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Assessment of Emergency Fire Rehabilitation of Four Fires From the 2000 Fire Season on the Vale, Oregon, BLM District: Review of the Density Sampling Materials and Methods¹

Jack D. Alexander III,² Jean Findley,³ and Brenda K. Kury²

Introduction

In 2001 and 2002, Synergy Resource Solutions, Inc. (Synergy) sampled 58 study sites on four fires which burned during the 2000 fire season in the Vale, Oregon Bureau of Land Management District.

Methods

Synergy collected density data and photo-plot data to measure seeding success and compare treatments over time. Synergy selected 31 sites which were reseeded immediately following the fires with three native and four non-native seed mixes. Synergy collected photo-plot data on 11 sites which were burned but not seeded following the fires. This study was designed to note general success rates of seeding. Synergy evaluated treatments of Mulford's Milkvetch (*Astragalus mulfordiae*), a state-listed sensitive plant found in the Jackson fire, by sampling 16 paired plots (seeded vs. unseeded) to assess effects of seeding treatment on known populations.

Conclusion

Our poster examined what we learned about our monitoring techniques. Plot size and shape was critical to sampling efficiency for density studies. A moving plot rod was more efficient than a fixed plot frame.

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Growth of Regreen, Seeded for Erosion Control, in the Manter Fire Area, Southern Sierra Nevada¹

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Introduction

The Manter Fire began July 22, 2000 in the Domeland Wilderness on the Sequoia National Forest, southern Sierra Nevada, California. It was declared controlled on September 6 after burning 32,074 ha (79,244 ac) of National Forest System, Bureau of Land Management (BLM), and private lands. The Burned Area Emergency Rehabilitation (BAER) team prescribed helicopter grass seeding along stream channels in high intensity burn areas to protect downstream values, which included golden trout habitat, willow flycatcher habitat, and the communities of Weldon and Onyx in the South Fork Kern River valley. Summer thunderstorms were expected to be the primary threat, and providing rapid revegetation near watercourses was hoped to prevent damaging sedimentation.

Because some of the proposed seeding would be in Wilderness areas, the BAER team chose to use Regreen, a sterile wheat-wheatgrass hybrid, in those watersheds to minimize impacts to native vegetation recovery while providing rapid ground cover. The Forest Service Pacific Southwest Research Station was asked to design a monitoring study because of the high cost of Regreen (\$435 ac⁻¹ applied, compared to \$38 ac⁻¹ for cereal grain), uncertainty about its effectiveness, and concern over its interactions with native plants.

Methods

This study was conducted in two drainages intersecting Long Valley Loop Road within the Chimney Peak Wilderness (BLM) at an elevation of 2,135 m (7,000 ft). Pre-fire vegetation consisted primarily of pinyon pine with an understory of sagebrush, rabbitbrush and herbaceous species. One drainage was seeded by helicopter with Regreen in December 2000, for approximately 45 m on each side of the channel, as part of the BAER implementation. The second drainage was omitted from aerial seeding. Ten pairs of plots were established in the unseeded drainage, and one of each pair was randomly chosen for hand seeding. Ten comparable plots were identified in the aerially seeded drainage.

Because of weather and logistical constraints, work on the study site did not begin until April 2001, just after snowmelt. A silt fence was constructed at base of the slope, just above the main channel, in each plot to measure erosion (fence about 5 m wide). Five 1 m⁻² vegetation subplots were located alongside each silt fence contributing area to measure vegetation response. Regreen seed was applied with a hand spreader to achieve 215 seeds m⁻² (20 seeds ft⁻², approximate aerial rate) in the

¹A poster version of this paper was presented at the 2002 Fire Conference: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States, December 2-5, 2002, San Diego, California.

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designated plots. Vegetation cover was estimated during mid-July in 2001 and 2002 by visual inspection of the 1 m² subplots.

Results

In April 2001, vegetation subplots in the aerially seeded drainage averaged 0.64 Regreen seedlings m⁻², with a range of 0 to 4.6 seedlings m⁻² per erosion plot. Many of the seedlings appeared to be drying out, despite abundant soil moisture. The hand-seeded plots contained an average of 197 Regreen seeds m⁻² (18.3 seeds ft⁻²), with a range of 129 to 296 seeds m⁻² (12.0 to 27.5 seeds ft⁻²).

The study site received about 1.0 cm (0.4 in) of rain during May 2001. On July 6, 1.5 cm (0.6 in) of rain fell, followed by approximately 2.5 cm (1 in) in less than an hour at around 1:00 am on July 7 (weather data obtained from the Bear Peak RAWS and Long Valley GOES stations). The silt fences were overwhelmed with material and deep rills formed on slopes. No further rain fell during the summer.

In mid-July 2001, less than 1 Regreen plant m⁻² was found in both the hand seeded and aerially seeded vegetation subplots. Regreen cover was very low (<0.1 percent). Total plant cover averaged less than 5 percent in all treatments, dominated by native species (table 1). In 2002, total plant cover was 20 to 25 percent. Regreen provided less than 0.5 percent cover, as plants present the previous year continued growth in 2002. Although Regreen plants formed inflorescences in 2001, no new Regreen plants were detected in 2002.

Table 1—Dominant plant species (by percent cover) in vegetation plots.

2001	2002
<i>Gilia cana ssp. cana</i>	<i>Lotus oblongifolius</i>
<i>Gayophytum diffusum</i>	<i>Sphaeralcea ambigua</i>
<i>Lotus oblongifolius</i>	<i>Gilia cana ssp. cana</i>
<i>Phacelia spp.</i>	<i>Lupinus adsurgens</i>

Discussion

Regreen established poorly after broadcast seeding (both aerial and hand), despite adequate seeding rates. The helicopter seeding was conducted just before snowfall, as recommended, and the hand seeding just after snowmelt, which should have been good times for successful establishment. The large seeds, similar to wheat, lying on the ground surface were undoubtedly attractive to birds and small mammals, and many may have been eaten. In April 2001, many seedlings from the aerial application were observed to have just one root barely penetrating the soil—most seedlings probably dried out before they could become established. Agricultural sources recommend drilling the seed, and, indeed, most successful plants from the 2001 hand seeding were growing in rebar stake holes or natural depressions. Many 2001 Regreen plants resumed growth in 2002—although considered annual, they can survive for several years. No new Regreen seedlings were observed (to be expected from a sterile hybrid); thus, although persistent, Regreen was not invasive. Seeded Regreen did not produce enough plants or ground cover to affect erosion or to negatively impact native vegetation. Because it produced so little cover, seeding with Regreen was not a cost-effective erosion control measure on this burn site.

Classification of Wildland Fire Effects in Silviculturally Treated vs. Untreated Forest Stands of New Mexico and Arizona¹

Douglas S. Cram,² Terrell T. Baker,² Jon C. Boren,² and Carl Edminster³

Introduction

Heavy grazing and prolific conifer regeneration around the turn of the century coupled with 100 years of aggressive fire suppression and fire exclusion have combined to change forest structure, understory and overstory composition, and fuel biomass conditions in southwestern forests. Catastrophic stand-replacement fires, particularly in ponderosa pine forests (*Pinus ponderosa* Lawson), have displaced high frequency low intensity historical fire regimes. We hypothesized forest stands treated recently (<20 yr) using silvicultural practices were less likely to experience catastrophic fire compared to untreated stands.

