Managing for Drought in California Ecosystems

Presenter's Name: Amarina Wuenschel
Presenter's Company/Employer: US Forest Service, Sierra, Sequoia and Inyo National Forests
Presenter's Title: Ecologist
Co-Presenter's Name: Christopher Fettig
Co-Presenter's Company/Employer: US Forest Service, Pacific Southwest Research Station
Co-Presenter's Title: Research Entomologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
We propose a symposium related to managing for drought in California that corresponds to a recent chapter in the USDA Forest Service-produced General Technical Report 'Drought Impacts on U.S. Forests and Rangelands: Translating Science into Management Responses'. This symposium will contain an overview of the topic, four additional presentations related to drought management in widespread California ecosystems (montane forests, redwood forests, oak woodlands, chaparral and coastal sage scrub, and grasslands) and conclude with a facilitated discussion. Presentations are germane to the conference topic 'Natural areas management in light of climate change' given that global climate models project severe droughts will become the norm in California. Drought presents significant challenges for natural resource managers in California, and future droughts will likely exert even greater impacts. Managers can intervene by altering plant structure and composition, increasing annual water yield, and conducting public outreach and education regarding water conservation. Due to strong environmental gradients in California, drought management should be tailored to individual ecosystems. For example, in forests and woodlands, drought management focuses on the use of mechanical thinning and prescribed burning both to decrease stand densities and to promote the growth and vigor of desirable tree species. In chaparral, frequent disturbances are stressors, so soil disturbances need to be limited as much as possible to reduce the spread of nonnative annuals that promote wildfires. Invasive plants are also an important problem in grasslands, where they should be removed and replaced with native grasses and forbs. In grasslands, prescribed fire may be useful to manage nonnative species and increase perennial plant cover to make grasslands more drought-resilient. By including a diverse group of presenters, experts in their respective ecosystems, this symposium will flesh out the fuller story of drought management across California, and convey specific, actionable, science-driven management options for each ecosystem as well as touch on commonalities across ecosystems. An overview will provide context on the recent 2012-2016 drought relative to historic droughts in California, and serve to convey the need to manage for future drought. Our symposium will act as a much needed forum for delivery of recently-published knowledge to practitioners.

Symposium Description:
1) Droughts and Drought Impacts in California: An Overview. Steve Ostoja, Director, California Climate Hub. 2) Managing for Drought in Montane and Subalpine Forests. Chris Fettig, Research Ecologist, Pacific Southwest Research Station, USDA Forest Service. 3) Managing for Drought in Redwood Forests. Ramona Butz, California Province Ecologist,

USDA Forest Service. 4) Managing for Drought in Oak Woodlands. Jonathan Long, Research Ecologist, Pacific Southwest Research Station, USDA Forest Service 5) Managing for Drought in California: Chaparral, California (Coastal) Sage Scrub and Grasslands. TBD 6) Facilitated Discussion. Christopher Fettig, Research Entomologist, Pacific Southwest Research Station, USDA Forest Service.

Application of empirical land-cover changes to construct climate change scenarios in federally-managed lands

Presenter's Name: Christopher Soulard
Presenter's Company/Employer: Western Geographic Science Center
Co-Presenter's Name: Matthew Rigge
Co-Presenter's Company/Employer: US Geological Survey
Topic: Natural areas management in light of climate change
Proposal Type: Individual Presentation

Abstract:
To better understand how climatic factors contribute to sagebrush-dominant ecosystems in the Great Basin, USGS researchers applied NLCD Back in Time fractional vegetation component data to measure the rate of cover change over three decades and quantified the relationship between historical climate and vegetation. Historical rates and causes of land cover change were used to create climate-land change scenarios to project how shrub, herbaceous, and bare cover may be located in the future. Historical data were used to project future rangeland cover in three different federal management areas (Beaty Butte Herd Management Area, Hart Mountain National Antelope Refuge, and Sheldon National Refuge) using a business-as-usual (BAU) scenario and RCP 8.5 climate change scenario spanning 32 years (2018-2050). Summaries of historical changes and gridded spatially-explicit map projections suggest that climate influences may make the landscape more homogeneous in the near future. Across the entire study area, 30m pixels with current high percent bare ground cover are projected to become less bare ground dominant; pixels with current moderate percent herbaceous cover are projected to contain less herbaceous cover, and pixels with current low percent shrub cover are projected to contain more shrub cover by 2050. Although change rates vary between scenarios, general patterns and composition do not differ much between scenarios by the end of the projected period. This is surprising given that RCP 8.5 climate projections suggest that minimum temperatures will be 17% higher and total precipitation will be 3% higher in the study area by 2050. Different patterns and trends are more apparent by comparing projections between management units. Hart Mountain National Antelope Refuge is projected to undergo the most change over the projected period. BAU and RCP 8.5 models project a larger decline in bare ground, as well as larger upticks in average herbaceous and shrub cover in Hart Mountain compared to the other management areas included in the study. These scenarios present alternate future outcomes that could help guide federal land managers to identify changes in cover that may affect certain species.

Managing the Effects of Drought and Facilitating Recovery from Drought in California's Montane and Subalpine Forests

Presenter's Name: Christopher Fettig
Presenter's Company/Employer: Pacific Southwest Research Station
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
In montane and subalpine forests of California, recent droughts have contributed to widespread bark beetle outbreaks, extensive tree mortality, reduced tree growth, and increased wildfire hazard, all of which in turn affect biogeochemical cycling and hydrologic processes. Reducing forest densities will increase the resilience of montane and subalpine forests to drought and other disturbances exacerbated by drought. The main tools are mechanical thinning and fire, the latter consisting of prescribed fires or wildfires that are allowed to burn under appropriate weather conditions (i.e., managed wildfire). Facilitating recovery and restoration of drought-impacted forests requires a flexible approach. For small patches of tree mortality (e.g., <20 hectares), intervention may be minimal. If green-tree seed sources are not nearby (generally within ~250 m for wind-dispersed conifers), intervention may be limited to planting more drought-tolerant seedlings. In more extensive patches of tree mortality, decisions about salvage harvesting, prescribed burning, planting, and controlling competing vegetation may vary with dead-tree patch size, potential natural seedling recruitment, management goals and fire hazard. The montane and subalpine forests of California provide immeasurable ecological goods and services, many of which warrant special protection and management considerations. In this presentation, several USDA Forest Service and California Department of Forestry & Fire Protection publications will be reviewed that guide thinking about managing forest structure to emulate the 'natural' heterogeneity of forests, to minimize the undesirable impacts of drought, and to facilitate recovery from drought. Key elements include: (1) increasing the pace and scale of thinning, prescribed burning and managed wildfire, (2) rebuilding the forest products industry in California to facilitate adequate biomass removals, (3) improving forest structure for wildlife habitat, (4) restoring ecologically-sensitive areas (e.g., meadows), (5) facilitating legislative and administrative reforms that act as barriers to project implementation, and (6) implementing monitoring and adaptive management.

