Managing fire regimes in a changing world (good fire/bad fire)

Bandits, Birds, Burning, and Beliefs: The Story of Florida Scrub Jays at Jonathan Dickinson State Park

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Rob Rossmanith
Florida Park Service

Jonathan Dickinson State Park (JDSP) is a 4,250 hectare property in south-eastern coastal Florida. JDSP is one of 175 state parks in the Florida Park Service system, which as an agency won its fourth National Gold Medal in 2019. JDSP annually welcomes 300,000 visitors and includes a rare ecosystem, Florida scrub. One of the inhabitants of Florida scrub is the Florida Scrub Jay, a Florida endemic bird that is Federally Threatened. The population of the bird, within JDSP, peaked in the early 1990s due to several wildfires in the 1970s and 1980s and then crashed in the early 2000s. Persistent use of prescribed fire and interpretation of these efforts to the public has created an accepting public outlook which supports the parks' prescribed burning. Due to prescribed fire in the scrub Florida Scrub Jays now thrive and are rebounding in numbers, which we know because of supervised citizen science. The park is a model for using prescribed fire in urban settings and in leveraging community efforts to monitor imperiled species.

Estimating the Impacts of Wildfire on Ecosystem Services in Southern California

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Emma Underwood
University of California, Davis

Emma C. Underwood, University of Davis, California, USA and
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Chaparral-type shrublands characterize the world's Mediterranean-type climate regions. In southern California they are the most extensive ecosystem and dominate the four southern USDA Forest Service National Forests. Wildfire is a natural disturbance in California's shrublands and critical for its healthy functioning. However, a rise in anthropogenic ignitions has resulted in increased fire frequency, which is having disastrous effects on property and human lives and incurring millions of dollars in suppression costs. Less obvious, though, are the intangible environmental impacts of wildfires – the consequences on the provision of ecosystem services to the millions of people who live in close proximity. We developed a web mapping tool to quantify fire impacts on six ecosystem services: carbon storage, water runoff and groundwater recharge, sediment erosion, recreation, and biodiversity. The removal of vegetation increases water runoff, recharge and sediment erosion post-fire, and decreases carbon storage immediately after. Moreover, frequent short-interval fire is causing the type-conversion of native shrubs to invasive annual grasses. Quantifying the impacts of wildfire on ecosystem services in addition to routine fire suppression expenses is increasingly recognized as an important component of natural resource management on public lands in southern California. In addition, assessing areas of high ecosystem service provision can help prioritize areas for post-fire management activities, such as stabilizing slopes in areas of high erosion risk, thereby helping to ensure their long-term provision.

Increasing Prescribed Fire Capacity and Quality in a Changing World

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Sasha Ernst
Florida Park Service

The Florida Park Service (FPS) is a four-time National Gold Medal winning state park system consisting of 175 state parks, trails, and historic sites spanning nearly 800,000 acres. The FPS mission to provide resource-based recreation while preserving, interpreting, and restoring natural and cultural resources in Florida is quite a challenge to meet while also hosting over 30 million visitors in 2019. Florida is a major tourism destination, has a booming housing market and economy, and has an ever-increasing resident population of over 20 million people. Many state parks are in, or near, the wildland-urban interface providing significant challenges for engaging community support, smoke management, and ensuring public safety. Despite these challenges, records for total acreage burned have been set in the past three years, and last year was the FPS's most successful prescribed fire season ever resulting in 96,417 total acres burned. FPS is accomplishing on-average an approximately three-year fire return interval while actively managing nearly 300,000 acres of fire-dependent natural communities. We are increasing capacity (burning more acres) and focusing on quality (meeting ecological objectives) by optimizing cooperation, effective prescriptions, and implementation window management. I will explore some of the strategies, successes, and failures of FPS burning efforts in order to share lessons learned and contribute to initiatives to help other land managers realize our common goal of maximizing prescribed fire to promote healthy, fire-maintained natural communities.

The heat is on. Cheatgrass engineered habitats are thermally unsuitable for shrub dependent Great Basin Reptiles

Topic: Managing fire regimes in a changing world (good fire/bad fire)

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McGinley and Associates, Inc.