Methods

We compared wildland fire damage in silviculturally treated vs. untreated forest stands in New Mexico and Arizona. Study sites ranged in elevation between 1,900 and 2,800 m. Silvicultural treatments included: lop, pile, burn; lop and scatter; harvest and burn; commercial thin; and shelterwood. Due to the unpredictability of how, when, and where wildland fire will burn, setting up elegant experimental designs pre-wildland fire is impractical. Nonetheless, we were fortunate to find suitable sites to replicate the first three treatments listed above, and a randomized complete block design was used for analysis of these treatments. We measured overstory and understory indices of fire damage and severity to determine stand conditions following wildland fire. It is noteworthy that three of the four fires studied for this project occurred under high winds and extended drought conditions.

Results

Preliminary results indicate fire severity in middle elevation (approximately 2,350 m) montane coniferous forests is allayed when the fuel leg of the fire behavior triangle is abridged. Under extreme conditions created by drought, high winds, and suitable topographical conditions, we observed treated forest stands that, although suffering less severe fire and ground char damage than adjacent untreated stands, were still subjected to near stand-replacement type damage. However, this illustrates

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that even under extreme conditions, fire severity can be mitigated by fuel reduction, and further that more aggressive treatments would likely have fared better. In particular, we observed prescribed fire in combination with mechanical thinning had the greatest impact toward mitigating fire severity.

Discussion

Silvicultural prescriptions designed to reduce stand susceptibility to catastrophic wildfire must consider slope and aspect, slash treatment, and residual tree and stand characteristics. Specifically, as density (stems ha⁻¹) and basal area (m² ha⁻¹) decrease and mean diameter at breast height (cm) increase, fire severity and ground char decrease. Further, a threshold in canopy bulk density (kg m⁻³) on stands with 0 to 5 percent slope was identified beyond which initiation of a crown fire was possible and below which it did not occur.

The Potential for Smoke to Ventilate From Wildland Fires in the United States¹

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Introduction

To help assess values of air quality and visibility at risk from wildland fire, a spatial time series of ventilation potential for the United States was generated. The ventilation potential was determined as a product of model-generated surface winds and spatially interpreted mixing height observations. The surface winds (approximately 10 m agl) were generated from Danard's primitive-equation model (1977), using heights and temperatures at 850 hPa, 700 hPa, and 500 hPa from the NCEP Reanalysis as the upper boundary.

Methods

The mixing heights were calculated from radiosonde observations using Holzworth's parcel method (1972). In addition, we approximated the location of potential valley inversions with a GIS algorithm that considered terrain slope, curvature, and flow accumulation. Nights on which local inversions occurred were approximated by matching the hourly surface weather observations with Pasquill's stability criteria (1962) for representative neighborhoods.

Results and Discussion

The data represent a 40 yr time series, twice daily, at 2.5' latitude/longitude (about 5 km) spatial resolution. A map-based, data acquisition system is available on the World Wide Web (<http://www.fs.fed.us/pnw/fera/vent>) for use by land managers to help assess local, regional, and national ventilation potential. Periods of calm winds, low mixing heights, and resulting poor ventilation are seen in all areas of the country. The frequency and magnitude of ventilation potential, however, varies from place to place and time to time. The data available through this system is useful in planning for prescribed burning in order to minimize impacts from smoke. The data can also be applied during wildfires to assess the risk of impaired air quality at a specified location.

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Effects of Fire and Mowing on Expansion of Reestablished Black-Tailed Prairie Dog Colonies in Chihuahuan Desert Grassland¹

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Introduction

Black-tailed prairie dogs (*Cynomys ludovicianus*) once ranged from Canada to Mexico throughout the Great Plains and west to Arizona. During the last 100 years, public and private control programs, plague, and habitat loss have reduced the distribution of black-tailed prairie dog populations by 98 percent, causing localized extinctions. This species is now considered uncommon or extirpated in many areas of its former range. Black-tailed prairie dogs significantly alter grassland ecosystems and are considered a “keystone” species that require active conservation efforts (Kotliar and others 1999). Conservation measures for this species, including reintroduction, are underway in a number of areas.

The best practical indicator of habitat suitability for reintroduction is visible evidence of previous prairie dog occupancy (Jacquart and others 1986, Ackers 1992, Truett and Savage 1998, Truett and others 2001a). Due to vegetation changes following the absence of prairie dogs from a site, vegetation manipulation is often required to provide reintroduced prairie dogs with suitable habitat (Truett and others 2001a). Woody plants (McDonald 1993) or tall grasses (Osborn and Allan 1949) that encumber vigilance behaviors for predators may require remedial actions to remove shrubs or reduce vegetation height (Player and Urness 1982, Truett and Savage 1998, Truett and others 2001a). Prairie dog colonies will not expand into areas where ocular vigilance is hampered. Dense vegetation greater than about 15 cm tall must be reduced in height so newly established colonies can survive and expand. Where mid- and tall grasses prevail, prairie dogs thrive mainly where fire, bison or cattle shorten the grasses by burning, or grazing and trampling (Truett and others 2001a).

Prior to the late 1800s, bison (*Bison bison*) coexisted with and helped sustain a diverse assemblage of animal and plant communities in grasslands, including black-tailed prairie dog colonies and associated species (Truett and others 2001b). Bison grazing historically reduced grass stature around prairie dog colonies. However, the system under which prairie dog-bison coevolved is largely absent. Under current

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conditions the grazing intensity is insufficient to remove mature vegetation (*fig. 1*). Grass mowing to simulate the effects of grazing has been used to facilitate expansion of reintroduced prairie dog colonies, but large-scale mowing is generally not cost-effective. Another alternative to grazing and mowing is prescribed fire. Fire is a natural disturbance that regulates ecological processes in southwestern grasslands (Ford 2000). Fire reduces the height of vegetation and attracts foraging bison for at least the first few years post burn (Shaw and Carter 1990, Vinton and others 1993, Hartnett and others 1996, Knapp and others 1999, Truett and others 2001b). Use of fire best simulates the system in which these species evolved and may provide a more cost-effective method to promote the expansion and vigor of reintroduced black-tailed prairie dog colonies.

We report on the preliminary results of an experimental study evaluating fire vs. mowing for facilitating expansion of reintroduced prairie dog colonies in the northern Chihuahuan Desert. Our objectives were to 1) find a cost-efficient management tool for enhancing habitats for prairie dog reintroduction, and 2) to understand the use of fire as a tool for managing colony expansion of black-tailed prairie dogs in Chihuahuan Desert grasslands. Our long-term goal is to use fire as a catalyst to help sustain a long-term dynamic between bison and prairie dogs. There is a documented pattern of bison grazing following fire. If this occurs, bison can be expected to concentrate on the burned areas for 3 to 4 years following fire. Once prairie dogs expand into the burned areas, they can, with the help of bison grazing, maintain their habitat at low stature (less than 15 cm tall) by trimming and eating the vegetation.



Figure 1—Black-tailed prairie dog, bison, and Chihuahuan Desert grassland, Armendaris Ranch, southern New Mexico.

Study Area

Our study was conducted on the Armendaris Land Grant located at the northern extent of the Chihuahuan Desert in southern New Mexico. The Armendaris Land Grant was purchased by Turner Enterprises, Inc., with the primary objective of producing bison (introduced in 1995), and promoting wildlife biodiversity. Efforts to restore black-tailed prairie dogs to previously occupied habitat on the ranch commenced in 1995. The site is located on deep mixed alluvium formed at the base of alluvial fans and adjacent flood plain. Soils are characterized as a Mimbres silt loam. Average annual precipitation ranges between 200 to 250 mm (SCS 1984) with most precipitation resulting from convectional storms during the summer growing season. Vegetation is dominated by a *Sporobolus/Pleuraphis/Scleropogon* grassland association.

