In 2016, the Cornerstone monitoring strategy was completed. It describes the long-term monitoring questions and indicators that were formulated to evaluate achievement of the CFLRP goals and objectives. It was developed by working group members.

Amador-Calaveras Consensus Group Monitoring and Science Symposium Highlights

These document contains highlights from the November 8, 2017 symposium. The intent of the symposium was to share knowledge and discuss ongoing monitoring and research work occurring within the ACCG footprint.

Key Findings

- The Cornerstone monitoring strategy includes 41 questions in the following monitoring categories: Implementation (1 question), Collaborative (4 questions), Ecological Effectiveness (30 questions), Social/Economic (6 questions).
- Thirteen ecologically focused monitoring and science presentations were presented at the November 8th symposium. Highlights from those presentations are presented in this report.

Project Overview


Collaborative monitoring on the Stanislaus NF

The Collaborative Forest Landscape Restoration (CFLRP) program was established under the Public Land Management Act of 2009, to better integrate ecological, social, and economic needs during restoration on National Forests. The Amador-Calaveras Consensus Group (ACCG) Cornerstone CFLR project was awarded in February 2012, with the core goals of moving landscapes towards sustainable conditions, reducing uncharacteristic wildfire, restoring a range of ecological functions, and maintaining rural communities and livelihoods. One of the requirements under the CFLRP funding is to conduct ecological, economic, and social monitoring to track restoration efforts.

Link to the Cornerstone Collaborative Forest Landscape Restoration Project Monitoring Strategy: http://acconsensus.org/wp-content/uploads/2015/08/01_Cornerstone_Monitoring_Strategy_Final.pdf

Contact: Shana Gross, segross@fs.fed.us; Becky Estes, bestes@fs.fed.us

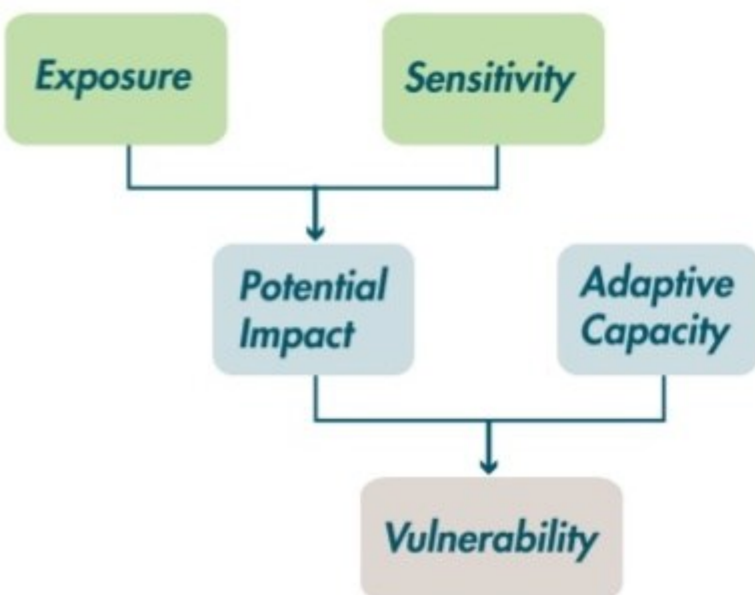
Table of Contents

	Ecological Monitoring Question
1	Did the status of undesired species change?
2	Did the quality/quantity of habitat for Threatened and Endangered and Forest Service Sensitive and other desired species change?
3	Did the local abundance/distribution of TE and FS Sensitive and other desired species change?
4	Did plantation treatments encourage a structure consistent with a more resilient forest stand (variable spacing designed to maintain the individual, clump and opening pattern, a desired future tree density consistent with historic forest conditions and more resilient forest stand?
5	How did treatments affect basal area and canopy cover in canyons and slopes with north-facing aspects compared to ridges and slopes with south-facing aspects?
6	How did treatments affect the tree density and species composition in all size classes?
7	Were treatments successful in promoting diverse plant forms or species of plants?
8	How did focus treatments improve cultural resource conditions?
9	Did restoration and conservation actions protect cultural resources from disturbance?
10	How did project actions protect, promote, and make accessible species with ethnobotanical importance?
11	Did vegetation treatments result in increased connectivity between cultural landscapes?
12	Did wildfire result in impacts to culturally sensitive areas?
13	How did fuel treatments meet the project goals and objectives?
14	Will fuel treatments result in future fire behavior consistent with the natural range of variability (size, frequency, pattern, severity)?
15	Were treatments effective in reducing smoke emissions over the project/landscape area (modeled wildfire)?
16	Did project activities improve growing conditions for hardwoods?
17	Have target invasive plant populations been reduced?
18	Are target invasive plants spreading throughout the Cornerstone area?
19	To what degree did the project move Special Aquatic Features or riparian corridors to desired conditions and maintain/improve hydrologic and ecosystem function?
20	Are pesticide treatments affecting aquatic resources?
21	Did restoration treatments or other disturbance result in a change in habitat suitability for sensitive plant species?
22	Did restoration treatments or other disturbance result in a change in population size of sensitive plant species?
23	Are levels of detrimental soil disturbance and erosion increasing or decreasing with project treatments?
24	Did the project treatments impact total carbon storage in soil?
25	Did forest treatments impact habitat of mature Forest Sensitive species across projects?
26	How many snags per acre by size classes were removed/retained during treatments?
27	To what extent are best management practices effective in protecting soil and water resources for Cornerstone management activities?
28	Are watershed Conditions improving in the cornerstone footprint, as evaluated through the Watershed Condition Ratings, particularly in priority watersheds?
29	Have treatments been successful in restoring: floodplain connectivity, channel/meadow/riparian habitat, improving water quality and quantity, and/or changed timing of base flows?
30	Have impacts to water quality or aquatic habitat from roads and trails been reduced?

Characterizing Sierra Nevada meadow vulnerability to climate change to prioritize conservation and restoration efforts

Preliminary findings suggest that meadows that are more heavily modified by humans are more sensitive to changes in hydrology.

This project analyzes meadow vegetation responses (i.e., their sensitivity) to contemporary variation in climate and characterizes how these responses vary in accordance with hydrogeomorphic contexts (e.g., geology, elevation, topographic position, etc.) at an ecoregional scale. This information will be used to develop a spatially-explicit vulnerability assessment of Sierra Nevada meadows and to develop a decision framework that provides guidance on where to focus restoration and conservation actions based on meadow vulnerability assessment results.



Climate change vulnerability assessment framework established by Glick et al. 2011

Link to the documents or publications:
http://climate.calcommons.org/project/decision-support-meadow-conservation-and-restoration-sierra-nevada-ecoregion

Key Findings

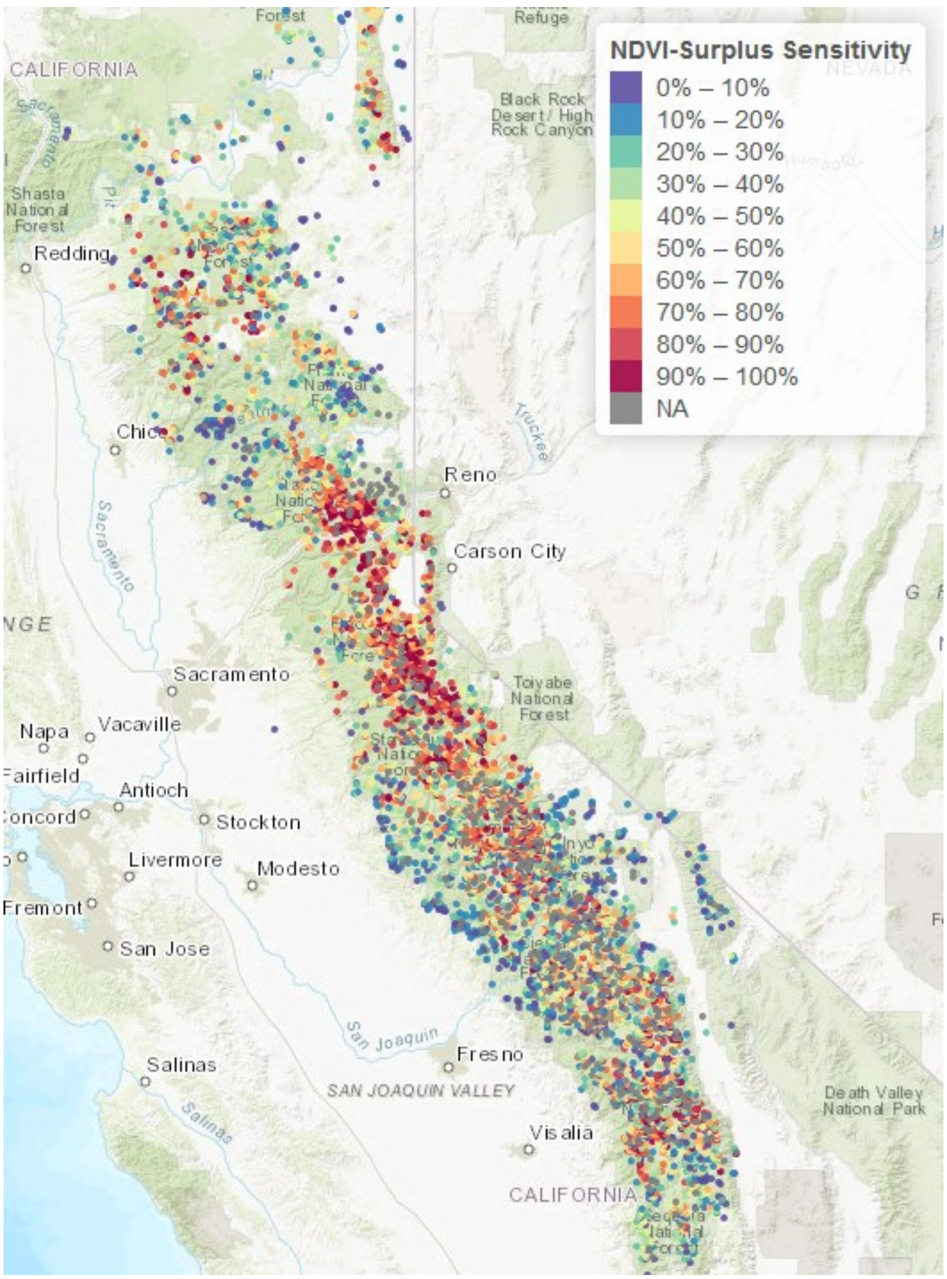
- Meadows that receive moderate snowpack, are greener in late summer, and green up earlier in the year tend to be more sensitive to climate-related changes in hydrology (water availability).
- Meadows with shallow root zones may be more sensitive to changes in hydrology than those with deeper root zones.
- Meadow sensitivity to hydrology varies among mountain, foothill, and basin ecoregion types.