Symposium Description:
We propose a symposium (Managing for Drought in California Ecosystems) related to managing for drought in California that corresponds to a recent chapter in the USDA Forest Service-produced General Technical Report 'Drought Impacts on U.S. Forests and Rangelands: Translating Science into Management Responses'. This symposium will contain an overview of the topic, four additional presentations related to drought management in widespread California ecosystems and conclude with a facilitated discussion. Presentations are germane to the conference topic 'Natural areas management in light of climate change' given that global climate models project severe droughts will become the norm in California.

Global change and ecosystem resilience: managing threats to sustainability

Presenter's Name: Hugh Safford
Presenter's Company/Employer: USDA-Forest Service
Presenter's Title: Regional Ecologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
This oral session, jointly sponsored by UC-Davis and the University of Nevada-Reno, centers on global change in western ecosystems and how managers are trying to ensure sustainability in the face of shifting disturbance and stress regimes. Focus is on western forests, chaparral, sagebrush, and meadow ecosystems. Speakers will discuss how interactions among drought, climate warming, fire, grazing, pests and pathogens are affecting ecosystem composition, structure and function, how management is impacted, and how management tactics and strategies may need to change to enhance ecosystem resilience and/or ensure long-term sustainability.

Symposium Description:
This is for an oral session on Wednesday October 15. It will begin with four 20 minute (15+5) talks during the oral session slots starting at 1330, then after the break it will continue with ten 15 minute (12+3) talks, finishing at 1800. The second set of talks will replace one of the roundtable slots Note that the title and abstract provided above are for the oral session itself, not for a talk (I will not be speaking during the session)

Regeneration of high-elevation five-needle pines limited by microclimate conditions across disturbance gradients

Presenter's Name: Lacey Hankin
Presenter's Company/Employer: University of Nevada, Reno
Presenter's Title: PhD Student
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Co-authors Sarah Bisbing, sbisbing@unr.edu Alexandra Urza, alexandra.urza@usda.gov Background/Methods High-elevation forests occupy environments near the physiological tolerances of tree species, and their extreme longevity have allowed for their persistence through significant climatic changes. Unprecedented climate change coupled with threats from mountain pine beetle, white pine blister rust, and changes in fire activity now threaten the resilience of these endemic forests. To improve our understanding of climate and disturbance effects on high-elevation forests dominated by limber pine (Pinus flexilis), bristlecone pine (Pinus longaeva), and whitebark pine (Pinus albicaulis), we asked: a) how does disturbance interact with water availability to influence the regenerating community?, b) to what extent is the regenerating community dominated by surviving advanced regeneration versus post-disturbance recruitment?, and c) what are the implications of species-specific responses to disturbance across climatic gradients? We evaluated natural regeneration in 70 sites varying in climatic and disturbance characteristics across eastern California and the Great Basin. Sites were either undisturbed or affected by one or more disturbance agent. We sampled community composition in addition to quantifying disturbance history and potential seed availability. We used structural equation models to evaluate direct and indirect effects of abiotic and biotic drivers on the regenerating community. Results/Conclusions Extensive recent mortality occurred across the study area. Natural regeneration was highly variable, with abundant regeneration of whitebark pine across varying disturbance and climatic conditions but significantly lower limber and bristlecone pine regeneration. All species showed reduced regeneration with increasing understory cover. Coarse acidic soils and decreased water deficit favored whitebark pine regeneration, while limber pine regeneration increased with increasing water deficit and tree density, suggesting potential buffering effects of tree canopy for microclimate. While increased spring snowpack and summer temperature favored bristlecone pine regeneration in undisturbed sites, these drivers had strong negative effects in burned sites. Our findings highlight the complex drivers of regeneration in arid high-elevation pine forests. Water availability, through increased snowpack, canopy buffering, or soils, is an important driver of regeneration, and water stress is expected to increase under projected future conditions. Bird dispersal may buffer the effects of disturbance by overcoming seed limitations, however forest mortality may exacerbate microclimate conditions, leading to increasingly rare opportunities for establishment. Widespread mortality necessitates continued monitoring of natural regeneration and implications for forest persistence. This work will help managers target areas for restoration to facilitate persistence of these species under current and future climate scenarios.

Droughts and Drought Impacts in California: An Overview

Presenter's Name: Steven Ostoja
Presenter's Company/Employer: USDA California Climate Hub
Co-Presenter's Name: Chris Fettig
Co-Presenter's Company/Employer: USFS-PSW
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Drought is a basic feature to California's climate. Moreover, droughts have been an important influence on California's ecosystems for millennia. Over the past century, the state has experienced several extreme drought events; but in the past 5 decades there has been a notable increase in drought frequency and severity. A notable hallmark of this was the 2012-2016 drought, which based on tree ring records, was the most severe in >1000 years. Droughts like this one can contribute to wide-spread ecological and economic impacts that touch many different industries and sectors. In California the most recent severe drought facilitated wide-spread mortality of trees and shrubs in forests and woodlands, was blamed for poor rangeland condition and leading to agricultural and forestry industry impacts. In this presentation we will examine how historical drought has differentially shaped California's natural ecosystems. We will also consider what is expected with future climate change especially in regard to extreme climate events like drought and heat waves. Mindful that the future climate change will bring increased frequency and severity of drought; attention will be given to how ecosystem components may be impacted directly and indirectly. We will conceptually introduce how management strategies and approaches can work to prepare forest and associated ecosystems with greater adaptive capacity in the face of future impactful drought events. Such considerations are of value so context-specific management strategies can be considered preemptively with the goal to ameliorate the impacts brought from climate change. Finally, some treatment will be given to what climate mediated impacts could mean for various societal and industry interests if management efforts are not prioritized preemptively. Author/Presenter: Steven M. Ostoja; Co-Authors: Christopher J. Fettig, Amarina E. Wuenschel, Jennifer Balachowski, Ramona J. Butz, Anna L. Jacobsen, Malcolm P. North, R. Brandon Pratt, Richard B. Standiford, Jonathan P. Long and Jon E. Keeley.