Co-authors: Chris R. Feldman - University of Nevada, Reno; Chris M. Gienger - Austin Peay State University.
The altered structure and function of cheatgrass (Bromus tectorum) engineered habitats have been implicated in biodiversity reductions throughout the Great Basin. Yet, an understanding of the mechanisms driving these losses is still lacking. Design and implementation of conservation plans requires an understanding of these local scale mechanisms. We have quantified significant declines in reptile abundance and diversity across cheatgrass dominated landscapes in the northwestern Great Basin Desert. We examined a likely mechanism behind these declines: that the state change from Great Basin sagebrush habitat to cheatgrass dominated landscapes has substantially altered the thermal regimes required by desert lizards. We deployed arrays of operative temperature models across NW Nevada to quantify the thermal regimes of both native-shrub and cheatgrass-invaded habitat types. These data were analyzed using several indices of habitat thermal quality and compared against published values of the thermal tolerances for a common and well-studied lizard species of the region, the western fence lizard (Sceloporus occidentalis). As a whole, cheatgrass habitat is significantly warmer than shrub habitat and represents a landscape in which S. occidentalis is likely to be thermally stressed. In particular, there are fewer optimal thermal patches and a significant reduction in the amount of activity S. occidentalis may achieve in cheatgrass habitat. The loss of shrub cover in cheatgrass landscapes represents a substantially increased risk of thermally induced death for this species. Our data show that cheatgrass habitat is thermally unsuitable for at least one species (Sceloporus occidentalis) and suggest that the altered thermal regime of cheatgrass engineered habitats is a mechanism driving the declines in Great Basin reptile biodiversity.

Wildfire effects on belowground carbon and nitrogen cycling and microbial biomass in the Sierra Nevada

Topic: Managing fire regimes in a changing world (good fire/bad fire)

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Coauthors: Erin Hanan, Jessica Miesel, Matthew Dickinson, Jonathan Greenberg, Carol Ewell, Laura Wade

Fire is a key factor regulating carbon (C) and nitrogen (N) retention in soils of the Sierra Nevada. As fire regimes shift in response to climate change and management, it is vital to understand how belowground C and N cycling will respond. However, studying fire is challenging. Fire timing and location are difficult to predict and as a result, researchers must often rely on space-for-time substitutions to evaluate fire effects. Unfortunately, these substitutions make teasing apart fire effects from other drivers challenging. To eliminate such problems, many studies have focused on prescribed fire, which enables researchers to conduct pre- and post-fire measurements at a known location. However, prescribed fires differ from unplanned fires (hereafter called wildfires) in their severity, heterogeneity, and spatial scale. Thus, to understand the effects of wildfire on soils, we need to incorporate location specific pre- and post-fire sampling. Here, we collected soil samples in the path of advancing wildfires in the Sierra Nevada and then resampled the sites immediately post-fire, one month, and six months later. Additionally, because some of our sampling sites did not burn, we were able to examine the role of wildfire alongside seasonal processes that influence soil dynamics. We analyzed the forest floor and mineral soil for N mineralization and nitrification rates, pH, microbial biomass, and total C and N.

Preliminary results show pronounced spikes in pH following fire for both mineral soil and forest floor. The magnitude of these spikes increased with fire severity and were larger in the forest floor than in mineral soil (i.e., 4 and 0.7 pH unit increases, respectively, in the high severity plot). Our results also suggest that microbial responses vary with fire severity: microbial biomass was higher in mineral soils that burned at high severity while plots that burned at low severity had similar mineral soil microbial biomass to unburned plots one month post fire. Forest floor microbial biomass however, was lowest in the high severity fire plots. Preliminary results also indicate different biomass response to spring thawing with larger increases in areas that did not burn. Our current work seeks to link soil temperature measurements from wildfires with belowground biogeochemical fluxes to quantify the effects of fire energy. These measurements are crucial for projecting how carbon and nitrogen retention will respond to future fire and climate conditions.

