Living With Fire in California’s Coast Ranges

Promoting Fire-Resilient Communities and Landscapes in an Era of Global Change

SYMPOSIUM PROCEEDINGS

Produced in partnership with:
California Fire Science Consortium
Pepperwood Foundation
Sonoma State University
Sonoma County Forest Conservation Working Group
Community Foundation Sonoma County
Make It Happen Project Services

May 7-9, 2018
Sonoma State University
Introduction

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Introduction

The purpose of these proceedings is to document a historic symposium that brought together fire-impacted communities with national experts to improve our understanding of fire resilience in counties from Monterey to Mendocino in California’s Coast Ranges.

This symposium was sponsored by the California Fire Science Consortium and co-produced with local partners using a model that has been effectively employed in various locations across the state. While the selection of Sonoma County as the site for this year’s event was in part driven by the recent Central LNU Complex Fires (Tubbs, Atlas Peak, Nuns, Pocket, and Oakmont) that impacted the region in October 2017, our aim was to go beyond simply interpreting recent events by putting the recent fires seasons of 2017 and 2015 in the Coast Ranges in a much deeper and broader historical and geographic context.

These proceedings include the following sections.

Symposium Overview
Symposium Materials Available for Education and Outreach
Symposium Agenda
Speaker Biographies
Presentation Summaries
Participant Evaluation Survey and Results
Acknowledgements
Supplementary Resources

Links are provided to a comprehensive archive of presentations to expand the reach of this interdisciplinary and timely conference far beyond the participants who were available to attend the event in person. Educational materials made available online, thanks to the generosity of a donor from the Community Foundation Sonoma County, are suitable for use by individuals, teachers, students, homeowner associations, and other groups seeking to better understand the history of fire in the region and opportunities to enhance our community’s resilience moving forward.
The Living with Fire in California’s Coast Ranges Symposium was held May 7-9, 2018 at Sonoma State University, in Rohnert Park, CA, as a partnership between the California Fire Science Consortium and local public and private agencies. The symposium brought together more than 400 participants, including members of the general public, scientific community, private sector, natural resource and fire safety agencies, and non-profit organizations.

The goals of the symposium included the following.

• To educate people about the ecology of fire in the California Central Coast Ranges and its relationship to humans, ecosystems, and natural resources.

• To discuss patterns and trends in wildfire over time and the factors influencing those trends.

• To explore what agencies, communities, and citizens can do moving forward to enhance community resilience to fire.

To meet these goals, the program committee recruited expert presenters from a broad range of disciplines, including forestry and fire ecology, human health impacts, fire hazards mitigation, and emergency response. Presentations were delivered over a two-day agenda, with the first day dedicated to improving our shared understanding of fire history in the region, and the second looking forward into the future including innovative land management case studies and climate change considerations to inform resilience strategies for the Coast Range Region.

A total of 22 live presentations were delivered and complemented by eight discussion sessions dedicated to participant engagement and interaction. Speaker biographies are provided on page 6. Day three of the symposium was dedicated to three full-day field tours hosted by local agencies to showcase fire impacts and fire resilient strategies for local communities.

Learning outcomes reported by attendees included:

• Exposure to basic principles of fire science from the perspective of several disciplines, including fire ecology, meteorology, ecosystem services, air quality, and geography.

• A better understanding of relationships between social and environmental perspectives grounded in historical, cultural, and social dynamics, through the lenses of public safety, urban planning, and risk management.

• Greater familiarity with CAL FIRE programs in place to support emergency operations, risk communication, and evidenced-based practices such as defensible space and ember control.

• Increased awareness of ongoing learning opportunities on topics including wildfire-resistant home design, the role of fire safety councils, and the emergence of new cross-sector coalitions to build resilient communities.

Results from the post-event evaluation survey of participants is provided on page 44.
Available for Education and Outreach

This document provides abstracts and highlights of expert presentations and also serves as a guide to how to access archived versions of the live presentations. Links are provided to access presentation archives made accessible at a central portal hosted by Pepperwood: www.pepperwoodpreserve.org/livingwithfire. Presentation materials are also being disseminated via partner sites including those of the California Fire Science Consortium and the Sonoma County Forest Conservation Working Group. Landing page links are provided for each product type listed below, while the Presentations Summary section (page 5) features links for individual presentations.

Educational products generated by the event include the following.

- A short video providing a summary of the goals and outcomes of the symposium, with guidance on how those interested can learn more and become involved.

- PowerPoint files provided by presenters.

- Video archives of 20 presentations with animated PowerPoints synchronized with the recorded voices of the presenters.

- A gallery of videos and photographs from two of the symposium field trips conducted on the third day of the symposium.

- Live video of May 8 presentations provided by KRCB Northern California Public Media.

As presentation summaries shared here focus on key talking points, the discussion and question and answer sessions are uniquely available via the presentation archives and often provide a deeper dive into questions raised by participants.

All available symposium media referenced above are accessible here: https://www.pepperwoodpreserve.org/livingwithfire/

We encourage you to share these resources broadly with your networks. We welcome feedback or questions. Please send them to cafirescience@gmail.com.
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**David Ackerly, Ph.D.** is Dean of the College of Natural Resources at UC Berkeley. He is also a Director of the Data Science for the 21st Century (DS42 Graduate Training Program) and serves on the Steering Committee of the Berkeley Initiative in Global Change Biology. He is a Senior Fellow of the Berkeley Institute for Data Science. His research interests include climate change impacts on biodiversity, integration of phylogenetics and ecology, and conservation biology in relation to 21st century climate change.

**Greg Bertelli** has been in the fire service for 28 years and is currently a Division Chief in CAL FIRE's Sonoma-Lake-Napa Unit. He has worked extensively in Sonoma, Napa, Lake, Yolo and Colusa counties throughout his career. Chief Bertelli has worked as a Captain on fire engines, helicopters and hand crews. Recent significant fires that he has commanded were the Rocky, Valley and Tubbs Fires. In 2015 he was awarded CAL FIRE's leadership award. Greg also has extensive experience working on CAL FIRE's Type 1 Teams for the past 10 years performing a variety of incident support roles. He is currently on Incident Management Team 1.

**Craig Clements, Ph.D.** is an Associate Professor of Meteorology at San Jose State University and Director of the Fire Weather Research Laboratory. He leads research on fire weather, extreme fire behavior, fire-atmosphere interactions, and conducting wildland fire field experiments. Dr. Clements teaches courses in Fire Weather, Mountain Meteorology, Climate Change, and Meteorological Instrumentation. He received his PhD in Geophysics from the University of Houston in 2007, his MS in Meteorology from the University of Utah, and a BS degree in Geography from the University of Nevada, Reno. In 2012, Dr. Clements received the National Science Foundation's CAREER Award for his research on wildfire dynamics and fire weather. His current research focuses on obtaining meteorological measurements using a state-of-the-art Mobile Atmospheric Profiling System at active wildfires in the western US.

**Tom Cova, Ph.D.** is Professor of Geography and Director of the Center for Natural & Technological Hazards at the University of Utah in Salt Lake City. His research and teaching interests are environmental hazards, emergency management, transportation, and geographic information science (GIS). His primary focus is wildfire evacuation analysis and planning, and he has published on a variety of topics in this regard in many leading hazards, transportation and GIS science journals. The National Fire Protection Association adopted his proposed minimum egress standards for fire-prone communities in NFPA 1141. His work on simulating wildfire evacuation traffic at the lane-level helped develop an evacuation routing plan for the 2012 Waldo Canyon Fire in Colorado Springs. He teaches courses on environmental hazards, human geography, emergency management, and geographic information systems.

**Will Harling** is the Director of the Mid-Klamath Watershed Council, serves on the steering committee of the Northern California Prescribed Fire Council, and is a co-lead for the Western Klamath Restoration Partnership. He has been a lifelong advocate for increasing the use of prescribed fire to create fire resilient forests and communities in the Western Klamath Mountains in Northern CA and beyond. Will is part fire ecologist, fire fighter, fire lighter, storyteller, community organizer, desk jockey, fisherman, grant slave, and father of two beautiful wild mountain kids.

**Jeff Kane, Ph.D.** is an Associate Professor of Fire Ecology and Fuels Management and Director of the Wildland Fire Lab at Humboldt State University. His research broadly focuses on providing information to better manage and restore fire-prone ecosystems in an era of rapid change. Recent research has focused on litter flammability, post-fire tree mortality, and vegetation responses to fuel treatments. He is an associate editor of the journal Fire Ecology, vice-chair of the Northern California Prescribed Fire Council, and a member of the Association for Fire Ecology Education Committee. He is also a contributing author to the second edition of Fire in California's Ecosystems.
Speaker Biographies

**Jon E. Keeley, Ph.D.** is Senior ST research scientist with the U.S. Geological Survey, adjunct professor at UCLA, former program director at the National Science Foundation, recipient of a Guggenheim Fellowship and Ecological Society of America Fellow. He has spent sabbaticals in all five Mediterranean climate regions of the world. His research includes ecological life history strategies of plants from fire-prone ecosystems, fire-stimulated seed germination, invasive species, taxonomy of *Arctostaphylos*, and biochemical pathways of photosynthesis in vernal pool plants. His current research is focused on climate change impacts on future fire regimes. He has over 400 publications, which have garnered more than 20,000 citations. He is senior author of a 2012 Cambridge University Press book *Fire in Mediterranean Climate Ecosystems: Ecology, Evolution and Management.*

**Ben Nicholls** is a Division Chief, Pre-Fire Division, in CAL FIRE’S Sonoma-Lake-Napa Unit. He has 24 years of experience in wildland firefighting with the California Department of Forestry and Fire Protection – CAL FIRE. Chief Nicholls oversees and coordinates the Defensible Space and Vegetation Management Programs within the Sonoma-Lake-Napa Unit.

**Lenya Quinn-Davidson** is an Area Fire Adviser for the UC Department of Agriculture and Natural Resources. She also serves as the Director of the Northern California Prescribed Fire Council. She is a core staff person for the Fire Adapted Communities Learning Network, where she acts as a member liaison, develops quick guides and other materials, and supports the Community of Practice for Using Fire and the Watershed Management Community of Practice. Lenya also works with the Fire Learning Network to coordinate their prescribed fire training exchange (TREX) program. She holds an M.A. in Social Science: Environment and Community from Humboldt State University and a B.S. Conservation and Resource Studies from UC Berkeley.