Across Time & Space: Species diversity response to fire severity in Sierra Nevada yellow pine and mixed-conifer forests

Presenter's Name: JonahMaria Weeks
Presenter's Company/Employer: UC Davis
Presenter's Title: PhD Candidate
Co-Presenter's Name: Clark Richter
Co-Presenter's Company/Employer: UC Davis
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Ecological disturbance regimes are changing due to a combination of effects from both direct human influences and climate change. Wildfire regimes in particular are being affected due to interactions between high fuel loads and climate warming, resulting in many regions that historically experienced low to moderate fire severity regimes now seeing increased area burned at high severity. Despite understory taxa comprising the vast majority of forest plant species and playing vital roles in overall ecosystem function, little is known of the effects of changing fire regimes on forest understory plant diversity. Furthermore, the role of time since fire when examining the relationship between fire severity and diversity is understudied, with space for time substitutions often being made. We examined understory plant diversity across gradients of wildfire severity in eight large wildfires in yellow pine and mixed conifer temperate forests of the Sierra Nevada, California, USA. Additionally, we sampled one of those fires at five time-steps across nine years. We found a generally unimodal relationship between local plant diversity and fire severity across fires and through time. High severity burning resulted in lower local diversity as well as some homogenization of the flora at the regional scale. Our research suggests that increases in fire severity in systems historically characterized by low and moderate severity fire may lead to plant diversity losses, which on a global scale may have important implications for biodiversity.
co-authors: Clark Richter, University of California-Davis; Marcel Rejmanek, University of California-Davis; Jesse E. D. Miller, Stanford University; Kevin Welch, University of California-Davis; Zack Steel, University of California-Berkeley; Evan Batzer, University of California-Davis; Hugh Safford, USDA Forest Service and University of California-Davis

Fire, carbon, and climate change in California's high elevation forests

Presenter's Name: Sara Winsemius
Presenter's Company/Employer: University of California, Davis
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Recent changes in high elevation forests worldwide indicate that forest structure and long-term ecosystem stability are threatened, with implications for carbon sequestration and ecosystem refugia. Biomass and disturbance models have high uncertainty in high elevation forests, where landscapes are more heterogeneous across short distances and data are more limited than in lower elevations. Anecdotally, subalpine tree mortality after fire is generally low in the first year, with substantial increases in mortality in the five years following. Delayed mortality and compounded disturbances may lead to an underestimation of mortality from disturbances. Given the increasing area and frequency of fires over the last decades, changes in high elevation forest fire regimes and their impacts on biomass are unclear. In this project I analyze temporal patterns of tree mortality using Bayesian machine learning methods with high resolution imagery. I expect the timing of mortality in the several years following fire to vary between drought and non-drought post-fire conditions, and locations, with implications for long-term carbon storage projections and management. California's high elevations are assumed to be stable carbon sinks due to relatively low levels of disturbance, however the severity of disturbances may be underestimated using current methods. Enhanced measurements of post-fire mortality will impact assessment of changing biomass stocks, which is essential for understanding current and projected trends in carbon sequestration.

Tree recruitment and forest expansion following reforestation in the Sierra Nevada, CA

Presenter's Name: Tara Ursell
Presenter's Company/Employer: University of California, Davis
Presenter's Title: Graduate Student
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
In post-wildfire landscapes in the western Sierra Nevada, the availability of live, reproductive trees is a strong predictor of conifer regeneration. One proposed management strategy is to reforest small patches as a means of establishing future conifer seed sources in areas where high mortality from wildfire inhibits natural regeneration and where reforestation is difficult at scale. However, certain post-fire successional processes (e.g., the growth of competing vegetation) are also known to inhibit tree establishment and growth, and these processes may become dominant before planted trees become reproductive. Thus, it is unclear whether a small planted stand that produces viable seed could plausibly result in seedling establishment and forest expansion in this system. In Summer 2019, we conducted an observational field study testing the contribution of now-reproductive planted trees relative to site characteristics in driving conifer seedling recruitment in unplanted areas. We found that regeneration was significantly higher closer to the plantations, suggesting that plantations do contribute to tree establishment outside of the planted area. We did not find a significant effect of shrub cover nor overstory cover on recruitment, leading us to reject the hypothesis that shrub cover limits recruitment even when seeds are present. Though we focused the study on areas that had high post-fire tree mortality, we still found that proximity to surviving trees was a significant predictor of recruitment. Collectively, these results suggest that plantations are a viable option for catalyzing tree recruitment in unplanted areas, but this effect may be most relevant for practitioners in areas where large, surviving trees are not available as seed sources. Co-authors: James N. Sanchirico, Department of Environmental Science & Policy, UC Davis; Hugh D. Safford, Department of Environmental Science & Policy, UC Davis and USDA Forest Service, Pacific Southwest Region

Managing Effects of Drought and Facilitating Recovery in California Oak â€“dominated Forests and Woodlands

Presenter's Name: Jonathan Long
Presenter's Company/Employer: USDA Forest Service Pacific Southwest Research Station
Presenter's Title: Ecologist
Co-Presenter's Name: Yana Valachovic
Co-Presenter's Company/Employer: UC Cooperative Extension
Co-Presenter's Title: County Director and Forest Advisor
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Oaks have many adaptations, including drought tolerance and resprouting abilities that afford them increased resilience to drought and associated natural disturbances. Shifts toward increased dominance of oaks are expected in many parts of California based upon projections of increased warming and drought. Such trends have become evident during the recent, widespread drought event that killed many pines and other conifers in the southern Sierra Nevada. Drought and fire-induced mortality are natural regulatory processes that may restore more sustainable forest conditions by reducing densities of oaks and competing conifers, especially if that mortality tends to kill smaller trees and trees in poorer soils, at low elevations, on south-facing slopes. However, mortality events could be degradative where they kill mature trees and inhibit regeneration. For example, in southern California, the combination of drought, wildfire, and expanding insect pests like the goldspotted oak borer may lead to reductions among some oak species. Meanwhile, sudden oak death is a novel stressor in northern California coastal forests. A goal for managing resilience throughout the state is to conserve mature oaks that provide ecosystem services such as acorn production and habitat for wildlife. That goal can be advanced by thinning overly dense oak stands, remove competing conifers, reducing fuels, and supporting use of fire, including cultural burning directed by tribes and informed by traditional knowledge. Treatments also need to create openings for regeneration to ensure sustainable conditions over the long-term. Several recent synthesis reports have proposed and developed these strategies, including the recent General Technical Report on management for drought in the US, a report on restoring California black oak for tribal values, and the 4th California Climate Change Assessment. Reducing competition for water by non-native annual grasses may also be important strategies in grazed woodlands and in urban forests. More active efforts to plant young oaks and water mature trees may be also appropriate in intensively managed areas. Meanwhile, in more remote locations, managing naturally ignited fires and using prescribed burns will be important strategies for resilience. However, managers and the public may want to help inventory and safeguard especially old and large legacy trees that have disproportionate ecological and social value to minimize potential losses from combined stressors.