Methods

Three experimental sites were established at the margins of three re-established prairie dog colonies on the Armendaris Ranch. These colonies, S-Curve (2 ha), Red Lake (8 ha), and Deep Well (1.27 ha), were established in 1998-1999. We established six to eight 50 x 50 m experimental plots (20 total) at the periphery of each colony. Burn or mowing treatments were randomly assigned to each plot, with treatments being conducted in early July 2001 just prior to the summer growing season. All burrows in each colony were georeferenced using Trimble®XXX geographical positioning system immediately preceding and four months after treatment with differentially corrected data mapped using ArcGis 3.2 software. Vegetation cover was sampled using five 20 m line intercept transects per plot before (June 2001) and after (October 2001) treatments were established.

Prior to establishing treatments prairie dogs were trapped at each colony. Each captured prairie dog was sexed and classified as juvenile or adult, morphometric measurements obtained, and examined for presence or absence of fleas. Further, each adult prairie dog was classified as breeding or non-breeding, based on the presence of descended testes in males and on evidence of lactation in females. Burrow data, vegetation data, and trapping data were analyzed using contingency table analyses, and Wilcoxon signed-rank and Chi-square tests. Because spatial coordinates were not recorded for prairie dog captures, these data could not be examined in relation to the treatments, but instead were analyzed with regard to possible differences in population structure among the three colonies.

Results

Numbers of newly established burrows in each treatment type within each of the three colonies were used as a measure of habitat suitability. Results indicate no significant difference ($P=0.59$) in the number of new burrows among treatments: burned (48 new burrows at Deep Well, 25 new burrows at Red Lake, 22 new burrows at S-Curve) vs. mowed (33 new burrows at Deep Well, 41 new burrows at Red Lake, 31 new burrows at S-Curve). However, there were strong differences among colonies in the total number of new burrows ($\chi^2=7.70$, D.F.=2, $P=0.021$): Deep Well 81, Red Lake 66, S-Curve 53.

There were statistically significant post-treatment increases in bare ground, litter and prairie dog feces for both burned and mowed plots (overall $\chi^2=5990.6$, D.F.=19, $P<0.001$). This pattern persisted when the three colonies were analyzed separately.

Table 1—Number of trapped prairie dogs classified by sex and breeding status (adults only) for each colony.

	Breeding		Non-breeding	
	females	males	females	males
Deep Well	15	11	4	3
Red Lake	5	7	5	2
S-Curve	16	8	4	10

Analysis of the number of trapped prairie dogs classified by sex and breeding status for each colony were not conclusive ($\chi^2=10.01$, D.F.=7, $P=0.188$). However, there were slightly more active-breeding females than males, active breeding individuals outnumbered non-breeders by about two to one, and the overall sex ratio

of trapped animals was slightly female-biased (*table 1*). There were differences in age and sex structure among the prairie dogs trapped at the three colonies ($\chi^2=18.49$, D.F.=6, $P=0.005$) (*table 2*); but these differences may be an artifact of our trapping protocol. Although we trapped intensively, we were not able to capture all colony members.

Table 2—Number of trapped prairie dogs classified by age (adult vs. juvenile) and sex, ignoring breeding status.

	Females		Males	
	Adult	Juvenile	Adult	Juvenile
Deep Well	19	14	14	23
Red Lake	11	6	9	8
S-Curve	20	0	18	7

Conclusion

In the short-term, fire and mowing appear to be equally effective in promoting colony expansion by black-tailed prairie dogs in Chihuahuan Desert grasslands. Based on our knowledge of the grazing behavior of large generalist herbivores, fire treated areas appeared more favorable to bison grazing than mowed areas. Fire may catalyze a self-sustaining interaction between bison and prairie dogs. Preferential bison grazing on burned areas may help to maintain post-fire reduced grass stature longer than mowing, thereby providing the potential for further colony expansion. However, persistence of these treatments and interaction will depend on prairie dog population dynamics and impact of treatments on the foraging dynamics of associated large ungulates.

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Data Collection and Fire Modeling Determine Potential for the Use of Plateau^{®1 2} to Establish Fuelbreaks in Cheatgrass-Dominated Rangelands³

Brenda K. Kury,⁴ Jack D. Alexander III,⁴ and Jennifer Vollmer⁵

Introduction

Plateau[®] herbicide was applied on recently-burned cheatgrass (*Bromus tectorum*) dominated rangelands near Boise, Idaho, to determine if the application of up to 12 oz ac⁻¹ of Plateau was a viable method to create and maintain firebreaks. Plateau has been used extensively throughout the U.S. to enhance native plant seedings and control cheatgrass. Synergy Resource Solutions, Inc. gathered data to determine biomass production, litter accumulation, and plant height in the study area on June 15 and 16, 2002. Fire behavior at each site was modeled with collected data using BehavePlus fire-modeling program (USFS v. 1.0.0). Modeling predicted that application of Plateau at rates above 6 ounces/acre would effectively reduce *Bromus tectorum* in fuel break areas. Between Plateau treatments, flame height increased slightly at the 12 oz ac⁻¹ rate due to an increase in the number of forbs (broadleaf) species compared to a greater percentage of grass species encouraged at the lower rates of 6 oz ac⁻¹ and 8 oz ac⁻¹. These data indicated that fuel breaks treated with Plateau for cheatgrass control would have lower flame lengths and rates of spread than untreated areas.

Results

Results indicated that areas treated with Plateau had substantially less cheatgrass by weight than the untreated areas, regardless of treatment level. Control treatments had substantially more Sandberg bluegrass. For the evaluated rates, cheatgrass levels

¹**Pesticide Precautionary Statement:** This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate state or federal agencies, or both, before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

²The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

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were the same in the 6 oz ac⁻¹ and 8 oz ac⁻¹ treatments, indicating that Plateau at 6 oz ac⁻¹ would be the most cost-effective application rate.

Plots treated with Plateau had a lower flame height and rate of spread than control treatment levels. Fuel modeling data indicated that areas treated with Plateau, regardless of the treatment level, would have a lower rate of spread and flame length than control treatments.

Discussion

These data indicated that Plateau can provide cheatgrass control in areas with high fire risk. Plateau could be used to create fuel breaks around important habitat resources (i.e., native sagebrush communities, Areas of Critical Environmental Concern) in fire-prone areas. Incorporating Plateau into management strategies could protect habitat for sage grouse and other species of concern. Potential Plateau application sites include areas along maintained roads and in or around maintained fire breaks. Plateau provides an opportunity to reduce the \$542 million spent by federal agencies to control wildland fires in 2001, reduce danger to life and property, and reduce destruction of wildlife and plant habitats. Finally, Plateau herbicide can be incorporated into land management plans and reduces the risk of loss of life, structures, and vegetation in areas of concern by reducing fuel loads.

Debris Flow Occurrence in the Immediate Postfire and Interfire Periods and Associated Effects on Channel Aggradation in the Oregon Coast Range¹

Christine L. May² and Danny C. Lee²

Introduction

The freshwater rearing environment plays an important role in the life history of anadromous fishes such as endangered socks of coho salmon (*Oncorhynchus kisutch*). Disturbances such as severe wildfire can accelerate rates of landslide and debris flow activity due to a loss of root strength and vegetative cover. These large influxes of sediment can result in substantial aggradation of mainstem river channels that provide habitat for juvenile salmonids. Our study investigated the linkages between the timing of fires and debris flows, and the associated affects on channel aggradation and fish survival in the Oregon Coast Range.