SYMPOSIUM: Fire restoration and consequences for ecosystem management

Applications of fire behavior modeling to strategic land management at project to landscapes in the Sierra Nevada, CA

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Edward Smith
The Nature Conservancy

Frequent-fire, dry conifer forests throughout the world are fire-starved and altered in structure, composition, and ecological function due to successful fire suppression activities for over a century in many locations. Re-introduction or restoration of fire regimes to fire-adapted forests is a key process toward improving conditions for wildlife habitat, watershed function and safety for human communities, but re-introducing fire can be difficult due to terrain, accumulated forest fuels, and activity costs, especially in a hotter, drier climate. There are millions of acres throughout the western USA in need of forest fuel removal through mechanical harvest of surface and ladder vegetation or re-introduction of prescribed fire, or both, but the cost of these treatments in both social goodwill as well as operational complexity is prohibitive. Using fire behavior modeling such as FLAMMAP and fire simulation modeler (FSIM) can provide planners and managers with tools to help prioritize areas for restorative treatments by disclosing where fire is more or less likely to occur, and when it does occur, the intensity of its behavior. This analysis can be used at the landscape scale to select which areas are in need of mechanical harvest or prescribed fire or both, to inform where investments are more likely to have a beneficial outcome. We employed fire behavior modeling on the French Meadows Project west of Lake Tahoe in the Sierra Nevada of California both to select areas for treatment, and also to disclose the potential reduction in fire intensity with and without treatment for environmental clearance documentation in the production of an Environmental Assessment for the Tahoe National Forest across 10,000 hectares. The project decision was signed in December 2018 and implementation began in summer of 2019. We also used fire behavior modeling across the 1-million-hectare landscape referred to as the Tahoe Central Sierra Initiative (TCSI) to prioritize large areas that could be restored, and to identify project areas that will be analyzed under subsequent environmental review. We are also using seasonally extracted fire behavior model outputs to identify areas within the Tahoe National Forest that are more suitable for the opportunity to utilize lightning-ignited wildfires for resource benefit. Fire behavior models have proven to be valuable tools for planning ecological restoration treatment projects and strategic plans in the Sierra Nevada. Broad application across large landscapes and project areas can help accelerate the implementation of projects to return fire to ecosystems that have co-evolved with fire.

Ecosystem impacts of managed wildfire in Yosemite National Park

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Scott Stephens
UC Berkeley

Since implementing policies to allow wildfires to burn the Illilouette Creek basin over 45 years ago, land managers have allowed fire regimes to return to a near natural state. Over the last 20 years we have done research examining the factors impacting fire severity, the proportions of landscape burned at different severities, how realistic our understanding of fire history is based on fire scar reconstruction, how vegetation states have been changed by a functioning fire regime, and how > 40 fires impacted the mountain hydrology of this 15,000 ha watershed. These questions, and their subsequent answers, are critical to furthering our understanding of how fire historically shaped the landscape and how it could continue to do so today. The Illilouette Creek basin provides hope for how upper montane forests in the Sierra Nevada could be managed into the future.

Fire restoration and consequences for ecosystem management

Topic: Managing fire regimes in a changing world (good fire/bad fire)

John Williams
University of California, Davis

In the western United States and in many other fire-adapted landscapes, decades of fire suppression policies have left forests out of equilibrium with natural fire regimes. Reintroducing fire to these landscapes under controlled conditions offers a path to restoring affected ecosystems and to achieving a variety of ecological, conservation, land management and risk abatement objectives. This symposium will specifically address the use of prescribed fire within or bordering public lands and protected areas, and how these and related management actions can be leveraged for multiple benefits. Speakers will describe how they integrate mixed- or limited-severity burn objectives, fuels reduction, timber management, habitat protection and other goals into burn plans. They will also discuss how they control for the vagaries of conditions that add risk and uncertainty to their ability to burn. Additionally, in the panel discussion, speakers and participants will talk about navigating the constraints of weather, smoke, personnel shortages, and narrow burn windows, as well as how to deal with out-of-control burns, damage control and public relations. Finally, participants will be encouraged to share ideas on the use of creative approaches and collaborations with communities, NGOs, the private sector and multiple land management agencies to improve the probability of executing a successful burn.