Channel incision in a Sierra Nevada meadow is a potential focus for restoration. (Incline Meadow)

Contact: Meredith McClure, 530-214-8905, meredith@csp-inc.org

Project Overview

Sierra Nevada meadow ecosystems are highly vulnerable to changing hydrologic regimes and processes associated with climate change, but also vary in their sensitivity to climate. We quantified meadow sensitivity to climate-driven changes in hydrology by analyzing time series relating montane meadow vegetation condition to interannual variability in climate. We then assessed how sensitivity to climate varies with hydrogeomorphic contexts at an ecoregional scale; in other words, how hydrogeomorphic context may shape meadow capacity to adapt when exposed to future climate change. Preliminary results suggest that aspects of meadow topography, climate regime, and soil characteristics may be important drivers of climate sensitivity. Identifying these generalizable patterns in sensitivity could help managers to anticipate climate impacts and guide prioritization of restoration efforts. Over the course of the next year, we will refine our preliminary analysis and translate it into a practical decision framework to guide prioritization of restoration and conservation actions based on meadow vulnerability.



Relative sensitivity of meadow mean September NDVI to total water year surplus water across the meadow contributing area.

> *We are beginning to identify aspects of meadows' hydrogeomorphic context that are ecologically meaningful drivers of climate sensitivity. This will provide valuable guidance for anticipating meadow response to climate change.*

Restoration of forest density to sustainable levels will decrease water use by the forest, and increase potential runoff.

Real-time hydrologic monitoring for Western Watershed Enhancement program: Hemlock Forest-Restoration project

This is a new project, the purpose of which is to make the first comprehensive assessment of the water-cycle implications of forest restoration in a Sierra-Nevada mixed-conifer forest. The aim of this study is to measure and assess the effects of restoration treatments on fire resiliency in source-water watersheds, and on downstream water supplies.

Key Objectives

- Results will inform land managers of the multi-year impacts of landscape-scale vegetation treatments in wet versus dry years, and the quantitative benefits of watershed management in source-water areas.
- The results will also provide quantitative tools for assessment, backed by solid measurements, which will enable extending the assessments to larger scales.
- This project fills a critical gap in our knowledge base around water, climate and forest management; and it has the potential to be transformative in bringing about inter-agency, multi-stakeholder cooperation.

Current high density forests are subject to moisture stress and mortality in a warming climate.

Open, restored forest in foreground, closed-canopy forest behind. Photo from E. Knapp, Stanislaus-Tuolumne Experimental Forest

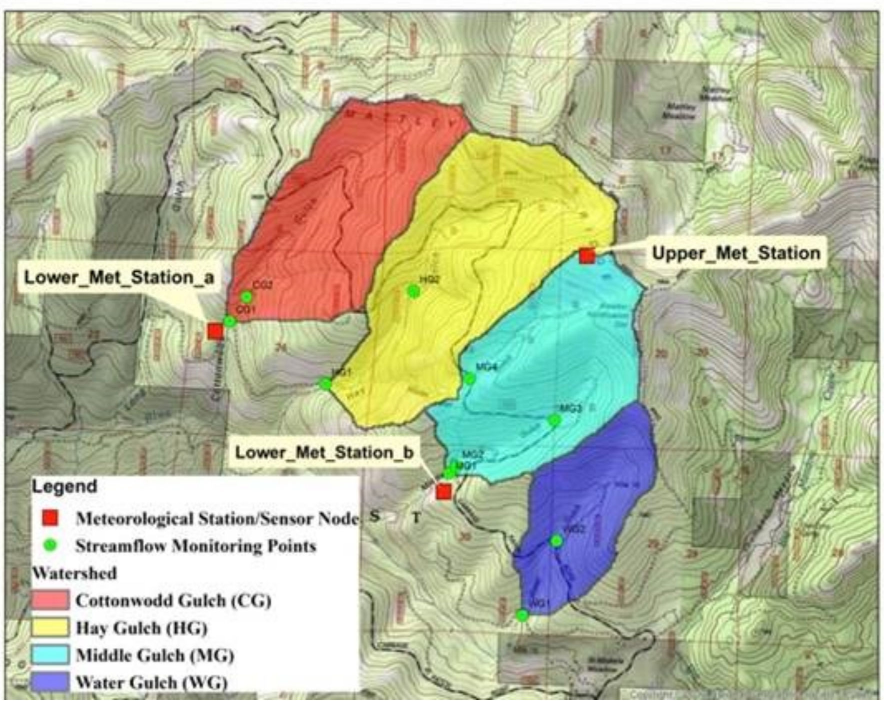
For background, see

Forest thinning impacts on the water balance of Sierra Nevada mixed-conifer headwater basins, Saksa et al., 2016. available at https://escholarship.org/uc/item/7mb285mg

Project Overview

The study area is the Hemlock Project a 12,000-acre landscape-restoration project, located in the Stanislaus National Forest and Mokelumne River basin. The overall aim of quantitatively evaluating the effects of differences in stand structure on wildfire resilience, water yield and the water cycle in the snow-rain transition zone will be met by a program of field measurements, integration of data using hydrologic modeling, and assessment. This project provides for a 10-year field-measurement program, accompanied by the modeling and assessment activities.

Road through dense forest in Hemlock study catchments.



Selected four study watersheds within Hemlock Project area, 10 stream stage recorders, and 3 snow/soil moisture sensor clusters.

The Stanislaus National Forest plans restoration actions to restore watershed functions and forest health. Their actions will also enhance water-supply reliability by restoring the fraction of precipitation that leaves the basin as runoff versus evapotranspiration, and maintain water and forest health as the climate warms and evaporative demand increases.

Power Fire Roads Assessment using the GRAIP Road Inventory and Model

We evaluated the types and sources of road related hydrologic and geomorphic risk in the area of the Power Fire on the Eldorado National Forest.

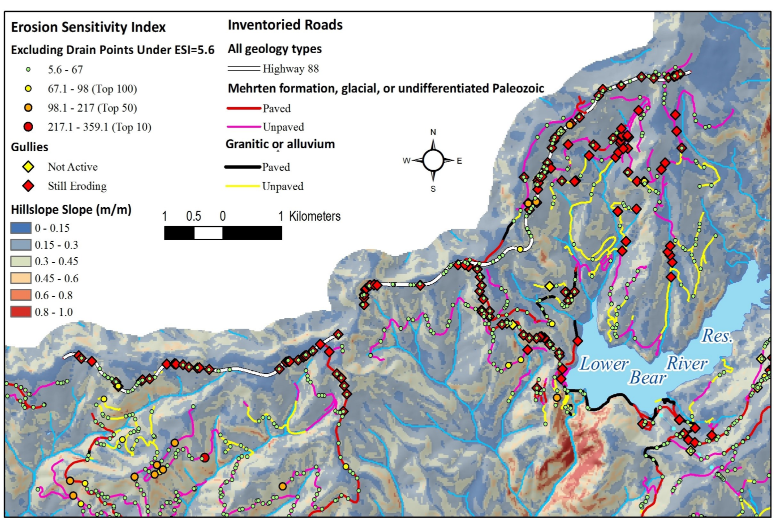
We also located and quantified the sediment sources and their contributions to the stream network to facilitate restoration prioritization.

Key Findings

90% of road surface sediment was delivered by 5% of the road drainage locations.

- Most geomorphic and hydrologic impacts associated with the Power Fire occurred in the first several years following the event. 10 years post–fire, there was little difference in sediment delivery distance between burned and unburned sites.
- 40% of the drainage features along highway 88 initiated gully erosion, particularly those located within the volcanic mudflow tuffs of the Mehrten formation.
- Road surface erosion produced nearly the same amount as gullies below the road, but gullies delivered 80% of eroded sediment to streams while drains delivered 14%.
- Outsloped or diffusively drained roads were most effective at limiting road to stream connection.

Measuring a road surface erosion sediment trap



Road related gullies observed in 2015 in the Power Fire area

Power Fire GRAIP Watershed Roads Assessment:

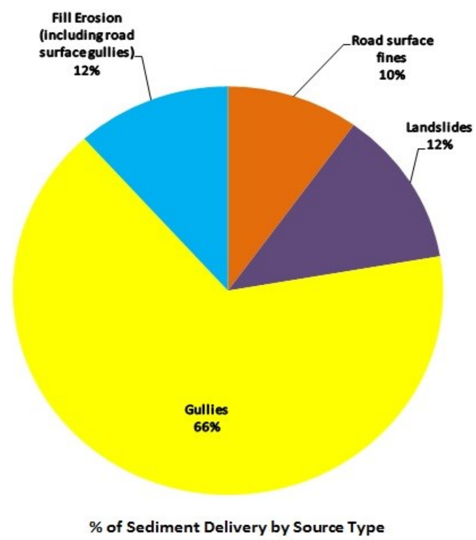
https://www.fs.fed.us/GRAIP/downloads/case_studies/WatershedRoadsAssesment_PowerFire_EldoradoNF2016.pdf

Contact: Tom Black, USDA Forest Service RMRS: tblack@fs.fed.us October 2017

Project Overview

Erosion related to forest roads is often the principle source of anthropogenic sediment in managed watersheds and can degrade water quality. The GRAIP road inventory and model was used to assess hydrogeomorphic risk associated with the roads in the area of the Power Fire in the Mokelumne watershed of CA. 337 km of roads were investigated in 2014 and 2015. 6 surface erosion measurement plots were installed with monitoring ongoing.