Methods

We used dendrochronology to estimate the time since the previous debris flow and the last stand-replacement wildfire in a 5 km² area within an unlogged Douglas fir forest (May 2001).

Results

In the thirteen streams investigated, the time since the last debris flow ranged from 4 to 144 years. Over half of these streams experienced a debris flow within 30 years of the last stand-replacement wildfire. In addition to this synchronous pulse of debris flow activity, large storms sporadically triggered debris flows in the inter-fire time period, resulting in a substantial background rate of debris flow activity. Stand-replacement fires, which are characteristic of the Coast Range, occur very infrequently. Long-term estimates of the average recurrence interval range from 230 years (Long and others 1998) to 452 years (Impara 1997). Extrapolation of the observed background rate of 0.05 debris flows per year indicates that the number of debris flows in the post-fire time period is exceeded by the background rate of debris flow activity 180 yr into the inter-fire period (*fig. 1*). Because fires occur so infrequently in this region, these results suggest that fire is not the dominant mechanism for triggering mass wasting when viewed over long time scales. However, the synchronous pulse of debris flow activity immediately post-fire can

¹A poster version of this paper was presented at the 2002 Fire Conference: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States, December 2–5, 2002, San Diego, California.

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result in substantial aggradation of mainstem river channels and have significant biological consequences.

Mainstem rivers in the sandstone lithology of the Oregon Coast Range tend to have a thin layer of highly mobile alluvium directly over the underlying bedrock. Channel aggradation downstream of debris flow inputs creates a deformable streambed of coarse gravel and the creation of deep pools. In two streams that we studied, such streambeds were extremely porous and resulted in a dry channel as streamflow went subsurface during the summer dry season. During the mid-summer period, fish were trapped in isolated pools and perished in those that later went dry. Severe crowding occurred in the few remnant pools that persisted throughout the summer. Channels that were not aggraded formed smaller pools that were limited by the depth to bedrock. These pools had a greater likelihood of remaining wet throughout the summer because they intercepted subsurface flow traveling parallel to the bedrock surface. Mortality of juvenile coho salmon due to desiccation in dry pools was 36 percent of the initial population (estimated by snorkel surveys).

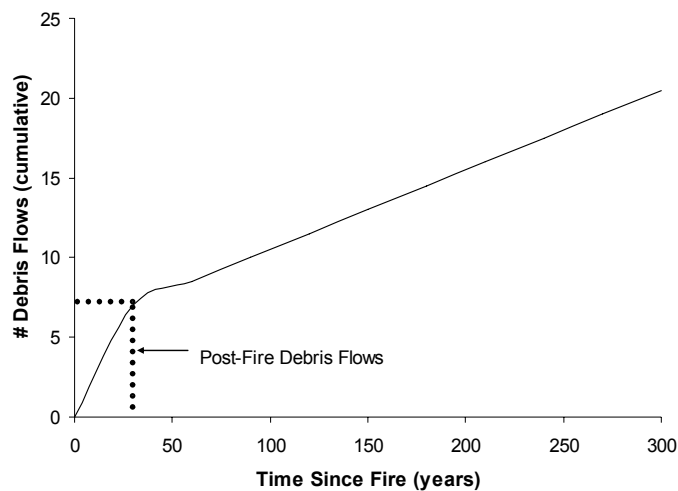


Figure 1—Debris flow activity in the immediate post-fire and inter-fire time periods.

Discussion

This study illustrates an important consequence of large influxes of sediment following severe wildfires. Because channel aggradation is directly linked to water availability and fish survival, increases in coarse sediment supply can be associated with sharp reductions in juvenile rearing habitat and productivity over the short-term. The long-term effects remain uncertain.

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LANDFIRE: Mapping Fire and Fuels Characteristics for the Conterminous United States¹

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Introduction

LANDFIRE is research and development project that will develop a comprehensive package of spatial data layers, models, and tools in support of the National Fire Plan, both at the national and local level. The project is being developed cooperatively between fire scientists at the USDA Forest Service, Rocky Mountain Research Station Fire Science Laboratory in Missoula, MT, remote sensing scientists at the USGS EROS Data Center in Sioux Falls, SD, and vegetation scientists at the RMRS Forest Inventory Analysis Laboratory in Ogden, UT.

Methods

LANDFIRE is a mid-scale project targeting map accuracies of 60 to 80 percent for the sub-watershed level (10,000 to 40,000 ac). The spatial datasets for LANDFIRE will be maintained at a 30 m pixel size. LANDFIRE is designed to be the safety net for land management agencies that do not have local-scale information, and is not a substitute for finer scale, local mapping efforts. It is intended to be scalable from sub-watersheds to a national level.

Discussion

Research and development have begun on 18,200,000 ha in two prototype areas: central Utah and western Montana. LANDFIRE Prototype is a three-year project starting in April 2002 with the prototype effort scheduled for completion in April 2005. Intermediate components/products will be available starting in summer 2002.

Conclusion

The purpose of this presentation was to introduce the audience to the LANDFIRE project. For more information about this project, please go to the LANDFIRE web page (www.landfire.gov). This web page is updated regularly with latest research information and project status. For more information about historical natural fire regimes and fire regime condition classes, please go to the following web page: www.fs.fed.us/fire/fuelman.

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Relationships Between Fire Frequency and Environmental Variables at Multiple Spatial Scales¹

Carol Miller,² Brett Davis,² and Katharine Gray³

Introduction

Understanding where fires can be expected to occur and the factors that drive their occurrence is of great interest to fire managers and fire researchers. Information about the locations and perimeters of historical fires can provide insights to where fires tend to occur on the landscape. We used fire frequency maps derived from maps of fire perimeters dating back to the late 1800s for the Selway-Bitterroot Wilderness (SBW) in northern Idaho and western Montana (Rollins and others 2001). We investigated the relationship between fire frequency and environmental variables at multiple spatial scales to understand how fire-environment relationships vary within the SBW and the spatial scaling of these relationships.

Maps of fire perimeters can be digitized and analyzed in the context of a GIS. Although these digital fire atlases can be fraught with inconsistencies and inaccuracies resulting from fire reporting, they are often the best information we have about fire history for many areas. Previous research by Rollins and others (2002) used digital fire atlases for the SBW to relate fire frequency to biophysical variables. This data set covered the time period from 1880 to 1996, and included data on fires occurring in 63 different years, with a total cumulative area burned of approximately 500,000 ha. Results from that study indicated that fires occurred most often at low elevations and on dry, south-facing slopes in the SBW.

Methods

We investigated how fire-environment relationships vary within the SBW and the spatial scaling of these relationships. Building on the research by Rollins and others (2002), we examined, at five spatial scales, the relationship between fire frequency and environmental variables such as elevation, slope, aspect, potential vegetation type (PVT), temperature, and precipitation. We performed Chi-square goodness-of-fit tests to determine if fire was more common in certain topographic categories than would be expected if fire were randomly distributed among the topographic types (Manly and others 1993). We defined eight topographic categories by elevation (low and high), slope steepness (low and high) and aspect (north and south).

Results

Results from this analysis varied among three large geographic zones (269,000 to 408,000 ha) within the SBW. The most significant pattern was seen in the Montana zone,

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where fires occurred most frequently on steep north facing slopes at low elevations (<1,950 m). In the Northwest zone, fires occurred most frequently at low elevations (<1,650 m), regardless of slope steepness or aspect. The least dramatic pattern occurred in the West-Central zone, where fire tended to occur somewhat more often on steep south-facing slopes at elevations below 1,800 m.