Projected impacts of climate change on northeastern California vernal pools

Presenter's Name: Kyle Merriam
Presenter's Company/Employer: USDA Forest Service
Presenter's Title: Ecologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium – Global change

Abstract:
Kyle E Merriam*, Peter J Weisberg, Meredith C Gosejohan, Ashton Montrone, Laurel Saito, John Meija Vernal pools are ephemeral wetlands characterized by complete inundation during the winter and spring, followed by hot, arid conditions during the summer. Plant and animal species that occur in vernal pools are highly specialized to tolerate these fluctuating conditions, and vernal pools exhibit zonation of plant community types according to the tolerance of individual species to the local inundation regime. Vernal pools across California have been extensively destroyed since the mid-1800s as a result of agricultural conversion and urban development, and many vernal pool specialist species have been federally listed as threatened or endangered. Remaining vernal pools have been degraded by activities that modify vernal pool hydrology, including the construction of dams, ditches and roads. An emerging threat to vernal pools is hydrologic alteration caused by changes in precipitation and temperature as a result of climate change. We used hydrologic models in combination with hydroregime and vegetation sampling to investigate the potential impacts of climate change on vernal pools in northeastern California. Our model simulations suggest that climate change would result in sharp reductions in vernal pool hydroperiod, which in turn would lead to declines of the long-term inundated plant community, whereas edge and shallow-tolerant communities would increase. Vernal pool specialist species of primary conservation concern are more commonly found in the long-term inundated community, while short-inundated communities are characterized by wetland generalist and non-native plant species. However, our results also suggest that management actions may be able to partially mitigate some of the predicted effects of climate change. For example, restoration of vernal pool hydrology may extend vernal pool inundation period in some cases. In addition, we found that litter accumulation associated with livestock exclusion may decrease inundation lengths in vernal pools. Our results are consistent with a number of other studies suggesting that active management of vernal pool landscapes to limit litter accumulation may also be necessary to maintain vernal pool hydroregimes in the face of climate change.

Managing Effects of Drought and Facilitating Recovery in California: Coast Redwood Forests

Presenter's Name: Ramona Butz
Presenter's Company/Employer: USDA Forest Service
Presenter's Title: Province Ecologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Within the redwood forests of northern California, annual water use by large redwoods is high, and the greatest demands for water occur during summer months when rain is sparse. Summer fog serves an important role in ameliorating water deficits. During drought, redwood forests continue to tap fog as a water source, and deep, loamy forest soils slowly release the water captured from winter rains. Coast redwoods tend to be poor regulators of water use, making them sensitive to ambient humidity and the presence or absence of cloud cover. During prolonged drought, decreased canopy water content and fog drip can lead to decreased germination and survival rates of seedlings, and reduced radial growth, limited foliar water uptake, and even death in mature trees. Although mature redwood forests are generally fairly drought tolerant, the effects of drought events of increased intensity and duration can be minimized through a number of management strategies. The loss of redwood trees to natural disturbances (e.g., wildfire, windthrow, floods, severe drought), extensive timber harvest, or other land-use practices converts forests to more open habitats reducing fog capture, thus altering the hydrological balance and creating more drought-prone conditions. Drought mitigation in coast redwood forests includes: (1) reduction of competing vegetation, such as Douglas-fir (Pseudotsuga menziesii), through prescribed burning and mechanical thinning, (2) reduction of practices that create forest structures that are too open, thereby losing their ability to capture moisture from fog, (3) minimization of soil disturbance, (4) reduction of road densities, (5) creation of small gaps for light availability for regenerating seedlings, and (6) protection of old-growth reserves.

The Evolution of Forest Restoration Planning in the Central Sierra Nevada

Presenter's Name: Kristen Wilson
Presenter's Company/Employer: The Nature Conservancy
Co-Presenter's Name: Patricia Manley
Co-Presenter's Company/Employer: Pacific Southwest Research Station
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Efforts to restore forests are increasing in pace and scale to improve forest resilience to climate change. Although forest management to achieve desired conditions has been practiced for at least a century, arguably several centuries in the Sierra Nevada, the complexity of the environmental context and the planning processes have increased significantly, creating a need to retool restoration planning approaches. We describe four projects that illustrate recent adaptations in forest restoration planning to broader spatial and temporal scales and to include climate change impacts. An early restoration effort that was designed and implemented over a 15-year period from 2005 to present at the Sagehen Creek Field Station and Experimental Forest, tested a then novel approach to restoration on National Forest System lands. The Sagehen Project created openings or gaps in the forest and thinned out small diameter trees over a 4,000-ha landscape. A more recent project, French Meadows Project, was designed and began implementation over only 3 years. The project tackled multiple land ownerships, and similarly complex silvicultural prescriptions over a 11,000-ha landscape. Both projects took a static view of current fire risk, departure of vegetation from historic conditions, and evaluation of assets at risk from fire. They qualitatively addressed climate change but did not quantify the projected influence of climate change. The Lake Tahoe West Restoration Partnership marked a transition in forest restoration planning. The planning scale increased again to a 24,000-ha landscape ranging from urban to wilderness. The partnership adopted a dynamic view of landscape conditions over 100 years across a large set of ecological and social outcomes modeled under future climates to inform a restoration strategy. The Tahoe Central Sierra Initiative (TCSI) builds on the Lake Tahoe West project by taking another leap to a 1-M ha regional landscape. TCSI also incorporates dynamic modeling over 90 years to inform forest restoration management inputs, and to support planning efforts at all scales within the regional landscape. Broader spatial and temporal scales of analysis along with quantitative evaluation of climate change as a driver of forest health across diverse land ownerships characterize the recent evolution of forest restoration planning.