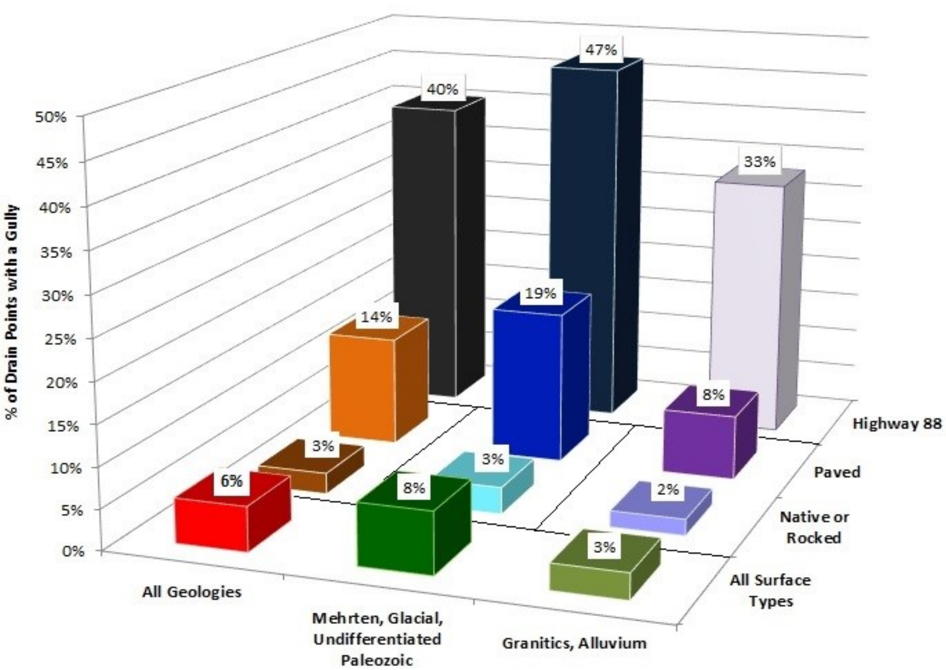
The results indicate that 16% of the road length and 17% of the drainage features deliver sediment to the channel network. Overall, the GRAIP model predicts that 503 Mg yr^{-1} are eroded from these road surfaces and 14% of that mass (70 Mg yr^{-1}) is delivered to streams. We mapped the volume of 20 road related landslides and 1,740 Mg were estimated to have delivered to streams (approximately 87 Mg yr^{-1} over 20 years). We mapped 218 gullies below roads and found 9,300 Mg delivered to streams (approximately 465 Mg yr^{-1} over 20 years). We mapped fill erosion below drainage points and found 82 Mg yr^{-1} over 20 years. Only 8% of stream crossings had a high risk of becoming plugged but 41% had the potential to divert flow down the road if pipe plugging did occur.



Percent of total road sediment delivered to streams by source over 20 years.

The mapping and modeling identified the locations, sediment delivery and risk metrics at 4,657 locations in the watershed. Remarkably, less than 10% of the drainage locations deliver 98% of the combined road surface sediment, gully and landslide sediment to streams.

This detailed risk and sediment delivery mapping will allow for strategic use of funds to reduce road sediment risks in this valuable municipal supply watershed.



Strategic management of road infrastructure and hydrology in the Power Fire area would minimize gully erosion, and stream crossing diversion potential which could yield dramatic reductions in sediment delivery risk.

Caples Creek Watershed Fuels Reduction and Meadow Restoration: A Future With Fire—Exploring Opportunities for a More Resilient California

The ecological condition of the mixed conifer forests in the watershed, was evaluated using the Natural Range of Variability (NRV) concept.

Key Findings

Mean (±SD) stand variables in mixed conifer stands summarizing the Natural Range of Variability (NRV), current Sierra Nevada (FIA) conditions and current Caples Creek conditions. Letters that were similar were not significantly different using an α level of 0.05. Red text indicates an increased departure and blue text indicates decreased departure.

Stand Variable	NRV	Sierra Nevada	Caples Creek
Tree Density (trees/acre)*	61 ± 37[a]	181 ± 63[b]	168 ± 146[b]
Large tree (≥31 inch dbh) density (no./acre)	17 ± 11[a]	10 ± 10[b]	11 ± 4[b]
Small tree (<8 inch dbh) density (no./acre)	34 ± 23[a]	255 ± 128[b]	80 ± 74[c]
Mean diameter (inch)	22 ± 4 [a]	9 [b]	12 ± 6 [c]
Canopy cover (%)	37 ± 14 [a]	46 ±22 [b]	75 ± 30 [c]
Tree regeneration (trees / acre)	143 ± 131 [a]	n/a	188 ± 178 [a]
Snag density (trees/acre)	5 ± 3 [a]	17 ± 28 [b]	36 ± 29 [c]
Shrub cover (%)	18 ± 2 [a]	n/a	21 ± 32 [a]
Herbaceous plant cover (%)	12 ± 7 [a]	n/a	10 ± 27 [a]
Fuel loading 1-100-hr fuels (tons/acre)	1.4 ± 1.3 [a]	3.0 ± 1.02 [b]	4.0 ± 6.9 [b]
Fuel loading 1000-hr fuels (tons/acre)	6.3 ± 3.8 [a]	9.3 ± 5.2 [b]	16.2 ± 30.9 [b]
Fuel loading litter and duff depth (inch)	0.6 ± 0.4 [a]	n/a	3.0 ± 2.0 [b]

Management Recommendations:

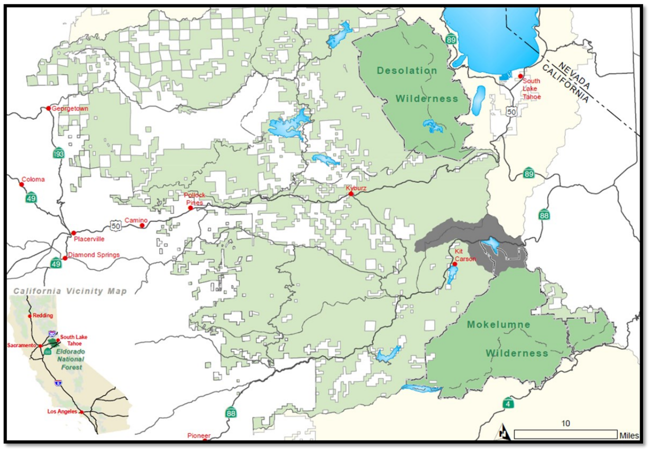
- Reduce tree density particularly small/medium trees prior to burning to reduce ladder fuels;
- Pre-treat in areas of high fuel loading to reduce negative effects from prescribed fire;
- Develop burn plans to reduce tree density of white fir and incense cedar less than 16 inches to within NRV;
- Pre-treat around large diameter trees to reduce fuel loading and prevent mortality.
- Develop allowable post-treatment burn conditions (e.g., percent of landscape within variable vegetative burn severities);
    - Develop allowable size of passive crown fire patches (individual tree torching) and indirect mortality.

Collaboration field trips framed forest restoration efforts

Contact: Becky estes, 530-642-5161, bestes@fs.fed.us October 2017

Project Overview

No recorded fires have occurred over the last century in the Caples Watershed. This has resulted in a decrease in forest health and resilience. Heavy fuel loading is of great concern where pre-European fire return intervals would have ranged from 5 – 35 years with generally low to mixed severity fires dominating. Numerous studies have shown that fire exclusion has led to an increase in stand density particularly in the lower tree size classes, an increase in shade tolerant species, and an increase in fuel loading (Collins et al. 2011, Knapp et al. 2013). These conditions have greatly increased the risk of high intensity fires and stand replacing events (Miller et al. 2012). This type of fire could have significant effects on water quality immediate after a fire and during the recovery period.



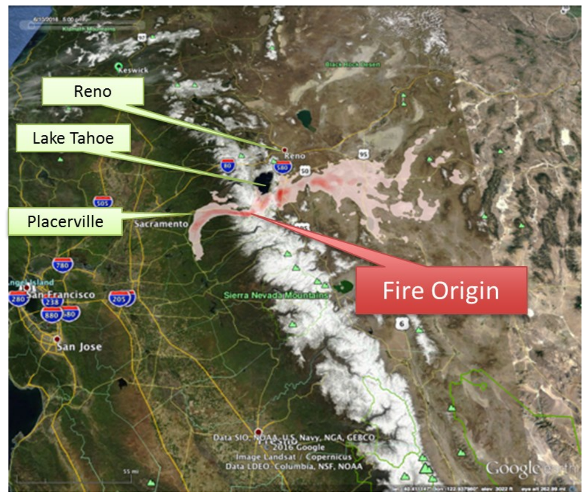
Field Assessment:

The current ecological conditions were evaluated using 60 common stand exams on a 400 meter grid stratified by fuel type and topographical location. CSE plots data included:

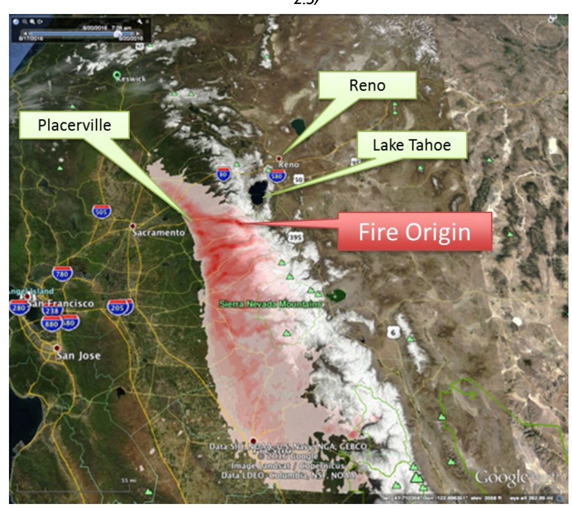
- plot level data (slope position, fuel model, slope, aspect and lifeforms covers);
- tree data (tree species, tree diameter; tree height, crown class, location of legacy trees, regeneration);
- fuels data (1,10,100,1000-hr fuel loading, litter/duff/fuelbed depth);
- and a full inventory of all plant species and surface cover variables.

Modeled smoke from a wildfire and prescribed fire

Spring Rx *(June 9, 2016; 500 acres/day; 350 tons $PM_{2.5}$)*



August Wildfire *(Aug 20, 2016, 1000 acres/day; 1100 tons $PM_{2.5}$)*



BlueSky Model—Leland Tarnay

A variety of vegetation types occur in the Caples Watershed

Forest Health Monitoring Within Red Fir Management Projects

Very little information exists regarding treatment effects within red fir forests, and this project will fill some of that knowledge gap.

The project goal is to monitor changes in red fir forest structure, health, and fuels before and after vegetation management at multiple project sites.

We aim to answer several of the ACCG's monitoring questions regarding forest structure and fuels, and to assess whether treatments effect metrics of forest health and disease.

Key Findings

- Pre-treatment monitoring was conducted at four project sites in 2016: 46 plots (38 treatment, 8 control) at 2 ACCG sites (Hemlock and Foster Firs), and 29 plots (23 treatment, 6 control) at 2 Lake Tahoe Basin sites (Ophir and Redside).
- Mean dwarf mistletoe ratings were significantly higher for ACCG plots (west slope Sierra Nevada) than for Lake Tahoe Basin plots (east slope Sierra Nevada).
- Plot level basal area did not differ between project sites.
- Tree density and med-large tree density did not differ among projects, but small tree density was significantly higher in Foster Firs than Ophir.