Discussion

We offer three possible explanations for the different fire-environment relationships among the zones. First, the Montana zone, which extends from the Bitterroot crest eastward to the Bitterroot River, is drier than the other two zones because of the rain shadow effect from the Bitterroot Mountains. Fire spread and extent may have been limited by the continuity of surface fuels in this less productive zone. The relatively productive north-facing slopes may therefore have had a greater continuity of fine fuels and higher likelihood of experiencing fire. Second, differences in the range and variability of elevation among the zones may explain the differences in the fire-environment relationships we saw. Where the range of elevation was great enough to provide a gradient in the vegetation or physical conditions that drive fire occurrence, elevation emerged as the dominant predictor of fire frequency. This was the case in the Northwest zone. In contrast, much of the Montana zone comprises very high elevations (alpine and subalpine) where few fires have occurred during the period of record. As such, the range of elevations experiencing fire was much narrower. In the analysis, elevation was, in effect, more homogeneous in this zone and other factors, such as slope and aspect, emerged to explain fire occurrence. The third explanation involves differences among geographic zones in the spatial scaling of the environmental variables. The terrain in the Montana zone is much more highly dissected than in the other two geographic zones, with steep west-to-east oriented glacial valleys cutting across the Bitterroot Range, which runs from north to south. These topographic features may serve to confine fires to smaller portions of the landscape, inhibiting fire spread across more diverse and broad areas. Indeed, in any given fire year, the amount of area that burns in Montana zone is much less extensive than in the other zones, supporting the notion of topographically confined fires.

We were successful in using digital fire atlases to investigate relationships between fire frequency and the biophysical environment in the Selway-Bitterroot Wilderness. We used a multiple scale approach and found that these relationships vary within this very large landscape. As such, we suggest that for understanding landscape controls on fire regimes, smaller geographic zones (approximately 300,000 ha) make more appropriate study areas. Finally, our results underscore the importance of understanding the spatial scaling of the environmental variables influencing fire regimes.

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Effects of Summer Prescribed Fires on Taxa Richness and Abundance of Avian Populations and Associated Vegetation Changes¹

Ken Mix,² William P. Kuvlesky, Jr.,³ and D. Lynn Drawe²

Introduction

The plant communities of the South Texas Plains and Gulf Coastal Prairies and Marshes have been undergoing changes from grasslands to brushlands in the past century. The vegetative community once dominated by tall grasses has now become a chaparral mixed-grass community. Applying late season prescribed fires may slow shrub invasion in south Texas coastal prairies, allowing the landscape to revert to a more open grassland. Late season burns may also alter the current composition of the fauna inhabiting these landscapes. Increases in woody vegetation can reduce the abundance of grassland nesting bird species. Few studies of summer fires have documented the responses of avian communities in prairie and chaparral ecosystems. Reduction in brush as a nesting substrate may open the area for grassland nesting species and reduce the abundance of brush nesting species.

The study sites are on the Rob and Bessie Welder Wildlife Refuge located in a transition zone between the South Texas Plains and Gulf Coastal Prairies and Marshes in San Patricio County, TX, and on McCan unit of the McFadden Enterprise Ranch located in the South Texas Plains in Bee County, TX. Average yearly rainfall in the area exceeds 76.0 cm. The dominant woody vegetation is honey mesquite (*Prosopis glandulosa*) and huisache (*Acacia smallii*), and the herbaceous plant community is composed of mixed forbs and mid- to tall grasses. The study sites are approximately 1,000 ha, with each block having a control and treatment of approximately 400 ha. The Welder pastures are grazed on a high frequency, low intensity regime. The McCan pastures are grazed on a low frequency, high intensity regime. The experimental design is a repeated measures complete block with one replicate in each ranch.

Methods

Point counts were used to collect data on breeding bird species in each pasture with an unlimited detection radius. There were 15 points separated by at least 400 m. Counts began at sunrise and detection periods were partitioned into 2 minute, 3

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minute, and 2 minute intervals. Counts were conducted three times from May 1 until June 21, 2001 and 2002. Ten vegetation transects were selected from the 15 avian points. Vegetation data were categorized as woody shrubs, tress, forbs, and grasses. A 30 m line intercept was used to collect percent cover of woody and herbaceous vegetation. A vertical pole was used to collect visual obscurity data at the 20, 40, 60, 80, and 100 ft intervals and measured from a distance of 4 m. The data were collected in June and July, 2001 and 2002.

Results

ANOVA (analysis of variance) was used to analyze avian population and vegetation changes between pastures within a block. Changes in vegetation occurred in the treatment pastures of both blocks between 2001 and 2002 with significance set at $p=0.10$. In Block 1 visual obscurity (VO) changed significantly in the treatment pasture after the fire in these intervals: 0 to 1 m ($p<0.0001$), 1 to 2 m ($p=0.0669$), and total VO ($p<0.0001$). Percent woody cover was significantly different after the burn, reduced from 28.12 percent to 11.25 percent ($p=0.0249$). In Block 2 VO was significantly different in these intervals: 0-1 m ($p=0.0060$), 1 to 2 m ($p=0.0023$), 2 to 3 m ($p=0.0599$), and total VO ($p=0.0018$). Percent woody cover was significantly different after the burn, reduced from 45.55 percent to 16.27 percent ($p<0.0001$).

No changes in the nesting species have been linked to changes in nesting substrate. Most avian species showed little or no change in population in the treatment pastures from 2001 to 2002. The following species significantly changed in population in treatment pastures: Block 1, northern mockingbird (NOMO) ($p=0.0993$) and painted bunting (PABU) ($p=0.0292$); Block 2, Cassin's sparrow (CASP) ($p=0.0198$), northern cardinal (NOMO) ($p=0.0051$), olive sparrow (OLSP) ($p=0.0517$), and PABU ($p=0.0248$).

Discussion

Overall changes in avian populations were not significant. Though a few species did exhibit significant changes in population, no attribution can be made to changes brought about by summer fires, particularly since two brush nesting species exhibited positive changes in population in a treated pasture: PABU, and NOCA in Block 2. Changes in percent woody cover do not appear to affect the avian population. Though there were reductions in percent woody and visual obscurity caused by the fire, it may be necessary to reduce each of these below a certain threshold to effect changes in the avian populations.

Chamise (*Adenostoma fasciculatum*) Leaf Strategies¹

Marcia G. Narog²

Introduction

Microhabitat and preceding environmental conditions may predispose chamise (*Adenostoma fasciculatum*) to a specific post-fire response. Improving predictions of post-fire response may require knowledge of the general phenological status of the chamise stand. Morphological plasticity of chamise leaves can be observed in varying degrees in seedling and resprouting individuals. Mature chamise have small, linear shaped leaves. Seedlings and initial post-fire sprouts produce complex multi-lobed leaves that are replaced with simple leaf structure over time. The occurrence of complex leaves may be instructive for developing knowledge of post-fire response. Controlled studies were designed to determine how environmental factors affect chamise leaf complexity and longevity. Determine if complex juvenile leaf morphology found on resprouting chamise after fire is affected by insolation level and water. Preliminary analysis of the effects of insolation level and hydration on chamise leaf complexity is presented.

Methods

Greenhouse grown chamise were treated with shade, water, nutrients, and pruning. After 6 months, new growth was evaluated for leaf complexity. Chamise leaves were sub-sampled from test plants to determine leaf morphology. Plants were divided into 4 equal above ground sections. Representative leaves in each third of the 4 sections were sampled and evaluated for complexity and measured (*fig. 1*). A total of 12 leaves were measured per plant. Chamise were described by the number and degree of complexity of leaves measured and by the position of the leaves along the stem. Youngest leaves were formed after the study was implemented and represent treatment effects.