Symposium Description:
In the past fifteen years, forest restoration planning increased in spatial scale by twenty times in the Central Sierra Nevada. Coincidentally, science modeling studies at even larger spatial scales and across long temporal scales (1550-1850; 2018-2100) were developed to inform forest planning. These regional landscape studies provide a science foundation for planning at all smaller nested scales and for a conditions-based management approach. This symposium presents the evolution in forest planning with a focus on projects within the Tahoe Central Sierra Initiative, a 2.4 million-acre area. Incorporation of the science is being tested in the proposed North

Water stress drives demographic shifts and the potential for type conversions in coastal California pine forests

Presenter's Name: Sarah Bisbing
Presenter's Company/Employer: University of Nevada - Reno
Topic: Natural areas management in light of climate change
Proposal Type: Symposium – Global Change
Abstract:
co-author: Brian Buma, University of Colorado - Denver Climate change-induced forest dieback is documented as a recent global phenomenon, with pervasive mortality having profound impacts on ecosystem services and natural forest functioning. The prolonged drought and scale of tree die-off in California from 2010-2016 (>145 million trees) was unprecedented in modern history. Morality of this magnitude can transform regional landscapes and have severe effects on forest function and ecosystem services. Ongoing drought and alteration of precipitation due to climate change will likely lead to continued mortality, which is most precarious for endemic species filling narrow yet essential ecosystem roles. Pinus radiata, an endemic to coastal California and Baja Mexico, is susceptible to non-native pine pitch canker and recently experienced widespread mortality following chronic drought stress. We used a 15-year dataset from permanent plot network to evaluate the 1) relative importance of exogenous vs. endogenous factors in shaping forest demography, 2) role of precipitation in the direction and magnitude of change, and 3) predicted impact of climate change on species persistence. Mortality peaked in during the 2014-2015 period of California's extended drought, with the greatest proportional mortality occurring in the small tree size class. Co-occurring Quercus agrifolia experienced negligible mortality over this same timeframe. For P. radiata, climatic water deficit was identified as the primary driver of mortality across all tree size classes ($p<0.001$). Small tree, sapling and seedling mortality were additionally influenced by the length of the frost-free period, with increasing mortality with increasing number of days ($p<0.001$). Pinus radiata recruitment was best explained by antecedent precipitation ($p<0.001$), while Q. agrifolia regeneration was driven by both antecedent and sampling year precipitation levels ($p<0.05$). Forest density was only influential in seedling mortality ($p<0.05$), and pine pitch canker incidence led to higher mortality in seedling and sapling size classes ($p<0.001$). The prevalence of disease significantly influenced demographic patterns over time, but, in all models, climate was the primary determinant of mortality and recruitment. Climate projections predict a decrease in annual precipitation and increase in the frost-free period, indicating a high likelihood for continued mortality and low recruitment for P. radiata into the future. Given the likelihood for ongoing decline of endemic P. radiata, management should focus on ongoing preservation of P. radiata stands in less impacted portions of the species' range as well as conservation of drought-adapted Q. agrifolia to support ongoing promotion and protection of forest ecosystems and associated ecosystem services.

Palaeoecological Studies for Past, Present and Future: A Case Study From Soldier Meadows

Presenter's Name: Mark Hall
Presenter's Company/Employer: Black Rock Field Office, Bureau of Land Management
Presenter's Title: Field Manager
Co-Presenter's Name: Dave Rhode
Co-Presenter's Company/Employer: Earth and Ecosystem Sciences, Desert Research Institute
Co-Presenter's Title: Research Professor
Topic: Natural areas management in light of climate change
Proposal Type: Poster Presentation

Abstract:
The purpose of this poster is to illustrate the utility of pollen cores as tools that can provide valuable insights into the past, present and potential future of local vegetation communities. Also illustrated will be the utility of pollen cores in informing land management decisions. A pollen core was obtained from the wet meadow surrounding Mud Meadows spring inside the Soldier Meadows Area of Critical Environmental Concern (ACEC) located in the Black Rock-High Rock Emigrant Trails National Conservation Area (NCA) in northern Nevada. It is an unique habitat for threatened plant (basalt cinqefoil) and animal (desert dace) species. The core was processed to recover pollen and non-pollen palynomorphs. A Bayesian age-depth model was constructed for the core from Pb isotope and radiocarbon dates. The core extends back 1500 years and its dated resolution ranges from a decade to just under 200 yrs. The irregular time series of the proportions of various plant species and taxa are discussed. Through the Medieval Climatic Anomaly (MCA), the vegetation community is dominated by Chenopodiaceae and Asteracea. In the Little Ice Age (LIA), Artemesia and perennial grasses dominate the vegetation communities and have remained fairly resilient through time, even in the presence of commercial grazing. Analysis of the charcoal grains suggests a decrease in the fire frequency from the MCA through the LIA. The cyanobacteria Rivularia increases and Glomus decreases circa 350 BP to the present. This is indicative of a change in water chemistry and potentially water level. The Modern Analogue Technique, in combination with the North American pollen database, is utilized to reconstruct climatic indicators. As expected, the MCA was a warmer and drier period--a climatic condition that is expected to become prevalent in the future. For planned and potential habitat restoration projects in the Soldier Meadows ACEC, the pollen core yields insights on the types of vegetation and relative quantities of it out there, and its resilience. In accounting for climate change and habitat restoration projects, the pollen core provides evidence of species and taxa that may be better suited for future conditions.

Where and when to plant trees after fire in the face of water limitation and shrub competition.

Presenter's Name: Quinn Sorenson
Presenter's Company/Employer: University of Californiaâ€”Davis
Presenter's Title: Postdoctoral Scholar
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Wildfires in the mid-elevation forests of California's Sierra Nevada mountain range have massively increased in size and intensity over the past half-century due to a century of fire suppression and possibly climate change. Disturbance on this scale was rarely seen in the Sierra Nevada prior to the initiation of fire suppression. As a result, post-fire forest tree regeneration has become weak in many areas, leading forest managers to invest in tree planting as a strategy to hasten forest recovery after fire. Despite the critical importance of tree planting for forest recovery, it remains unclear how environmental variation in tree stress determines natural regeneration versus planting success. To address this gap, we joined efforts with the U.S. Forest Service to ask how variation in the physical environment (e.g., temperature, precipitation, light intensity, etc.) and competition from shrubs impact natural regeneration and tree planting success after forest fires throughout the Sierra Nevada. We found that natural regeneration is lowest at the hottest, driest sites and that tree planting can provide a moderate boost to forest recovery under these conditions. We also found that the timing of tree planting matters but depends on competition from shrubs. In places where shrub competition is intense, tree planting is much more successful if planting occurs the year immediately following a fire (the soonest that it is practical to plant). Alternatively, in places where shrub competition is weak, waiting a few years to plant trees until some shrubs establish actually facilitates tree survival, perhaps by providing shelter from harsh conditions. Overall, we recommend forest managers prioritize the hottest, driest sites for reforestation projects and plant trees as soon as possible where competition from shrubs will be most intense.