Following fire with fire: fire as a key restoration tool in areas affected by California's largest wildfire

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Gabrielle Bohlman
USDA Forest Service

During the summer of 2018, the Ranch Fire burned over 410,000 acres in the northern California Coast Ranges, about 288,000 of which are on the Mendocino National Forest. The Ranch Fire was the largest fire in California history. The fire burned with varying intensity, leaving a mosaic of burn patterns on the landscape that ranged from unburned islands to large areas where tree canopies were completely consumed. In order to help managers with the task of restoring this post-fire landscape, I used the US Forest Service Region 5 Post-fire Restoration Framework to develop a restoration strategy for yellow pine and mixed conifer forests within the fire perimeter. The resulting strategy identifies the use of prescribed fire and managed wildfire as a key tool for restoring large portions of the Ranch Fire footprint. This talk will provide a brief overview of the development of the Ranch Fire post-fire restoration strategy followed by specific examples for how the Forest plans to use fire in their restoration efforts.

Framework for post-fire restoration in California's national forests

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Marc Meyer
USDA Forest Service Pacific Southwest Region

Increasing extent and frequency of high severity wildfires and other large-scale disturbances pose a significant threat to California's ecosystems. This is apparent in forest, chaparral, and sagebrush steppe landscapes, where departure from natural fire regimes may result in large-scale alteration of terrestrial ecosystems and deterioration of the services they provide. Based on these trends and a broader consideration of sustainability, there is a growing need for a comprehensive and science-based approach to post-fire management. We propose a framework to guide the development of post-fire restoration strategies on the national forests in California. The framework is founded on a set of guiding principles and a flexible five-step process that leads to the development of restoration planning and projects. The restoration framework can inform future post-fire management, monitoring, and research in California's diverse ecosystems.
Coauthors: Jonathan W. Long, Hugh D. Safford, Becky Estes, Kyle Merriam, Nicole Molinari, Shana Gross, Michelle Coppoletta, Sarah Sawyer, Ramona Butz, Amarina Wuenschel, Angela White, Brandon Collins, Malcolm North, Scott Conway, Michele Slaton, Clint Isbell, Dana Walsh, and Emma Underwood

It's now or never: the narrowing window of opportunity for maintaining fire resilience in a restored old growth stand

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Michelle Coppoletta
USDA Forest Service Region 5 Ecology Program

The restoration of forest structure, which was historically created and maintained by frequent fire, has become a central tenet of forest management on public lands. However, information about vegetation and fuel succession in restored stands, as well as the influence of these variables on the longevity of fire resilience, is currently incomplete or lacking. The Beaver Creek Pinery in the Ishi Wilderness of California is frequently cited as a contemporary example of a heterogeneous wildfire-resilient forest with structural attributes that are characteristic of historical frequent-fire ponderosa pine forests. We examined stand-level and landscape-scale changes in forest structure, species composition, and surface fuels in this contemporary reference site by revisiting plots that were established following a 1994 wildfire. We then used this data in forest growth models to project future changes in stand structure over time and evaluate potential fire behavior and fire effects under different fire weather scenarios. In the 22-year absence of fire, the Beaver Creek Pinery experienced substantial infilling of canopy gaps, declines in oak regeneration, and increases in the size and density of tree clusters. Despite these changes, forest conditions are currently considered within the historical range of variability for these forest types and are predicted to be resilient to wildfire in the near-term. However, our modeling of future stand conditions and potential fire risk also suggests that this resilience may be short-lived, with crown fire becoming the predominant behavior in as few as ten years. As vegetation and fuels develop, the effectiveness of prescribed burning at maintaining and restoring desired conditions, will also diminish. Burning in the next 10-20 years, under controlled conditions, will likely be the most effective strategy for reducing surface fuels and small trees, and for maintaining the unique structural heterogeneity of this ecologically significant reference stand.
(Co-authors: Michelle Coppoletta, USDA Forest Service Region 5 Ecology Program; Eric Knapp, USDA Forest Service Pacific Southwest Research Station; Natalie C. Pawlikowski, USDA Forest Service Pacific Northwest Research Station; Alan H. Taylor, The Pennsylvania State University

Leveraging monitoring, modeling, and messaging to minimize smoke impacts during fire restoration

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Leland Tarnay
USDA Forest Service, Pacific Southwest Region (Region 5)