Figure 1—Variability in chamise leaf morphology varies (a) among seedlings, (b) resprouting and mature plants.

Results

Chamise under shaded and well-hydrated conditions produced and retained more complex leaves. Plants with more light and less water began producing simple leaves sooner than shaded well-hydrated individuals. As time progressed after germination or following disturbance, production of leaf complexity decreased (*fig. 2*). Hot and dry

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conditions reduced complex leaf retention and survival. Shade and hydration appear to promote greater leaf complexity in chamise.

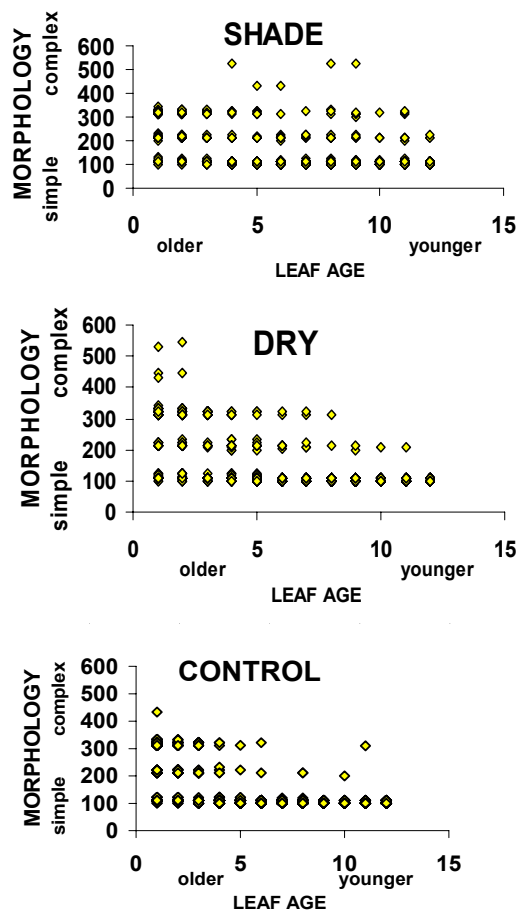


Figure 2—Leaf complexity decreased with time, yet was retained longer when a chamise was watered and shaded.

Discussion

Highly evolved complex leaves may promote growth or competitive advantage but appear to increase the plants sensitivity to environmental conditions. Evaluating leaf morphological characteristics and expected environmental conditions after a burn may be useful for determining post fire recovery or diversity in chamise or mixed chaparral.

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Stereo Photo Series for Quantifying Natural Fuels in the Americas¹

Roger D. Ottmar,² Robert E. Vihnanek,² and Clinton S. Wright²

Introduction

Photo series are useful tools for quickly and inexpensively evaluating vegetation and fuel conditions in the field. The natural fuels photo series is a collection of data and photographs that collectively display a range of natural conditions and fuel loadings in a wide variety of ecosystem types throughout the Americas from central Alaska to central Brazil. Fire managers are the primary target audience of the natural fuels photo series, although the data presented will also prove useful for scientists and managers in other natural resource fields.

Methods

Phase I included 18 ecosystem types in the United States organized geographically into six volumes. Phases II and III will add volumes for ecosystem types in Hawaii (grassland, shrubland, woodland, and forest) and the northeastern United States (pitch pine, balsam fir/red spruce, and mixed hardwoods).

Discussion

Ongoing and future work will supplement already published volumes with new series in new ecosystems or additional sites in already published series. Additionally a volume has also been produced for savannah (*cerrado*) ecosystem types in central Brazil and a volume is under development for pine forests in Mexico. Ten ecosystem types have been photographed and inventoried to date with publication anticipated in the next two years.

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Prescribed Fire Effects on California's Oaks¹

Timothy E. Paysen²

Introduction

Urban encroachment, heavy use of public lands, and private land treatments create challenges for managing natural resources—in particular, California's oaks. Like many of the State's resources, the State's oaks are uniquely Californian. They give a Mediterranean flavor to the landscape that is unequalled in the country.

California oaks

California's oaks serve as havens for human recreation and use, and as buffers to disaster (*fig. 1*). They also host numerous wildlife species. Many oak species have become depleted, and some so heavily that their roles in the future of California's landscape are seriously questioned.



Figure 1—Post fire erosion problem.



Figure 2—U.S. Forest Service prescribed burning program.

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Fire, a common element in most California oak communities, can be a boon or a bane—depending upon the character of the fire and the condition of the ecosystem. A U.S. Forest Service program is underway with the objective of determining the appropriate use in the production of forest health and sustainability in California's oaks (*fig. 2*). A prime requirement is that the prescribed fire studies address effects on the complete ecosystem, as much as possible (“holistic” is the current buzz word). To do so is not a simple task. If fire can be used, then certain issues are important: what kind of fire, and when? Should the fire be “hot”? “cool”? Winter? Summer? What will the effects on the entire community be?

International oak research

Interest in fire effects on California's oaks is not just limited to California. Similar kinds of oaks, growing under similar conditions, and which are subject to frequent fire, can be found in a number of countries around the world; countries with Mediterranean-type ecosystems (*fig. 3*). Thus, cooperation with scientists from various parts of the world can be beneficial—perhaps imperative.

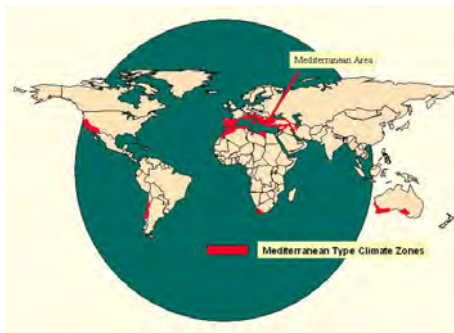


Figure 3—Mediterranean-type ecosystems.

Study Implementation

The Prescribed fire program at the PSW Research Station, Riverside, CA is already underway. Documentation has been prepared, and a number of studies are in place (*figs: 4-8*).



Figure 4—Thin and understory burn to produce a shaded fuel break in a canyon live oak (*Quercus chrysolepis*) forest on the San Bernardino National Forest, San Bernardino, CA.



Figure 5—Prescribed burn of invasive grass in oak (*Quercus engelmannii*) savannah on the Santa Rosa Plateau, The Nature Conservancy, Murrietta, CA.

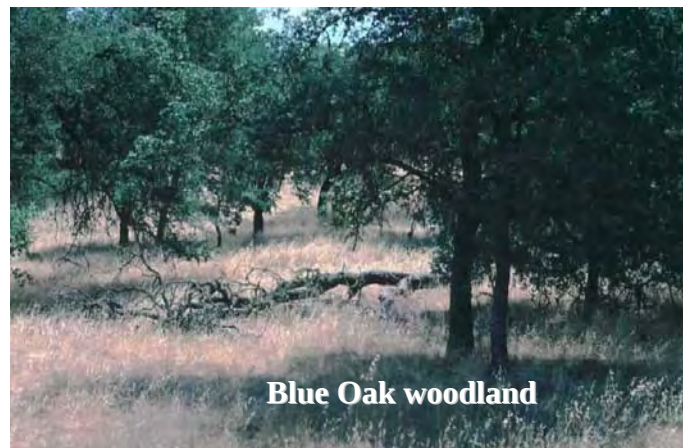


Figure 6—Heavy fuel reduction prescribed burning in oak (*Quercus kelloggii*, *Q. douglasii*, *Q. chrysolepis*) woodland at Camp Roberts, San Luis Obispo, CA.



