students.	Long Presentation (50 min slideshow)
2004	Dec	**Pacific Interagency Resource Advisory Council.** Eureka, CA. 20 members.	Long presentation (50 min slideshow)
	Nov	**Interagency Resource Advisory Council.** Ukiah, CA. 20 members.	Long Presentation, (50 min slideshow) Field Tour
	Apr	**Joint Fire Science Program Conference.** Phoenix, AZ. 100 attendees.	Poster Presentation
	Mar	**UC Berkeley, Fire Science class.** 20 students.	Long Presentation (50 min slideshow)
	Jan	**UC Berkeley, College of Natural Resources.**	Handout "Chaparral Fire and Fuels: Investigating Ecological Effects of Fuel Management Practices"
2003	May	**Multiple federal, state and local agencies.** BLM, CA Dept of Fire Protection, CA Dept. of Fish & Game, FireSafe Councils, Wilderness Society. 60 attendees.	Long Presentation, (50 min slideshow) "Seasonal Effects of Prescribed Fire and Mastication in Northern California Chaparral" Field Tour
	Mar	**UC Cooperative Extension, Agricultural and Natural Resources Website.** http://ucanr.org/delivers/storylist	Web-based Success Story (still posted - Sept 2006) "Re-examining Chaparral Fire Management Practices – What are the Ecological Effects?"

YEAR	MONTH	*UPCOMING* PRESENTATIONS AND/OR FIELD TOURS	PRESENTATION TYPE
2006	Nov	**3rd Int'l Fire Ecology & Management Congress.** San Diego, CA. 3000 attendees expected.	2 short presentations (20 min each) "Bird Community Response to Prescribed Fire and Mechanical Cutting in California Chaparral" "Non-Native Plant Response to Prescribed Fire and Mechanical Cutting in California Chaparral"

LESSONS LEARNED

Despite the overall success of this project, we encountered several situations where we were forced to deviate from our ideal project design. We describe each scenario below and explain the tradeoffs that guided our decisions.

1. Replicates are split over two calendar years

Our goal was to complete all four replicates of each treatment within the same calendar year (ex. all four winter burns were scheduled for completion in 2002). Unfortunately, weather conditions did not allow us to meet treatment prescriptions for four replicate sites in a single calendar year, and we were forced to split treatment replicates over two years (ex. two winter burns were completed in 2002, and two burns in 2003, etc).

2. Slope disparity exists between prescribed fire and mastication treatments

Our original intent was to install mastication and prescribed fire treatments on slopes with similar slope angles. Since mastication equipment can not operate safely on slopes >35%, mastication treatments were naturally restricted to sites with <35% slope angles. Ideally, fire plots would have been assigned to areas with similar slopes, but there was a lack of available sites with similar management history and ecological characteristics. Consequently, fire treatments were assigned to areas with slopes between 35 and 60%. Despite this slope angle disparity, pre-treatment plant composition did not differ between fire and mastication plots.

3. Separating treatment seasonality

Fuel and soil moistures were collected before each prescribed fire, and these variables were used as proxies for seasonal differences in fire behavior and soil heating. We assumed these moisture variables would be significantly different between fall, winter and spring so that treatment seasons would be distinct, but our data only showed slightly significant differences between fall and winter. Since our fuel and soil moisture levels lack strong seasonal differences, we will also use the amount of precipitation following treatment as an additional explanatory variable.

4. Prescribed Fire Ignition Techniques

The prescribed fires conducted in this study were ignited with driptorches in headfire and flanking patterns. Many managers may prefer and/or have access to helicopter ignition devices that increase the rate and intensity of burning. Managers should note that our results only reflect recovery patterns following hand ignition.

5. Treatment Placement Tradeoffs on the Landscape

Our goal was to have completely independent research plots that are separated from one another by an untreated chaparral buffer area. In designing our demonstration site however, we were forced to locate sites adjacent to one other to facilitate visitor accessibility. We acknowledge that there may be unintended impacts caused by placing sites close together (ex. seed dispersal, altered habitat use, etc.) but we feel that the value of the demonstration site outweighs these potential effects.

6. Fire Behavior and Fuels Monitoring

Our initial proposal stated that we would use video recordings to monitor flame length and rate of spread in the prescribed fire treatments. We were not able to record each burn to accurately quantify these values, but we were able to obtain ocular estimates to determine a range of flame lengths. Using this information, we are able to calculate general fireline intensity values.

We also intended to quantify dead and downed fuel load, depth and decay rates in the mastication plots. We were unable to perform these measurements with precision because fuel was surprisingly sparse and had depths <1cm. Based on our knowledge that chaparral fire behavior is largely driven by volatile compounds in the live fuels, we decided to only collect data on live fuel cover and height.

FUTURE DIRECTIONS

Long-term monitoring studies are urgently needed to better understand fuel resurgence and ecological response to fuel treatments over time. While this project looks at three years of post-treatment data, managers have indicated that they would greatly benefit from longer-term studies. The project's demonstration area, with complete interpretive displays and permanent plots, lends itself to this type of long-term monitoring. This project can also be expanded to include other fuel treatment locations for a more comprehensive understanding of treatment effects.

Overall, field tours have been a cornerstone of this project's achievements. Professional land managers, land owners, fire fighters, environmental groups, professors, students and administrative personnel have had the opportunity to walk through research plots firsthand and learn about this project. In every case, the response has been overwhelmingly positive and visitors have expressed the power of the demonstration site to convey the pros and cons of fuel reduction treatments. As researchers, we could not be happier about the outcome of this aspect of the project, and we look forward to leading more on-site tours with even broader audiences.