**Caerleon Safford** is Executive Coordinator for Fire Safe Sonoma, the county’s nonprofit Fire Safe Council. Her work there focuses on outreach, education, and planning for residents of Sonoma County’s Wildland Urban Interface (WUI). Additionally, she works part-time as a fire inspector for Sonoma County Fire and Emergency Services Department, specializing in vegetation management programs. She is a Captain with the Fort Ross Volunteer Fire Department, where for the past 20 years she has responded to emergency incidents in a 55-square-mile remote WUI community. A lifelong resident of California’s WUI, she is passionate about increasing understanding of the principles of home hardening and defensible space to make our communities safer and more sustainable.

**Sarah McCaffrey, Ph.D.** is a Research Forester for the USDA Forest Service. Her research focuses on understanding the social aspects of fire management. This has included a range of work examining key dynamics before and during fires including public acceptance of fuels treatments, influences on homeowner fire mitigation practices, and evacuation decision making. She received her PhD in Wildland Resource Science in 2002 from the University of California Berkeley, where her dissertation research topic examined homeowner views and practices related to defensible space and fuels treatments in Incline Village, Nevada.

**Lisa Micheli, Ph.D.** has over 25 years’ experience leading ecological research, education and restoration programs in concert with local communities. Micheli has been distinguished by the Switzer Foundation as a California Environmental Leader and as a Fellow of the California Academy of Sciences. In 2009 she was appointed the premiere Executive Director of the Pepperwood Foundation, dedicated to advancing the health of Northern California’s land, water and wildlife. She was a founding member of the North Bay Climate Adaptation Initiative and presently serves as co-chair of the Terrestrial Biodiversity Climate Change Collaborative (TBC3), as a technical advisor the federal Climate Data Partnership for Resilience and Enhanced Preparedness, and as a Director of the Rebuild Northbay Foundation.

**Photo by Joshua Asel**
Hugh Safford, Ph.D. is the Regional Ecologist for the USDA-Forest Service’s Pacific Southwest Region (California, Hawaii, Pacific territories), and also holds a research position in the Department of Environmental Science and Policy at the University of California Davis. His areas of professional expertise are restoration ecology, community ecology, biogeography, and disturbance ecology. Safford is the manager of the Regional Research Natural Area program, the Sierra Nevada region leader for the California Fire Science Delivery Consortium, and a member of several science advisory boards. Safford also works internationally, and provides technical assistance on fire, forest management, and climate change issues to the US Agency for International Development (USAID) and the International Program of the Forest Service. Safford was an editor of *Historical Environmental Variation in Conservation and Natural Resource Management*, a recently published book exploring the challenges of applying historical reference conditions to the sustainable management of ecosystems in a rapidly changing world. Safford holds a Ph.D. in Ecology from the University of California, an M.A. in Secondary Education from San Francisco State University, and a B.S. in Geology from Montana State University.

Scott Stephens, Ph.D. is Professor of Fire Science and the director of the UC Center for Fire Research and Outreach and co-director of the UC Center for Forestry. He is the leader of California Fire Science Consortium which works to more effectively deliver fire science information to natural resource managers. Stephens’ areas of expertise focus on interactions of wildland fire and ecosystems. This includes how prehistoric fires once interacted with ecosystems, how current wildland fires are affecting ecosystems, and how management and climate change may change this interaction. He is also interested in wildland fire policy and how it can be improved to meet the challenges of the next decades.

Dave Sapsis currently serves as Senior Fire Scientist with CAL FIRE’s Fire and Resource Assessment Program, where he leads work on wildfire hazard and risk assessment, mapping, fuel and fire behavior modeling for strategic and tactical support, and impacts of land management activities on long-term forest health, carbon sequestration, and risk mitigation on both natural resources and human assets. He has over 30 years of experience in the field of wildland fire science, beginning with seasonal work conducting prescribed fire for a variety of land management agencies and conducting basic research on live fuel combustion. Dave received his B.S. in Forestry from UC Berkeley in 1986, an M.S. in Fire Ecology from Oregon State University in 1990 and is a Ph.D candidate in Fire Science at UC Berkeley, hoping someday to finish his dissertation. When not wondering about how things burn, Dave pursues varied hobbies that require risk assessment skills, ranging from racing motorcycles to brewing beer.

Chuck Striplen, Ph.D. is an Environmental Scientist with the North Coast Regional Water Quality Control Board and a member of the Amah Mutsun Tribal Band (Monterey Bay Region). He received his BA in Biology and Environmental Studies from UC Santa Cruz, and his MS and PhD in Environmental Science, Policy, and Management from UC Berkeley. Over last 25 years, Chuck has worked in public, private, tribal, non-profit, and academic settings, primarily in the areas of tribal management of natural resources, historical ecology, water quality, and watershed stewardship. He currently serves as a Science Advisor to California’s Ocean Protection Council and sits on the Governmental Advisory Committee for US EPA.

Alexandra D. Syphard, Ph.D. is a senior research scientist at the Conservation Biology Institute who has spent the last two decades analyzing the ecological and social drivers and impacts of landscape change. She uses a variety of mapping and modeling approaches to investigate how change has occurred in the past, how it is likely to occur in the future, and how different policy or management scenarios may impact ecological and social well-being. Alexandra is particularly interested in the interactions among wildfire patterns, land use change and urban growth, climate change, vegetation dynamics and biodiversity, invasive species, and species’ range shifts.
Speaker Biographies

**Leland (Lee) Tarnay, Ph.D.** is an ecologist working for the USFS Region 5 Remote Sensing Lab. Lee received his Bachelor of Science from University of California, Davis in biological sciences (1995), and his Ph.D. from the University of Nevada, Reno (2001). He spent 10 years as Yosemite National Park’s Air Resource Specialist before joining the USFS, and his core expertise is in smoke and emissions monitoring, dispersion modeling and smoke management. His current focus is on helping land management agencies in California increase pace and scale of proactive fire while minimizing smoke impacts.

**Marshall Turbeville** is a Battalion Chief assigned to the Russian River Battalion, Sonoma County, of the Sonoma-Lake-Napa Unit of CAL FIRE. Marshall holds a BS from Cal Poly, San Luis Obispo with a concentration in watershed, chaparral, and fire management. He started as a seasonal fire fighter with CAL FIRE in 1995 and was hired permanently in 2000. Additionally, he has 10 years’ experience on CAL FIRE incident management teams with statewide response deployments and is qualified as a Fire Behavior Analyst. He also serves at Santa Rosa Junior College Fire Academy and Forestry and Natural Resources as an Instructor.

**Emma Underwood, Ph.D.** is a research scientist with the Department of Environmental Science and Policy at the University of California, Davis and is a visiting fellow with Southampton University in the UK. A central theme of her research is the application of geospatial tools and remote sensing techniques to address biodiversity and conservation issues and inform environmental decision-making. Her research interests include conservation assessments of biodiversity, estimating conservation return on investment, evaluating ecosystem services, and mapping and predicting the distribution of invasive plant species. During the past 15 years Emma’s research has spanned a variety of ecosystems including tropical forests and a global conservation assessment of Mediterranean-type climate regions. Prior to UC Davis, she worked for the World Wildlife Fund-US and has since undertaken collaborative research with The Nature Conservancy, the US Geological Survey, and the US Forest Service. Emma received her Ph.D. in Ecology from the University of California.

**Yana Valechovic** is County Director/Forest Advisor for Humboldt and Del Norte Counties for the University of California Cooperative Extension. As Forest Advisor, she works to address the needs of forest landowners in the fields of forest management and ecology through research, technical consultations, short courses and regional conferences. Her program emphasis is on redwood and Douglas-fir silviculture, forest policy, education, incentives to improve forest stewardship, watershed management, conservation biology, fuels management and insect and disease management. She is a Registered Professional Forester.

**Leroy Westerling, Ph.D.** is an Associate Professor of Management and Founding Faculty of the Ernest and Julio Gallo Management Program, the Department of Management of Complex Systems, and the Management of Innovation, Sustainability and Technology Graduate Group at UC Merced. Previous appointments included tenured professor of Geography and of Environmental Engineering. Prior to coming to UC Merced, he spent six years in the Climate Research Division of Scripps Institution of Oceanography as a Post-graduate Researcher and an Assistant Project Scientist. His research interests include applied climatology and seasonal forecasting for wildfire management, climate change impacts on wildfire and related particulate emissions, carbon flux, forest vegetation and property losses; paleo reconstructions of climate-wildfire interactions, and simulation and scenario analysis for resource management and policy. Dr. Westerling holds a B.A. from the University of California Los Angeles; and a Ph.D. from the University of California, San Diego. He has published extensively on wildfire and climate.
Setting
The Stage
Fire Ecology and Fire History of the Central and North Coast Ranges
Introduction

Presenters: Hugh Safford, US Forest Service Pacific SW Region
Lisa Vollendorf, SSU Provost

Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/#intro

Abstract: Welcome, introductions, Sonoma State support, and agenda overview.

Presentation Highlights
Provost Vollendorf welcomed participants to Sonoma State University (SSU) and acknowledged how hard the entire community had been hit hard by recent fires. She invited participants to use the symposium as an opportunity for thinking, leading, and partnering among diverse members of the community. She expressed SSU’s commitment to helping the region thoughtfully rebuild in a way that will better prepare us for future natural disasters.

Safford and Quinn-Davidson welcomed participants to the event, provided some background on the California Fire Science Consortium, and outlined the program committee’s goals for the agenda. They reminded listeners that wildfire is a natural process and there are many opportunities to make our infrastructure more fire-adapted to improve community resilience. They discussed logistics and facilities issues and thanked the multiple volunteers who made the event possible.
Abstract: Fire is an implicit part of California - foundational to its ecological and human heritage. Even in coastal northern California, the landscapes we know and love are mostly adapted to fire, and in many cases, they are dependent on it. This presentation covers basic concepts in fire science and ecology, including the fire triangle, the fire behavior triangle, and fire regimes, as well as local examples of fire-adapted and fire-dependent ecosystems. The presentation also lays a foundation for the talks and field tours that follow, and helps participants see and understand California's diverse landscapes through the lens of the fire regimes by which they were shaped.

Presentation Highlights
Quinn-Davidson explained key vocabulary and concepts relevant to fire ecology, including the following points.