Smoke from wildland fire, if unmanaged, can have substantial impacts on air quality and public health. Historically, the way such impacts have been avoided, especially during prescribed fire, has been to minimize acres burned to a level that nearly assures no impacts to air quality beyond the local area. However, minimizing acres rather than impacts also potentially minimizes the scale at which subsequent fire will be slowed or suppressed, especially for those projects which have the purpose of creating, or building on landscape-scale fire mosaics. We discuss the current smoke management framework and toolbox used in California, and review case studies selected from over two decades of smoke monitoring where that toolbox has been used. We show how wildfires (and Rx fires), proactively managed to moderate spread rates and severity patterns, rarely create the regional-scale impacts we've seen from the latest megafires and likely result in daily emissions rates that the airshed can readily disperse. Thus, a strategy for managing spread rate (actively or passively, as appropriate) such that dispersion and emissions are well-matched, and messaging to warn people where and when any smoke still does occur appears to be one of the most promising ways to increase the pace and scale of the fire effects that reinforce resilient forests. In this way, healthier forests can lead to healthier air.

Linking wildland fuel characteristics to smoke emissions: Development of a compact smoke measurement instrument

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Kellen Nelson

University of Nevada-Reno

Coauthors: Adam Watts, Jayne Boehmler, Vera Samburova, Andrey Khlystov, Hans Moosmüller, Eric Wilcox (Desert Research Institute, Reno, NV).

Smoke emissions from wildland fire can result in poor air quality that threatens human health and therefore requires planning to mitigate effects from prescribed burning and monitoring to inform air resource managers during periods of active burning. To better understand how smoke emissions vary with fuelbed characteristics and environmental conditions, we developed and tested a compact instrument package that integrates direct air sampling with air quality and meteorology sensing, suitable for in situ data collection within burn units and as a payload on multi-rotor small unmanned aircraft systems (sUASs). The instrument employs co-located sensors to collect temporal profiles of carbon dioxide, carbon monoxide, and particulate matter with a microcontroller-based system that includes independent data logging, power systems, radio telemetry, and a global positioning system. Sensor data facilitates precise remote canister collection of air samples suitable for laboratory analysis of volatile organic compounds (VOCs) and other major and trace gases. The sensing system was tested at the Sycan Marsh Preserve, OR during controlled burns in a ponderosa pine/western juniper (Pinus ponderosa/Juniperus occidentalis) forest type with a sagebrush/bitterbrush (Artemisia tridentata/Purshia tridentata) shrub understory. The sensing device was hung at 8-m height to monitor the temporal profile of gas concentrations as a head fire passed under the device. Calibrated carbon monoxide concentrations in the smoke plume rose to 197 ppm and carbon dioxide concentrations rose to 6330 ppm. Modified combustion efficiency estimates ranged from 0.84 to 1.00, similar to other studies that observed flaming combustion in senescent grass and pine litter fuel types. The canister sampling system was tested onboard a sUAS at the Tall Timbers Research Station, FL during controlled burns in a longleaf pine-wiregrass (Pinus palustris/Aristida beyrichiana) forest type. We collected five canister samples for VOC determination by remotely triggering the valve system from outside the burn perimeter. Prefire ambient samples contained total VOC concentrations of 0.8 to 1.8 ppbv, whereas samples collected during active burning contained 7.3 to 24.3 ppbv. Six VOCs (i.e., iso-pentane, benzene, 1-butene + isobutene, 1,3-butadiene, toluene, and styrene) accounted for ~71% and 15 VOCs accounting for ~90% of total VOCs observed in the smoke plume. Understanding how fuel characteristics influence smoke composition and production is critical for fire and fuels management applications used to reduce contemporary heightened fuel loadings and to restore historic ecosystem composition, structure, and function.