Pre-treatment monitoring at Foster Firs

Pre-treatment monitoring at Hemlock (Thompson unit)

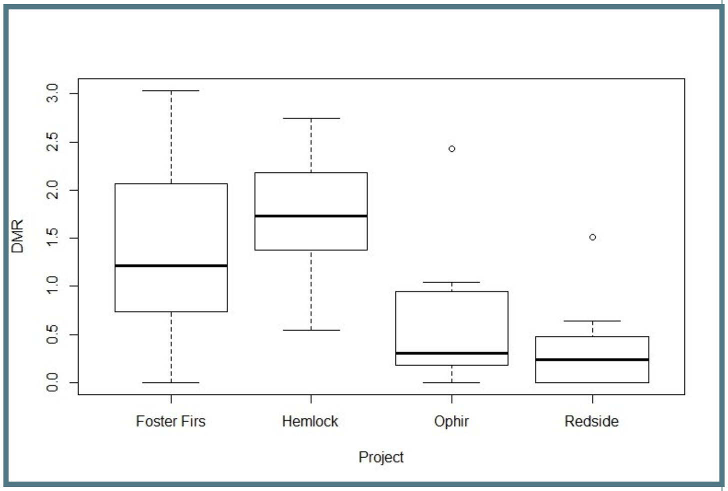
Selected Monitoring Questions:

- How did treatments affect basal area and canopy cover across different Landscape Management Units?
- Did forest treatments impact habitat of Mature Forest Sensitive species?
- Were treatments successful in increasing/ maintaining structural diversity?

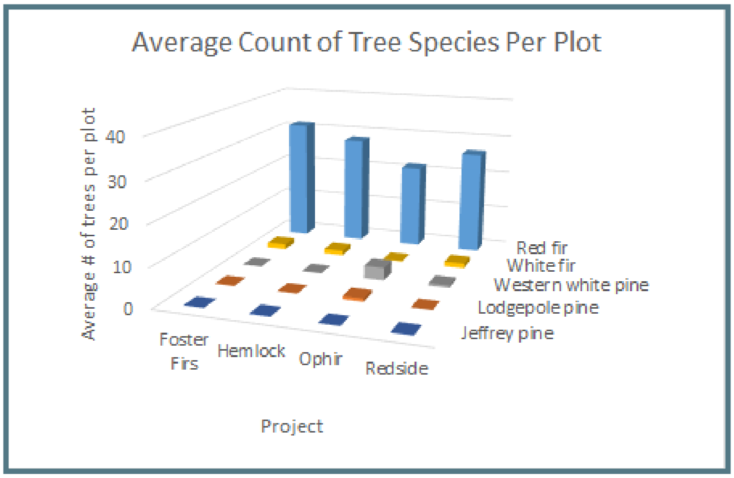
Contact: Rebecca Wayman, 530-401-0471 rbwayman@ucdavis.edu

Project Overview

Several red fir vegetation management projects in the northern and central Sierra Nevada are being planned or are underway, providing an opportunity to conduct monitoring across an array of treatment types, management histories, and vegetation conditions. We conducted pre-treatment monitoring on four projects in 2016, and will follow up with post-treatment monitoring after each project is completed. We aim to evaluate changes in forest structure, health, and fuels, and to assess how well treatments meet stated project goals such as fuels reduction, improvements in forest health, retention of wildlife habitat, and promotion of structural diversity.

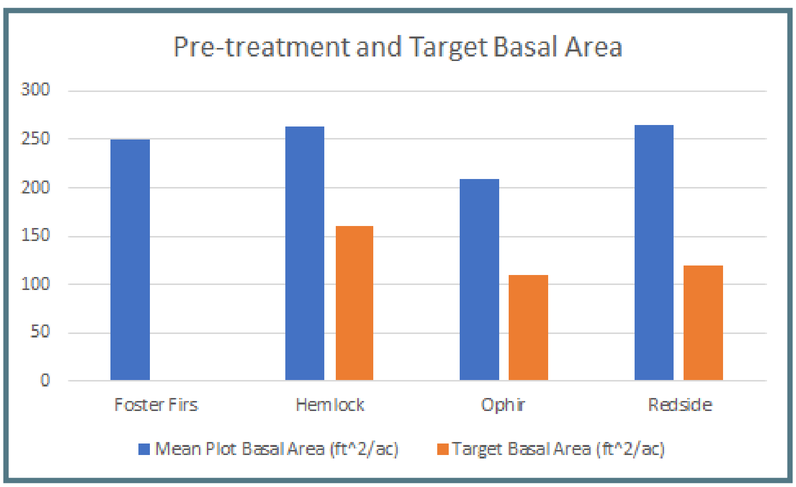


Average pre-treatment plot dwarf mistletoe rating by project.



Average number of trees per plot by species and project.

Average dwarf mistletoe ratings by plot were significantly higher within ACCG project sites (Foster Firs and Hemlock) than for Lake Tahoe Basin projects (Ophir and Redside). Post-treatment monitoring will evaluate changes in this and other health, structure, and fuels metrics.



Pre-treatment mean plot level basal area and target basal areas listed in vegetation management prescriptions for each project. No target listed for Foster Firs. Hemlock prescribes different target basal areas for each Landscape Management Unit type (target range: 140 to 180 ft^2/ac).

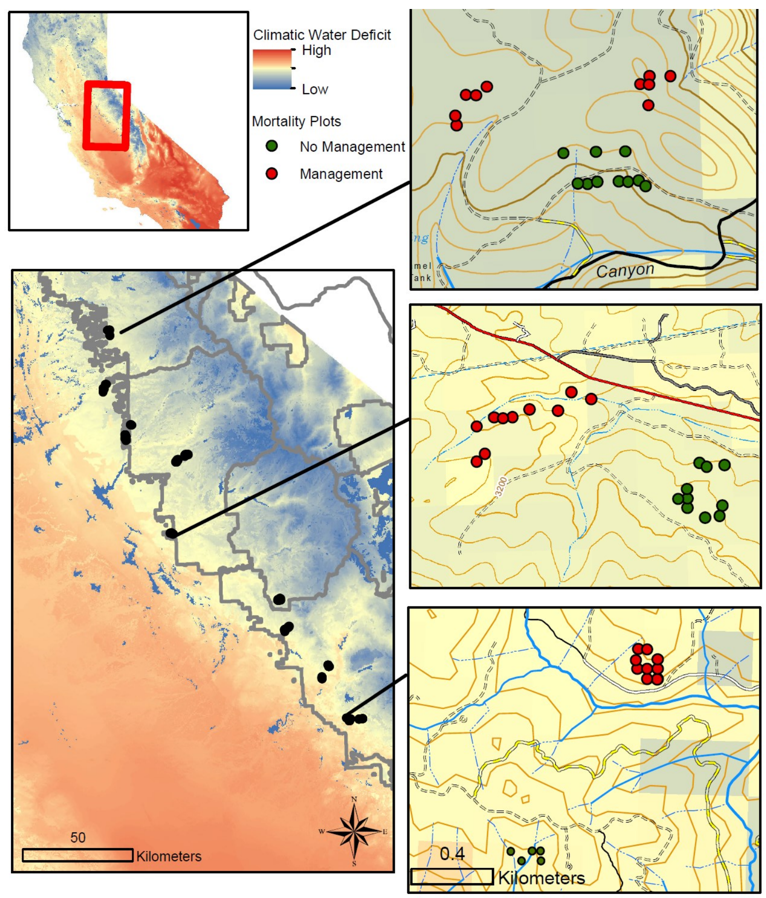
Were treated forests more resistant to the 2012-2015 bark beetle epidemic in the Sierra Nevada?

Treatment works! But as water stress increases treatment effectiveness decreases.

Extreme drought stress and unprecedented bark beetle population growth contributed to the extensive tree mortality event in California, resulting in more than 100 million trees dead as of late 2016. Although changes in climate are an important driver of this mortality event, past management activities and the consequent densification of California forests have also contributed. In some areas, land management agencies have worked to reduce stand density through the use of mechanical treatments and prescribed fire with the goal of restoring forests to more open conditions that are thought to be more resilient to disturbance and changes in climate.

Key Findings

- High tree density leads to more mortality
- Low tree density leads to less mortality
- If water stress is too high density does not matter. Likewise, if density is too high, increased moisture will not compensate for water demand in system
- There was a gradient in treatment effectiveness from north to south



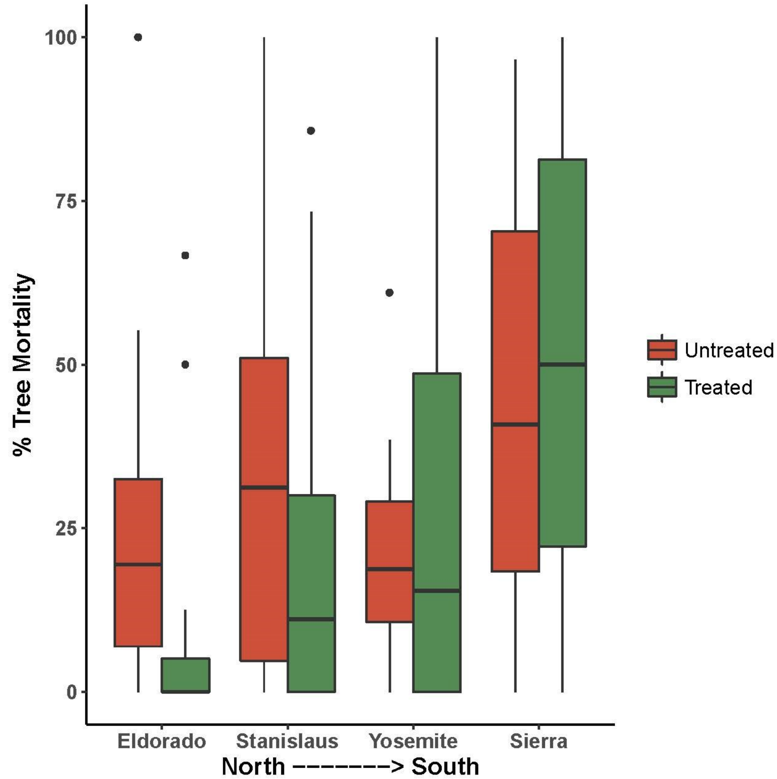
Map of 311 plots at 13 paired study sites (treated versus untreated) across the Sierra Nevada

Additional Contacts: Becky Estes, Shana Gross: Central Sierra Province; Amarina Wuenschel, Marc Meyer: Southern Sierra Province, U.S. Forest Service Region 5 Ecology Program