Figure 7—Prescribed burn in mixed conifer oak forest for hazardous fuel reduction on the San Bernardino National Forest, San Bernardino, CA.

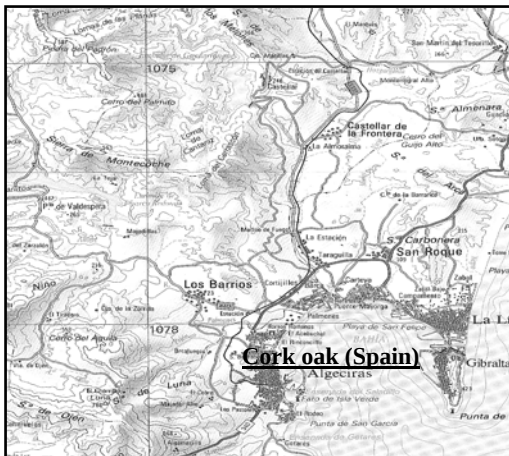


Figure 8—Understory burning in cork oak (*Quercus suber*) forests in Spain.

Discussion

Studies are in cooperation with other agencies, branches of the USDA Forest Service, other countries, and with a variety of professional disciplines. To properly carry out the necessary studies, more research disciplines must jointly direct their efforts toward the effects of prescribed fire, and the nature of factors that determine its effects—both short- and long-term. Such efforts must be deliberate, and coordinated.

Effect of Prescribed Fire on Recruitment of *Juniperus* and *Opuntia* in a Semiarid Grassland Watershed¹

Burton K. Pendleton,² Rosemary L. Pendleton,² and Carleton S. White³

Introduction

The Bernalillo Watershed Protection Project was begun in 1953 following catastrophic erosion and flooding of small communities below. Although erosion control features and protection from grazing successfully increased grass cover and stabilized watershed soils, the expansion of juniper woodland (*Juniperus monosperma*) into the grassland watershed prompted concern that gains in watershed stability could be reversed. In 1995, fire was reintroduced into the grassland as a means of maintaining perennial grass cover and preventing further expansion of the juniper woodland community.

Methods

Burns were conducted on randomized 1 ha plots during November of 1995 and January of 1998. Juniper and *Opuntia* plants were censused in February of 2002. We counted all juniper plants occurring on treatment plots and measured height and crown diameter to the nearest decimeter.

Results

Burned plots had significantly fewer live juniper and significantly more dead juniper (table 1). Average size of living juniper on burned plots was greater, indicating a reduction in juniper recruitment.

Table 1—Mean number and size of juniper occurring on burned and unburned plots.

	Live juniper/plot	Dead juniper/ plot	Height (m)	Diameter (m)
Burned	7.25 a	5.0 a	1.70 a	2.14 a
Unburned	22.75 b	0.5 b	1.35 b	1.55 b
P value	<0.0005	<0.0005	0.0463	0.0445

¹A poster version of this paper was presented at the 2002 Fire Conference: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States, December 2-5, 2002, San Diego, California.

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The three species of *Opuntia* found on the Bernalillo watershed—*O. phaeacantha*, *O. imbricata*, and *O. clavata*—were censused using belt transects. Patch area of *O. phaeacantha* and *O. clavata* patches was calculated using two perpendicular diameter measurements (cm). Both height and crown diameter were measured for cholla (*O. imbricata*). The mean number of cholla plants was significantly lower in burned plots, averaging 6 plants per plot as compared with 31 plants per plot in unburned areas. In addition, control plots averaged three patches of *O. clavata* per plot compared with zero in burned plots. The average number of *O. phaeacantha* patches was approximately equal for burned and control plots, averaging 131 and 138, respectively. However, patch size for *O. phaeacantha* was significantly reduced on burned plots (fig. 1). These data support the use of prescribed fire in reducing woody vegetation while maintaining cover of perennial grasses.

Opuntia phaeacantha

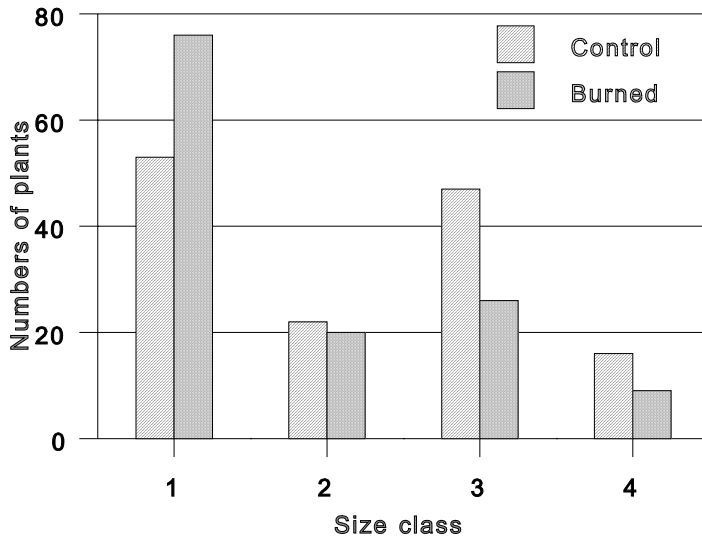


Figure 1—Size class distribution of *Opuntia phaeacantha* plants occurring on control and burned plots.

Monitoring Land Cover Change in California Using Multitemporal Remote Sensing Data¹

John Rogan,² Doug Stow,² Janet Franklin,² Jennifer Miller,²
Lisa Levien,³ and Chris Fischer⁴

Introduction

Growing concern over the status of global and regional forest resources has led to the implementation of numerous multi-agency projects to establish long term operational systems for land cover monitoring. Land cover change (i.e., location, extent and cause) is identified as the most important and challenging research theme for many of the programs recently initiated by monitoring agencies. A key element in successfully addressing this theme is the involvement of regional and state-level management authorities to provide the necessary link between local/municipal and national/international land cover monitoring projects. Increasingly, these projects are using complex mapping procedures that require the integration of remotely sensed data, state-of-the-art image processing approaches, collateral spatial data, and georeferenced (GPS) field validation data within a Geographic Information System (GIS).

To address the challenge of forest and shrubland sustainability in the midst of rapid and widespread land cover change in California, the USDA Forest Service (USFS) and the California Department of Forestry and Fire Protection (CDF) are collaborating in the statewide Land Cover Mapping and Monitoring Program (LCMMP) to improve the quality and capability of monitoring data, and to minimize costs for statewide monitoring. Changes in forest, shrub, and grassland cover types are the primary focus in this program, but changes in urban/suburban areas are also mapped. Land cover change maps are required for regional interagency land management planning, fire and timber management, and species habitat assessment

An examination and comparison of the variety of remote sensing methods available, such as scene normalization, change feature extraction, classification, and accuracy assessment is warranted, in order to meet operational and standardization needs of the LCMMP. Faced with this task, the USFS and CDF staff associated with the LCMMP welcomed a research alliance with San Diego State University (SDSU) as a way to improve and automate change monitoring procedures. Specifically, techniques that minimize time-consuming human interpretation and maximize automated procedures for large area mapping of land cover change are being evaluated. The long-term objective of this study is statewide application of its *proof of concept* to the ongoing LCMMP.

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Data and Pre-Processing

Landsat TM and ETM images captures four to five years apart are geometrically registered to the UTM WGS84 projection with GCP points located at major road intersections, dispersed throughout the entire scene with less than 0.45 pixel RMSE. A nearest neighbor algorithm is used to resample the images to a 30 m output grid. These data are acquired within a three-month acquisition window (June-August) to provide operational flexibility (i.e., to minimize atmospheric contamination from cloud cover or wildfire smoke plumes), and to assure that they occur before the onset of foliage change in hardwood vegetation. These image data are then independently normalized for atmospherical illumination differences and converted to reflectance values using a dark object subtraction (DOS) approach.