Tahoe Central Sierra Initiative: Modeling Historic Range of Variability to inform restoration planning

Presenter's Name: Becky Estes
Presenter's Company/Employer: USDA Forest Service
Presenter's Title: Province Ecologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Estes, Becky1, McGarigal, Kevin2, Conway, Scott3 1 Pacific Southwest Region 2 LandEco Consulting 3 Conway Conservation The Tahoe Central Sierra Initiative (TCSI) spans 2.4 million acres covering a range of forest types in the Sierra Nevada in California. The landscape is dynamic, developing as a result of complex natural and human land use history driven largely by disturbance. Fire is the dominant disturbance driving vegetation succession, in which cycles of fire and recovery occur variably over large extents and long periods producing a constantly shifting mosaic of ecosystem conditions. It is generally believed that prior to Euro-American settlement in the mid-1800s, the TCSI landscape was in a dynamic equilibrium with a stable shifting mosaic of vegetation conditions that was highly resilient to permanent change. To understand this dynamism, TCSI felt it was important to develop a quantitative assessment of the historical (ca. 1550â€“1850) range of variability (HRV) in landscape structure that can be used as a restoration planning tool to: 1) define a reference to evaluate the current landscape 2) develop a framework for deriving desired future conditions and 3) create a monitoring tool to measure restoration success. To simulate disturbance and succession processes representative of the HRV period within the project area, we developed a landscape disturbance-succession model using fine scale LIDAR data in the LDSIM framework and simulated the dynamics in vegetation driven by wildfire during the historical reference period At the landscape scale, the historical reference period was best characterized as a shifting mosaic of vegetation types and conditions that was subject to a remarkably high wildfire disturbance rate. We quantified the range of variability in composition and configuration of the landscape mosaic and compared the results to the current landscape to quantify departure. Current conditions compared to the simulated HRV showed departures in both composition and structure. For example, HRV was characterized by more late seral forests and smaller and more distributed openings than our current conditions. These outputs can define the reason for change and help prioritize where to do treatments. HRV can also be expressed using a biophysical unit framework that defines departure from HRV at a stand scale providing quantitative estimates that can be built into project level silvicultural prescriptions (gap size, seral stage). The HRV departure estimates will ultimately be used to help guide large landscape scale projects in TCSI such as the one underway in

Estimating loss of carbon stocks in postfire chaparral shrublands in southern California

Presenter's Name: Mark De Guzman
Presenter's Company/Employer: UC Davis
Topic: Natural areas management in light of climate change
Proposal Type: Symposium – Global Change

Abstract:
Carbon sequestration is one of the many ecosystem services provided by chaparral shrublands in Southern California, however chaparral's effectiveness in providing this service is dependent on its resilience to mitigate disturbance. Estimates of carbon stocks pre- and post-fire in chaparral where fire occurrence is within the historical range is directly quantifiable (e.g., aboveground, belowground, litter, soil carbon), but quantification of stocks in areas with short fire return intervals and tailored to the different functional life histories of chaparral species (seeders versus resprouters) has yet to be determined. We estimated carbon stocks through compiling biomass estimates from the literature to build regeneration models for the seeder and resprouter life history types. We then integrated our models with Landsat-derived Enhanced Vegetation Index (EVI) and historical fire perimeter data to estimate changes in carbon stocks in chaparral pre- and post-fire. Carbon stocks were disproportionately affected in areas with the shortest fire return interval which was mainly driven by changes in the vegetation composition. The greatest losses occurred in type-converted landscapes that are heavily dominated by resprouter life history types, which store a higher proportion of biomass belowground compared to seeders. Our methods could be applied to environmental damage assessments to estimate the amount of carbon permanently lost due to fire and changes in fire regime.

Modeling human and natural disturbances under climate change

Presenter's Name: Charles Maxwell
Presenter's Company/Employer: North Carolina State University
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Kristen Wilson, Robert Scheller, Patricia Manley Between a history of fire suppression and changing climate, forests are moving outside of their historical range of variation. As fires are becoming more severe, forest managers are searching for strategies that can restore forest health and reduce fire risk. However, management activities are just one part of an integrated suite of disturbance vectors that shape forest conditions. To test this concept of the substitutability of disturbances, a disturbance return interval (DRI) was calculated that represented the average return time for any disturbance, human or natural, for any particular point, specifically to investigate the consequences of changing that interval on the proportion of high severity fire and the net sequestration of carbon on the landscape. In order to explore and quantify trade-offs between human and natural disturbances, we used management scenarios that were developed between forest managers and stakeholders in the Central Sierra Range of California. These scenarios were integrated into a mechanistic forest landscape model that accounted for climate change, harvesting, wildfire, and insect outbreaks. Our results suggest increasing the frequency of all disturbances on the landscape was found to reduce the percentage of high severity fire on landscape but not the total amount of wildfire in general. However, increasing the DRI reduced landscape carbon storage and sequestration, particularly in management strategies that emphasized prescribed fire over hand or mechanical fuel treatments.

North Yuba Project: a spatially explicit condition based

Presenter's Name: Scott Conway
Presenter's Company/Employer: Conway Conservation Group
Co-Presenter's Name: Andrew Salmon
Co-Presenter's Company/Employer: South Yuba River Citizens League
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
The North Yuba Project's planning approach synthesizes ecological, economic, and social data to inform complex forest restoration decision-making across a 275,000-acre landscape. In conjunction with a nine-entity collaborative, a risk assessment and spatially explicit condition-based restoration framework informed by historical, current, and future scenario modeling is being developed to establish a multi-decade treatment design. Priority-setting for restoration was informed through the quantitative valuation of strategic areas, resources, and assets aggregated with disturbance modeling outputs. With the objective of increasing ecosystem resiliency through improved forest structure and function, a spatially explicit condition-based framework was developed addressing the landscape's dynamic needs over time. Leveraging the modeling outputs from LDsim and Landis, restoration plans and silvicultural treatments were developed based on historical, contemporary, and future conditions. As environmental conditions change, this flexible condition-based approach will provide land managers with an adaptable scientifically-informed suite of options to draw upon in both the present as well as when the future inevitably changes conditions.