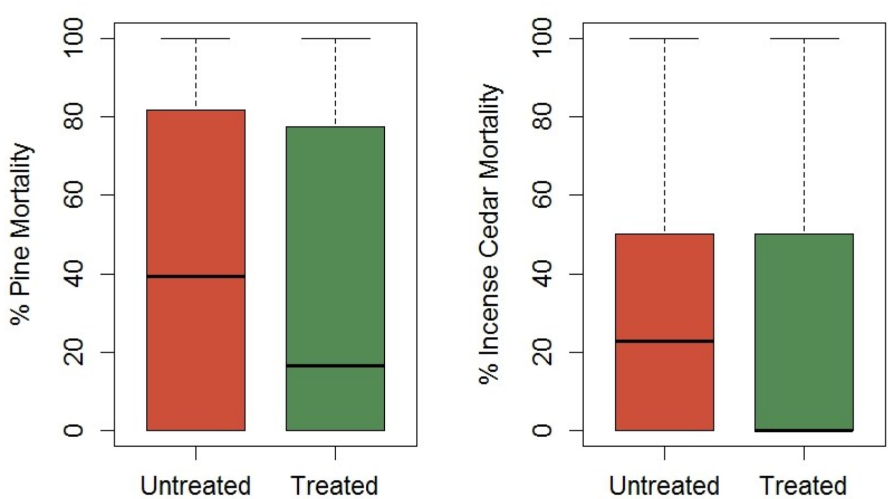
Contact: Christina Restaino, UC Davis, cmrestaino@ucdavis.edu October 2017

Project Overview

We evaluated if treated forests (e.g. thinned and prescribe burned) were more resistant to the bark beetle epidemic and subsequent mortality. We measured tree mortality in paired units (treated vs. untreated) in the central and southern Sierra Nevada. We found that treated units had lower stand density and basal area and that there was less mortality in treated units in almost all cases. Treatment effectiveness decreased with decreasing latitude, which is closely correlated with climatic water availability. Treatments were only effective when and where annual precipitation exceeded 400 mm, and precipitation in our southernmost sites dropped below 400 mm in 2014 and 2015. An even stronger relationship emerged with climatic water deficit (which combines precipitation and temperature to reflect evaporative demand). Even at low stand densities, the probability of mortality exceeded 90% when CWD reached 900 mm, which occurred in 2013 in the southernmost sites. Our findings demonstrate that forest thinning treatments are efficacious in reducing water stress in forests, but underscore the important interaction between water and forest density.



Treatment effectiveness decreases along a latitudinal gradient of water stress. Sites in the southern past of the study (Sierra NF) experienced significantly higher levels of mortality where water stress was so high that density was less important. Conversely, sites in the north (Eldorado NF) experienced less mortality and treatment was more effective.



Tree mortality was higher in untreated units when summarized across all study sites. Solid line represents the median level of mortality.

Plant species diversity is maximized at low to moderate fire severities; drought strongly reduced seedling growth; shrub cover was negatively related to seedling density

Inventory of Vegetation Conditions, Forest Stand Structure, and Tree Regeneration in the Power Fire Burn Area

The purpose of our project was to inventory post-fire conditions throughout the Power Fire (2004) area to determine the effects of fire severity, topography and other factors on vegetation recovery and other variables like fuels. Our data will serve as a baseline for future monitoring of vegetation succession, tree regeneration and fuels accumulation, as well as the effects of future land management in the Power Fire area.

Key Findings

- Seedlings of shade-intolerant tree species were most abundant in high severity classes while shade-tolerant seedlings were most common in unburned and low severity classes.
- As shrub cover increased, tree seedling density declined, most likely due to competition for light and/or water.
- Comparisons of tree regeneration from 2009 to 2015 found conifer seedling abundance nearly doubled and height increased, but annual growth rates significantly slowed, likely due to drought conditions and decreased annual precipitation.
- There was significantly more coarse woody debris in high severity classes than low severity classes.
- Snag abundance increased with fire severity class. The majority of dead trees were still standing and possess some branches (higher decay classes probably had already fallen).
- Native species richness was highest in moderate severity plots. Exotic plant richness increased with fire severity. We found the highest understory diversity in moderate fire severity classes. This result was in keeping with the intermediate disturbance hypothesis.

Stand replacing patch in Power Fire, August 2014, photo taken by Becky Estes

Link to the documents or publications:

Please email me: cjrichter@ucdavis.edu

Contact: Clark Richter, (530) 752-1092, cjrichter@ucdavis.edu

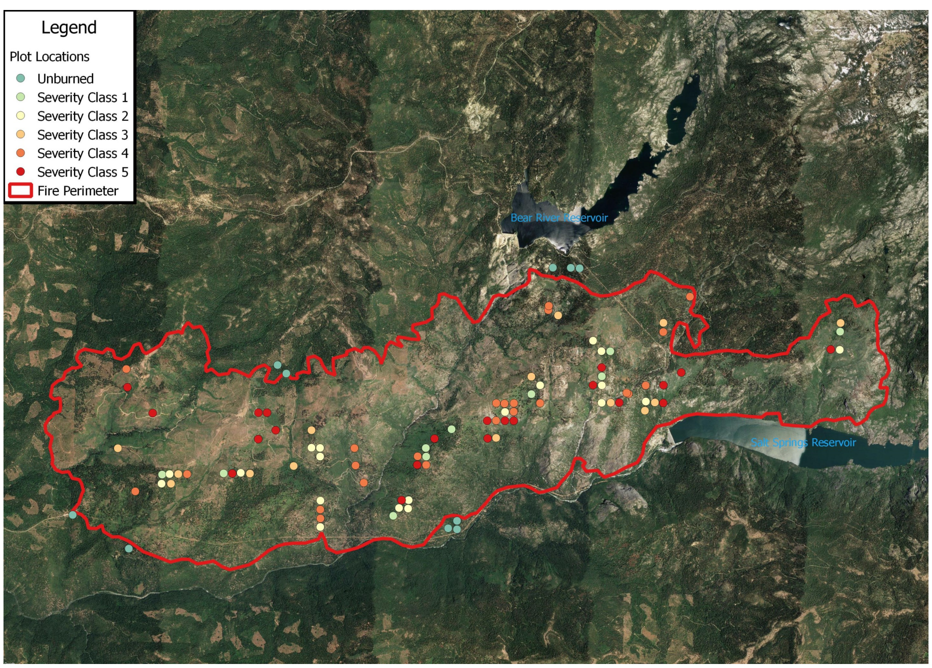
Project Overview

Crew at work, July 2015, photo taken by Clark Richter

The Power Fire burned 16,835 total acres in 2004. During the summers of 2014 and 2015, we established 118 permanent common stand exam and regeneration plots throughout the burn area to summarize current overstory/understory vegetation conditions, forest stand structure, fuel conditions, and conifer/hardwood tree regeneration. A subset of our plots were resampled in 2009. Overall, the greatest differences in conditions were found between unburned/low/moderate fire severity classes and high fire severity classes. These patterns were not always statistically significant, but they were generally consistent with other recent studies on fire effects on mixed conifer forests. In particular: drought (manifested in lack of snowpack and available soil water) reduced tree seedling growth rate (not surprising), moderate severity wildfire encouraged understory plant diversity, and tree seedlings were strongly negatively affected by competing shrubs species that often dominate severely burned sites.

We are interested in the effects of fire severity and other environmental characteristics on faunal species that plants depend on for seed dispersal. We are also interested in comparing conditions within the burn area that were managed post-fire with plots that were left unmanaged.

Our work highlights the implications of high severity burning on plant diversity. It also documents the effect of recent drought on tree regeneration. Both should be considered in future land management decisions aimed at encouraging biodiversity and ensuring robust tree regeneration.



Power Fire plot locations categorized by fire severity class

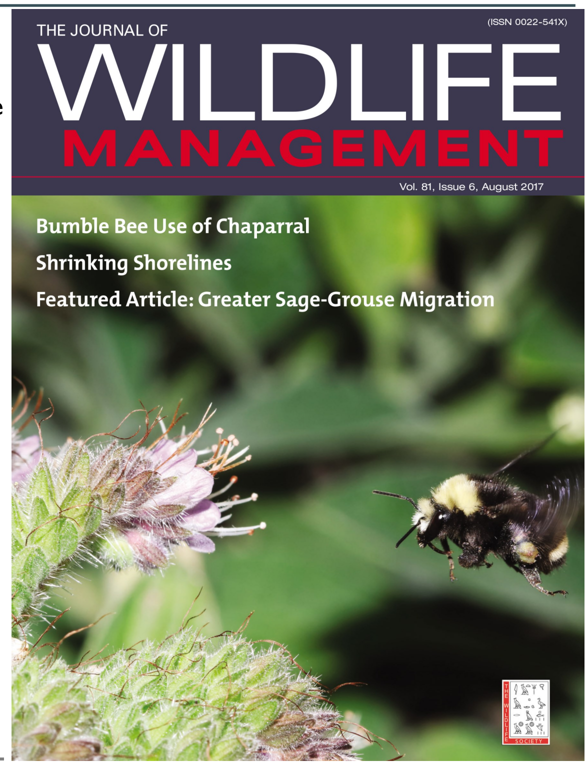
Key Findings

- Bumble bee abundance and species richness was substantially greater in riparian plots than in upland plots.
- Plots dominated by herbaceous vegetation had greater overall species richness and greater individual species abundance.
- Bearclover (*Chamaebatia foliolosa*) was foraged on preferentially over all other shrub species and all but one forb taxon.
- *Phacelia spp* was the plant taxon most frequently used by bumble bees.
- Plant species preferences changed with bloom availability throughout the summer season.

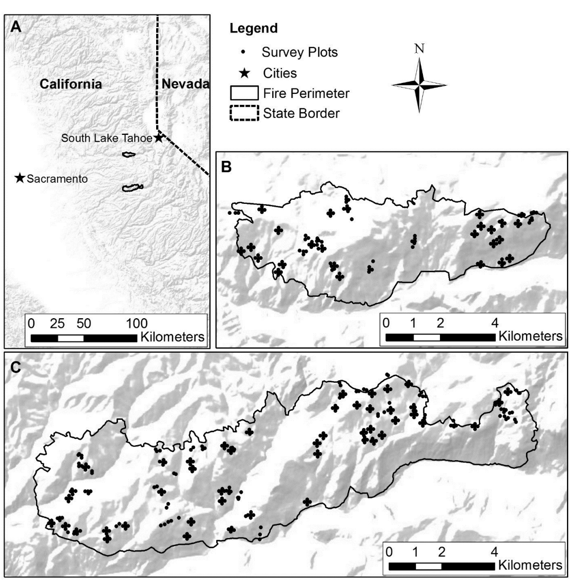
Bumble Bee Use of Post-Fire Chaparral in the Central Sierra Nevada

Our goals were to describe bumble bee abundance and species richness in a post-fire landscape, to compare results from chaparral-dominated upland vegetation with results from interspersed patches of riparian vegetation and to identify characteristics of individual chaparral stands that might make some stands more valuable to bumble bees than others.