The Landsat TM Multitemporal Kauth Thomas (MKT) linear transformation is used to spectrally enhance the data prior to supervised classification. MKT produces six features of interest; three features that represent change in brightness, ΔB (MKT1), change in greenness, ΔG (MKT2), and change in wetness, ΔW (MKT3), and three features that represent mean, or stable brightness (MKT4), stable greenness (MKT5) and stable wetness (MKT6) between dates. Further, ancillary data layers such as elevation, slope and aspect are included in the classification process.

Land Cover Change Classes

The land cover change classification scheme (*table 1*) describes three discrete categories of forest canopy cover decrease and two classes of canopy increase. Further, a shrub cover increase and shrub decrease class is used, along with change in developed (urban) areas and no-change (+15 to -15 percent canopy change) categories. The -15 to 15 percent change class was designed to reduce the confusion between phenological related increase and post-disturbance recovery classes. This classification scheme was developed and is currently in statewide use by the LCMMP. In situ reference data were collected for classification training and testing phases, based on a stratified random sampling scheme and was acquired using both aerial photographs and field visits.

Table 1—*Land cover change categories for the study.*

Land Cover Change Classes
+15 to -15 pct canopy change
-71 to -100 pct canopy change
-41 to -70 pct canopy change
-16 to 40 pct canopy change
Shrub/grass decrease >15 pct
+16 to +40 pct canopy change
+41 to 100 pct canopy change
Shrub/grass increase >15 pct
Change in existing developed areas

Change Mapping Approach

A univariate classification tree algorithm are used to produce tree-structured rules that recursively divide the data into increasingly homogenous subsets based on splitting criteria. At each split, the values of each explanatory variable are examined and the particular threshold value of a single variable that produces the largest reduction in a deviance measure (e.g., increase in subset homogeneity) is chosen to partition the data. Explanatory variables that have already been used in the model may be reexamined and potentially reintroduced into the tree structure. As a result, hierarchical, non-linear relationships within the data are revealed (*fig. 1*).

Spectral and ancillary variables are readily integrated and their contribution to map accuracy revealed in the hierarchical structure of the classification trees, and in the increase in accuracy when ancillary data were included in the classification. The methods used in this study were successful for mapping discrete categories of land cover change at overall accuracy levels of 72 to 92 percent. *Figure 2* shows a portion of a land cover change map of southern California from 1990 to 1996.

Conclusions

To address the concern about the amount and health of forest and shrubland ecosystems in California from accelerating land cover change, several agencies are collaborating in a land cover mapping and monitoring program. We monitored land cover change in San Diego County (1990 to 1996) using multi-temporal Landsat TM data. Change vectors of Kauth Thomas features were combined with stable Kauth Thomas features and a suite of ancillary variables within a decision tree classification. A combination of aerial photo interpretation and field measurements yielded training and validation data. Overall accuracies of the land cover change maps were high. The Kauth Thomas (brightness, greenness and wetness) and ancillary variables were important in mapping land cover change.

Predicting Patterns of Alien Plant Invasions in Areas of Fire Disturbance in Yosemite National Park¹

Emma Underwood,² Robert Klinger,² and Peggy Moore²

Introduction

The location and size of Yosemite National Park means that it captures both a variety of interesting flora and fauna and also harbors many of the ecosystem processes that are characteristic to the Sierra Nevada. However, one of the increasing challenges confronting park management is the invasion of alien plant species. This is particularly problematic in areas which have experienced disturbances, such as fire or flooding (Rejmanek 1989, Mack and D'Antonio 1998). Such areas of disturbance provide ideal environments for alien species to establish; by removing the dominant species, and increasing bare ground, light and nutrients (Austin 1985).

Over the last few decades there has been an increase in both the number and mean size of fires occurring in Yosemite owing to a change in park policy which allows burning in designated areas. In order to assist park management in monitoring alien species in these susceptible areas, we conducted a community scale analysis of site collected data and also developed a landscape model to predict areas vulnerable to invasion based on their environmental envelope.

Materials and Methods

Our community level analyses assessed field data collected in 1998 and 1999 in the park (N=236). Field attributes included the identity and percent cover of alien and native plant species in each plot. This was supplemented with additional environmental data, such as slope, aspect, soil composition, in a Geographic Information System. A series of regression analyses found the best subset of these variables that explained first the presence and then the percent cover of the alien species and a TWINSpan analysis also grouped co-occurring species to make modeling more efficient.

We then used a predictive model, the Genetic Algorithm for Rule-Set Prediction (Stockwell and Noble 1991), to extrapolate from the field collected data to the landscape scale. Models using the key environmental variables identified in the community analyses were run for each of the groups of alien species.

In order to target fieldwork to areas with the greatest probability of harboring alien species the results of from the predicted distribution were intersected with areas of greatest disturbance. We defined these as the largest and most recent wildfires that

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had occurred in the park. We then generated a set of random points to help guide fieldwork for monitoring invasives.

Results and Discussion

The community level analyses identified elevation, slope, percent tree cover and percent shrub cover as the factors best able to explain the distribution of alien species in the site collected data. Using these key variables, the GARP model was run using a selection of site collected locations to train the model, and the remaining sites were reserved to test the accuracy of the results. The overall accuracy of the model, that is, its ability to successfully predict the invisibility of sites was 76 percent.

Our selection of burn areas with the greatest disturbance included the Ackerson, A-rock, Hoover, Leconte, and Steamboat wildfires, which have all occurred since 1990. A total of 200 random points were generated for field work in areas predicted to harbor alien species which fell within these wildfire boundaries. The number of points assigned to each burn was determined by the size of the burn, a minimum distance from the boundary of the burn was specified to avoid spurious edge effects.

Conclusions

These results provide a foundation for sampling and monitoring alien species within areas of disturbance in Yosemite National Park, and also a means to allocate limited park personnel and financial resources. Fieldwork conducted across a continuum of areas with different accuracy results will also yield important information on the way alien species respond to fire. In the long-term such analyses can be applied to other disturbances in the park, such as areas of flooding or disturbances in the park caused by human visitation, to provide a holistic monitoring plan for alien species.

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Fuel Consumption During Prescribed Fires in Big Sage Ecosystems¹

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Introduction

Fuel consumption was evaluated for a series of operational prescribed fires in big sage (*Artemisia tridentata*) ecosystems throughout the interior West. Pre-burn fuel conditions (composition, loading, arrangement, and moisture content) and day-of-burn environmental conditions (temperature, relative humidity, wind, and time-since-rain) dictate fire behavior and subsequent fuel consumption. The amount of fuel available to burn, which is influenced by season of burn, site productivity, time-since-last-fire, grazing, and environmental conditions, is the most important factor controlling consumption. Fuel consumption can be manipulated to some degree, and poor burning conditions can be mitigated in some cases, by adjustments to firing techniques.

Methods

Relationships gleaned from these fuel consumption data will be incorporated into a predictive model and built into the software program CONSUME 3.0 (currently under development), a fire management and planning tool that predicts fuel consumption and emissions during prescribed and wildland fires.

Discussion

Future research will seek to refine, test, and expand on previous observations. New experiments will be designed to address questions about the effects of small changes in environmental conditions and season of burn on fuel consumption. Future work will also evaluate the effects of prescribed fire in shrub-type ecosystems composed of different species.

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