- Ecosystems in California are not only adapted to fire, their ecology and dynamics are driven by fire.

- 54% of all of the ecosystems in the state are dependent on fire.

- “Fire-dependent” and “fire-adapted” mean different things. “Dependent” means fire is required for proper functioning processes and dynamics (e.g. knobcone pine). “Adapted” means organisms have evolved traits that allow them to survive fire (e.g. Douglas-fir).

- “Fire intensity” and “fire severity” are also often mistakenly interchanged. “Intensity” refers to the amount of heat produced, while “severity” refers to the amount of impact on the habitat. They do not necessarily go hand in hand, and sometimes low intensity fire can be high severity. Post-fire maps typically show severity and help us understand the impacts that each fire had.

The “fire triangle” depicts what a fire needs to burn (fuel, heat, oxygen), vs. the “behavior triangle” (weather, topography, fuels) and vs. the “fire regime triangle” (vegetation, ignition, climate). Fire return interval is an important concept of fire regimes, and this concept describes the typical amount of time (seasons or years) that habitats and ecosystems are adapted to fire to ensure important ecological processes are in place. Historical fire return intervals are typically <35 years in California, but some ecosystems are adapted to low severity and some to high severity, which is largely determined by climate/weather, ignition sources, vegetation (fuel), and landscape characteristics.

Humans have been driving and controlling fire for a long time. In fact, some landscapes (e.g., Sierra Nevada) have already adapted to human-induced fire patterns. Humans are now an integral part of the fire regime.
Fire Ecology of the Central and North Coast Ranges of California

Presenter: Scott Stephens, University of California at Berkeley

Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/ecology

Abstract: The vegetation of the north and central coast is diverse and includes coastal scrub and prairie, chaparral, coastal pine and cypress forests, redwood forests, Douglas-fir-tanoak forests, Oregon white oak woodlands, coast live oak woodlands, mixed evergreen forests, and annual grasslands. Fire regimes in these vegetation types vary from frequent, low intensity (grassland, prairie, oak woodlands, redwood), to mixed severity (coast scrub, Douglas-fir-tanoak forests, mixed evergreen forests), and finally vegetation types adapted to infrequent, high severity fire (chaparral, coastal pine and cypress forests). Lightning ignitions are rare in this area of California, with Native Americans the most important ignition source in the pre-historic period.

Presentation Highlights
Stephens emphasized that this region has very diverse vegetation, from prairie to forest, and the local fire regimes are just as diverse. There is a long history of fire science in this area. Hoberg's Resort, location of key a convening on fire science in 1967, burned in the 2015 Valley Fire.

He addressed ignition sources include lightning (generally high elevations) and humans (lower elevations). Native Americans have a long history of using fire to manage ecosystems - an idea against which there was significant bias until recent research confirmed native peoples' significant role in driving and managing fire regimes.

Sudden Oak Death (SOD) in tanoak forest interacts with fire. Where SOD has occurred, severity tends to be higher. Fire regimes are complex and there is quite a lot of variation within ecosystems and overlap between habitat types. There is no “one size fits all” management strategy; you must optimize for each habitat type.

Summaries were provided of fire dynamics in the following individual habitat types.

- Coastal prairie dominated by perennial grasses are dependent on frequent fire.
- Coastal redwood forest are adapted to short-interval (10-15 years) low-severity fire.
- Annual grasslands are adapted to relatively frequent and relatively high-severity fire.
- Coastal scrub is adapted to moderate return interval and high-severity.
- Oak woodlands are adapted to frequent low-severity fire.
- Mixed evergreen ecosystems are adapted to mixed severity and moderate fire intervals.
- Chaparral burns at high intensity and severity, with a very reactive fuel bed, but recovers quickly following fire (unless frequency is too high).
- Knobcone pine burns at high severity with moderate to long intervals - cones open when burned, so fire is critical to reproductive success.
- Blue gum eucalyptus forest burns at moderate severity.
- Douglas fir forest burns at moderate to high severity.
- Ponderosa pine is adapted to low severity fire with short return intervals.
Modern Era Fire History in the Central Coast Region: What the past can tell us about the future

Presenters: Marshall Turbeville, CAL FIRE, Sonoma-Lake-Napa Unit
Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/#history

Abstract: An overview of fires from the last 100 years in the California Coast Ranges focusing on the central coast area from Monterey to Sonoma. This fire history portrays trends that will likely continue into future years.

Presentation Highlights
Turbeville opened his talk emphasizing that modern fire history is dominated by fire suppression. “Suppression” is the portion of fire management that deals with putting fires out as quickly as possible. Most (14) of the 20 largest fires in CA history have been in coastal counties, including Monterey County. Seven of 20 most destructive fires have been in coastal counties.

Fire behavior is dependent on weather, topography, and fuels. Humans can control fuels only. Red flag warnings are a tool to manage human behavior during specific weather conditions.

Fire history can influence behavior as well. Some notable fires in Marin, Santa Cruz, Monterey, Lake, Napa, and Sonoma County were discussed. When conditions align, many fires can erupt simultaneously (e.g. June 2008, October 2017).

North and offshore winds exacerbate fire risk. There may be some link between fires and droughts and floods, but the relationship is unclear. Benefits of coastal weather generally make fires unlikely, but when conditions change then very destructive fires can occur and spread quickly. Under current conditions, firefighters are being stretched thin across many fires outbreaks, making suppression even more difficult.
Understanding the Wine Country Fires
Fall 2017 Sonoma Fires: An operational perspective on emergency response, tactics, and the modern Urban-Interface fire problem

Presenter: Greg Bertelli, CAL FIRE, Sonoma-Lake Napa Unit

Presentation link: The CAL FIRE-produced video shared is available here https://www.pepperwoodpreserve.org/livingwithfire/#responder

Abstract: Chief Bertelli relates his experience as a First Responder and Command Officer in the Central Coast area of California where he has worked for 26 years. Fire behavior over the last several years has increased significantly. Fires have moved quicker and farther into populated areas. Utilizing our experience, tools, and tactics to serve and safeguard the people and protect and resources and property of California, the challenges of managing wildland fires for both natural resource protection and public safety are increasing.

Presentation Highlights
Bertelli described his experience as a tactical officer in the October 2017 fires, where he was the second Incident Commander assigned to the Tubbs Fire and had to make the evacuation call for communities from Calistoga to Santa Rosa. He put this event in the context of a general observation that fires in the last five years have changed a lot from what first responders were used to. Once-predictable fires now burn differently and really put firefighting crews on edge. These kinds of changes in fire behavior are occurring across the world. Wildland-urban interface (WUI) tactics have to be much different now, and more attention is being given to these tactics.

He suggested in the future it may be necessary to move more quickly from defensive suppression to check and go tactics when fires threaten residential areas. Safety of public and firefighters is first priority, and keeping traffic flowing during evacuations is particularly important. The CAL FIRE video shared of conditions during the Tubbs Fire included audio communications from Napa command center revealed the rapid response of engaged firefighters.
Meteorology & Weather Associated with Extreme Wildfire in Central California

**Presenter:** Craig Clements, San Jose State University  
**Presentation link:** [https://www.pepperwoodpreserve.org/livingwithfire/#weather](https://www.pepperwoodpreserve.org/livingwithfire/#weather)

**Abstract:** California’s Coast Ranges are associated with two key meteorological phenomena: nocturnal drying events and offshore winds, known as Diablo winds. Nocturnal drying in the higher elevations along California’s central coast is a unique phenomenon that affects fire behavior in higher elevations of the region. Single-digit relative humidity is not uncommon during summer nights. A low-elevation source region of dry air is located over the northeastern Pacific. This extremely dry air forms above the marine inversion and is transported inland overnight with the marine layer through gaps in the coastal mountains. An average of 15-20 nocturnal drying events per year occur in elevations greater than 700 m in the San Francisco Bay Area and their characteristics are highly variable, making them a challenge to forecast.

Diablo winds are offshore, downslope winds that flow northeasterly over Northern California’s Coast Ranges, often creating extreme fire danger for the San Francisco Bay Area. Diablo winds affect the region west of the Sacramento Valley, with a northernmost border in Lake and Mendocino Counties and a southernmost border in Santa Clara County. The mean annual frequency of Diablo events was 2.5 and the highest monthly frequency occurred in October when live fuel moistures were at a minimum. These winds are caused by mesoscale pressure anomalies that are produced when high pressure builds over the Great Basin, similar to Santa Ana winds of Southern California.

This presentation will show high-resolution numerical simulations of the atmospheric dynamics associated with the Tubbs Fire. Simulations indicate that the downslope winds created a period of very strong surface winds to occur during the event, but these low-level winds eventually decoupled from the surface creating a region of calm atmospheric conditions downwind of the Coffey Park neighborhood resulting in reduced rate of spread of the fire.

Finally, this presentation will highlight how wildfires can
modify the atmospheric conditions in their vicinity, creating their own weather. Data obtained from Doppler LIDAR deployed during a number of wildfires in coastal California highlight how plumes interact with the marine inversion and can accelerate surface winds surrounding the fire front.

Presentation Highlights
Clements summarized that common weather conditions constituting “fire weather” include hot, dry, and windy conditions, which can be driven by a combination of meteorological phenomena. Red flag warnings are triggered when wind speed and humidity combine to create conditions favorable to fire ignition. Two important patterns can create very dry and dangerous conditions: nocturnal drying events and Diablo winds.

Nocturnal drying events occur at night in elevated terrain (700m and above) with relative humidity less than 10%. California’s Coast Ranges display the highest frequency of nocturnal drying events in the State, and occur most frequently in the summer. These conditions tend to occur at high elevations because marine fog, which reduces air temperature and increases humidity, can be dominant at lower elevations. The effect of the formation of a marine boundary layer, which generally entails northwesterly wind conditions, does not directly increase humidity, but rather draws higher humidity air masses into lower elevations which in turn dries out the higher elevations quickly, especially at the leeward side of mountain ranges.

Diablo winds in Northern California are essentially the equivalent of Southern California’s Santa Ana winds. A pressure gradient from low pressure off the coast to high pressure in the interior creates wind downslope and erodes the marine layer, essentially driving the moister air out towards the ocean. Ambient humidity during these events can change drastically within minutes. Diablo winds tend to occur in the winter.