Prescribed burn monitoring in California forests

Topic: Managing fire regimes in a changing world (good fire/bad fire)

John Williams
University of California, Davis

Joe Restaino
CalFIRE

After a century of fire suppression, there is a growing understanding that fire plays a natural and necessary part in many California ecosystems. Even with interest on behalf of government agencies, NGOs and academic researchers, there is a lot to be learned about the art and science of reintroducing fire to fire-adapted landscapes. Given the backlog in forested areas that are long past their historic fire return intervals, how do we prioritize where, when, and how much to burn? How should we apply controlled fire to reduce the risk of catastrophic fire, while managing the inherent risks of conducting prescribed burns and the negative effects of the smoke they create? What are the impacts of prescribed fire on different forest types with respect to tree density, timber productivity, species composition, wildlife habitat and forest heterogeneity? How frequently, how many times, and at what severity do we need to burn before we start seeing a return to pre-suppression forest conditions and the ecosystem service benefits that come with restored fire regimes? These are some of the questions that CalFIRE and researchers from UC Davis are trying to answer in a multi-year prescribed burn monitoring partnership. Working together, these two institutions are leveraging resources and drawing on a broad joint network of land managers to identify sites on private, state and federal forested lands where they are setting up a system of permanent burn monitoring plots. So far, field teams have put in pre- and post-fire plots in multiple sites across the Sierra Nevada, with plans to extend the plot network elsewhere across the State. In this talk, we describe the goals, design and progress of this partnership, and discuss its role in raising awareness about and the application of prescribed fire as a management tool for risk abatement and ecological benefit.

Retrospective analysis of burn windows in the Lake Tahoe Basin

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Randy Striplin
USFS R5

Stephanie McAfee
University of Nevada, Reno

Prescribed fire is an essential ecosystem management tool in the Sierra Nevada, but it is relatively underused because of the number of conditions that need to co-occur to burn. Assessing the likelihood of burn windows -- days on which weather is in prescription, air quality regulators permit burning, and sufficient personnel and other resources are available -- is useful for managers planning and implementing a prescribed fire program. To assess burn window patterns in the Lake Tahoe Basin, this study evaluated the daily occurrence and co-occurrence of 1) burn permits granted by the California Air Resources Board, 2) weather within burn plan prescription at local RAWS stations, and 3) local or National Preparedness level less than 3 from 1999-2019. Burn windows were most frequent in the spring and autumn and far less common during the summer or winter. There was considerable interannual variation, even in months when burn windows were relative common. At least part of this interannual variability was due to changes in air quality permitting standards in 2008 that allowed burning under a wider range of conditions. This case study demonstrates how simple planning tools developed from readily available data can be used to identify underutilized burn windows, evaluate regulatory and resource changes that could increase burning opportunities, and provide insight into the research needed to confidently take exploit winter and early spring burn windows that may become more common as temperatures rise.

Springs Fire Case Study: The importance of prescribed burn monitoring for reaching long-term ecological goals.

Topic: Managing fire regimes in a changing world (good fire/bad fire)

Ashley Grupenhoff
UC Davis

In late July of 2019, the Inyo National Forest contacted the California prescribed-burning monitoring team (PBMT) about the potential for deployment to the Springs Fire NE of Mammoth Lakes, which was being managed for resource benefit. The PBMT is a joint effort by CalFire and the Safford lab at the University of California-Davis and is intended to produce a database of ecosystem conditions and fire behavior resulting from prescribed burning and to help California tie these findings to climate change adaptation, carbon capture, and environmental sustainability objectives. The PBMT worked on the ground with fire-suppression and burn teams tasked with managing the fire to sample forest and fuels conditions immediately before, and immediately after fire passage. The focus was on areas within the predicted final fire perimeter that had been treated with prescribed fire in previous years. High levels of cooperation between the PBMT and fire management personnel on the ground led to important learning on both sides (e.g., fire crews received informal training in fuels and forest structure measurement, and PBMT staff with red cards received informal training in firing techniques). Plot data were fed to the air quality monitoring team working on the fire which resulted in more accurate and credible air quality predictions. Additionally, a terrestrial LiDAR sampling effort was undertaken by a team from the University of Nevada-Reno to better quantify preburn fuels. Finally, after follow up sampling this season (2020 and continuing for a few years thereafter), the Inyo National Forest will receive a report as to the effectiveness of prescribed fire treatments in reducing fire severity, conserving forest carbon, and outcomes on ecosystem condition due to subsequent fire. The Springs Fire provided an outstanding and, to this point, unique opportunity to conduct real-time collaboration between scientists and managers. We hope to use lessons-learned from the Springs Fire to make this sort of science-management collaboration more likely in the future. I will present the outcomes of this collaboration, including initial data, to demonstrate the importance of on the ground monitoring before, during, and after burning events.