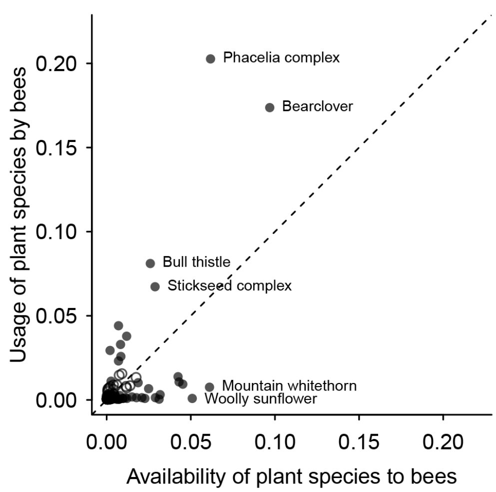
Loffland, H.L., J.S. Polasik, M.W. Tingley, E.A. Elsey, C. Loffland, G. Lebuhn, and R.B. Siegel. 2017. Bumble bee use of post-fire chaparral in the central Sierra Nevada. *The Journal of Wildlife Management* 81:1084–1097.



Right: Cover of August 2017 Journal of Wildlife Management, Bombus vosnesenskii foraging on *phacelia.*



Above: Plot locations for bumble bee surveys on the Power and Fred's Fires, Eldorado National Forest, CA.



Left: Usage versus availability of 70 plant species or species complexes on which bumble bees were observed foraging during the summers of 2015 and 2016.

The Institute for Bird Populations

Link to the documents or publications:

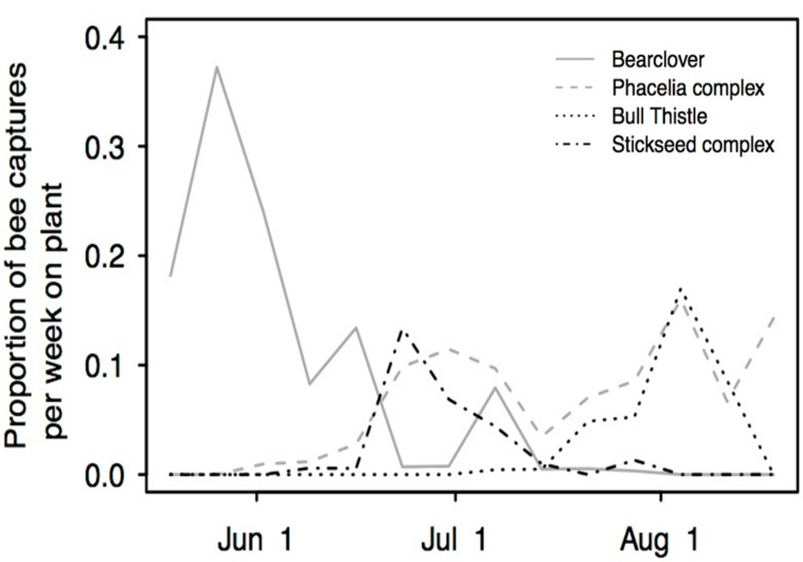
http://onlinelibrary.wiley.com/doi/10.1002/jwmg.21280/full

Contact: Helen Loffland, The Institute for Bird Populations, hloffland@birdpop.org   November 2017

Project Overview

Bumble bees (*Bombus* spp.) are declining across many regions in the Northern Hemisphere, leading to a need for management actions that will protect and enhance their habitats. In the Sierra Nevada of California, montane chaparral is prevalent across the landscape, particularly after forest fires, and may provide important floral resources for pollinators. However post-fire montane chaparral is often targeted for removal during reforestation efforts, to reduce competition with young trees. In 2015 and 2016, The Institute for Bird Populations conducted non-lethal bumble bee surveys within 2 areas in the Sierra Nevada that burned in forest fires in 2004.

We captured 2,494 bumble bees of 12 species, and used Bayesian hierarchical modeling to determine that bumble bee abundance was substantially greater in riparian plots (modeled mean capture rate = 1.10 ± 0.31 bees/survey in 2015, and 2.96 ± 0.83 bees/survey in 2016) than in upland plots (0.47 ± 0.07 bees/survey in 2015, and 1.27 ± 0.18 bees/survey in 2016), which comprised a mix of chaparral shrubs and associated herbaceous plants. Modeled species richness was also greater in riparian plots, with an average mean richness of 4.1 ± 1.8 bumble bee species in riparian plots versus 2.3 ± 1.3 species in upland plots across the 2 years of the study. Within upland and riparian areas, plots dominated by herbaceous vegetation had greater abundance and species richness. Bearclover (*Chamaebatia foliolosa*) was foraged on preferentially over all other shrub species and over all but 1 forb taxon. Abundance of bearclover was associated with increased occupancy probability in the most abundant bumble bee species on our study plots. The genus *Phacelia,* commonly associated with upland chaparral in our study area, was the plant taxon most frequently used by bumble bees, and appeared to be particularly important during mid-summer after bearclover flowers became scarce. Our findings suggest that post-fire chaparral communities are generally less intensively used by bumble bees than nearby riparian vegetation but may provide habitat. Because habitat characteristics affected the occupancy of individual bumble bee species differently, managers should consider foraging preferences of target bumble bee species when making land management decisions.

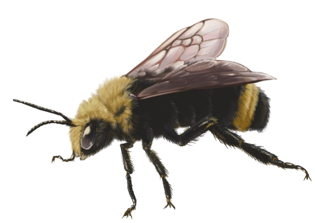


Above: The temporal stratification in blooming by 4 significantly preferred plant species highlights the value of heterogeneous upland habitat.

Management Implications

Our results suggest that Bumble bees in post-fire landscapes will benefit from reforestation techniques that:

- Retain some patches of herbaceous cover interspersed with bearclover to provide temporally and spatially varied foraging resources.
- Postpone mechanical treatment or herbicide applications until after peak bearclover bloom period.
- Use only targeted herbicide applications to avoid treatment of non-target shrubs and forbs.



Bumble bee artwork by Lauren Helton.

Contact: Helen Loffland, The Institute for Bird Populations, hloffland@birdpop.org November 2017

Sierra Nevada forests support a diverse bat community.

Wildfire and forest management influence forest structure and subsequently bat habitat quality.

Monitoring bats in the Power Fire: ecological implications for post-fire restoration

Bat monitoring was conducted 10-13 years following the 2004 Power Fire to assess the impact of the burn on the local bat community. Acoustic surveys that record bat echolocation calls were designed to test for effects of varying levels of burn severity, and post-fire management on bat occurrence and activity levels.

Key Findings

- All 17 Sierra Nevada bat species were observed at least once either within the Power Fire or at nearby unburned sites.
- Average species diversity was higher at burned locations than unburned locations.
- Average species richness did not vary with burn severity, but the composition of the local bat community shifted across the severity gradient.
- Any negative effects of post-fire salvage logging and reforestation on species richness were not apparent a decade following the fire.

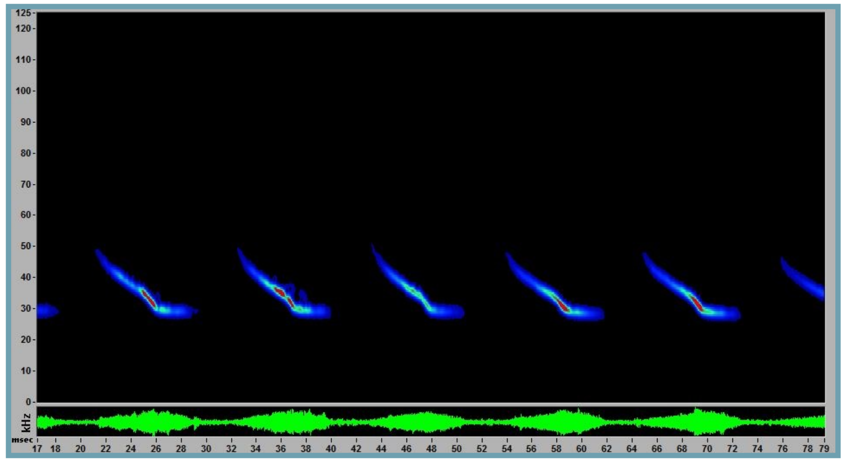
An automated recording unit deployed in the Power Fire.

The Power Fire created a range of habitats utilized by a variety of bat species.

Power Fire Monitoring Report:

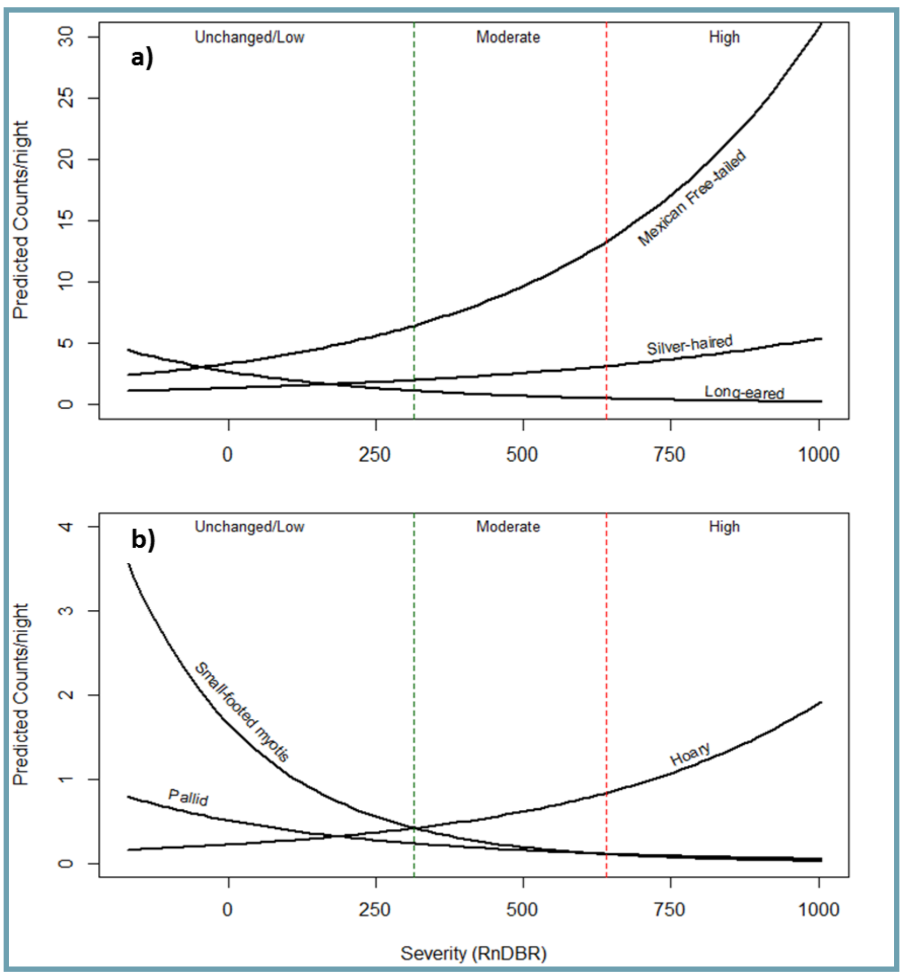
Steel, Z. L. and H. D. Safford. 2017. Acoustic inventory and monitoring of bat species in the Power Fire burn area – 2014, 2015, and 2016 field season. Prepared for Eldorado National Forest, California, USDA Region 5.