Local topography can interact with wind speed in very complex ways, potentially leading to strongest and driest conditions on the lee side of mountain ranges. Clements described his lab’s mobile system (including the application of LIDAR) for recording weather and smoke plume conditions. The resulting smoke distribution is also complex. Smoke plumes can get split by wind shear and spread in multiple directions based on the direction of stratified wind layers. However, both onshore and offshore winds can lead to low relative humidity conditions.
**Nexus Between Climate, Weather and Ignition Sources: Regional patterns in California**

**Presenter:** Jon Keeley, US Geological Survey

**Presentation link:** [https://www.pepperwoodpreserve.org/livingwithfire/#patterns](https://www.pepperwoodpreserve.org/livingwithfire/#patterns)

**Abstract:** North and south, 2017 was a phenomenal year for fires in California and demonstrates we are a long way from thoroughly understanding wildland fire. Complicating the picture is the extraordinarily large latitudinal gradient in the state, along with diverse ecosystems and very different fire regimes. In interior mountain ranges seasonal climates are strongly correlated with annual variations in area burned, but on coastal landscapes from Sonoma County to San Diego, spring and summer temperatures are not closely tied to fire activity. In these regions powerful offshore winds are a major determinant of fire size but are dependent on the juxtaposition of wind events and human ignitions. On these landscapes fire prevention is likely to effect the greatest change in fire losses and thus understanding historical patterns of ignition sources could provide guidance on future prevention actions. Throughout the state, fire frequency has increased steadily since the early 1900s until a peak around 1980, followed by a marked drop to the present. Most human-caused ignition sources have declined markedly in recent decades with one notable exception, powerline ignitions. Powerlines have been reported ignition sources since 1905 but as human infrastructure expanded into wildland landscapes the probability of powerline ignitions has risen. These typically occur during high wind events and are capable of rapid spread over long distances. One important avenue for future fire hazard reduction will be consideration of solutions to reduce this source of dangerous fires.

**Presentation Highlights**

Keeley postulated that the 2017 fires, while reported as “unheard of” and a direct result of climate change and thus are the “new normal,” are not that far away from what has been experienced in the past. In 2017, winter was actually cooler than the long-term average, while spring, summer, and fall were all warmer. What effects climate change has/will have on fire activity may depend on the seasonality of the warmer temperatures, not necessarily the annual average. His team’s work showed that winter and autumn temps do not influence fire activity, but spring and summer conditions do, and the resulting effects depend on which part of the state you are in.

While there is no direct relationship between fire activity and minimum temperature in local areas, there is a positive relationship statewide on average. In the Sierra Nevada, higher precipitation and lower temperatures are associated with decreases in area burned, but not in southern California. There was a switch around 1960 where, prior to that, area burned was dependent on precipitation, while after 1960 it appears to be driven primarily by temperature. In southern California, prior year precipitation (which promotes grass growth) is the only important factor that can be identified.

Models explain approximately only 50% of the variance, so other unmeasured and non-weather factors are clearly also important. The meteorological phenomenon labeled “the Ridiculously Resilient Ridge” largely drove the dry conditions prior to 2017 and led to 10 days of Santa Ana winds prior to December 2017 Thomas Fire in southern California. Long-term drought is almost certainly a driver of major fires (major fires have been correlated with preceding conditions of 7-50+ months of drought). Ignitions are an important determinant of area burned as well, not just wind. Apparently the number of Santa Ana wind days is uncorrelated with area burned.

There are changing ignition patterns across the state, however, increasing from 1900-1990 but showing a sharp decline since then. Area burned does seem to correlate with number of ignitions. Fire history, including prescribed fire, is not influential enough to change the fire risk in many cases. Damages from mudslides were likely exacerbated by lack of fire in recent history in southern California fires.
**Native Management of the Land**

**Renegotiating our understanding of fire**

**Presenter:** Chuck Striplen, North Coast Water Quality Control Board

**Presentation not available**

**Abstract:** Tribes utilized fire as a landscape management tool throughout North America in highly complex, thoughtful, and systematic ways for millennia prior to Euro-American colonization. Fuels management was just one of the motivations for applying fire to the landscape under indigenous systems of management, and by focusing only on that function, modern managers may not be benefitting from the full breadth of its possible applications. Significant new research has been developed in recent years indicating these fire traditions were likely far more widespread and influential in shaping the development of terrestrial plant and animal communities in California than previously understood by the dominant culture. Colonial systems almost universally suppressed these traditions, and acknowledgement of the effectiveness of those management practices has been slow – perhaps slower in the US than in other countries. Major disasters of the kind experienced in 2017 remind us of how much work remains exploring alternative cultural relationships with fire, how our modern scientific and regulatory frameworks can both challenge and incentivize this work, and how repairing relationship with tribes may help facilitate new approaches to stewardship of fire-resilient watersheds.

**Presentation Highlights**

*Fires of Spring video:* Selective burning has been used for thousands of years by Native Americans to create advantageous ecological conditions (hunting, trapping, food, insect reduction, firewood, aesthetic and religious reasons).

One use of fires was to protect settlements from large fires and to fireproof villages. Changes to laws were implemented after a particularly large fire and thus made it harder for Native Americans to burn. Grasslands transitioned into shrublands and forest.

Striplen noted that images from Alberta in the video are starkly different from the images we tend to see now about fire (which focus on large scale devastation and burned houses). Cultural fire thus is distinct from other types of fire. Current prescribed fires are very surgical, burning tiny patches in a strategic way vs. the holistic use of cultural fire to actively manage an entire landscape. Basketmaking is a key element of the local Native American cultural history. The raw materials used are created by fires. An average tribal community of 850 individuals would need approximately a 150 square mile territory for required food, fuel, and raw materials. Prior to European settlement fire was very common and recorded by early expeditions. “Traditional knowledges” are important to tribal understanding and interactions with the ecosystem.

Striplen has spent 20 years assembling data and knowledge, hoping to guide the return of cultural fire to the landscape with many benefits. One is protection against large, damaging fires like those in October 2017. Clearly more fire is necessary to restore many important ecological processes. North Coast tribes have more ability to work with CAL FIRE and others because of better staffing and cooperation than in much of the rest of the state. In the Bay Area, seasonal burning occurred in the fall when conditions were relatively dry. Other parts of the country were different because of cultural and ecological differences.
What to do About Smoke?
Air quality and effects of wildfires on human health

**Presenter:** Leland Tarnay, US Forest Service
**Presentation link:** [https://www.pepperwoodpreserve.org/livingwithfire/#smoke](https://www.pepperwoodpreserve.org/livingwithfire/#smoke)

**Abstract:** Smoke contains fine particles measured in micrometers, PM2.5 and PM10. The smaller particles tend to cause the most health hazards, as they can get deep inside lungs and the bloodstream. Smoke is unhealthy, irritating your eyes, respiratory system, and can be especially dangerous for those with chronic heart disease and other conditions. Monitoring includes measures such as Air Quality Index (AQI) of conditions at 24-hour resolution (midnight to midnight). Fires generally do not create even conditions across 24-hour periods. More common are intermittent spikes in smoke for shorter periods of time. New monitoring products include NowCast, which provides short term measurements based on levels over the last 12 hours, and guides activity levels rather than reporting how unhealthy the air is. This enables individuals to gauge their outdoor activity and recognize their own sensitivities.

**Presentation Highlights**
Tarnay explained that smoke contains fine particles measured in micrometers, with key particulate pollutants classified as PM2.5 (particles less than 2.5 micrometers in diameter) and PM10 (particles greater than 2.5 micrometers but less than 10 micrometers in diameter). The smaller particles tend to cause the most health hazards, as they can get into the bottom of your lungs and into your bloodstream. Generally smoke is unhealthy, irritating your eyes, respiratory system, and can be especially dangerous for those with chronic heart disease and other conditions.

Operating under the US Forest Service’s Wildland Fire Air Quality Response Program ([https://wildlandfiresmoke.net](https://wildlandfiresmoke.net)), Air Resource Advisors (ARA) are trained specialists deployed for fire events. They provide graphs of activity and predictions of future smoke conditions on a map. Large fires and prescribed fires have very different smoke conditions, with large fires vastly worse. Landscape strategies can have an impact on air quality, generally slowing down the fire can limit smoke impacts. Other pollutants and toxins can be volatilized by fires, and typical monitoring...
does not capture any of that, only particulate concentrations. More research is needed to determine whether these toxins are present in levels harmful to humans in smoke during fire events.

Air quality control districts, sometimes perceived as a hurdle to use of prescribed fire, have been incorporating new data on smoke impacts to improve regulations. Lessons learned on what to do about smoke have lagged behind much of the other research on fire. Generally, smoke is smoke, and concentrations in the air dictate the health impacts, but there are some differences depending on what type of habitat is burning and more research is needed to this end. Moving forward, we need to define how to optimize the increased use of prescribed fire by determining when conditions for smoke are best, rather than the alternative of wildfire depositing smoke into the atmosphere regardless of other air quality conditions.

Fires generally do not create even conditions across 24-hour periods. It is more common to have intermittent spikes in smoke for shorter periods of time. New monitoring products include “NowCast," which often approximates a 3-hour measurement, should be used as the short-term guide for activity level advice rather than reporting how unhealthy the air is. Recommendations include to recognize your own sensitivities and use the NowCast to gauge your own outdoor activity.

In summary, the wildfire air quality and smoke problem is at its root a landscape problem. Dealing with the fuels using fire that moves slowly and only chews up small, strategically important chunks of the landscape and doesn't fill the atmosphere with smoke allows for those affected to have periods of clean air so they can avoid and get relief from that smoke. If we don't effectively manage fuels on the ground so that fires move slower—at least in some areas—and create less air quality impact, we'll continue to see the type of smoke impacts the mega-fires are producing right now. Healthier fire-adapted forests mean healthier air.
Abstract: The processes and interactions of a healthy, functioning ecosystem provide a suite of natural assets, or ecosystem services, that are critical to human health and society. These services include the provision of food and water, climate regulation, erosion control, biodiversity, recreation, and cultural values. However, the ability of natural landscapes to deliver these services is threatened by a variety of global change factors including climate change, land conversion, invasion of non-native plants, and altered fire regimes. These threaten the condition of natural ecosystems and lead to the altered provision of services for which substitutes are costly or unavailable. In this talk we describe the effects of wildfire on the provision of ecosystem services and present a case study from the shrub dominated ecosystems of southern California. The incineration and removal of shrubland increases water runoff and sediment erosion (with often drastic consequences for downstream communities) and decreases carbon storage immediately postfire. The increase in fire frequency since Euro-American settlement, particularly in the last few decades, affects the recovery of native shrubs and results in type-conversion to invasive annual grasses. Understanding the consequences of these changes on the provision of services is fundamental to developing effective means of adapting to changing fire regimes and estimating the financial and ecological impacts of wildfire which can be used for fire damage assessments.