Seasonal water availability drives trait variation in isolated Pinus ponderosa populations

Presenter's Name: Tessa Putz
Presenter's Company/Employer: University of Nevada, Reno
Presenter's Title: Master's Student
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Tessa Putz, Sarah Bisbing, Alexandra Urza Combined effects of rising temperatures and drought are threatening forests globally. These unprecedented conditions are likely to decrease forest resilience, leading to widespread tree mortality and loss of associated forest ecosystem services. Drought adaptations may, however, confer success under these projected extreme conditions and be key to the perpetuation of long-lived tree species. The timing, amount, and type of moisture strongly influence the degree of drought adaptation in a given population, and local topographic heterogeneity may exacerbate or mitigate these effects, driving variation in trait response both within and among populations. Although drought adaptations are well-studied in widespread tree species, knowledge is limited on the extent of drought-responsive traits in disjunct conifer populations. In the northern portion of the arid Basin and Range province of the western United States, Pinus ponderosa var. scopulorum is isolated to montane sky islands, making it a model system for testing the effects of climate and topography on conifer species trait variation. We sampled 55 populations across six ranges in Nevada and Utah to quantify trait variation in cone volume, wood density, and needle lifespan. To investigate the relationship between interacting climatic and topographic conditions on drought adaptations we explored the role of seasonal climatic moisture deficit (CMD), monsoonality, and aspect on trait variation using linear mixed models. Traits varied widely both within and among populations, with seasonal water availability most influential in trait response. Cone volumes increased with increasing summer CMD but decreased in areas with a heavy monsoon influence. The seasonality of moisture similarly influenced wood density, with densities increasing with increasing winter CMD, signaling the importance of winter moisture for tree growth. Needle lifespan was also influenced by monsoonality, indicating that late summer precipitation leads to reduced needle retention. Local topographic variation had a minor influence on trait variation for the populations tested here, mediating climate on northern slopes and acting as a compounding stressor on southern aspects for wood density response alone. These findings suggest the importance of seasonal moisture stress on drought-adapted conifer traits and potential of these conifers to alter traits to conserve growth and alter resources under water limitations, both which have implications under the threat of altered climatic conditions for semi-arid systems.

Developing snowpack/forest management support tools for montane forests in the Sierra Nevada

Presenter's Name: Sebastian Krogh
Presenter's Company/Employer: University of Nevada, Reno
Presenter's Title: Postdoctoral Fellow
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Montane snowpack in the Sierra Nevada provides critical water resources for ecological functions and downstream communities. Understanding the effect of forest removal (e.g. forest thinning) on the snowpack in montane forests is critical to designing effective strategies that account for the co-management of several ecological services such as wildlife habitat, soil erosion, and water quality and quantity. Given the complex and heterogeneous effects that the forest canopy exerts on snow accumulation and melt, and the need to include different climates and forest structures, a multi-site, high-resolution study is required to understand how forest thinning affects snowpack over large areas. Here, we apply a high-resolution (1-m) state-of-the-art snow model to simulate the impact of forest thinning on the snowpack across a variety of sites with lidar-based forest characterization in the northern Sierra Nevada. The snow model is an ideal tool to study the influence of forest thinning on snowpack because it explicitly represents many of the physical processes affecting the snowpack mass and energy balance in the forest, such as tree shading, wind redistribution of snowfall, and canopy interception and sublimation of snowfall. The model is run with the current lidar-based forest structure (height and density), and two virtual thinning scenarios in which trees below 10 and 20-m are removed, during wet and dry years. This multi-site and -year approach allows us to quantify the impact of forest thinning on melt volumes across a gradient of climates and forests conditions, where current dry/warm places may serve as a proxy for future warmer and drier conditions in the Sierra Nevada. The wide range of snowpack conditions and forest structures represented in this study enables us to create a decision support tool that can be extrapolated to sites with different environmental conditions. This tool is expected to help guide ongoing and future forest thinning strategies in the Tahoe Basin that aim to increase melt volumes and mitigate the historically declining snowpacks in the region.

Managing small natural areas in light of climate change

Presenter's Name: Peter Dunwiddie
Presenter's Company/Employer: University of Washington
Presenter's Title: Affiliate Professor
Presenter's Email: pdunwidd@u.washington.edu
Topic: Natural areas management in light of climate change
Proposal Type: Individual Presentation

Abstract:
Considerable efforts have been made in recent decades to enlarge or connect many natural areas to include more complex, heterogeneous landscapes based on the premise that greater size, connectivity, and habitat diversity may allow many species to move to suitable sites as climates change. While protecting key linkages and rewilding natural habitats may be feasible strategies in some areas, in others, these options do not exist. Urban sprawl and development, conversion to farmland and production forestry, and road construction may have irrevocably severed corridors and preclude increasing the size of natural areas and surrounding habitats. This presents enormous challenges and questions regarding the long-term viability of many small, often isolated natural areas that were set aside at a time when conservation paradigms were less aware of the importance of size and connectivity in maintaining ecological functionality. In this talk, I propose an alternative for managing such sites by reconsidering their overall goals. Rather than focusing on trying to maintain unsustainable ecological functionality, I suggest that such sites might be more suitably managed as refugia or 'lifeboats' for maintaining populations of a high diversity of both rare and common species. On the continuum that describes the management of assemblages of native species, with largely untrammeled wilderness at one end and arboretums, gardens, and zoos at the other, this perspective nudges these small natural areas more forcefully towards the latter. Such a shift runs counter to how many such areas have been traditionally managed and is certain to be regarded with skepticism if not outright hostility by many. Yet, I suggest it presents a number of advantages and opportunities both for significant conservation benefits as well as for learning through experimentation. First, many species could be sustained through intensive and proactive management that is often impossible at larger scales on more extensive sites. Such practices could help sustain unique genotypes and add redundancy to populations of rare species that could serve as sources for restoring other sites as needed. Equally important, these sites could ably serve as locations for experiments with assisted migration. It is imperative that conservation practitioners begin to learn how to deliberately transport species that may be threatened in their current habitats due to changing climates and introduce them in a responsible manner to new, more suitable sites that maximizes learning opportunities. This talk will illustrate these ideas with examples from natural areas in the Pacific Northwest.

Management to promote the resilience of sagebrush ecosystems: invasive species, altered fire regimes, and climate change

Presenter's Name: Alexandra Urza
Presenter's Company/Employer: US Forest Service, Rocky Mountain Research Station
Presenter's Title: Post-doctoral Research Ecologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
In the sagebrush semi-desert of the western United States, the invasion of fire-adapted annual grasses such as cheatgrass (Bromus tectorum) can initiate a grass-fire cycle that results in the progressive loss of native plant communities. Climate change is exacerbating this risk by increasing the size and frequency of wildfires, expanding the climate niche of cheatgrass and other invaders, and reducing the recovery of native perennial species. The resilience of sagebrush ecosystems to fire is highly variable in space and time, and many recent fires have resulted in the conversion of large areas of valuable habitat to annual-grass-dominated ecosystems. There is thus a pressing need to identify management strategies that can promote ecological resilience given the interacting effects of invasive species, altered fire regimes, and warming climate. In this talk, we will discuss post-fire management options for promoting vegetation recovery in heterogeneous landscapes, based on the results of multiple long-term studies. We will show how landscape-scale post-fire recovery potential is related to environmental characteristics and pre-fire biotic conditions, emphasizing the need to target management efforts in those portions of the landscape that will benefit the most. For example, in the driest portions of the landscape where resilience to fire and resistance to cheatgrass invasion are both low, post-fire management interventions are unlikely to result in the successful restoration of native ecosystems. In contrast, post-fire management interventions are often unnecessary in cool and moist sites at higher elevations, where the rapid recovery of native perennials characterizes a resilient post-fire response. Post-fire management investments often have the greatest benefit in intermediate environmental conditions, including in mosaics of sagebrush shrublands and pinyon-juniper woodlands, where interventions such as seeding have the potential to greatly increase resistance to annual grass invasion. We will share experimental results that demonstrate the effectiveness of post-fire native seeding treatments, and will show how functional diversity can be an effective bet-hedging technique for seeding into heterogeneous landscapes. We will then share research on climate-driven episodic establishment patterns in big sagebrush, discussing how an adaptive management approach that includes repeated seeding can minimize the risk of recovery failure for sagebrush and other key species. Finally, we will discuss how post-fire recovery potential is expected to shift in response to climate change, including increases in the proportion of the landscape characterized by low resilience to fire, and will present management principles for promoting ecosystem adaptation and reorganization in a time of increasing uncertainty.