Project Overview



Example visualization of a recorded bat call (pallid bat)

Fire drives landscape pattern and wildlife community composition across many ecosystems in the western United States. Yet the influence of wildfire on habitat quality of forest bat species is largely unknown. We used automated recording units and classification software to survey forest bat species during 2014-2017 in and around the 2004 Power Fire burn area. Bat activity was generally greater within burned areas as compared to unburned controls. However, both the direction and magnitude of this effect varied by species. Likewise, individual species diverged in their response to the level of burn severity within the fire perimeter. These findings suggest that diversity of the Sierra Nevada bat community may benefit from fire in the aggregate. A mix of fire effects such as those found in a natural fire regime may be necessary to maintain the range of habitats utilized by the various species observed. Salvage logging has the potential to negative effect roost availability for some bat species in the short-term, but such effects were not apparent a decade following the fire.



The effect of burn severity on bat activity of a) three common species and b) three uncommon species.

The maintenance of a variety of forest structures and habitats represented in post-fire landscapes would promote a diverse bat community.

The increased use of prescribed fire and managed wildfire, which mimic the natural fire regime, would help provide the range of resources and habitats needed by Sierra Nevada bats.

Contact: Zack Steel, zlsteel@ucdavis.edu

Using birds to monitor the effectiveness of post-fire restoration in central Sierra Nevada fires

Burned areas, including those that burned at high severity, host an abundant and diverse bird community.

At 10-12 years post-fire, the shrub-associated birds are most abundant.

This project was designed to measure bird response to landscape fire effects and post-fire management practices in two older fires - the 2004 Power and Freds fires on the Eldorado National Forest. Point count surveys during 2014-2016 were used to estimate bird abundance and species richness of post-fire focal species in response to burn severity, high severity patch size, salvage logging, shrub abatement and reforestation efforts.

Key Findings

- Snag-dependent and shrub-nesting species such as House Wren and Fox Sparrow reached their highest abundance in high severity burned areas.
- Models showed 40-70% shrub cover was ideal for shrub-associated bird species.
- Edges of high severity patch showed higher diversity compared to interior areas.
- At 10-12 years post-fire, snag-associated species had higher abundance in unsalvaged areas compared to salvaged areas.
- Areas treated with herbicides had 30% lower shrub-nesting bird abundance compared to similar untreated high severity burned areas.

Fox Sparrow nests at high density in older burned areas, taking advantage of moderate to dense shrub cover. Photo by Tom Grey.

The Power Fire landscape shows a range of fire severity effects including dense shrub fields, live conifers and standing snags. Photo by Zack Steel.

Full Report

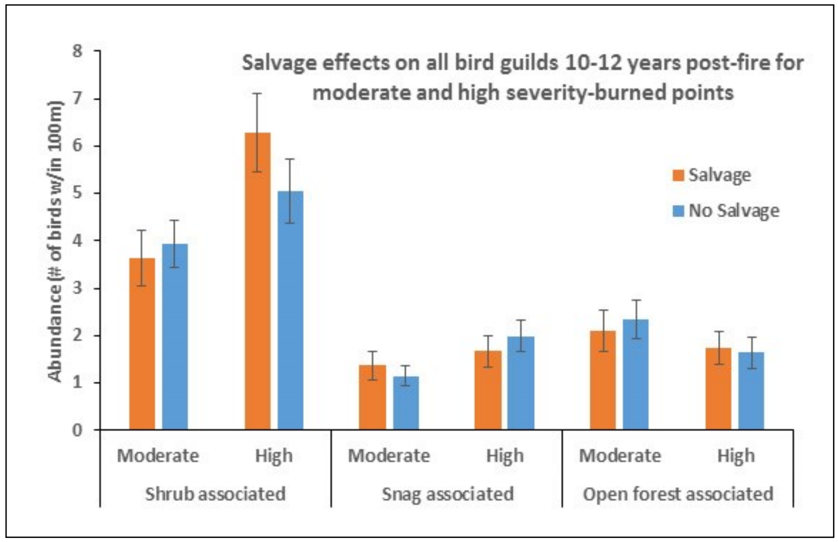
Avian Monitoring in the Freds and Power Fire Areas: Final Report. Alissa Fogg and Ryan Burnett, Point Blue Conservation Science; Zack Steel, UC Davis. April 2017. Point Blue Contribution # 2138.

Contact: Alissa Fogg, (530) 903-5830, afogg@pointblue.org

Project Overview

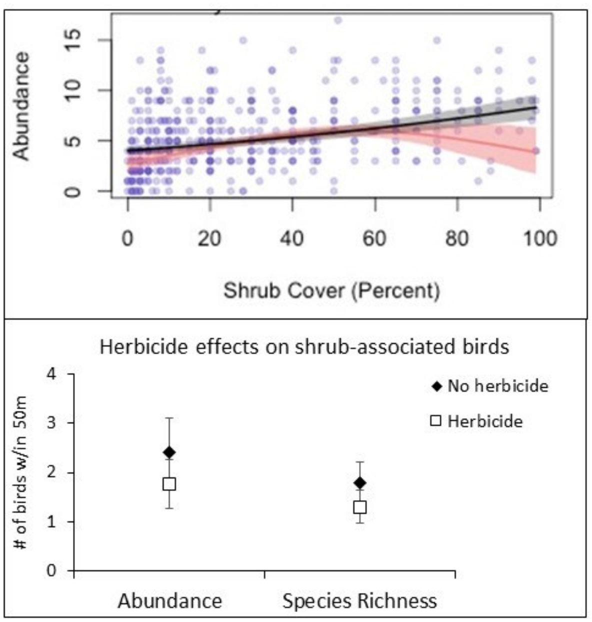
Post-fire management typically focuses on snag removal, conifer establishment and reduction in shrub cover that dominates after stand replacing fire. Birds are excellent ecological indicators and can tell us how post-fire management is affecting the ecological community.

The legacy of salvage logging benefited shrub nesting birds, possibly due to less nest predators that use snags. However, more recent herbicide efforts to reduce shrub cover below 20% resulted in a significant decline in abundance compared to untreated areas. For snag-associated birds, such as House Wren, these species were more abundant in unsalvaged areas that burned at high severity, indicating the continued need for snag nesting habitat.



Salvage logging had a positive effect on shrub birds, however, salvage had a negative effect on snag species in high severity areas, even 10-12 years post-fire. Snag retention varied from 4 per acre in Freds Fire to 0.25 - 5 acre snag patches in the Power Fire. Error bars show 95% confidence intervals.

The size of high severity patches is an important predictor of bird species abundance in the Freds and Power fires. Species such as Fox Sparrow and Green-tailed Towhee prefer the interior of large high severity patches, while others such as Brown Creeper and Red-breasted Nuthatch prefer to be on the edge near green forest patches.



Top panel: Shrub associated bird abundance increased (black line) with shrub cover; there was also support for moderate shrub cover values (40-70%; red line). Bottom panel: herbicide treated areas had lower bird abundance and species richness. Error bars on both figures are 95% confidence intervals.

Large high severity patches with dense shrub cover provide important habitat for interior-nesting bird species, such as Fox Sparrow and Green-tailed Towhee.

If shrub control herbicides are needed, these should be focused near mature tree patches to reduce fuels and protect those areas from future high severity fire. Consider using prescribed fire or managed wildland fire.

Contact: Alissa Fogg, (530) 903-5830, afogg@pointblue.org

Black oaks need fire to thrive against conifer competition, but severe burns jeopardize the benefits provided by mature oaks. Field studies are examining whether thinning treatments might speed their recovery.

Does thinning California black oak basal sprouts following severe fires yield ecosystem dividends?

Land managers want to know whether thinning the basal sprouts on top-killed California black oaks following wildfire pays dividends by enhancing growth of the remaining stems. Such treatments may offer a way to more rapidly restore key services that mature oaks provide. We have synthesized published research and have initiated a new field study on the Power Fire, as part of a larger collaboration in with researchers from Humboldt State University in the northern Sierra Nevada.

Key Findings

- High– and moderate-severity fire often kills the above-ground stems of black oak trees,
- Even though the trees typically resprout (Fig. 1), such top-kill results in decades of lost services from acorn production and wildlife habitat.
- Thinning resprouting stems down to one or a few stems has potential to increase growth of remaining stems, based upon local accounts and some limited studies.
- Field studies are underway, including one on the Power Fire, to evaluate the potential benefits of such treatments.

Figure 1: Severe fires commonly kill the stems of mature black oak trees, resulting in many small sprouts at the base of the dead stem.

Figure 2: Oak groves that burned at low severity in the Power Fire remain important habitat for deer and other wildlife species.

For information on restoring black oaks, see Long, J. W.; Anderson, M. K. Quinn-Davidson, L.; Goode, R. W.; Lake, F. K.; Skinner, C. N. 2016. Restoring California black oak ecosystems to promote tribal values and wildlife. Gen. Tech. Rep. PSW GTR-252. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station. 110 p. https://www.fs.usda.gov/treesearch/pubs/51080

Contact: Jonathan W. Long, (530) 759-1744, jwlong@fs.fed.us

Project Overview

Introduction

Managers want to know whether thinning the resprouts is effective in accelerating recovery of ecosystem services such as acorn production and wildlife habitat.

Methods

We reviewed the limited research on thinning stems resprouting from the base following top-kill from the Sierra Nevada and from Spain, where such treatment has been used. We gathered field data on effects of the Rim Fire and Power Fire on black oaks. We also designed a field study for the Power Fire as part of a larger collaborative research effort in the Sierra Nevada with researchers from Humboldt State University.

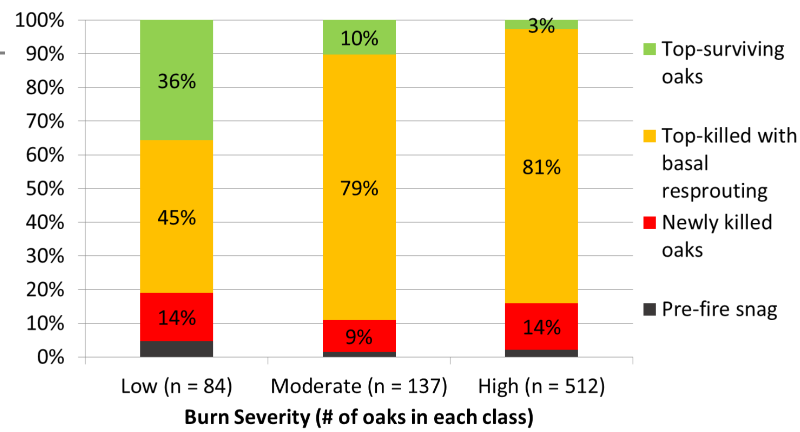


Figure 3: The tops of black oak trees did not survive well in areas mapped at moderate or high severity that were sampled 1 year after the Rim Fire.