Presentation Highlights
Underwood introduced the definition of ecosystem services as including all benefits that people get from nature, a field of study which has been around since the 1980s. The 2005 Millennium Ecosystem Assessment provided a framework for categorizing ecosystem services: indirect (supporting, regulating), and direct (cultural, provisioning). Protecting biodiversity has distinct benefits that can be measured and converted to monetary value ($). Questions under study include what threats to ecosystem services result from too frequent or eradication of fire.

Tribal burning of chaparral at the right time of year can improve plant productivity, increase wildlife habitat, and improve water quality. Fire frequency changes, such as more frequent fire in southern California, and less frequent fire in Sierra Nevada, can threaten ecosystem services. Impacts may include increased runoff and snowmelt, increased sediment loads, more flooding, closure of recreation areas, increase in trace elements and toxics in water which can impact aquatic species.

Impact of fire on recreation value differs by vegetation type (e.g. impacts may be higher in forest than in shrublands). Property values adjacent to fires drop in the year following fire, then increase two to four years following fire. Runoff, groundwater recharge, sediment erosion, biomass, biodiversity, and carbon storage changes can all be mapped and modeled given fire severity and soil conditions incorporating data such as the USGS California Basin Characterization Model and Marxan. Summarizing the impacts on ecosystem services across years can help account for the total damages (measured in dollars) and help prioritize recovery and restoration activities as well as climate change considerations.
Day One: Closing
Concluding comments and notes for Day Two

**Presenter:** Hugh Safford, US Forest Service Pacific SW Region

**Presentation Highlights:** Safford provided an overview of what was covered in the course of the day and what will be covered the following day.

The first session before lunch today focused on three central themes: 1) Santa Rosa was not generally considered a high fire risk area, but historically and ecologically it really is a fire-adapted ecosystem and based in a fire-dependent landscape; 2) understanding what a fire regime entails is important, and there is nuance in defining what post-fire habitat is and how important it is; 3) the role of people in the region is very important, particularly in terms of ignition hazards, since lightning-caused wildfire in this region is rare.

Humans have always been an integral part of fire regimes in this landscape, so post-fire restoration should not aim for conditions lacking anthropogenic influence. The second session today focused on protecting people living in a fire-prone land mosaic and at the wildland urban interface, and maintaining the cultural and ecological resources and services that the landscape provides.

During day two, experts will discuss what the future may hold for fire behavior in the Coast Ranges, and what research shows we can do as a community.
What Does the Future Hold?

Day Two: Introduction, Agenda
Recap of Day One

**Presenter:** Hugh Safford, US Forest Service Pacific SW Region

**Abstract:** We have received very positive feedback on yesterday’s program, and today will build on that foundation. Yesterday we talked about the issues and fire ecology in a historical context, and today we will talk about what we can do about it now and in the future.
Abstract: Coastal California's diverse vegetation is adapted to a wide range of climates, from redwoods in the coastal fog belt to chaparral on hot, interior hillsides. During periods of climate change, the distribution of different vegetation types can shift dramatically. For example, at Clear Lake, the fossil pollen record records a change from conifer forests to oak woodlands in the surrounding forests in response to warming at the end of the last ice age. The magnitude of climate change in this century could eventually lead to similar changes, and projections suggest that the conditions favoring hot and dry vegetation types, such as chaparral, will spread across the region. However, little is known about how fast such changes can occur. Several ecological processes limit the rate of change in plant communities and their distributions across the landscape. The roles of disturbance, demography and dispersal will be addressed in this talk, as well as a range of conservation strategies that will be increasingly important as plant communities adapt to changing conditions.

Presentation Highlights
Ackerly provided an overview of common vegetation types in the Bay Area, including redwoods, oak woodlands, chaparral, annual grasslands. Vegetation spatial patterns are influenced by a gradient of distance from the coast. Climate is what shapes that pattern, and that's a reflection of what climate does to plants worldwide. Pollen records from Clear Lake show that over the last 20,000 years (since end of the ice age/glacial maximum) the forest composition has shifted from pine and other conifers and then shifted at around 17,000 years ago to be dominated by oaks. This shift took approximately 3,000 years to stabilize.

Global annual carbon emissions have been rising for over 60 years, and future projected scenarios of CO2 emissions vary from continued increases at current rates, to a reduced (mitigated) rate of increase, to net zero emissions. Temperature follows a similar pattern as CO2 emissions.

What effect will this have on plants? Water availability drives current spatial patterns in plants, as indicated "climatic water deficit" (CWD), a measure of the amount of useable water needed by plants. Future conditions may be characterized by higher CWD across ecosystem types, and there is the potential for more pervasive drought-like conditions for plants, even under scenarios with high rainfall, due to the potential for extreme rates of evapo-transpiration driven by higher temperatures.

The future climate of California is likely to show warming trends at roughly the same rate as rest of the planet, but a local effect is that the climate gradient from coast to inland will become steeper, e.g. there will be a higher contrast between the cool coast and warmer interior valleys. Rainfall will likely be even more variable than in the past. Future vegetation projections indicate that the geographic extent of shrubland...
Day Two: Presentation 12

may increase while conifer and herbaceous habitats may decrease. If an overall drier future occurs, more deciduous woodland is projected in some areas instead of shrubs.

Disturbance in ecosystems is essential for creating opportunities for organisms to reproduce and disperse. Drought can be looked at as a disturbance, and is similar in some ways to fire. Vegetation changes due to climate shifts can occur slowly, since trees can persist for decades in certain locations even if they are outside of the climate space in which they established and to which they are adapted. A hotter future will likely expand habitats that we currently find on south facing steeper slopes, as well as other plants adapted to warmer and drier regions (e.g. coast live oak). Seed dispersal is an important process that will influence how plant communities establish in areas with newly suitable climate conditions for survival in the future.

Key ecological processes (disturbance, dispersal, demography, seeding, restoration, and management) will interact to influence the trajectory of vegetation change in the future. The type of disturbance (e.g., fire vs. thinning treatments) will help drive species composition towards plants that are adapted to future conditions. The seasonality of temperature change may be important to certain species if they are limited by climate during certain periods of the year compared to others.
Wildfire Response to Climate Change in California's Central and North Coast Ranges

**Presenter:** Leroy Westerling, UC Merced  
**Presentation link:** [https://www.pepperwoodpreserve.org/livingwithfire/#climate](https://www.pepperwoodpreserve.org/livingwithfire/#climate)  
**Abstract:** not available

**Presentation Highlights**

Westerling emphasized that different ecosystems in California display different responses to fire. Montane habitats may be more sensitive to changing temperature because of the influence of snow, since depending on the timing of snow melt, vastly different summer conditions can occur.

Statewide wildfire simulations indicate that in the future fire will be more frequent in many areas, especially northern coastal areas and the Sierra Nevada/Cascades. Probabilistic models suggest potential increases in north coastal California of about 50-100% by 2070, and up to 300% by end of century.

Bay Area increases are estimated at about 50% by 2070 in much of the region, with a hot spot in San Mateo County, projected to increase up to 100-200% by end of century. Examples of extreme fire scenarios indicate that several large fires concurrent in a particular region or across the state could overwhelm firefighting resources and that may be a more common scenario in the future.
Housing Patterns, Wildfire, and Community Vulnerability: Historical perspectives and future possibilities

**Presenter:** Alexandra Syphard, Conservation Biology Institute

**Presentation link:** [https://www.pepperwoodpreserve.org/livingwithfire/#housing](https://www.pepperwoodpreserve.org/livingwithfire/#housing)

**Abstract:** Since the middle of the 20th century, a trend of rapid population growth has led to widespread expansion of housing development, especially in the form of sprawling suburbs throughout coastal California. As development has moved farther into wildland vegetation, the number of structures destroyed by wildfire has also been increasing, culminating in the worst losses in state history in 2017. To better understand why, whether, and how these trends could continue into the future, the first part of the talk explores research on past housing loss to wildfire across California and the US. Results show that, across all regions studied, housing pattern and location have been the most significant factors explaining structure loss to wildfire, relative to vegetation and topography. Despite substantial geographical variability, one consistent finding is that the highest probability of structure loss, as well as the vast majority of structures historically destroyed, has occurred when housing density was low, clusters of development were small, and homes were close to the edge of developments. In some cases, however, once a fire reaches a development, the relationship can reverse, with high-density development facilitating fire spread across buildings, like what happened in the Coffey Park neighborhood. This type of fire spread in high-density development has been infrequent, however, when compared across the 10 most destructive wildfires in state history. The second part of the talk presents results from a modeling study in which we projected future patterns of large wildfire activity and structure loss under different climate change and housing growth scenarios. Model results from the coastal region north of San Francisco suggest that future potential for structure loss will be sensitive both to climatic effects on fire activity as well as the pattern of new development. Future housing growth concentrated in high-density urban areas could prevent a substantial increase in structure loss to wildfire. In conclusion, houses are destroyed by wildfire for many reasons, including fire weather, topography, structure and property characteristics, and often, just random shifts in weather and fire behavior. Nevertheless, a review of past events and a projection into the future suggest that the one of the most influential ways to prevent future destruction is to carefully consider the location and arrangement of new housing development.

**Presentation Highlights**

Syphard opened by emphasizing that the role of human impacts on wildfire is a key factor to consider and will likely increase looking into the future. A transition in fire patterns from the 1940s to 1950s may be analogous to what we will see in the near future, where shifts in demographics and development of the Wildland Urban Interface (WUI) (which can also be described as “sprawl”) brought housing into areas
previously shaped by fire. Housing growth across the country has outpaced population, as has low density development vs. high density development.