Simulating wildlife habitat dynamics to inform best management

Presenter's Name: Angela White
Presenter's Company/Employer: USFS Pacific Southwest Research Station
Presenter's Title: Research Ecologist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Angela M. White, Timothy Holland, Eric Abelson, Alex Kretchun, Charles Maxwell and Robert Scheller Many forests of the western United States have undergone over a hundred years of anthropogenic impacts that have led to increased tree density, homogenization in forest structure, and accumulation of woody material, all of which pose threats to valued social and ecological features. Forest conditions in California are particular extreme, as evidenced by recent waves of tree mortality and unprecedented large and destructive fires. Collaborative approaches to finding solutions have been identified by the US Forest Service as key to making restoration progress. In California, the US Forest Service and collaborators recently formed a science-management partnership intended to increase the pace and scale of forest restoration on a 60,000 ac landscape in Lake Tahoe. Using LANDIS-II we modeled how forest management and natural disturbance processes (such as wildfire and bark beetle outbreaks) alter habitat for terrestrial vertebrate species over the next century on the west shore of Lake Tahoe. Although wildlife populations are susceptible to many stressors, we assumed that the probability of a species' persistence over the long-term would in part be determined by the maintenance and configuration of high-quality reproductive habitat patches on the landscape. Suitable reproductive habitat for upland-associated vertebrates was interpreted at each decadal time step. Results suggested that the average number of species with high-quality habitat was expected to increase under all scenarios due to forest growth out-pacing stand replacing disturbances. Scenarios that incorporated more aggressive treatments led to the highest mean performance of biodiversity metrics including species richness, redundancy in ecological function, and diversity supported in early, mid and late seral habitat conditions. This highly collaborative effort has enhanced our understanding the effectiveness of different management actions in achieving desired outcomes, while addressing significant uncertainties, such as the impacts of climate change.

Prioritizing Post-fire Restoration in Chaparral Shrublands in Southern California

Presenter's Name: Nicole Molinari
Presenter's Company/Employer: US Forest Service
Presenter's Title: Ecologist, Southern California
Co-Presenter's Name: Emma Underwood
Co-Presenter's Company/Employer: UC Davis
Co-Presenter's Title: Research Scientist
Topic: Natural areas management in light of climate change
Proposal Type: Symposium – Global change
Abstract:
The occurrence and size of wildfires in southern California have increased with human population growth. Chaparral vegetation recovery in post-fire landscapes can be impeded by a number of factors, including drought, excessive fire, and non-native species. Active restoration may be needed to enhance native shrubland recovery in areas affected by these stressors, yet across large fire scars identifying the need for restoration can be challenging. We developed a Post-fire Restoration Prioritization (PReP) tool to aid resource managers with early detection and prioritization of degraded chaparral landscapes in need of restoration. The PReP tool incorporates information on the post-fire regeneration strategy of plant communities and its interaction with fire history, pre- and post-fire drought, and non-native annual species to predict where recovery may be impeded, thereby identifying candidate areas for restoration. The tool also integrates spatial data on erosion risk for recent fires, so that areas in need of restoration can be prioritized for hillslope stabilization. Outputs from the tool can also be integrated with hotspots of ecosystem service provision and accessibility data to further refine restoration decision making. We demonstrate a proof of concept using the Copper and Powerhouse fires on the Angeles National Forest in southern California and find that 1,642 acres (10%) and 3,786 acres (14%) respectively are predicted to have low regeneration capacity and need restoration. Through field monitoring, we verified that areas predicted to have the lowest regeneration capacity indeed had the highest cover of non-native annual grasses and herbs and the lowest cover of native shrubs. The framework of the PReP tool is transferable to chaparral ecosystems across southern California and can guide management decision making to ensure long-term sustainability of chaparral and the ecosystem services it provides.

Managing Drought-Prone Chaparral Landscapes

Presenter's Name: Jon Keeley
Presenter's Company/Employer: US Geological Survey
Presenter's Title: Researcher
Topic: Natural areas management in light of climate change
Proposal Type: Symposium - select this if you are part of an organized session

Abstract:
Beginning in 2012 California experienced one of the most intense droughts in history. The duration of the drought varied throughout the state. In the Sierra Nevada it lasted three years and was a factor in massive mortality of trees in mid-elevation conifer forests. In southern California the drought continued through most of 2018 and resulted in massive dieback of chaparral shrublands. There is good reason to believe this dieback was a major factor contributing to the size of the 2017 Thomas Fire and the 2018 Woolsey Fire, the largest fires in the region in recent history. This presents a significant management challenge because dead woody fuels likely contribute to extreme fires, and in this climate these fuels decompose slowly, plus future climate change is predicted to increase the incidence of severe droughts. Our work has used remote sensing methods (Landsat NDVI) for detecting and verifying vegetation dieback in southern California shrubland landscapes, and then relating these to fire severity patterns in the 2018 Woolsey and 2017 Thomas fires (using Monitoring Trends in Burn Severity, MTBS data). This provides insight into relationships between severe drought, vegetation dieback and subsequent fire severity, and to what extent this information could be used to inform land and fire management activities in the region. Management options must consider the wildland-urban interface risks associated with prescription burning on this landscape, thus making this obvious management option for dealing with drought an unlikely strategy. Future focus must deal with drought impacts by concentrating on the urban environment and considering the 5 P's of 1) people as the primary problem, 2) prevention of fire ignitions during extreme wind events, 3) planning future developments, 4) p rotection of structures by home-hardening, and 5) predicting capacity for fire trajectories during extreme wind-driven fire events.