Findings to Date

Studies of several fires has shown that the frequency of top-kill increases with burn severity, and relatively few stems survive in high severity patches. Where such patches are particularly large, management interventions to accelerate stem development may be a priority. Although local managers commonly suggest that thinning basal sprouts is effective in accelerating the growth of residual stems, there has been limited study to evaluate its effectiveness in post-fire conditions. Thinned stems can respond by forming new branches, which limits the effectiveness of the treatment, and information about the recovery of untreated oaks is also lacking. Field research will be conducted in 2018, with plans for future monitoring as well.

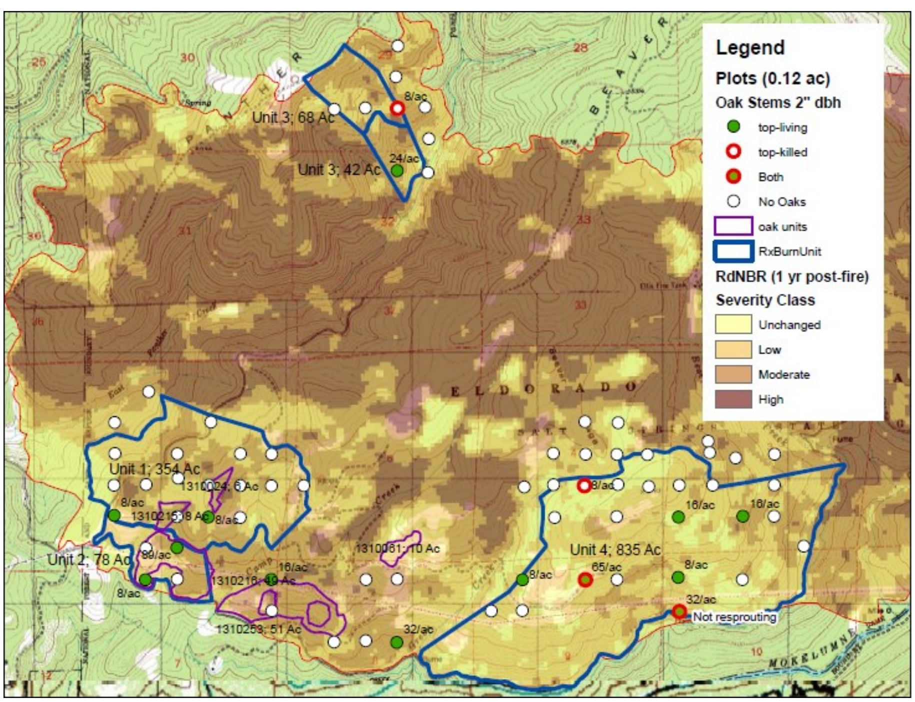


Figure 4: Preliminary study plots in Power Fire, showing location of top-living, top-killed, and fully dead black oaks relative to burn severity.

We lack information on how long it will take for top-killed black oaks to regrow to form large trees and produce acorns, or how trees will respond to thinning treatments. People interested in these treatments for their lands may want to follow or replicate our ongoing study to help answer these questions.

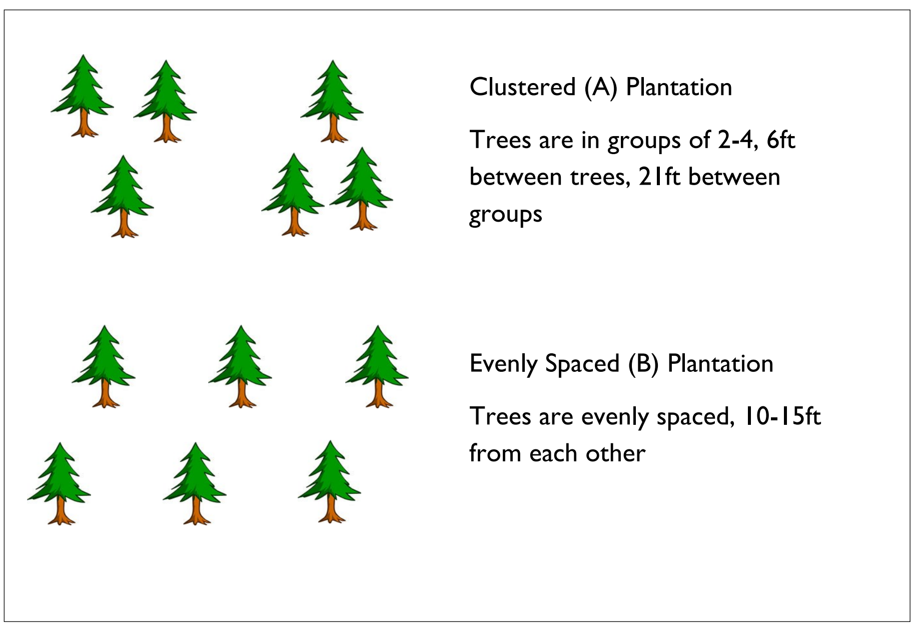
With appropriate management techniques, plantations are an important tool in restoring post fire environments to resilient forests

Post-fire management regimes on plantation growth and development: can we find effective tools to quickly restore a resilient forest?

The goal of this study is to compare the effects of two different planting arrangements, clustered and evenly spaced, and natural regeneration on stand growth dynamics and plant diversity under different microsite conditions in a post fire project. All stands were established after the high-severity Power Fire in the Eldorado National Forest in 2004.

Key Findings

- Planted trees grew significantly larger than naturally regenerated trees with available seed sources
- Plantations are much easier to be pre-commercially thinned and restore forests faster than natural regeneration sites
- Ponderosa and Jeffery pine dominate both plantations and natural regeneration sites, but there is considerable incense cedar naturally regenerated on clustered plots and on the natural regeneration sites
- No difference was found in growth between the two types of planting configuration



Description of plantation arrangement

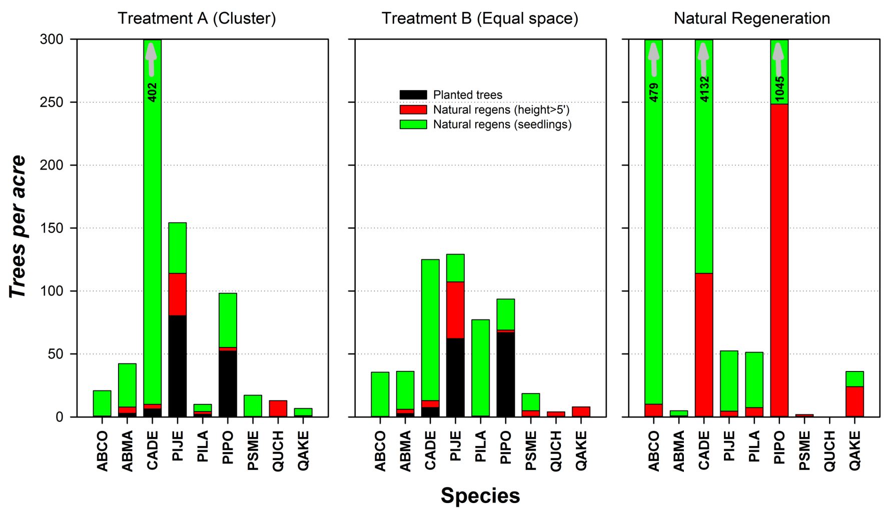
Top to bottom: Cluster plantation, evenly spaced plantation, natural regeneration

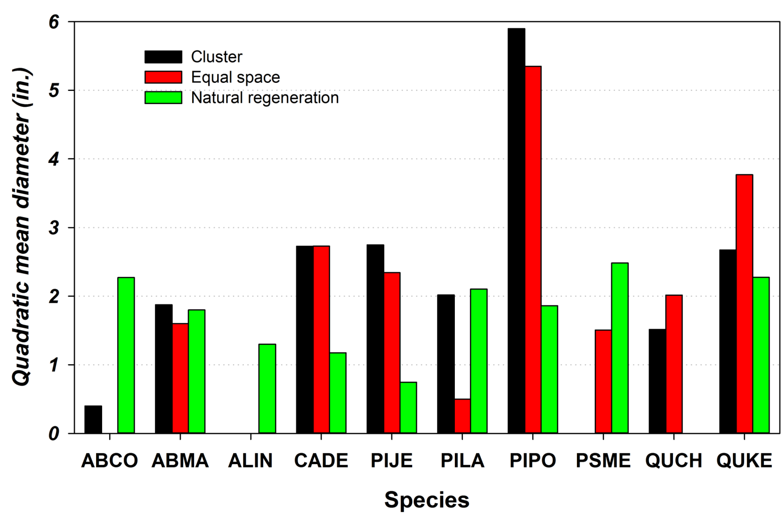
Contact: Jianwei Zhang, jianweizhang@fs.fed.us

Project Overview

After high severity fires, regeneration of conifers is often limited because of loss of seed source and shrub encroachment. Plantations are a common tool in restoring the forest quickly. After the 2004 Power Fire in Amador County, two types of plantations were implemented: a clustered arrangement with trees in groups of 2-4 and evenly spaced plantations. The goal of the clustered plantation is to promote spatial heterogeneity into the stand to facilitate the growth of the stand into pre-fire conditions. Our project has the following goals:

1. Identify functional differences between clustered and evenly spaced plantations and natural regeneration stands
2. Characterize the spatial patterns of natural recruitment and mortality in planted and unplanted stands
3. Model fire behavior in each stand
4. Model stand growth at least 50 years into the future





Top: Trees per acre for planted trees and natural regenerated saplings (height>5') and seedlings by species and treatment. Bottom: Quadratic mean diameter by species at different planting configuration plots (including some natural regens) and natural regenerated plots.

We intend for the results of this research to help inform land mangers when working to restore post-fire lands by providing feedback on multiple ecological elements

SPECIES KEY:

- **ABCO** = *Abies concolor*
- **ABMA** = *Abies magnifica*
- **ALIN** = *Alnus incana*
- **CADE** = *Calocedrus decurrens*
- **PIJE** = *Pinus jefferyii*
- **PILA**= *Pinus lambertiana*
- **PIPO** = *Pinus ponderosa*
- **PSME** = *Pseudotsuga menziesii*
- **QUCH** = *Quercus chrysolepis*
- **QUKE** = *Quercus Kelloggii*

Data collection and preliminary summary were done by collaborating with Iris Allen, Mukti Subedi, and Sophan Chhin in West Virginia State University.

Contact: Jianwei Zhang, jianweizhang@fs.fed.us