What does research show about why some homes burn in wildfires and some don’t? Syphard clarified a distinction between “Interface WUI” zones and “Intermix WUI” zones, with the latter characterized by sparsely distributed houses within a matrix of natural vegetation. Do development patterns affect fire? People cause most fires, and more people up to a certain concentration does appear to cause more ignitions, but not at very high population density (high density areas are generally characterized by low fuels availability and rapid suppression).

Some locations are more fire-prone due to topography, wind patterns, clustering of housing and vegetation (edges have highest risk), and other factors. The pattern of arrangement of homes is consistently important across all regions. Low housing density, with small clusters of development, are at highest risk. (Tubbs Fire was unusual compared to other fires, in that a high proportion of non-WUI urban areas burned.) In general, intermediate housing density areas have highest fire frequency, but intermediate amounts of loss.

Construction material choice, drought and climate patterns, and other factors can influence amount of loss and fire frequency. In the future, for large fires, topography, climate, and fuel are most important factors, but loss of housing depends more on other factors. Future simulations indicate that large fires will increase in both rural and urban areas, but structure loss will depend on patterns of development. Scenarios of future risk indicates that pursuing higher density development can reduce large fires and structure loss. Preventing rural sprawl will be important, but this means countering a historic pattern of people increasing the density of houses in fire prone areas during post-fire recovery.
Wildland Urban Interface: Fire And Your Home
Home Design and Retrofitting Techniques for Wildfire Defense

Presenter: Yana Valachovic, UC Cooperative Extension
Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/#design
Abstract: not available

Presentation Highlights
Valachovic opened with the observation that there is no silver-bullet that solves all wildfire defense problems: effective hazard reduction will take implementation of a variety of approaches. In the 2017 fires, homes were the most combustible part of the landscape (frequently trees in the yard survived the fire, but the home burned). These patterns can be explained by understanding mechanisms of ember ignition in high-wind fire environments. Embers come in two forms, vegetation vs. construction material fragments. Ember control technologies are low cost, evidence-based practices that can reduce risks of home ignition.

Fuel arrangement and availability are two additional factors that can be manipulated to reduce fire hazards. Defensible space includes the following zones, defined by distance from the home: 1= first five feet, 2= five to thirty feet, 3= thirty to one hundred feet. Exposure of homes to fire includes ember exposure, direct flame contact, and radiant heat. Zone 1 should be non-combustible (reduced flame contact), zone 2 should be landscaped with green and live vegetation (reduces radiant heat exposure), and zone 3 should be treated to reduce fuels (which in turn reduces ember exposure). Fire-resistant plants are nonexistent. It matters how landscaping elements are maintained and positioned. All plants can burn depending on conditions, and mulch can burn as well.

Home design priorities start with the roof. Venting is important, but vents, gaps and other openings must be blocked to prevent ember retention. Leaf litter clearing is important to reduce ignition points (dormers can be a weak point). Eighth-inch or smaller mesh coverings are recommended. Think carefully about choices of vent components: consider new and better options now reaching the market. Siding should include a vertical non-combustible section. Locations of ignition points such as firewood storage, leaf accumulation, other combustible items should not be stored near the house, especially not under decks. The condition of your close neighbors’ houses is also critical.
Defensible Space
Controlling ignition potential in the Home Ignition Zone

**Presenter:** Ben Nicholls, CAL FIRE, Sonoma-Lake-Napa Unit
**Vegetation Management**
**Presentation link:** [https://www.pepperwoodpreserve.org/livingwithfire/#defensiblespace](https://www.pepperwoodpreserve.org/livingwithfire/#defensiblespace)

**Abstract:** Without regular maintenance, both ornamental and native vegetation around buildings in or next to wildland areas allow fire and or embers to readily transmit a wildland fire into the building. There are measures homeowners can take to break the link in the chain allowing fire into their home.

**Presentation Highlights**
Nicholls summarized that in the WUI, defending against fires prioritizes first life, then property, then fire perimeter control. Typical wildland fires can expose many structures to danger very quickly. From the early part of 20th century, typical developments were placed in a landscape featuring lower levels of fuel than exists in the WUI today. The growth of more dense, mature trees and lack of fire and lack of timber removal have contributed to the current conditions.

Homes themselves contribute a large amount of fuel to the landscape as well. Stark examples of living, intact vegetation surrounding a burnt-up home point to the conclusion that we need to make homes more fire resistant. Defensive belts and vegetation management zones on the landscape are important for stopping small fires from becoming large fires.

Nicholls reviewed the CAL FIRE defensible space guidelines. Pursuant to CAL FIRE guidance, individual homeowners are responsible for zone 1-3 defensible space and home hardening. Vertical fuels, a.k.a. ladder fuels, should maintain a separation of three times the height of shrubs and bushes to upper tree canopy. Horizontal separation should be at approximately 10-30 feet depending on slope (steeper slopes require larger spacing). Total fuel loads need to be reduced almost everywhere. Mechanical management (vs. prescribed fire) may be more appropriate where ingress/egress is problematic and where the risk is higher to implement prescribed fire for fuel reductions.
Presenter: Caerleon Safford, Sonoma Fire Safe Council
Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/#pathways

Abstract: This presentation examines some of the challenges and tools available to achieve widespread acceptance of defensible space standards and home hardening recommendations in Sonoma County’s WUI. Regulation, community education and incentives for voluntary compliance can be utilized to achieve the critical goal of preventing home loss. Working in conjunction with fire agencies and other local stakeholders, Fire Safe Councils can be a powerful grassroots force to help achieve critical goals.

Presentation Highlights
Safford emphasized that homeowner action is key and can have great positive impacts on improving safety. There are significant challenges, however, including the difficulty in understanding certain recommendations. Individuals may face some difficult decisions, and full implementation can be expensive. Retrofitting/home hardening options are especially expensive. Demographics present a challenge: aging communities have been shown less likely to accept recommendations. Reducing fuel loads and improving home hardening are critically important measures however, to reduce risks to property and loss of life.

In the 2017 fires, even in worst-hit neighborhoods, some homes survived. If homes don’t ignite, then much of the process that leads to WUI fires can be stopped and the risk reduced. Regulations are the most effective approach to convincing homeowners to improve hardening. These include California Public Resource Code §4291, local ordinances, and inspection programs for education or mandated abatement. Different regulations apply in different areas. Who does the inspections and who pays for them are very important questions to answer. Fire Safe Councils and their allies (RCDs, watershed groups, communities and residents) lead the way in educating the public. Councils can be as large as a county, or small as a neighborhood. They rely on peer-to-peer outreach and collaboration. Fire Safe Sonoma is working on a template and bringing communities together, but still needs more public involvement and funding.
Land Use and Community Planning
Abstract: Data, models, and maps represent quantitative assessment of fire risk, and can serve as effective means of communicating risk and developing mitigation strategies that include regulations, land-use planning considerations, operational support (reduced ignitions and fire spread from fuel treatments; improved suppression response) and individual human behaviors. While well-intended, the messaging and response to increasing WUI losses implicate the maps as insufficient in redressing a well-recognized and reasonably well-understood natural phenomenon. A variety of issues related to science, uncertainty, governance and human behavior will be discussed in an attempt to clarify what risk mapping can provide, and what new approaches may be necessary to both better plan for the future, as well as better understanding of the limits of risk reduction strategies at our disposal.

Presentation Highlights
Sapsis opened with the observation that in general, built-up areas have acted as fire breaks (e.g., San Diego in 2005), but recent fires are not holding to this trend. He emphasized that maps of fire risk generated by fire models can only be interpreted at the proper scale. Not everything is scalable, which hinders the ability of scientists to inform the public. Fire risk is a function of probability multiplied by outcome, and models can quantify this. Models inherently have stochasticity, uncertainty, and output probability. These numbers don’t translate well into how it effects people’s lives. People have unique histories that inform their perspective, and thus everyone’s perspectives are different.

Presently, enhancing the dialog between the public and scientists is of the utmost importance. Fire Hazard Severity Zones will be updated soon (last version in late 2000s), with a target release by the end of 2019. Fire weather index reconstruction for last 10 years shows southern and desert California have very high risk conditions, but northern California regions rank lower. CAL FIRE’s Very High Fire Hazard Severity zone maps did not include Coffey Park, but future ones might. Ignition management under extreme fire potential days would be useful. Fire Hazard Severity Zones will be required to be included in land use planning in the future, and if you’re in those zones that is how CAL FIRE will be involved in county planning.
**Abstract:** As exurban development expands into fire-prone areas, more people face wildfire risks every year. When wildfires occur, emergency managers issue recommended protective actions to the public to minimize casualties. Evacuation is the most common action, but in cases where there is not enough time to evacuate, seeking shelter in its many forms may be more effective. Although public wildfire warnings have a high success rate in terms of life protection, there are still cases where problems occur. These can range from wildfire detection to clearing the last few residents out of a low-egress canyon. Dr. Cova reviews research on wildfire warning and evacuation systems from detection to return-entry, as well as presents work in this area at the Center for Natural & Technological Hazards at the University of Utah. With fire ecologists predicting more fire and planners predicting more growth in fire-prone areas, emergency managers and residents will have to step up their preparedness activities to new levels to achieve resilient, safe communities.

**Presentation Highlights**

Cova acknowledged that in terms of emergency response access, lots of neighborhoods in California are scary, with few routes in or out. Through lack of planning and incremental development, clusters of population density can develop without providing enough roads to get everyone out during an evacuation. An example shown includes Mission Canyon, Santa Barbara, where the development was started in 1928, roads were laid out in 1943, and then high density development filled in the site in the 1990s. As a result, the Jesusita Fire caused a community-wide panic.

Mapping tools can be used to identify locations in the USA characterized by “one-way-out” communities in high fire areas. Southern California has highest number of these, followed by Colorado. Potential evacuation time is a function of incident detection, decision time (on the part of incident commanders), warning systems, household preparation, and network clearing (traffic management). The community of Los Alamos is has developed an excellent evacuation plan, but few other locations have this type of plan in place. If traffic controllers have enough time to plan and have good policies in place, then good things can happen. The textbook approach to effective fire warning systems is to establish trigger points, and then when fire reaches these points then the local community must evacuate. Agencies must be prepared for contingencies though, and in some cases, if fire occurs inside the trigger point then a warning is instantaneous. Sometimes fires move faster than expected (e.g., Yarnell, Arizona).

