Photo caption: *2017 Prescribed Fire at UC Blodgett Research Station near Georgetown, CA.*

Symposium Organizer: John Williams

NAC20 Program Topic: Managing fire regimes in a changing world (good fire/bad fire)

Description: 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. This symposium will focus on how fire can be reintroduced to fire-adapted landscapes in the form of prescribed burns to achieve a variety of ecological, conservation, land management and risk abatement objectives. Talks may span agency, academic, and other land management perspectives, as well as the application of fire across a range of forest types. Speakers are encouraged to give real-life examples of how prescribed fire and other fuel mitigation activities can be used to meet multiple objectives while limiting risk and minimizing disturbance to and complaints from the inhabitants of surrounding areas.

Presenters: John Williams and Joe Restaino

Presentation Title: Prescribed burn monitoring in California forests-a partnership for risk abatement and improved forest health

Presentation Abstract: 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 Cal FIRE 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 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.

Presenter: Marc Meyer

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

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

Presentation Abstract: 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 abrader 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

Presenter: Gabrielle Bohlman

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

Presentation Abstract: 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.

Presenter: Ashley Grupenhoff

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

Presentation Abstract: 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.

Presenter: Michelle Coppoletta

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)

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

Presentation Abstract: 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.

Presenter: Adam Watts.

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

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

Presentation Abstract: 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 fuel bed 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.

Presenter: Edward Smith

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

Presentation Abstract: 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 across10,000 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.

Presenter: Scott Stephens

Presentation Title: Ecosystem impacts of managed wildfire in Yosemite National Park

Presentation Abstract: 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.

Presenters: Randy Striplin and Stephanie McAfee

Presentation Title: Retrospective analysis of burn windows in the Lake Tahoe Basin

Presentation Abstract: 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.

Presenter: Leland Tarnay

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

Presentation Abstract: 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.