In summary, a resilient fire-prone community has a good evacuation plan, warning system, and viable back up plan for when lead times are short. Evacuation plans in the California WUI are currently optional, unfortunately.
Landscape Management, Collaboration, Education
Learning To Live With Fire
Fuel Management Strategies to Reduce Wildfire Impacts in California's Coast Ranges

Presenter: Jeff Kane, Humboldt State University

Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/#fuel

Abstract: Fuel treatments, such as prescribed fire, mastication, and thinning, are commonly implemented by land managers to modify wildfire behavior and effects. These treatments reduce stand density, increase crown base height, reduce crown bulk density, and remove surface fuels to promote desired fire behavior. The application of these treatments will depend on existing fuel conditions, vegetation types, and other factors. In each area, the specific approach taken will require an evaluation of the efficacy of these treatments that consider the management objectives for the site and ecological impacts of treatments. In some instances (e.g. wildland urban interface) trade-offs among objectives and impacts may be warranted. While we have a sound understanding of how to treat vegetation in fire-prone ecosystems, implementing these treatments at a pace and scale sufficient to affect change at the landscape level remains a challenge. Thus, we will need to prioritize areas for treatment such as high value resources (communities, rare species, etc.) and areas at greater fire risk. Ideally, we would also implement treatments in a way that allows greater use of managed wildfire to promote landscape effectiveness. This effort will surely require a unified front among stakeholders to facilitate the coexistence of humans and wildfire in the California Coast Ranges.

Presentation Highlights
Kane spoke to the clear need to move from reactive to proactive fuel management approaches. He emphasized that there is a huge backlog of area that needs to be treated due to long periods of fire suppression. Managers will need to actively engage communities to increase acceptance of use of prescribed fire and other treatments, and to create opportunities to collaborate on planning, prioritization, and implementation.

To reduce overall fire risk and damage, a combination of treatment, prescribed fire, and wildfire is necessary. Treatment approaches depend on several things including vegetation type, past fires and fire regime, weather, topography, proximity to communities, ownership. At the stand scale, the goals are reducing total fuel loads and vertical connectivity, but at the landscape level we track the proportion of area treated, heterogeneity of fuel conditions, and prioritization of treated areas (e.g., in the WUI).

Trade-offs between ecological/ecosystem services priorities with the need to protect communities are always part of the equation. Examples of treatment options include: prescribed burning (reduces surface fuel loading, drawbacks include air quality); mechanical thinning (reduce stand density, drawbacks include higher surface fuel loading and need for subsequent treatments); mastication (decreases fuel bed height, drawbacks include higher surface fuel loading and vegetation composition changes); managed wildfire (increases pace and scale of treated area, drawbacks include danger to communities and unclear distinction between managed and unmanaged wildfire); fire suppression (protects communities, drawbacks include no reduction to fuel loads and cost). Even treated areas can still burn however, especially when weather conditions are right for fire. Combining treatments, e.g. thinning and prescribed fire can be the most effective approach.
Learning to live with wildland fire, or any natural hazard, is rarely a straightforward endeavor. Wildfire is particularly complex because, in many ecosystems, it is not simply a hazard but a necessary ecological process and inherent part of the landscape. While a great deal of attention has been paid to understanding the biophysical science underlying how to effectively manage fire on the landscape, much less attention has been paid to an equally important part of the living with fire equation: what science can tell us about what shapes how humans, both within and outside fire management, make decisions about how to best live with fire in their landscape. This presentation will address this latter human behavior item. The good news is that there is no need to start from scratch; much has been learned in recent decades about social dynamics around natural hazard mitigation, and in recent years about wildfire mitigation specifically. The bad news is that this information is often overlooked in favor of standard narratives about the problem and potential solutions that are often inaccurate. This presentation will provide a brief idea of the range of ways where better use of existing social science knowledge could improve adapting to having fire on our landscape in a way that both promotes the ecological benefits of fire while minimizing potential negative social impacts.

**Presentation Highlights:**
McCaffrey opened with the observation that living with fire includes social, physical, and ecological components. But, she pointed out that when we talk about living with fire, the social aspects tend to be ignored in favor of looking for technological or physical solutions. She argues that more attention to social aspects will lead to better outcomes, because changing behavior can be more effective in reducing risks than resorting to technical solutions. Challenges faced in achieving behavior change include ignoring the interconnectedness of issues, which can result in approaching fire management challenges in a "vacuum" when in reality they are related to multiple issues, and too much reliance on technology alone for solutions.

Based on the social science research on natural hazards, we already know many things about how communities respond to wildfire. Response strategies can include loss absorption, acceptance, risk reduction (mitigation), or complete behavior change (in extreme cases, preventing people from reoccupying a certain hazardous location). Key among these is mitigation, which includes two stages: modifying the environment (suppression, for example, which can exacerbate the issue), or modifying human behavior (changing choices of where to live, for example). A complete risk reduction plan should be a combination of multiple strategies, both structural and non-structural.

Data does not support key assumptions about why people choose to live in the "wrong places" (results show these assumptions can be a result of sampling bias and/or confirmation bias). Such assumptions can be summarized as different "narratives." There is a "risk perception narrative" that assumes individuals don't understand fire risk and have subjective interpretations of risk. Other narratives include: "fire is bad-and-people don't take responsibility;" "new or
seasonal residents don’t understand,” and “fires are necessary to motivate action.” All of these are all unsupported by empirical data.

By contrast, McCaffrey points out that three primary dynamics are empirically supported as potentially effective in shifting behavior: knowledge, trust, and interactive communication. Other important dynamics include efficacy of actions, ability to undertake actions, combined with other values/social norms. Evacuation decisions are influenced by response efficacy, type of cue to act, risk attitudes, financial situation. Overall, improving outcomes will depend on shifting from exclusively biophysical knowledge and solutions to solutions that incorporate social and behavioral knowledge and thinking creatively outside of the “fire vacuum.”
Back to the Future: Partnerships embracing fire as a resource for a resilient future

Presenters: Lisa Micheli, Pepperwood; Will Harling, Director Mid Klamath Watershed Council and Orleans/Somes Bar Fire Safe Council
Presentation link: https://www.pepperwoodpreserve.org/livingwithfire/#partnerships

Abstract: Building the resilience of our local communities in a fire-adapted ecosystem will require the formation of strong and diverse partnerships that integrate the strengths of public and private entities capable of bridging traditional boundaries between disciplines, counties, and cultures. This session will highlight case studies of dynamic partnerships weaving together science and traditional knowledge to meet the challenge of advancing vegetation management from a landscape-level perspective. This session will briefly highlight efforts in Sonoma County to create a unified approach across public and private land ownerships, and then provide an in-depth look at a successful partnership in the Klamath River basin focused on collectively creating a better fire future. A key success of the Klamath case study is effectively shifting the public’s perception of managed wildfire, prescribed burning, and necessary manual and mechanical treatments to create the social conditions needed to safely apply “good fire” at the landscape scale.

Presentation Highlights:
Micheli summarized how multi-agency climate vulnerability assessments led by Pepperwood were already tuned in to fire risk reduction as a key element of climate adaptation in our region prior to the 2017 fire season. At Pepperwood’s preserve, there exists over five years of baseline data prior to the Tubbs Fire, which burned 95% of the property and structures. Using satellite data, in partnership with Sonoma State University and other science leaders, they are now in a position to explore questions about precursors to fire and the effects of fire disturbance on the landscape. Pepperwood has also been actively utilizing prescribed burns as an adaptive land management tool in partnership with CAL FIRE and diverse tribal, research and agency partners since 2013, and studying the effects of forest thinning techniques via short- and long-term monitoring frameworks. Pepperwood also serves as a venue for training land managers about the nuts and bolts of forest treatment implementation.

Micheli provided examples of effective public-private partnerships in the region, including Sonoma County’s Watershed Collaborative, facilitated by the Sonoma County Agricultural Preservation and Open Space District, which recently released a “Living in a Fire-adapted Landscape” report to the Board of Supervisors, a valuable resource for local governments and the public. This report integrates feedback from over 65 organizations and 200 individuals on opportunities for public-private partnerships in the region to optimize post-fire management and recovery, and is now informing priorities for the County’s new Office of Recovery and Resiliency. Pepperwood’s Mayacamas to Berryessa Landscape Connectivity Network is comprised of open space managers spanning Sonoma to Napa to Lake Counties who are taking a landscape-level approach to habitat protection and forest management across county boundaries. The Sonoma County Forest Conservation Working Group is a collaborative dedicated to getting the best management recommendations to private landowners in the region via ongoing outreach and trainings. AlertNorthBay is a new fire detection network underway with Sonoma County Water Agency, Pepperwood, and Sonoma State using infrared video to inform early
warnings and emergency response. She concluded her section of the presentation by introducing Will Harling.

Harling showed how in the Klamath River basin, a multitude of tools have been implemented to increase the dialog between the public and government agencies (including the engagement of Fire Safe Councils, the Firewise Program, and Community Liaisons). For example, prescribed fire training sessions have been developed that provide an excellent opportunity to bring individuals representing multiple demographic groups together. Harling continued to share how engagement of Type 3 Incident Management Teams can also bring multiple stakeholder together.

Recently, the Western Klamath Restoration Partnership and the organizers of the Klamath Fire Ecology Symposium produced a movie titled “Catching Fire: Prescribed Burning in Northern California” to advance community awareness of fire as a management tool. The team has found that the Indigenous Peoples Burning Network and social media including Facebook have been good for telling the story of fire in this rural region.

Sharing experiential examples of beneficial prescribed fire that people can experience firsthand is important. Prescribed fire produces far less smoke than large intense wildfires. The creation of organizational charts that link landowners and all fire and governmental officers and liaisons can help facilitate effective communication. Investing in mapping planned prescribed fire and other management activities makes coordinating prescribed fires and projects much more feasible. Creating positive experiences for people with fire is critical. The Western Klamath Resource Partnership has been in place since 2013 and participants have accomplished many collaborative projects using prescribed fire, thanks to decades of relationship-building in the region.
Nuns Fire Area Field Trip
The Bouverie Preserve, owned by Audobon Canyon Ranch, is in Sonoma Valley. Conference organizer Sasha Berleman, both a firefighter and a fire ecologist, was instrumental in saving historical structures on the preserve while most of the property burned. It includes an area of recent prescribed burn, dramatically showing the impact of treatment on fire behavior. It has a pastiche of different burn types to demonstrate in oak woodland.

Tubbs Fire Area Field Trip
The Franz Valley School Road—Pepperwood field trip focused on a variety of burn severities over a variety of forest and rangeland types, including oak woodland, mixed conifer forests, and chaparral. It will also look at high severity burns near homes, and address aspects of planning, construction, and defensible space maintenance that contributed to loss or retention of structures. Discussions will include fire recovery options, fire recovery assistance programs, and what to expect moving forward after high burn severity fire events.

Fire Mitigation in the Coastal Zone
The WUI-Jenner field trip focused primarily on planning, infrastructure, and structural hardening, with a stop at the Jenner Headlands to look at shaded fuel breaks in coastal mixed evergreen forests that have been treated for fuels, and where controlled burns have been conducted on some of the plots. It also looked at high severity burns near homes, and addressed aspects of planning, construction, and defensible space maintenance that contributed to loss or retention of structures.
Given the time and resources invested in this event, we gathered information from participants about what worked and what could be improved in developing and delivering follow up events. Surveys also provided information on attendees—their backgrounds, professional roles, and interests. Below we summarize quantitative and qualitative survey results, followed by the full suite of survey questions.

The first set of questions asked participants to rank their involvement or assessment of outcomes based on a set number of criteria, with the response breakdown summarized based on percentage of responses in a chart format, as follows.

**Quantitative results**

Out of a total number of 178 surveys returned, the following breakdown of responses was provided. Outreach effectiveness and engagement by key affiliations. Summary metrics include: 82% agreed that the event helped them better understand fire science and how to apply it.

### Outreach effectiveness and engagement by key affiliations

**How did you find out about the event?**

- Email: 22%
- Website: 10%
- Employer: 18%
- Friend/Colleague: 24%
- Other: 23%
- Blank: 3%

**What is your affiliation (based on options provided)?**

- Private forest owners: 21%
- Firefighters/Safety Personnel: 17%
- Interested public/other: 16%
- Government employee: 13%
- Researcher/Academic: 10%
- Non-profit: 8%
- Land/natural resource manager: 6%
- Educator/Communicator: 6%
- No answer: 3%

### Fulfillment of basic symposia goals

**The event helped me to better understand fire science**

- Strongly agree: 47%
- Agree: 35%
- Neutral: 9%
- Disagree: 3%
- Strongly disagree: 2%
- No answer: 4%

**The event will help me better apply fire science information**

- Strongly agree: 43%
- Agree: 39%
- Neutral: 9%
- Disagree: 3%
- No answer: 5%
More than 70% of participants thought the event helped foster communications across disciplines and build partnerships.

The event improved communication among fire scientists, fire managers and private forest owners.

The event connected me to new potential partners and resources.

The event presented information that was easy to understand.

The event presented information that is useful and relevant.
Participant Evaluation Survey and Results

Comments on symposium strengths/outcomes

- Comments speaking to symposium strengths/beneficial outcomes
- Talks were effective in translating science to practical problems facing regular people
- I learned more about fire weather in our Mediterranean climate
- I appreciated hearing CAL FIRE’s perspective from the operational side
- It was beneficial to have all parties in one room—academics, first responders, agencies, and private landowners, and to have discussion sessions between presentations supplemented by information tables
- The event provided the opportunity to meet others with shared concerns
- Now I know I need to take action on my property, and have resources to move forward
- It was interesting to learn about the nuts and bolts of implementing prescribed fire

Comments on symposium weaknesses, ways to improve, and suggested additions

- Lack of ethnic and gender diversity among speakers
- Lack of discussion of equality and disproportionate impacts on different social groups
- No tribal leadership speakers
- I needed more practical information
- It feels like we are putting “band aids on bullet holes”
- We need to better understand how our area is different from the rest of California
- No mention of physical effect of toxics from city fire or from forest fire or a comparison between them
- Consider adding in structured breakfast groups for networking with all these great people
- Get better screen lighting
- Would have been great to have had round table discussions/small group breakouts
- Presentations somewhat repetitive and presenters needed more guidance to ensure relevancy and comprehensibility
- Add youth groups or information on curricula for youth
- This group needs to more effectively network with politicians
- We needed more discussion regarding the political causes of fire hazards
- Left some private landowners with the feeling they are “on their own”
- Would like more information on role of utilities, insurance, and banks in post fire recovery
- At registration table, ask if folks want to have their email addresses in a database for future contact

Accessibility, relevance, and quality of presentations and event overall

More than 85% of participants felt that the symposium met this criteria.

On a scale of 1 (low) to 5 (high), how would you rate today’s event overall?

- Strongly agree: 63%
- Agree: 27%
- Neutral: 7%
- Disagree: 1%
- Strongly disagree: 1%
- No answer: 2%
- On a scale of 1 (low) to 5 (high), how would you rate today’s event overall?

Strongly agree: 63%
Agree: 27%
Neutral: 7%
Disagree: 1%
Strongly disagree: 1%
No answer: 2%
This event would not have been possible without the time generously contributed by the members of the symposium Steering Committee.

David Ackerly, UC Berkeley
Kim Batchelder, Sonoma County Agricultural Preservation and Open Space District
Sasha Berleman, East Bay Regional Parks (formerly of Audubon Canyon Ranch)
Jill Butler, retired Forester
Stacey Sargent Frederick, California Fire Science Consortium
Tom Greco, Pepperwood
Frances Knapczyk, Napa Resource Conservation District
Claudia Luke, Sonoma State University
Lisa Micheli, Pepperwood
Ben Nicholls, CAL FIRE
Chad Roberts, Conservation Ecologist
Jay Roberts, Point Blue
Caerleon Safford, Fire Safe Sonoma Council
Hugh Safford, USFS and UC Davis
David Sapsis, CAL FIRE
Jeff Schreiber, Sonoma Resource Conservation District
Sloan Shinn, Pepperwood
Cate Steane, Make it Happen Project Services
Steven Swain, UC Extension
Dee Swanhuysen, Sonoma County Forest Conservation Working Group and Greenbelt Alliance
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### 1. Creating Safer Homes and Defensible Space

More on CAL FIRE Defensible space requirements:

More on Wildfire Protection Building Construction:
CAL FIRE. Available from [http://osfm.fire.ca.gov/codedevelopment/wildfireprotectionbuildingconstruction](http://osfm.fire.ca.gov/codedevelopment/wildfireprotectionbuildingconstruction)

More on California’s Wildland-Urban Interface Code Information:
CAL FIRE. Available from [http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes](http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes)

More on wildfire research at the University of California: University of California. Forest Research and Outreach. Available from [http://ucanr.edu/sites/forestry/Wildfire/](http://ucanr.edu/sites/forestry/Wildfire/)

Webinar. Home and landscape wildfire defense:

### 2. Wildfire Preparedness

More on Living with Fire in Sonoma County:

More on NOAA’s National Weather Service, “this site will help you prepare, be aware and act early if a wildfire comes your way”:

Various education programs.
- Ready, Set, Go: [http://www.sbcfire.org/Programs/ReadySetGoFire.aspx](http://www.sbcfire.org/Programs/ReadySetGoFire.aspx)
- NFPA Firewise USA: [https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA](https://www.nfpa.org/Public-Education/By-topic/Wildfire/Firewise-USA)
- Fire adapted communities: [https://fireadapted.org/](https://fireadapted.org/)
- UC Cooperative: [http://ceventura.ucanr.edu/Agricultural_Threats/Fire_Information/](http://ceventura.ucanr.edu/Agricultural_Threats/Fire_Information/)
- Insurance Institute for Business & Home Safety (IBHS): [https://disastersafety.org/](https://disastersafety.org/)

### 3. The Geography of Fire

More on research at the University of Utah: Center for Natural & Technological Hazards.
The University of Utah. Available from [http://hazards.utah.edu/](http://hazards.utah.edu/)
Supplementary Resources


4. Fire Weather
San José University Fire Weather Research Laboratory Website. “Dedicated to uncovering the science behind fire-atmosphere interactions.” Available from http://www.fireweather.org/

5. Wildland Fire Science
UC Berkeley Stephens Lab Website - Research & Education in Wildland Fire Science. Available from https://nature.berkeley.edu/stephenslab/


6. Fire and People

Film: “Every Fire Tells a Story” explores collaborative ground-breaking work happening with prescribed fire and managed wildfire in the Western Klamath Mountains.” Stormy Staats. Every Fire Tells a Story. Available from https://www.youtube.com/watch?v=kpglLhmwPMc&feature=youtu.be

7. Fire and Air Quality
For current information on California communities affected by wildfire smoke: California Smoke Information. Available from http://californiasmokeinfo.blogspot.com/

For Air Quality Index (AQI) and hourly NOWCAST values Environmental Protection Agency. AirNow. Available from https://www.airnow.gov/

More on “If you don’t have an Air Resource Advisor (ARA)”, see: Wildland Fire / Air Quality Tools. Available from https://tools.airfire.org/monitoring/v4#!/?category=PM2.5_nowcast&centerlat=41.9677&centerlon=-94.9658&zoom=4

8. Fire and Climate Change


9. Forest Restoration

UC Extension Forest Research and Outreach Website. “This website contains information, resources, publications, and big ideas about how to steward forest land in California.” Available from https://ucanr.edu/sites/forestry/

10. Conservation Organizations Active on Forest Issues
Information regarding Sonoma County Forest Conservation Working Group: Sonoma County Forest Conservation Working Group | Healthy forests, oak woodlands, and watersheds. Available from https://sonomaforests.org/

More on Sonoma County’s Watershed Collaborative, convened by Sonoma County Ag + Open Space to identify short-term actions for watershed recovery and long-term strategies for watershed resiliency in the wake of the wildfires. Available from https://www.sonomaopenspace.org/watershed-collaborative/

More on Pepperwood’s Fire Mitigation and Forest Health Initiative: https://www.pepperwoodpreserve.org/what-we-do/conservation-initiatives/fire-and-forest-health/

More on “Maintaining resilient Klamath ecosystems, communities, and economies guided by cultural and contemporary knowledge.”: Western Klamath Restoration Partnership. Available from https://www.wkrp.network/
Living with Fire in California’s Coast Ranges

Promoting Fire-Resilient Communities and Landscapes in an Era of Global Change

Symposium focus area

View full-length presentation videos and other helpful resources from the symposium at:

www.pepperwoodpreserve.org/livingwithfire